BENEFIT-COST ANALYSIS OF THE NATIONAL ANIMAL IDENTIFICATION SYSTEM

NAIS BENEFIT-COST RESEARCH TEAM

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Executive Summary

Purpose

The purpose of this study was to conduct a benefit-cost analysis of the United States National Animal Identification System (NAIS). The NAIS is a voluntary federal animal identification system operated by the Animal and Plant Health Inspection Service (APHIS) of the United States Department of Agriculture (USDA). NAIS is designed primarily to protect the health of the nation's livestock and poultry to enhance animal health and maintain market access. The three components of NAIS are: 1) premises registration, 2) animal identification, and 3) animal movement tracking. Objectives of this study included estimating benefits and costs of adopting NAIS by the livestock and poultry industries as well as determining how net benefits are likely to be allocated among industry sectors, consumers, and government. The benefit-cost analysis focuses on impacts of NAIS adoption in the bovine, porcine, ovine, poultry, and equine industries.

Procedure

The approach included:

1. Assimilating a comprehensive set of published literature associated with aspects of animal ID and tracing.
2. Synthesizing a broad set of information on expected benefits, costs, challenges, recommendations, and concerns associated with NAIS adoption from personal meetings and phone conversations of our research team with industry and government stakeholders. The research team completed in excess of 50 interviews with more than 100 industry and government stakeholders.
3. Developing direct cost estimates of adoption of NAIS practices by firms operating in the bovine, porcine, ovine, poultry, and equine industries.
4. Using the direct cost estimates to determine short-run and long-run societal benefits and costs and who realizes the associated benefits and costs of adoption of NAIS practices by the bovine, porcine, ovine, and poultry industries under a variety of scenarios.

Summary Results: Bovine, Porcine, Ovine, and Poultry

Estimated costs of adopting bookend or full tracing NAIS practices by species for an average operation in selected industry segments are summarized in table 1. A bookend system refers to simply identifying the animal individually or in group/lot fashion at its birth premises and then terminating the record at the packing plant when the animal is processed, with no intermittent tracing or recording of animal movement. A full tracing system refers to the bookend plus also tracing and recording movements of animals (individually or by group depending on species) through their lifetime as they change ownership.

For a typical dairy cow operation, total cost of a bookend system would be $2.47 per cow and full tracing $3.43 per cow annually. A large portion of the costs for dairy cow operations are costs of individual electronic tags for calves for a bookend system plus scanning costs for a full tracing system. The typical beef cow operation would incur higher cost than the typical dairy producer with a $3.92 per cow bookend adoption cost and a $4.22 per cow full tracing cost. Other segments of the beef industry (i.e., backgrounders, feedlots, auction markets, and packers) incur much smaller costs than the cow sector because their main costs are replacing lost tags for a bookend and incurring scanning costs for full tracing.

Porcine adoption costs of bookend and full tracing are much smaller than bovine costs because porcine utilize primarily group identification by pen or lot rather than individual animal identification (with the exception of cull breeding animals that use individual identification). For a typical farrow-to-wean operation, annual costs of a bookend system are $0.01 per animal sold and a fully tracing system costs $0.025 per animal sold.

Ovine operations would use group identification for lambs but individual identification for breeding animals. Annual costs to adopt a bookend system would be $0.71 per animal sold and to adopt a full tracing system would be $1.07 per animal sold.

Poultry operations would utilize exclusively lot identification systems and have relatively low adoption costs of about $0.02 per animal sold annually for layers and $0.001 per animal sold for broilers.

Table 1. Average Annualized Adoption Costs of NAIS per Animal

Species/Segment	Units	Bookend	Full Tracing
<u>Bovine</u>			
Dairy Cow	($/cow)	$2.468	$3.433
Beef Cow	($/cow)	$3.919	$4.220
Backgrounding	($/hd sold)	$0.233	$0.710
Feedlot	($/hd sold)	$0.204	$0.509
Auction Markets	($/hd sold)	$0.000	$0.230
Beef Packers	($/hd sold)	$0.099	$0.099
<u>Porcine</u>			
Farrow-to-Wean	($/hd sold)	$0.010	$0.025
Farrow-to-Feeder	($/hd sold)	$0.010	$0.028
Farrow-to-Finish	($/hd sold)	$0.031	$0.126
Wean-to-Feeder	($/hd sold)	$0.000	$0.007
Feeder-to-Finish	($/hd sold)	$0.002	$0.012
Packers	($/hd sold)	$0.001	$0.001
<u>Ovine</u>			
All operations	($/hd sold)	$0.709	$1.065
<u>Poultry</u>			
Layers	($/hd sold)	$0.019	$0.019
Broilers	($/hd sold)	$0.001	$0.001
Turkeys	($/hd sold)	$0.002	$0.002

As industry adopts a new information technology and incurs direct adoption costs, adjustments occur in market supply and demand and associated prices and quantities at every level of the vertical market chain from producers through consumers including the export market. In particular, adoption of NAIS shifts supply curves to reflect added costs and shifts demand curves to reflect changes in market access associated with industry adoption of NAIS practices. These shifts in market supply and demand determine who ultimately absorbs benefits and costs of NAIS adoption. To determine net benefits and costs of NAIS adoption, we evaluated numerous scenarios of market responses to varying industry adoption rates.

The first set of scenarios compare doing nothing (status quo) to adopting full animal tracing for just the bovine sector. The bovine sector is the focus here because it is it the sector among bovine, porcine, ovine, and poultry that would incur the largest adoption cost of NAIS practices. Under the status quo scenarios, we further explore what the impacts are if by doing nothing we also lose export market access. We are likely to lose export market access over time if we do not adopt NAIS practices, even without any major market or major animal disease event, because the international marketplace is making animal identification and tracing systems the norm and any country that does not conform will have less market access.

Table 2 summarizes the total loss per head to producers in the beef sector, after all markets adjust as a result of not adopting NAIS practices (i.e., status quo) under 0%, 10%, 25%, and 50% permanent export market losses for beef. If we do nothing to adopt NAIS, and nothing happens to export markets, the result is no cost, no market loss. If we do nothing and we lose market access, which we believe is likely, the beef industry will suffer losses. The losses would amount to $18.25 per head if we do not adopt NAIS and we lose 25% of export market share. To put this into perspective, this would be about like losing access to the South Korean export market at 2003 export market shares.

Table 2. Net Annual Loss in Beef Producer Surplus from Status Quo with Varying Export Market Losses

Export Market Loss Incurred			
0%	10%	25%	50%
($/head sold)			
$0.00	-$7.31	-$18.25	-$36.47

The second set of scenarios address what happens if the industry adopts full animal tracing in the bovine sector, and as a result, is able to avoid losing beef export market access. Table 3 summarizes this set of scenarios under varying full bovine tracing adoption rates. The diagonal values of the table are underlined to highlight that as adoption rate increases, more of the export market share is likely to be retained. If 30%

adoption of full tracing occurred and the export market loss that was saved is 0%, the producer losses would be $3.72 per head reflecting adoption costs. If adoption rate was 70% and this resulted in saving 25% of the export market, the benefit (net of costs) of full tracing adoption to beef producers would be $9.26 per head.

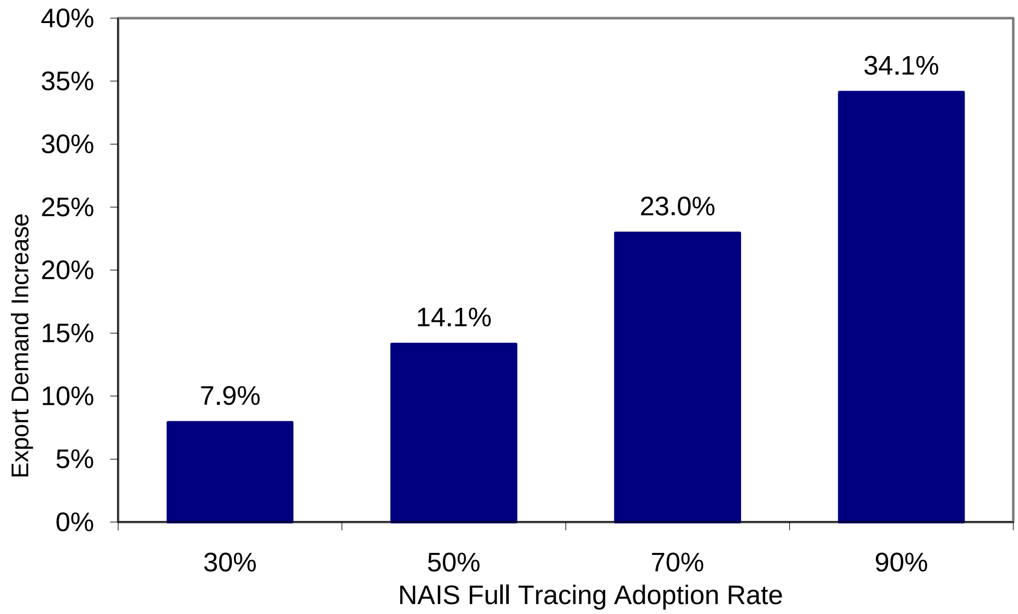
Table 3. Net Annual Gain in Beef Producer Surplus Under Varying Adoption of Full ID and Tracing Rates

Full Tracing Adoption Rate	Export Market Loss Avoided			
	0%	10%	25%	50%
	($/head sold)			
30%	**-$3.72**	$3.59	$14.53	$32.74
50%	-$5.62	**$1.70**	$12.63	$30.85
70%	-$8.99	-$1.68	**$9.26**	$27.47
90%	-$15.02	-$7.71	$3.23	**$21.45**

Additional scenarios included estimating the size of beef export demand and domestic beef demand gains that would each individually just completely pay for NAIS adoption by producers in the beef industry.

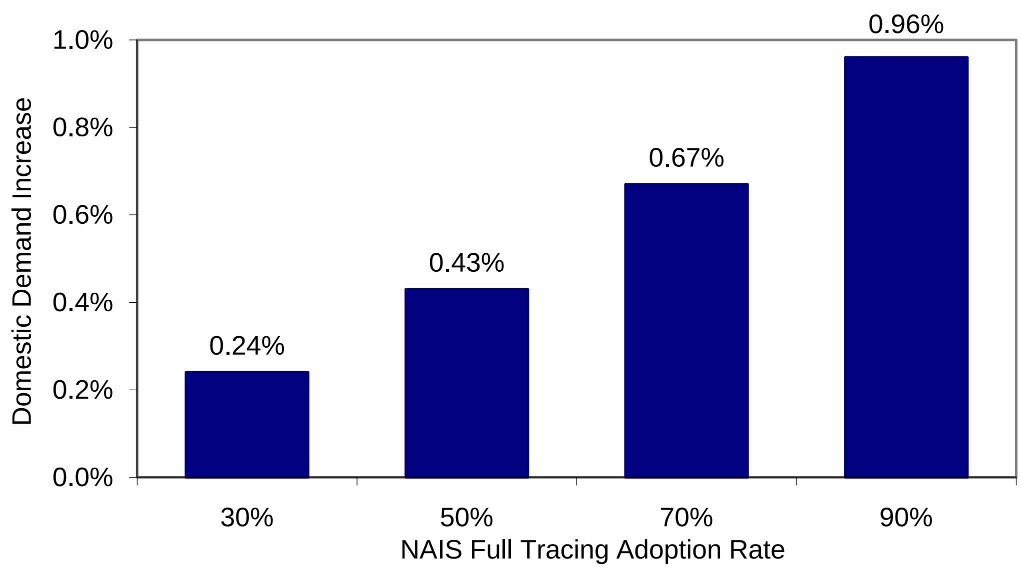
The magnitude of beef export market demand increase that would encourage beef producers (cow/calf, backgrounders, feeders, dairy, auction markets, and packers) to adopt full animal ID and tracing is shown in figure 1. Full animal ID and tracing with 30, 50, 70, and 90% industry adoption rates could be completely paid for with increases in beef export demand. A 23% increase in beef export demand would completely pay for 70% adoption of full animal ID and tracing in the US beef herd over a 10-year period. No other benefits beyond these would be necessary to make the investment in NAIS economically viable.

FIGURE 1. CHANGE IN BEEF EXPORT DEMAND NEEDED SO THAT WHOLESALE BEEF, SLAUGHTER CATTLE, AND FEEDER CATTLE SECTORS DO NOT LOSE ANY CUMULATIVE PRESENT VALUE 10-YEAR SURPLUS OF FULL TRACING BY ADOPTION RATES



Research indicates that domestic beef demand is likely to be greater for products having animal ID and traceability. Small increases in domestic beef demand, with all else constant, would also completely pay for full animal ID and tracing in the beef industry. Figure 2 shows the increase in domestic beef demand needed to just pay for cattle and beef producer investment in full animal ID and tracing with 30, 50, 70 and 90% adoption rates. A one-time 0.67% increase in domestic beef demand would be enough to fully pay for 70% adoption of cattle ID and tracing, with no other benefits, over a ten-year period. This is a modest increase in beef demand needed to pay for animal ID and tracing relative to the results found in previous studies of more than 5% higher demand for fully traceable meat products. With 70% NAIS adoption of full animal tracing and a 0.67% increase in domestic beef demand, all producer and consumer sectors of beef, pork, and poultry gain economic surplus and lamb producers and consumers lose a small amount of economic surplus. The overall societal gain under this scenario (producer plus consumer surplus) is a 10-year cumulative net present value of $7.2 billion. In other words, NAIS adoption would result in large positive net returns to producers and consumers with a very small increase in domestic beef demand resulting from NAIS adoption.

FIGURE 2. CHANGE IN DOMESTIC BEEF DEMAND NEEDED SO THAT WHOLESALE BEEF, SLAUGHTER CATTLE, AND FEEDER CATTLE SECTORS DO NOT LOSE ANY CUMULATIVE PRESENT VALUE 10-YEAR SURPLUS OF FULL TRACING BY ADOPTION RATES



Whether the presumed market gains would be realized with the various NAIS adoption rates for full animal ID and movement tracing is uncertain. However, the assumed demand enhancements are within the realm of probable outcomes suggesting NAIS adoption in bovine, porcine, ovine, and poultry industries, as a whole, offers substantial net economic benefits to producers over a 10-year period. Though economic impacts of NAIS adoption are not positive for all sectors of all four species or all market participants as reported in detail in Section 9, overall total net benefits are positive.

Summary Results: Equine

Conducting a benefit-cost analysis of NAIS adoption in the equine industry was a significant challenge. Even published data on horse population in the United States have a wide range of estimates including from around five million to more than nine million horses. Collecting accurate equine data is a challenge because a considerable number of horse owners are not included in USDA surveys as many are not farm operations. As a result, we rely heavily on surveys and private industry data sources for information on equine population, animal movement and comingling activities, and industry characteristics in our analysis. Because of substantial data limitations in the equine industry analysis, unlike our analysis for livestock and poultry species, we did not estimate separate costs for varying NAIS adoption rates. Our estimates are for 100% of equine owners to adopt each NAIS practice. Rough estimates of varying adoption rates could be made by taking an adoption percentage times the 100% adoption cost.

Direct net present value of cost of 100% adoption of premises registration by equine owners is estimated at $2.7 million annually; adoption of individual horse micro-chipping is $34.5 million; and animal tracing is $38.7 million. The total annual estimated net present value of direct cost of 100% adoption of all three NAIS activities is $75.9 million per year.

Benefits of NAIS adoption in the equine industry are potentially numerous. However, the largest benefits appear to be from animal health surveillance, potential endemic disease eradication, and export market access in the event of a major equine disease outbreak. Annual costs of Equine Infectious Anemia (EIA) testing alone are $57.5 million (75% of total NAIS adoption costs). The equine export market represents some $460 million annually. Any major equine disease outbreak would adversely affect the equine export market. Though our analysis is unable to definitively conclude whether the benefits of full NAIS adoption in the equine industry exceed adoption costs, if adoption were able to eradicate diseases such as EIA and prevent major export market losses, benefits would quickly exceed adoption costs.

Dealing with Uncertainty in Estimates

Generally throughout our study, as assumptions were made especially where ranges of probable costs of NAIS adoption were available, we tended to use either the median or upper range of cost estimates. As such, our cost estimates are likely higher than what industry would experience especially as adjustments are made over time after adopting new technology. As benefits of NAIS adoption were estimated, we focused on benefits associated with animal disease management and likely market access (domestic and export demand impacts) affects of NAIS. Because many more benefits associated with NAIS are likely to accrue, we know that we underestimate potential benefits of adoption. Combined, this means net benefits (benefits minus costs) of adopting NAIS practices likely exceed those presented in our study.

1. Background

ANIMAL IDENTIFICATION HAS EXISTED in a variety of forms in the United States for a long time. For example, brands and brand registry, used primarily for animal ownership verification, have been in place in the United States since the late 1800s. Animal breed registries typically use some form of animal identification for maintaining individual animal records. Several federal and state disease surveillance and eradication programs such as the sheep scrapie, swine pseudorabies and brucellosis, cattle tuberculosis and brucellosis, and equine infectious anemia have required forms of animal identification and/or passports for many years. Most vertebrate animals imported into, or exported out of, the United States must have official identification. Permits are required in addition to Certificates of Veterinary Inspection (CVI) for interstate livestock movement. The vast array of animal identification systems and methods vary by state, by species, and by animal disease surveillance or eradication program. The variation in systems and ID protocols results in inconsistencies, duplication, and inadequate rapid animal tracing relative to a more unified and coordinated system.

Concerns about the overall inability of US animal health officials to rapidly trace animals in the event of an animal health issue motivated industry and government to design more standardized, effective, and efficient animal identification systems. In 2002, the National Identification Development team made up of some 100 animal and livestock industry professionals, brought together by USDA, presented an animal identification plan that became known as the US Animal Identification Plan (USAIP). Through work of numerous animal and livestock industry stakeholders, a plan was developed to establish the USAIP in 2003. The BSE discoveries in Canada and the United States in 2003 heightened interest in a national animal identification system. Since that time, the animal identification plan has been further developed and renamed the National Animal Identification System (NAIS).

NAIS is a voluntary federal program administered by the Animal and Plant Health Inspection Service (APHIS) of the United States Department of Agriculture (USDA). NAIS involves three dimensions of identification: 1) premises registration, 2) animal identification, and 3) animal movement tracking. The main purpose of NAIS is to enhance animal tracing to protect the health of US livestock and poultry. Additional goals of NAIS include monitoring vaccination programs, documenting affected and unaffected regions in a disease outbreak to maintain trade, providing timely animal movement information when needed, and establishing animal health inspection and certification programs. NAIS covers a broad array of animal species with the December 2007 APHIS *Business Plan to Advance Animal Disease Traceability*[1] designating bovine as highest priority for NAIS development; medium priority for porcine, equine, poultry, cervids, and caprine; and low priority for ovine and aquatics. With much of the NAIS designed, the next critically important step in implementation is an assessment of likely economic benefits and costs associated with adoption of the system. Before widespread industry adoption is likely, a better understanding of the types and magnitudes of benefits and costs and who will bear each as NAIS is adopted by industry is essential to understand the direct and indirect economic impacts of such an effort. The purpose of this study is to estimate the benefits and costs of NAIS.

[1] As of the publication date of this report, the most recent version of the *Business Plan to Advance Animal Disease Traceability* was published in September 2008 and is available at: http://animalid.aphis.usda.gov/nais/naislibrary/documents/plans_reports/TraceabilityBusinessPlan%20Ver%201.0%20Sept%202008.pdf.

2. Objectives

The general purpose of this project was to conduct an assessment of the economic benefits and costs of a National Animal Identification System in the United States including premises registration; animal identification systems; and animal movement reporting for major species of cattle, hogs, sheep, poultry and horses and to a limited extent, minor species of bison, goats, cervids, and camelids. In particular, specific objectives were:

1. To determine similar and different attributes and methods of NAIS across species so benefit and cost estimates unique to accepted methods of adopting NAIS techniques could be completed (e.g., individual animal vs. group/lot identification methods).

2. To determine direct benefits and costs for livestock producers who adopt NAIS practices and standards. Different industry sub-sectors for each species are analyzed separately because benefits and costs can differ for different production phases (e.g., cow/calf, backgrounding, and feedlot producers in beef production). Furthermore, benefits and costs are estimated separately for different operation size categories for each major production phase because benefits and costs may not be scale neutral.

3. To determine direct benefits and costs for livestock marketing institutions (e.g., local auction and video markets) as applicable of adopting NAIS practices and standards. Benefits and costs are estimated by operation size category to evaluate differences across alternative operation sizes.

4. To determine direct benefits and costs to livestock slaughtering operations associated with adoption of NAIS practices and standards. Benefits and costs are estimated by operation size to assess scale neutrality.

5. To determine overall short- and long-run net benefits to society from NAIS adoption. We specifically estimate how benefits and costs would accrue to livestock producers, processors, consumers, and state and federal government agencies.

3. PROCEDURE

TO ACCOMPLISH THE OBJECTIVES OF THIS PROJECT, several phases of research were completed. These phases included collecting considerable amounts of information, data, and past research. A detailed assessment of costs of adoption and administration of NAIS technology was undertaken, and a sizeable modeling effort was employed to determine short- and long-run benefits and costs. The research process included:

3.1 LITERATURE REVIEW

We conducted a substantial literature review related to benefits and costs of animal ID and traceability systems. Past literature has been used to identify potential benefits and costs, develop estimates of benefits and costs, and parameterize models to analyze the distribution of net benefits across industry segments and society. Discussion of past literature is interspersed as relevant throughout this report and a reference section at the end of the report (section 15) provides a complete reference list. We compiled the body of literature and provided it to APHIS in electronic format to provide ease of investigating in further detail specific information and studies cited in our report and to help provide a foundation for future work.

3.2 INDUSTRY STAKEHOLDER MEETINGS

Our research team conducted more than 50 meetings with more than 100 stakeholders representing a broad range of industry sectors, species, and professional leaders. A complete list of organizations represented in our meetings is provided in Appendix 3. The purpose of these meetings varied depending upon the specific organization or person visited. In general, we gathered information about anticipated costs, potential benefits, challenges, and opportunities associated with NAIS adoption from the perspectives of the stakeholders represented by each organization. Information gleaned from these meetings is integrated in a variety of places throughout this report. Additionally, in Section 13 we summarize related information gleaned from these meetings that is not necessarily incorporated directly into our benefit-cost estimation discussion and analyses.

3.3 Direct Industry Cost Estimation

Estimation of direct costs for premises registration, animal identification, and animal tracing was undertaken to develop a foundation of costs of NAIS adoption in each major directly affected sector by species. Care was taken to complete as accurate an industry-wide representation of these adoption costs as could be completed subject to available data. Detailed methods, assumptions, and estimates of NAIS adoption costs are presented in Sections 4 through 7.

3.4 Government Costs and Benefits

Costs to federal and state government of developing and operating NAIS as well as potential benefits government health organizations would gain from NAIS adoption were estimated to assess governmental impact. Results from these analyses are presented in Section 8.

3.5 Market and Societal Benefit and Cost Allocations

To determine how benefits and costs of premises registration, animal identification, and animal tracing would be reflected in short- and long-run industry sectors and consumers, we developed an economic model (equilibrium displacement model). The model and associated results are documented in Section 9. The equilibrium displacement model is used for estimation and allocation of benefits and costs specifically in the cattle, swine, poultry, and sheep industries.

3.6 Equine Industry Benefits and Costs

Equine represents a substantial economic industry, but one that is quite distinct from meat animal industries from a market supply and demand framework. As such, a separate independent analysis was conducted to estimate benefits and costs of NAIS in the equine industry. The approach used and resulting benefit and cost analysis of NAIS adoption in equine is presented in Section 10.

3.7 Minor Species Benefits and Costs

NAIS includes species that represent a much smaller direct economic impact than the major species addressed in other sections of our report. In particular, deer, elk, goats, bison, and aquatics are included within the NAIS program. Development of comprehensive benefit and cost analyses for these more minor species was not a focus of our study. We provide brief summaries of the extent of animal ID in selected minor species in Section 11.

Preface to Direct Cost Estimation

Before producers are likely to adopt an animal identification (AID) system, they need to know and understand the direct costs to compare with expected benefits. Likewise, if the government were to mandate an NAIS, it is important to understand direct costs that producers would incur. Direct costs are those costs that are incurred to adopt NAIS technology. Estimation of direct costs is the focus of the next four sections of this report. Who actually bears these costs and the associated benefits once market supply and demand adjust is evaluated and reported in a later section of this report (Section 9). This information is also important for policy decisions regarding cost-share, subsidies, etc. that might be put in place to help offset costs for producers.

To estimate direct costs associated with an AID system for bovine, porcine, ovine, and poultry, assumptions as to the type of identification system used were required. In the cattle (bovine) industry, it was assumed the technology used for animal identification would be electronic identification (eID) using Radio Frequency Identification (RFID) ear tags and identification would be on an individual animal basis. For the swine (porcine) industry it was assumed market hogs would be identified with a group/lot ID and cull breeding stock would be identified with a unique visual premises ear tag. Sheep (ovine) industry cost estimates were based on a scrapie program tag for breeding animals and group/lot ID for lambs. For the poultry industry it was assumed group/lot ID would be used for all poultry. These individual animal or group/lot identification methods by species were all based upon the general guidelines developed by the NAIS working groups for each species.

Costs were estimated at the producer level for all four species (beef and dairy cattle, swine, sheep, and poultry) and at the packer level for beef, dairy, swine, and sheep. Because of the integrated nature of the poultry industry, separate costs were not estimated at the packer level. With group/lot ID, additional costs incurred at the packer level are minimal as systems capable of group/lot ID are already in place allowing tracking and traceability of individual groups. Because a high percentage of cattle are sold through auction markets, costs also were estimated for auction markets for beef and dairy cattle. Total costs to the respective industries were estimated under three scenarios: 1) premises registration only; 2) bookend AID system, where animals are identified at birth and at termination (slaughter) without intermittent movement recording; and 3) animal ID with tracing of animal movements. Industry costs of each of these scenarios were estimated at adoption levels ranging from 10 to 100 percent in 10 percent increments. To aid the process of reporting direct costs in the preceding three scenarios, specific costs are categorized as (a) tags and tagging costs; (b) reading costs; and (c) premises registration costs. The next four sections discuss methods and assumptions for estimating NAIS implementation cost for the cattle, swine, sheep, and poultry industries, and include summaries of the cost analysis.

4. Direct Cost Estimates: Bovine

COSTS WERE ESTIMATED BY SEGMENTING the cattle industry into six main groups (referred to as operation types): 1) Beef Cow/Calf, 2) Dairy, 3) Backgrounder (also referred to as Stocker), 4) Feedlot, 5) Auction Yard, and 6) Packing Plant. Estimating costs separately for these different operations makes it possible to see how different segments of the cattle industry would be impacted by adopting NAIS practices.

The Beef Cow/Calf group was defined as all producers who breed cattle for the express purpose of raising and selling a calf crop. The Dairy group was defined as all producers who raise and breed cattle for the express purpose of raising and milking lactating cattle. The Backgrounding group refers to operations that feed weaned animals for a period of time prior to selling them to a feedlot where they are finished. In this analysis, only background operations that buy weaned cattle are included in the cost estimation. Operations that background their own weaned animals would not have the added costs associated with NAIS adoption that a backgrounder who buys market cattle would incur. Feedlot operations are defined as any operation that feeds a weaned animal a concentrated diet for the purpose of selling that animal to a packing plant. Auction yards were defined as any bonded company that sells cattle as a marketing service. Packing plants were defined as any operation that slaughters live animals under government inspection to produce meat products for sale to the public.

The Beef Cow/Calf and the Dairy groups were split into two subcategories: operations that currently identify calves individually and those that do not. Operations that currently identify calves individually use various methods of identification (e.g., plastic ear tags, metal tags, branding, tattoos, etc.). Of the various methods, plastic ear tags is the most common with 80.7% of operations identifying calves individually using this form of ID (USDA 2008q). For this report, all operations that currently identify calves individually are referred to as “tagging operations” and incremental costs associated with RFID are based on a “second tag” used. The breakdown of tagging operations for Cow/Calf producers was based on information reported in the National Animal Health Monitoring System (NAHMS) publication titled *Part 1: Reference of Beef Cow-Calf Management Practices in the United States, 2007-08* (USDA, 2008q). Similarly, the breakdown of tagging operations for Dairy producers was based on information found in the NAHMS report *Dairy 2007 Part I: Reference of Dairy Cattle Health and Management Practices in the United States* (USDA, 2007a). The methods of estimating costs hereafter discussed will apply to both subcategories unless stated otherwise.

The following discussion of cattle industry costs is partitioned according to the six operation types. The Beef Cow/Calf group is followed by the Dairy, Backgrounders, Feedlot, Auction and finally the Packing Plant groups. Each section describes the methods and assumptions used to estimate the cost for that sector. These six group subtotals were summed to find the total final cost for the cattle (bovine) industry. Because some methods and assumptions were employed for two or more groups, the Cow/Calf group will be explained fully; thereafter, if another industry sector uses the same approach as the Cow/Calf groups, the reader is referred to the appropriate subsection in the Cow/Calf section. Also, the following discussion pertains to costs associated with all cattle being identified and movements tracked (i.e., Scenario 3 listed above). Costs of just premises registration (Scenario 1) and just bookend systems (Scenario 2) are summarized separately later in this section.

4.1 Beef Cow/Calf

4.1.1 Tags and Tagging Costs

Operation Distributions

One of the objectives of this study was to determine if the implementation cost of an animal identification system varied by operation size. To determine if economies of size exist, costs of adopting animal identification were estimated for various operation sizes. The USDA National Agriculture Statistics Service (NASS) report most cattle data (e.g., number of operations, inventories, calf crop) by size groups. Thus, NASS size categories were used as breakpoints for this study. Cattle inventories (*Cows that Calved – Beef*) for January 2007 and July 2007, the 2007 percent of cattle by size of operation, and the number of operations per size group operating in 2007 were collected (USDA, 2008e). The total head of beef cows per operation for each size category was found by averaging the January and July inventories and multiplying this number by the respective percentage of cattle by size of operations. Dividing this cow inventory number by the total number of beef cow/calf producers in that size group revealed the average number of cows per operation for each size category. To estimate the number of breeding bulls per premises, the 1997 NAHMS Beef Report (USDA 1997a) estimate of one bull for every 25.3 cows was used. With these two pieces of information, the total breeding herd inventory was calculated for the seven different operation size categories.

RFID Tags Placed

To determine the number of tags purchased, the total number of animals tagged in a year needed to be calculated. The operation size subcategories were each assigned an adjusted calving rate of 94.6% and a cull rate of 11.0%. This adjusted calving rate does not represent the number of pregnant cows, but rather, the number of calves born alive per 100 cows after accounting for twinning. This value was calculated by taking the 2007 calf crop (USDA, 2008e) and subtracting the number of dairy calves, which was calculated by taking the 2007 dairy inventory (USDA, 2008e) and multiplying it by the percentage of dairy cows giving birth to weaned calves (USDA, 2007a). Adding parturition related deaths for beef calves (USDA, 2006d) to total beef calves weaned gave the total number of beef calves born alive. Dividing this by the total number of beef cows gave the calving rate, which was then adjusted to account for twinning. According to the 1997 NAHMS Beef Report (USDA, 1997a), the average pregnancy rate was approximately 92.6% and the cull rate was 11.9%. This indicates that the pregnancy and cull rates used in this analysis are reasonable, where the difference was small and likely due to differing years between the NAHMS report and the data used in this analysis.

To figure the number of replacements retained and kept in the breeding herd, the percentage of culls was added to the percentage of cow deaths and this percentage was multiplied by the average herd size. Table A4.1.1 in Appendix A4 reports the number of beef cow/calf operations and various production and inventory level values by size of operation.

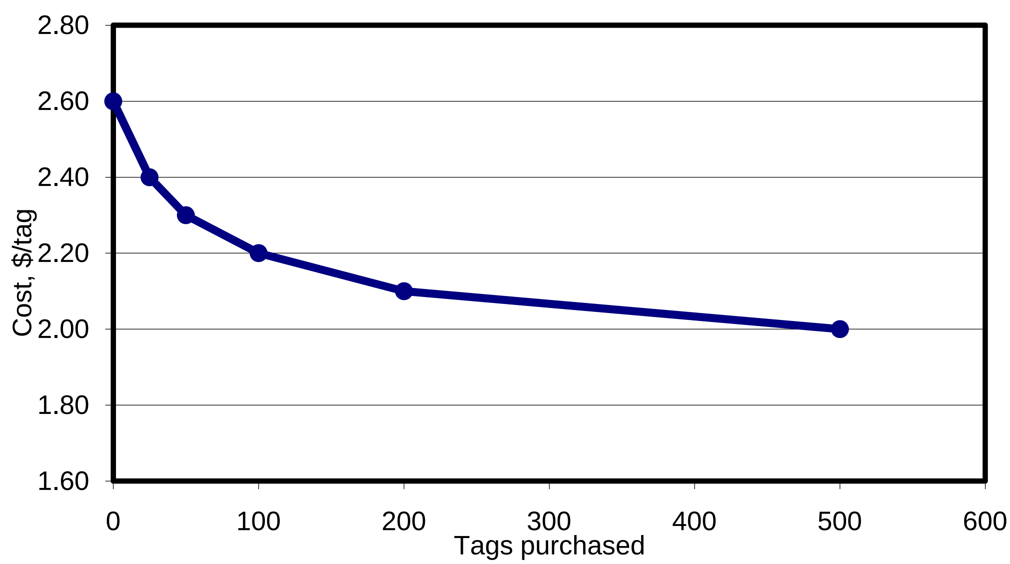
To calculate the number of RFID tags placed, different assumptions were used for the subcategories of operations currently tagging versus operations not tagging. For operations that currently tag, it was assumed that parturition-related deaths were not tagged and all calves that died after parturition were tagged. Death loss percentages from *Cattle Death Losses* (USDA, 2006d) were applied to the 2007 calf crop numbers. It was also assumed that these operations would incur a tag loss rate requiring some animals (calves and cull cows and bulls) to be retagged before shipping to buyers. For operations that do not currently tag, it was assumed that nothing was tagged until the animals were shipped to the auction yard where they were tagged by an auction yard crew for a fee.

The tag loss rate applied was 2.5%. This loss rate is higher than the 1% manufacturers' guidelines from the USDA (Walker, 2006). Research has revealed RFID tag loss rates vary from less than 1% to as much as 5% (Williams, 2006; Watson, 2002; Evans, Davy and Ward, 2005). The median value of 2.5% from the various research studies was used for this analysis.

RFID Tags and Applicator Cost

To find the cost of RFID tags, an internet search was conducted resulting in 12 companies located that offered RFID cattle tags. These businesses were located in the lower 48 states of the United States. The prices ranged from a high of $3.00 to a low of $2.00, with the average cost being $2.25. Based on discussion with industry participants, it was assumed that economies of size exist when RFID purchases are made resulting in lower tag cost with higher volumes. The high price of $3.00 per tag was considered to be an outlier and was excluded from the analysis. A non-linear relationship between volume (tags purchased) and cost was used where the high price was $2.60 per tag and the low price was $2.00 per tag. Figure 4.1 shows the tag prices used in the analysis as they relate to tags purchased (i.e., operation size).

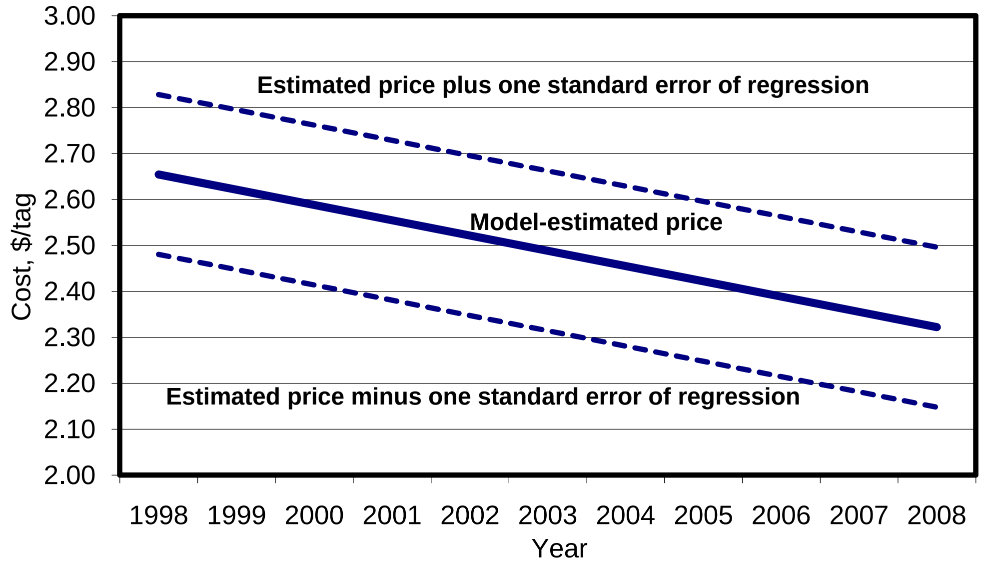
Figure 4.1. Assumed RFID Tag Purchase Price as Volume Varies



As technology improves over time and the use of electronic ID tags increases, the cost of this technology is expected to decline. Thus, the costs of tags and readers will likely fall over time, which implies tag costs used in this analysis likely represent an upper estimate. An attempt was made to quantify how the nominal (not inflation-adjusted) cost of individual electronic animal ID button tags has changed over time. To assess the change over time, a spectrum of electronic ID button ear tag prices were collected from several vendors over 1998-2008. Collecting consistent prices from a large number of the same vendors each year was not possible. Many tag supply companies entered and exited the market during this time frame. Also, tag price data were frequently unavailable because firms considered it confidential and because of the relative newness of this technology. Because price trends from the same consistent set of vendors were unavailable for a continuous 10-year period, prices were collected from as many vendors as possible for as many years as was available from each. The result was a total of 63 prices of button electronic ID tags (excluding visual tags), spread across the 11-year period, representing a total of 22 different vendors/sources. As much as possible, tag prices reflected an order of 100 or fewer tags, to not further complicate the analysis with volume-order discounts that can be sizeable. Ordinary least squares regression was used to estimate a model with dummy variables for vendors and a time trend for year using the 63 observed prices. A regression model with the time trend squared was also estimated to test whether the price over time was changing nonlinearly with time. The quadratic time trend term was not statistically significant and thus was not retained.

Results of the regression analysis indicated that, on average, the nominal cost of electronic ID button tags, after adjusting for vendor differences, has declined about $0.033 cents per year or $0.33 cents per tag over the past 10 years (this estimate was statistically different from zero with 95% confidence). The regression analysis also demonstrated statistically and economically important variation in tag prices across different vendors within a year. The regression-predicted electronic ID button tag price by year is illustrated in figure 4.2. Included in this figure are dashed lines illustrating the standard error of the regression-predicted price (these lines represent an approximate 68% confidence interval on expected tag price at the means of the data). The dashed lines demonstrate the magnitude of unexplained variation in tag price in the regression modeling exercise. We attempted to collect similar data on hand-held wand readers. However, we were not able to obtain sufficient numbers of observations and consistent technology over time to complete a reliable trend analysis in costs of readers.

FIGURE 4.2. REGRESSION-PREDICTED ELECTRONIC ID BUTTON TAG PRICE OVER TIME



While conventional, two-piece applicators might work with RFID tags, it is possible that the RFID button will be damaged during application with conventional tag applicators. Thus, it was assumed the incremental cost of implementing an RFID program included the full cost of RFID-specific applicators. That is, producers were assumed to have to purchase an RFID applicator in addition to whatever they currently use for identifying calves individually. To find the RFID applicator costs, an internet search was conducted to obtain estimates of applicator costs. The average cost of RFID applicators was $44.83, which compares to an average cost of $18.62 for conventional two-button applicators. Average life span of an applicator was assumed to be four years and the number of applicators required increased as the operation size increased. Tables A4.1.2 and A.4.1.3 in Appendix A4 report the number of tags and tag applicators required by size of operation for beef cow/calf operations that currently tag and those not currently tagging, respectively.

Labor and Chute Costs for Tagging Cattle

Producers who adopt RFID technology will have an additional time outlay in placing the RFID tag into a calf's ear. To account for this, it was assumed that it would take 30 seconds to insert a second tag for those operations currently tagging. Because producers that currently tag already incur the initial setup time and tagging costs associated with a conventional tag (or some other method of individual identification), only the extra time to tag an animal was considered as this reflects the incremental cost. The labor rate used was $9.80 per hour (US Department of Labor, 2007). Operations that do not currently tag will not incur this cost in their operations as they do not tag their animals, but they will incur a cost associated with tagging when their cattle are sold.

To account for the marginal labor and chute costs when tagging weaned and culled animals, setup time, tag time, number of employees, and chute charges were considered. For operations that tagged at birth, only the animals that lost their tags were considered (i.e., animals needing to be retagged). An article published at North Dakota State University indicated that it took 66 seconds to work an animal in a squeeze chute (Ringwall, 2005b). Using this value and an assumed setup time of 15 minutes along with the total number of cattle needing to be tagged, the total number of hours to tag/retag animals was estimated. This number was then multiplied by the number of employees and the labor rate to come to a total labor cost. The number of employees ranged from one to six and was assigned to the different size categories based on producer opinion.

The last component was the chute cost associated with tagging animals. For producers who already tag, a rate of $1.00 per head was used. This reflects the feedlot industry chute charge that ranges from $0.75-1.50 (Boyles, Frobose, and Roe, 2002; Ringwall, 2005b).

For producers who do not currently identify calves individually, i.e., non-tagging operations, it was assumed that the auction yard would charge these producers for a tagging service. Based on survey results on tagging costs from auction yards (Bolte, 2007) and Livestock Marketing Association (LMA) data regarding the distribution of auction market sizes in the US, it was estimated that the average chute and labor cost would be $2.54 per head. This did not include the cost of an RFID tag, but it did include added liability insurance premiums and human injury costs to the extent that auction markets incorporate these costs into their charges.

Injury Costs Associated with Tagging Cattle

Tagging cattle involves the risk of injury to both the people doing the tagging and to the cattle. Thus, human and animal injury cost was estimated on a per animal head basis. To estimate the cost of human injury associated with tagging cattle the total labor cost associated with tagging cattle was multiplied by 10% as an estimate of workman's compensation, which is used as a proxy for human injury costs.

To estimate the animal injury cost associated with tagging an animal, the total number of cattle (Beef Cow/Calf and Dairy) workings per year was estimated. Because many dairy cattle workings are routine in nature (e.g., milking each day), they are less likely to cause an injury and thus they were assigned a weight of 10% compared to beef cattle workings at 100%. In other words, from an injury standpoint, milking a cow 10 times was assumed to be equivalent to tagging a beef animal once. The USDA estimate of the total value of lameness and injury to cattle of $104,427,000 (USDA, 2006d) was divided by the estimate of total annual cattle workings. This provided an estimate of the animal injury cost per working, which was then used to estimate the marginal animal injury cost of working cattle associated with animal identification. While it is a strong assumption to assume all lame animals were caused by working them, it was the only estimate that could be found. This number, now on a per head basis, was then applied to the number of animals being sold that needed tags.

Cattle Shrink Associated with Tagging Cattle

When cattle are processed through a chute for tagging, they may incur weight loss or a short time of not gaining at the rate they were without processing. Many publications have shown the affects of shrink related to time off feed (Barnes, Smith and Lalman, undated; Gill et al. undated; Ishmael, 2002; Krieg, 2007; Richardson, 2005; Self and Gay, 1972). However, the complexity of the cow/calf industry and the published information available was such that it was impossible to determine a reliable average incremental shrink associated with tagging calves. Additionally, management style, working weights, and other factors that contribute to shrink costs vary considerably from operation to operation.

In order to calculate a shrink cost for those operations that tag, a two-pound loss was assumed for every weaned animal that needed to be retagged before they were shipped. While most of the literature suggests that total shrink is more than this, the literature points out that most of this shrink is feed and water. For those operations retagging their animals, the feed and water loss can be replaced as soon as the animals are turned back into their pen or pasture. However, what cannot be replaced is the loss of animal weight gain for that day (at least not by the seller). While operation dependant, most will have an average daily gain between one and three pounds for weaned animals. This study used the median point of two pounds as the shrink and used 25% of the average market price for calves ($121/cwt) to arrive at a cost per head. The reason only 25% of the lost weight was included was because of the compensatory gain that the buyer of the cattle would realize.[2] The cost associated with shrink for cull animals was figured in the same manner only a lost weight of 2.5 pounds and an average price of cull cows ($48/cwt) were used.

The shrink costs for operations currently not tagging was estimated in a similar fashion. However, the total pounds of shrink was assumed to be slightly higher than calves that are tagged at the ranch because calves tagged at the livestock auction market would not have the same

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[2] While the seller might actually incur a higher cost than this, the buyer would receive a benefit associated with compensatory gain and thus the 25% reflects a net loss to the industry due to tagging. The 25% is generally consistent with the consensus of an informal survey of animal scientists, veterinarians and producers.

opportunity to eat or drink prior to being sold. For these operations the assumed shrink was 2.62 pounds, based on a shrink rate of 0.5% observed with 30 minutes of sorting animals (Richardson, 2005). Cull breeding animals needing to be tagged at the time of sale were assumed to shrink at a rate of 2.75 pounds. The total amount of shrink for both weaned and cull animals were multiplied by the group's respective average selling price to find the cost of shrink per head and ultimately per operation. Shrink costs varied slightly between operations that currently tag cattle versus those that do not, but they did not vary by operation size (i.e., operations of all sizes incurred the same per head shrink costs associated with tagging cattle). Tables A4.1.4 and A4.1.5 in Appendix 4 report the various tagging-related, i.e., cattle working, costs for beef cow/calf operations that currently tag and those currently not tagging, respectively.

4.1.2 Reading Costs

The RFID component and reading costs was a function of animals read, ownership and operating costs associated with the RFID technology (e.g., electronic readers (panel and wand), data accumulator, software), and database charges. The following is a brief discussion of these components.

Animals Purchased or Transferred

It was assumed that tags would not have to be read when they were initially applied as this information would be recorded by the seller of the tag. That is, cow/calf operations that tag calves will not have to read these tags, they only will have to read tags of calves brought onto their premises from outside sources. To estimate the cost of reading RFID tags, the average number of animals brought onto buying premises was determined by using information found in the 1997 NAHMS Beef Report (USDA, 1997a). This study reported the average percentage of animals brought onto buying premises for the study year. Using this information, the average number of animals bought per buying premises was determined by multiplying the total number of Cow/Calf operations by size with their corresponding percentages as shown in Table 4.1.

Bolte, Dhuyvetter, and Schroeder (2008) indicated that auction yards would likely install reading panels in their facilities as a service to customers. Thus, it was assumed that producers would not need to read electronic tags on any cattle purchased through an auction yard as they would already be read by the auction market. Schmitz, Moss, and Schmitz (2002) estimated that 72.2% of all cattle are sold through local and video auctions. Contained in that same report was a quote from a leading authority that suggested 67% of animals were sent through these two channels. The average of these two values (69.6%) was taken to attain the percentage of animals sold through an auction. The remaining cattle (30.4%) were assumed to be sold through channels other than auction markets (e.g., private treaty) and thus would need to have their RFID tags read at the time of sale.

The average number of cattle marketed through auction markets was applied uniformly to the number of cattle bought by operation size to find the number of cattle bought through the auction. [3] After this number was calculated, it was subtracted from the total number of animals brought onto the premises to find the total number of tags still needing to be read. For example table 4.1 shows that operations with 50-99 head bought an average of 18.2 head per year. If 69.6% of those were purchased through an auction market that would leave 5.5 head (30.4% × 18.2) that would need to have their tags read either at the farm or at some other location.

Panel readers miss up to 2.8% of all RFID tags (Reinholz et al., undated). To capture this and the extra time needed to ensure 100% read when using hand held readers, the number of animals needing to be read was increased by 2.8% to account for expected misreads. The combination of cattle needing to be read and misreads gives an estimate of the total tags read required for an operation on an annual basis.

[3] We believe that smaller operations tend to sell a larger percentage of their cattle through auction markets compared to larger operations. However, information substantiating this could not be found and thus the uniform assumption was used.

Table 4.1. Estimates of the Number of Cattle Brought onto a Cow/Calf Operation Premises by Operation Size

	Operation Size, head				
	Less Than 50	50-99	100 -500	500 or More	All Operations
Percent of operations that brought any beef or dairy cattle or calves onto the operation in 1996 by class and herd size:					
A. Any cattle or calves	32.9%	48.7%	63.2%	74.5%	38.7%
Number of cattle and calves brought onto the operation in 1996 as a percent of January 1, 1997, total inventory by herd size:					
B. Cattle and calves	36.8%	27.9%	24.8%	15.0%	26.6%
Calculated Cattle Buying Operations by Size in 2007					
C. Number of beef cows, 2007	9,174,406	6,160,432	12,817,672	4,968,090	33,120,600
D. New cattle in herd (B × C)	3,376,181	1,718,760	3,178,783	745,214	9,018,938
E. Number of cattle operations, 2007	585,050	94,490	72,855	5,505	757,900
F. Number of cattle buying operations (A × E)	192,481	46,017	46,044	4,101	293,307
G. Cattle bought per year per operation (D / E)[1]	5.8	18.2	43.6	135.4	11.9
H. Cattle bought per year per operation (D / F)[2]	17.5	37.4	69	181.7	30.7

[1] Based on total operations.

[2] Based on only operations that brought cattle onto their premises.

ELECTRONIC READERS

A US government compliant RFID tag is assigned a unique, 15-digit number (USDA, 2006a; USDA 2007d). This number is printed on the outside of the tag so it can be read visually, and it is recorded in a memory chip inside the tag so it can also be read electronically. For the purpose of this study, it was assumed that a producer had three options to electronically read the animal's unique, 15-digit ID: (1) custom hire, (2) a wand reader, or (3) a panel reader. It should be noted that even though the unique ID is a 15-digit number, producers would not have to visually "read" all 15 digits given the numbering system used (e.g., first three digits are country code). Nonetheless, visually reading the individual number on the tag was not considered because of the substantial amount of time involved which would cost the producer more than it would if the producer employed one of the other three options. Additionally, the potential for error when reading and recording a small, printed 15-digit number would be high.

The system used to read RFID tags was based on the number of animals read. If the cost of the RFID components divided by the total number of reads was greater than a custom read rate, then the operator would hire someone to read the tags on the animals. If the rate was smaller than a custom read rate, then the operator would own the equipment needed to perform the task. The equipment assumed to be owned in this case was either a wand or a panel reader, whichever had a lower cost on a per head basis.

Based on work by Bass et al. (2007), the cost for RFID wand readers was based on an initial outlay of $1,091 and a useful life of three years. Using an interest rate of 7.75% along with the assumptions about initial outlay and useful life resulted in an annual cost of owning a wand reader of $422. RFID readers in this price category are able to capture and temporarily store RFID numbers until downloaded into a computer. While this type of reader is more expensive than those that do not store RFID data, some producers already own desktop computers and would not be able to move them to their chute area. Therefore, in order to account for computers already owned by producers, the system being used had to be flexible enough to allow interfacing with stationary or portable accumulators. Panel readers were also based on Bass et al. (2007) and were annualized over four years with an initial outlay of $3,580. Panel systems were assumed to incur a $500 installation cost, which was annualized over a 10-year life. The annualized cost of purchasing and installing a panel reader was $1,150. It was assumed that there would be an annual maintenance cost of $500 for operations that employed a panel reader. While the annualized costs for panel readers are considerably higher than wand readers, the reading cost per head can be lower given sufficient volume of reads because there is minimal labor associated with running panel readers once in place.

A search of the literature did not reveal any unsubsidized, custom rates for reading RFID tags; therefore a rate needed to be estimated. To estimate these rates, 10 states with 15 unique brand inspection fees were analyzed.[4] Some of the inspection fee schedules included hours, which were charged at an hourly wage of $9.80 per hour (US Department of Labor, 2007) and some schedules included mileage. For custom tag reading, we assumed a 50-mile round trip at the government recommended reimbursement rate of $0.485 (US General Services Administration, 2007). The 15 brand inspection fee rates were applied to groups of cattle ranging from three head to 20,000 head. After this was done for each of the 10 states and 15 brand inspection rates, individual costs were weighted by the number of operations in each state to get a weighted average cost. The weighted average cost associated with the different breakpoints was used to determine the custom read cost. Figure 4.3 shows the relationship between the custom reading cost per head and the number of reads. This schedule of custom read rates exhibits large economies of size (i.e., costs decrease as volume increases). However, costs drop rapidly and plateau such that there are only small gains with really large numbers of reads. For example, the cost of reading five head is $1.87 per head compared to $0.98 per head for 50 head and $0.86 for 500 head.

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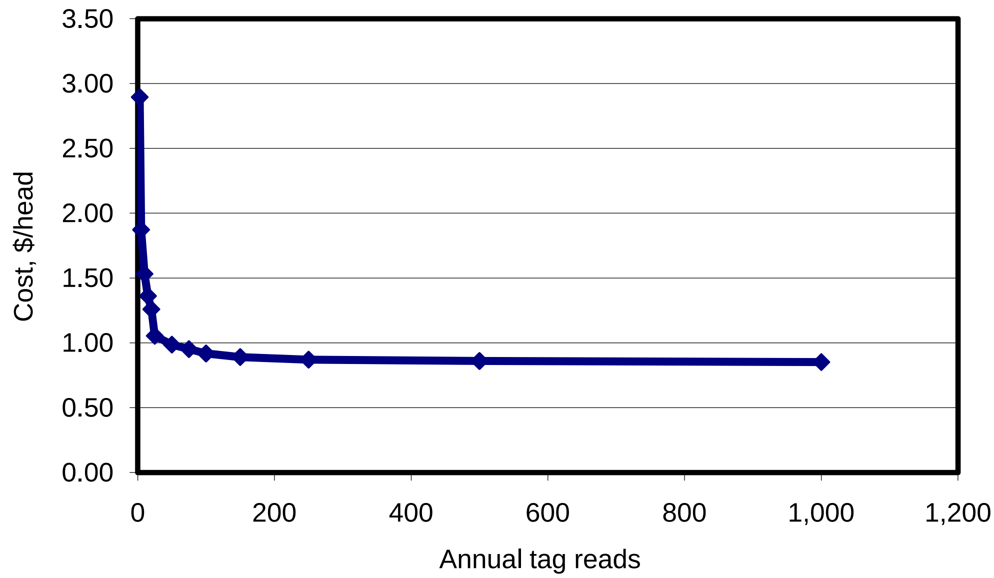
[4] The states with brand inspection rates used for this analysis are the following: CA, CO, ID, MT, NM, NV, OR, SD, UT, and WY.

FIGURE 4.3. ESTIMATED RFID CUSTOM TAG READING COST PER HEAD AS NUMBER OF READS INCREASES



DATA ACCUMULATOR AND SOFTWARE

The data accumulator cost represents the average price for laptop computers obtained from six internet web sites. This cost was annualized over four years with a $0 salvage value. Given an initial investment of $692, a 4-year life, and an interest rate of 7.75%, the annual cost of a data accumulator is $208. Of this total annual cost, 50% was allocated to an animal ID program as it was assumed that a computer would have other uses in the operation. According to the NAHMS Beef report (USDA, 2008q), some operations already own computers and thus, would not need to purchase one. Large operations were more likely than smaller operations to already own a computer. For example, only 15.3% of operations with less than 50 cows owned computers compared to 48.2% for operations with 200 or more cows (USDA, 2008q). To account for operations that currently own computers, the annual cost of the data accumulator (i.e., computer) was multiplied by one minus the proportion of operations that currently own computers resulting in a weighted average cost per operation for each size category.

Many different software packages are available that would satisfy the software requirement of an eID system. The value used here is the suggested retail price of Microsoft Office Professional (Microsoft, 2008). Because this software would have uses in addition to meeting the needs of an eID system, only 50% of the cost was allocated to the animal ID program. This software package includes Microsoft Office Word, Office Excel, Office PowerPoint, Office Access, and other programs. While most producers would not use some of the programs included in Office Professional, Microsoft Office Word and Microsoft Office Excel or Microsoft Office Access would need to be employed to keep track of reads and to write the necessary documents. Other software packages that also maintain management information likely would be utilized by producers, but the higher cost associated with these software packages are not appropriate to include in an animal ID system as these are providing value beyond that required by NAIS. In other words, producers might choose to spend more for additional management benefits, but this is not something they would need to adopt NAIS procedures. It was assumed that producers that already own computers would also own software that would satisfy the requirements of an eID system. Thus, as was done with data accumulators, the cost of software was reduced by the proportion of operations currently owning computers (USDA, 2008q).

Labor, Chute, and Other Costs Associated with Reading RFID Tags

In addition to the hardware and software required for reading RFID tags, other costs such as labor, chute, and human/animal injury would also be incurred. It was assumed that all Cow/Calf operations that buy cows run them through chutes for vaccinating, deworming, or other basic animal husbandry practices. Thus, the incremental labor cost of reading tags would only be the added time required given that the animal is already going through a chute. Therefore, the total number of animals that needed to be read on an operation was multiplied by 20 seconds to find the incremental time of reading RFID tags. The total time was multiplied by the labor rate of $9.80 per hour (US Department of Labor, 2007) and the total number of employees to find the cost of labor for reading tags. The number of employees needed to work cattle was broken into two groups: 1) the employee using the reader (if a panel reader was not used) and 2) other employees doing other tasks (herding, sorting, etc).

The other employee group had differing amount of people for different size operations, which was determined based on producer opinion.

The full chute charge was reduced by 75% because of the assumption that producers will already be working their animals when they read the RFID tags. The 25% applied towards the total cost represents the extra time the animals will spend in the chute.

Animal and human injury costs were added according to the amount of extra time the animal was in the chute being read. Shrink was not added to cows being read because these animals would be for breeding purposes. If operations brought animals in for purposes other than breeding (i.e., backgrounding or feedlot) a cost for shrink was included.

Database Charge

According to the NAIS business plan, "The most efficient, cost-effective approach for advancing the country's traceability infrastructure is to capitalize on existing resources—mainly, animal health programs and personnel, as well as animal disease information databases" (USDA, 2007f p. 4). As of May 2008, there were 17 approved Animal Tracking Databases or Compliant Animal Tracking Databases meeting the minimum requirements as outlined in the Integration of Animal Tracking Databases that were participating in the NAIS program and have a signed cooperative agreement with USDA Animal Plant Health Inspection Service (USDA, 2008d).

The research team attempted to contact multiple RFID database providers to obtain costs per head of their databases so an average cost for data storage could be ascertained. Not surprisingly, this information was not readily given out, and the information that was expressed was not specific enough for this study. To find a more accurate estimate, Kevin Kirk from Michigan's Department of Agriculture was contacted. Mr. Kirk, who oversees the Michigan State AID database, provided the total data storage cost for Michigan producers. Based on this information, a per-head charge of $0.085 was estimated. This per-head charge was included anytime an animal was assumed to have its RFID tag read.

Other/Fixed Charges

The time needed to submit the RFID reads to a central database and the internet fee was considered here. To determine clerical costs, the time required to submit a batch of RFID numbers and the number of batches submitted needed to be ascertained. The Wisconsin working group for pork found that it took 15 minutes to submit a batch (Wisconsin Pork Association (WPA), 2006). It was assumed that a minimum of four batches (one hour of clerical labor) would be assigned to the smallest size category operations and a total number of 16 batches (four hours of labor) would be assigned to the largest operations. Clerical labor was multiplied by the average secretary wage for the US (US Department of Labor, 2007) to find the total cost associated with recording and reporting animal ID information.

In order to be able to achieve a "48 hour trace back system" producers would need to submit their RFID numbers via an internet access point. An internet charge of $50 per month was assumed for 12 months. As with computers and software, the internet would have multiple uses and thus only 50% of the cost is allocated to the animal ID system. Additionally, because some operations already have a computer, it was assumed they likely also had internet access so a weighted cost of internet was used similar to what was done for the cost of data accumulators and software. Table A4.1.6 in Appendix A4 summarizes the costs associated with reading RFID tags by size of operation. In all cases the RFID system for reading eID tags is outsourced as opposed to owned in house (i.e., operations would rely on custom reading services to read their tags). This is because even the largest operations would not have sufficient numbers of cattle requiring their tags to be read annually to justify purchasing readers.

Premises Registration Costs

Currently premises registration is free and many states are trying to make the process as seamless as possible and NAIS reports that 33.8% of all operations with over $1,000 income have been registered as of September 29, 2008 (USDA, 2008d). While the premises registration is a free service, there are potential costs incurred with registering an operation's premises (e.g., management time, mileage, paperwork). To capture this cost, it was assumed that a producer would incur a cost of $20 associated with time, travel, and supplies to register his/her premises. Theoretically, once premises are registered the registration lasts for the life of the operation as well. However, many producers will need to renew or modify their premises registration on a regular basis as their operations change. Thus, it was assumed that the lifespan of premises registration would be three years. The cost of renewing premises registration every three years was assumed to be 50% of the initial cost, or $10 per operation. When accounting for the time value of money, the initial premises registration cost of $20 and the renewal every three years of $10 equates to a cost of $4.64 per operation annually in current dollars.

Interest Costs

Investments required for an animal ID system that have useful lives of more than one year (e.g., tag applicators, readers, premises registration) were annualized using an interest rate of 7.75%. Annual operating cost such as tags for calves, labor, internet, etc. were charged an interest cost at this same rate for the portion of the year a producer's money would be tied up. For example, for operations that buy tags, interest was included in the cost of calf tags to account for a period of nine months, which reflects the amount of time that a producer bought the ear tags to the time that the calf was sold.

Summary of Beef Cow/Calf Costs

Tables 4.2 and 4.3 summarize the costs associated with an individual animal ID system that has full traceability included (i.e., Scenario 3 discussed earlier) by size of operation for operations that currently tag and those that do not, respectively. The cost per animal sold ranges from a low of $2.48 per head (largest operation currently tagging, table 4.2) to a high of $7.17 per head (smallest operation not currently tagging, table 4.3). Figure 4.4 shows the cost per head sold graphically for the two types of operations by operation size. Two things are readily apparent from this figure. First, economies of size exist as larger operations have over a $2/head lower cost compared to the smallest operations. Second, operations that currently tag their cattle have lower costs. This is because the incremental cost of using their labor and facilities (i.e., chute) are lower than hiring tagging done by a third party and because of a higher shrink cost. Operations that tag calves at birth were assumed to have considerably lower costs associated with shrink compared to operations that tag their calves at sale time.

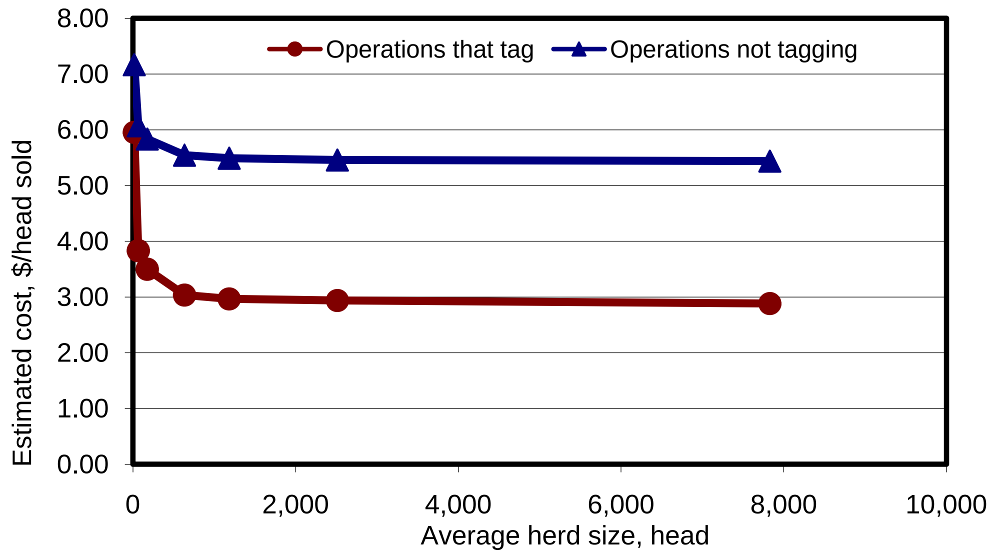
Table 4.2. Summary of RFID Costs for Beef Cow/Calf Operations by Size of Operation that Currently Tags Cattle

	Size of Operation, number of head						
	1-49	50-99	100-499	500-999	1000-1999	2000-4999	5,000+
Total annual cost, $/operation	$80	$215	$529	$1,655	$3,019	$6,350	$19,418
Total annual cost, $/head sold	$5.95	$3.83	$3.50	$3.04	$2.97	$2.94	$2.88
Total annual cost, $/cow	$5.12	$3.30	$3.01	$2.61	$2.55	$2.53	$2.48
Total number of operations	228,755	58,867	50,889	2,985	700	207	39
Total industry cost, thousand $	$18,365	$12,649	$26,944	$4,939	$2,112	$1,315	$763

Table 4.3. Summary of RFID Costs for Beef Cow/Calf Operations by Size of Operation Currently Not Tagging Cattle

	Size of Operation, number of head						
	1-49	100-499	500-999	1000-1999	2000-4999	5,000+	5,000+
Total annual cost, $/operation	$97	$340	$883	$3,022	$5,585	$11,792	$36,605
Total annual cost, $/head sold	$7.17	$6.07	$5.83	$5.55	$5.49	$5.46	$5.44
Total annual cost, $/cow	$6.16	$5.22	$5.02	$4.77	$4.72	$4.69	$4.68
Total number of operations	356,295	35,623	21,966	1,195	280	83	16
Total industry cost, thousand $	$34,436	$12,124	$19,385	$3,613	$1,565	$978	$576

Figure 4.4. Estimated Cost of RFID Full Traceability Technology Adoption for Beef Cow/Calf Operations by Operation Size



4.2 Dairy

4.2.1 Tags and Tagging Costs

Operation Distributions

Similar to Beef Cow/Calf operations, dairy budgets were developed for different size category dairy operations and for operations that currently tag cattle versus those currently not tagging cattle. The distribution of Dairy operations and the average inventory of dairy operations were calculated using NASS statistics (USDA, 2008e) for the year 2007. For a more thorough discussion of the methods used to derive these numbers, see Section 4.1.1 in the Beef Cow/Calf section. While a similar procedure was used for determining the number of operations and average size of each operation for dairy as beef cow/calf operations, there were a couple of minor differences. USDA NASS reports eight size categories for dairy compared to only seven for beef. To maintain consistency regarding the budgets, the smallest two categories (1-29 head and 30-49) were combined. The cow inventory and operation numbers used for beef cow/calf operations were an average of January 1 and July 1, 2007 reported values. For the dairy budgets, only January 1, 2007 reported values were used for cow inventories and operation numbers.

To estimate the number of breeding bulls located on a dairy premises, Dr. Jason Lombard, contact for the 2007 NAHMS Dairy report (USDA, 2007a), was contacted and a special query was run on the 2007 NAHMS Dairy report data. The original request was for the number of bulls per operation by operation size; however, because of a large standard error, the query was adjusted to retrieve the average number of dairy breeding bulls for all operations. The average across all operations was 1.38 bulls per operation with a standard deviation of 0.07. This average was multiplied by the total number of operations to establish a total number of bulls used for dairy operations. Dividing this number with the 2007 inventory of dairy cattle, a bull to cow ratio was established at 92.8 cows per bull. This ratio was applied to the average number of dairy cows for the different size operations to find the average number of bulls per operation by operation size. Given the average number of cows per operation from the USDA NASS data and the estimated number of bulls, the total breeding herd inventory was calculated for the seven different size categories.

RFID Tags Placed

To calculate the number of tags purchased, the total number of animals tagged in a year was calculated. For operations that currently tag, total tags required is the sum of all calves born and alive within 48 hours after birth plus any re-tags required (calves, cows, and bulls) due to tags being lost. It was assumed that calves that died within 48 hours of birth were not tagged, but calves that died after 48 hours following birth were tagged. Death loss rates for heifer calves reported by NAHMS were used in this analysis. It was assumed that this rate plus an arbitrary one percent increase would apply to male animals (male calves are expected to have a slightly higher death loss rate because of more calving problems associated with male calves being larger than females). For operations that currently do not tag, the number of tags required is the total number of animals sold.

It was assumed that dairy operations will incur the same tag loss rate of 2.5% as the Beef Cow/Calf sector. Operations that currently tag will retag animals that lose tags before shipping to buyers. For operations that do not currently tag cattle, tag loss rate is irrelevant as such cattle are not tagged until sold and it was assumed they would be tagged by an auction yard crew for a fee of $2.54 per head.

The cull rate impacts the number of tags required and varied from 23.4% to 24.1% between the different size operations, with larger operations having slightly higher cull rates (USDA, 2007a). The percent heifers retained was calculated by dividing the average (January 1, 2007 and July 1, 2007) inventory of Dairy Heifers, 500+ lbs by the annual average inventory of total number of Milk Cows (USDA, 2008e). The calculated heifer retention rate of 44.8% was held constant for all size operations and when combined with the cull rate was used to calculate the number of heifer calves that would be available for sale. Total animals sold was the sum of cull cows and bulls plus total calves born, less death loss and the number of heifers required to maintain a constant herd size. Cow death loss and calf death loss, both within and post 48 hours of birth, as well as calving rate varied by operation size based on NAHMS data (USDA, 2007a). Table A4.2.1 in Appendix A4.2 reports the number of dairy operations and various production and inventory level values by size of operation.

The 2007 NAHMS Dairy study reported approximately 4.1% of all dairy operations currently used electronic identification (Pedometers, Bar Code, RFID, etc.) (USDA, 2007a). It was assumed that all 4.1% of these operations currently employed the use of RFID tags on their premises. [5] Thus, total costs estimated for dairy operations that currently tag were adjusted by this amount accordingly in the final reported cost estimate for the dairy industry.

RFID Tags and Applicator Cost

Costs of RFID tags varied by purchase volume and the same rates used for the Beef Cow/Calf sector were used for the dairy sector. For the

[5] It is recognized that not all dairies currently using electronic ID use RFID tags as the identification method. However, because RFID tags are generally less expensive than some of the alternative electronic identification methods being used (e.g., electronic collars), moving to the RFID tag technology actually represents a cost savings to these dairies. Because we did not allow for a reduction in costs with the adoption of RFID, this component of our costs are overestimated.

discussion of tag costs see Section 4.1.1 in the Beef Cow/Calf section. Similarly, the costs of RFID tag applicators for dairy operations were calculated using the same assumptions as for beef cow/calf operations (see Section 4.1.1 for more details). Tables A4.2.2 and A4.2.3 in Appendix A4.2 report the number of tags and tag applicators required by size of operation for dairy operations that currently tag and those not currently tagging, respectively.

Labor and Chute Costs for Tagging Cattle

Labor and chute costs associated with tagging cattle for dairy operations were calculated in the same manner and using the same assumptions as they were for beef cow/calf operations. Thus, for a more detailed discussion of these costs see Section 4.1.1 in the Beef Cow/Calf section.

Injury Costs Associated with Tagging Cattle

Human and animal injury costs associated with tagging cattle for dairy operations were calculated in the same manner and using the same assumptions as they were for beef cow/calf operations. Thus, for a more detailed discussion of these costs see Section 4.1.1 in the Beef Cow/Calf section.

Cattle Shrink Associated with Tagging Cattle

The costs of cattle shrink due to tagging cattle for dairy operations were calculated in the same manner and using the same assumptions as they were for beef cow/calf operations. Thus, for a more detailed discussion of these costs see section 4.1.1 in the Beef Cow/Calf Operations section. One assumption that varied for dairy operations is that it was assumed calves would not shrink (beef calves were assumed to shrink 2.0 pounds per head). This was because the dairy calves were assumed to be sold shortly after birth and thus the lost gain or cost of gain would be minimal compared to a beef calf weighing over 500 pounds. Shrink on dairy cull cows and bulls were calculated the same as for beef cattle, but the price used to value the shrink was slightly lower ($45/cwt for dairy cattle compared to $48/cwt for beef cattle). Tables A4.2.4 and A4.2.5 in Appendix A4.2 report the various tagging-related, or working cattle, costs for dairy operations that currently tag and those currently not tagging, respectively.

4.2.2 Reading Costs

The RFID component and reading costs for this study was a function of animals read, ownership and operating costs associated with the RFID technology (e.g., electronic readers (panel and wand), data accumulator, software), and database charges. The following is a brief discussion of each of the relevant components.

Animals Purchased or Transferred

As with beef cow/calf operations, dairy operations purchase cattle and bring them onto their premises. Cattle that are purchased through auction markets are assumed to have their tags read at the time of sale and thus only non-auction market purchase will be required to be read (see Section 4.1.2 in the Beef Cow/Calf section for additional discussion). However, the dairy industry is more complex in regards to animals moving between premises than the beef cow/calf industry because of how replacement heifers are raised. Dairy operations will at times hire people with off-site operations to raise their heifers. For producers that pursue this option, custom growers will raise a heifer until it is ready to calve and then return the bred heifer to the dairy. There are also those that choose to raise the heifer to 250-350 pounds, send it to another premises to have it finish the growing process and be bred, and then it is sent back to the premises of origin when it is ready to calve. In other words, it is not uncommon in the dairy industry for a replacement heifer to move to several premises before it ends up in the dairy herd as a lactating cow.

To account for these non-sale heifer movements, the percentage of operations that outsource any heifer growing (USDA, 2007a) was multiplied by the total number of dairy operations (USDA, 2008e) to find the total number of operations that outsource heifer management. This was broken further into two categories: 1) operations that have heifers move to one premises to grow, and 2) operations that move replacement heifers to multiple premises to grow.

It was assumed that heifers that move to multiple premises would have their eID tags read 3.5 times on average and heifers that were moved to a single premises and back would have tags read two times. Weighting these values by the percentage of operations in each of the categories resulted in a weighted-average of 2.3 reads per heifer. Multiplying the number of operations by the average number of head and by the number of times read gave a total number of reads for each size category. This number was divided by the total number of operations in each size category to achieve an average number of reads of non-sale replacement heifers per operation by operation size. The number of non-sale reads were added to the number of animals purchased needing to be read (animals purchased but not bought through auction markets) to come up with the total number of animals needing to have their RFID tags read. Using this information the total number of RFID tag reads required per year per operation was estimated for the different size dairy operations (table 4.4).

Electronic Readers

See Section 4.1.2 in the Beef Cow/Calf section for discussion.

Data Accumulator and Software

See Section 4.1.2 in the Beef Cow/Calf section for discussion on data accumulator (computer) and related software costs. As was done with beef cow/calf operations, data accumulator and software costs were adjusted to reflect operations that currently own computers. According to the NAHMS Dairy report (USDA, 2007a) over 90% of the large operations had computerized record-keeping systems compared to less than 15% of the smaller operations. To account for operations that currently own computers, the annual cost of the data accumulator (i.e., computer) and software was multiplied by one minus the proportion of operations that currently own computers resulting in a weighted-average cost per operation for each size category. Also, for operations that purchased computers and software, only 50% of the total cost was allocated to the animal ID program because it was assumed they would be used for other purposes as well.

Labor, Chute, and Other Costs Associated with Reading RFID Tags

Costs related to reading RFID tags for dairy operations were calculated in the same manner and with the same basic assumptions as for beef cow/calf operations. For a discussion of these costs see 4.1.2 in the Beef Cow/Calf section.

Database Charge

Charges for storing data for dairy operations were calculated in the same manner and with the same basic assumptions as for beef cow/calf operations. For a discussion of these costs see 4.1.2 in the Beef Cow/Calf section.

Other/Fixed Charges

Other identification-related costs for dairy operations were calculated in the same manner and with the same basic assumptions as for beef cow/calf operations. For a discussion of these costs see 4.1.2 in the Beef Cow/Calf section. Table A4.2.6 in Appendix A4.2 summarizes the costs associated with reading RFID tags by size of operation. Note that dairy operations having more than 500 cows would own an RFID system for reading tags, whereas smaller operations would outsource this function. This is because larger operations have a sufficient amount of tag reads required per year to justify owning readers and other associated computer hardware and software. The total RFID cost per read is considerably lower for the largest operations compared to the smallest operations ($0.31/head (2000+ cows) versus $1.62/head (1-49 cows)).

Table 4.4. Estimates of the Number of Cattle Brought onto Dairy Operation Premises by Size of Operation

	Size of Operation, number of head						
	1-49	50-99	100-199	200-499	500-999	1,000-1,999	2000+
Average cattle bought, head	2.9	9.5	19.3	43.9	134.4	264.2	709.6
Animals sold through auction, %[1]	69.6%	69.6%	69.6%	69.6%	69.6%	69.6%	69.6%
Average non-auction cattle bought, head	0.9	2.9	5.9	13.4	40.9	80.3	215.7
Heifers moved to new premises, head	9.6	31.9	62.5	142.3	319.8	628.8	1688.8
Average reads per heifer	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Total reads of replacement heifers	22.3	73.9	144.7	329.4	740.4	1455.8	3909.5
Non-auction cattle reads	23.2	76.8	150.6	342.8	781.3	1536.1	4125.2
Misread percentage	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%
Total animals misread	0.6	2.1	4.2	9.5	21.6	42.5	114.3
Total reads of RFID tags	23.8	78.9	154.7	352.2	802.9	1578.6	4239.5

[1] Cattle that are sold/purchased through an auction will have tags read at time of sale

Premises Registration Costs

Costs associated with registering dairy operation premises were calculated in the same manner and with the same basic assumptions as for beef cow/calf operations. For a discussion of these costs see Section 4.1.2 in the Beef Cow/Calf section.

Interest Costs

Interest costs for dairy operations were calculated in the same manner and with the same basic assumptions as for beef cow/calf operations. For a discussion of these costs see Section 4.1.2 in the Beef Cow/Calf section.

Summary of Dairy Costs

Tables 4.5 and 4.6 summarize the costs associated with an individual animal ID system that has traceability included (i.e., Scenario 3 discussed in Section 4 above) by size of operation for dairy operations that currently tag and those that do not, respectively. The cost per cow ranges from a low of $2.53 per head (largest operation currently tagging, table 4.5) to a high of $5.84 per head (smallest operation not currently tagging, table 4.5). Figure 4.5 shows the cost per cow graphically for the two types of operations at the various operation sizes. Several things are readily apparent from this figure. First, economies of size exist such that larger operations have considerably lower costs – larger operations have over a $2/head lower cost compared to the smallest operations. Second, operations that currently tag their cattle have slightly lower costs relative to those that do not tag. However, the difference between these two groups is not nearly as large as it was for beef cow/calf operations because a higher portion of the costs for dairy operations is associated with reading tags as opposed to tagging cattle. Furthermore, the cost for the smallest operations that currently tag is actually slightly higher than for the same sized operations that do not currently tag.

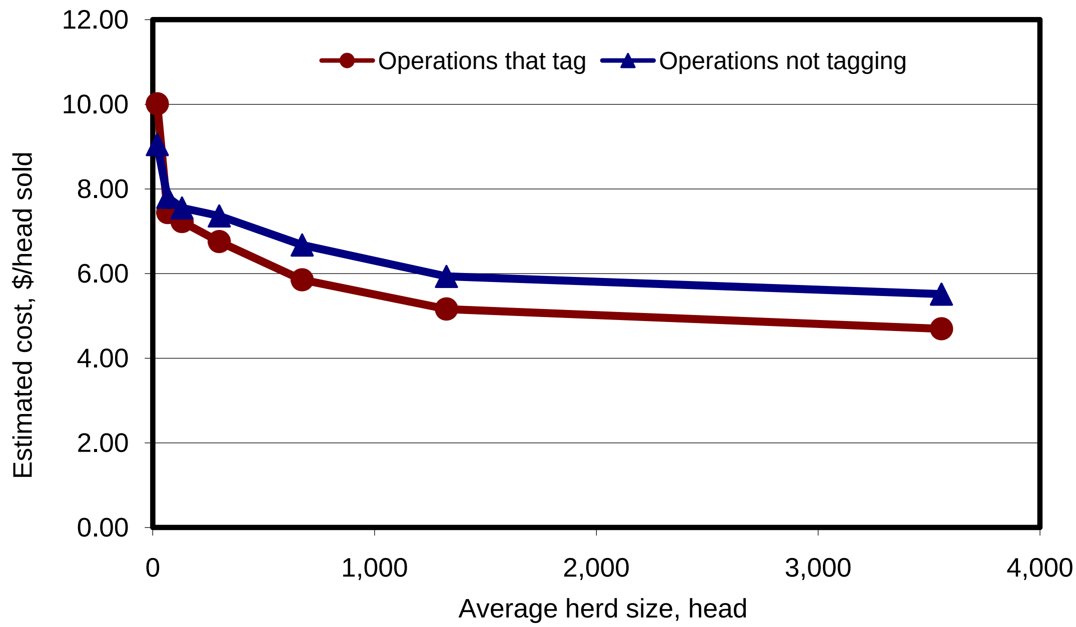
Table 4.5. Summary of RFID Costs for Dairy Operations by Size of Operation that Currently Tags Cattle

	Size of Operation, number of head						
	1-49	50-99	100-199	200-499	500-999	1,000-1,999	2000+
Total annual cost, $/operation	$118	$292	$525	$1,116	$2,126	$3,687	$9,007
Total annual cost, $/head sold	$10.01	$7.44	$7.23	$6.76	$5.85	$5.16	$4.70
Total annual cost, $/cow	$5.84	$4.34	$3.99	$3.72	$3.16	$2.78	$2.53
Total number of operations	28,921	18,148	8,066	3,940	1,471	796	515
Total industry cost, thousand $	$3,425	$5,299	$4,231	$4,397	$3,126	$2,934	$4,636

Table 4.6. Summary of RFID Costs for Dairy Operations by Size of Operation Currently Not Tagging Cattle

	Size of Operation, number of head						
	1-49	50-99	100-199	200-499	500-999	1,000-1,999	2,000+
Total annual cost, $/operation	$107	$306	$548	$1,216	$2,425	$4,237	$10,577
Total annual cost, $/head sold	$9.05	$7.80	$7.55	$7.36	$6.68	$5.93	$5.52
Total annual cost, $/cow	$5.28	$4.55	$4.16	$4.06	$3.60	$3.20	$2.97
Total number of operations	4,514	2,832	1,259	615	230	124	80
Total industry cost, thousand $	$483	$867	$690	$748	$557	$526	$850

FIGURE 4.5. COST OF RFID FULL TRACEABILITY TECHNOLOGY ADOPTION FOR DAIRY OPERATIONS BY OPERATION SIZE



4.3 BACKGROUNDING (STOCKERS)

4.3.1 TAGS AND TAGGING COSTS

OPERATION DISTRIBUTIONS

Information on the number of backgrounding operations or the average inventory number of stocker cattle in the US are not regularly reported by any governmental agency. In order to determine if economies of size exist regarding animal identification costs for backgrounding cattle operations, the number of backgrounding operations needed to be established along with a distribution of average inventory to serve as size estimations for this segment of the beef industry.

To estimate a number of operations, USDA NASS was queried for the total number of cattle operations in 2007 (USDA, 2008e). From this number, the total number of Cow/Calf, Dairy, and Feedlot operations were subtracted leaving approximately 50,870 "other" operations. This residual value represents operations that have multiple livestock sectors (i.e., beef and dairy cattle, cow/calf and feedlot, etc.) and backgrounding or stocker operations. Because information was not available to break this value down further, this residual number of operations was used for the total number of backgrounding operations.[6]

The 2002 census (USDA, 2002b) revealed that 73,509,165 head of cattle (beef and dairy) were sold in 2002. Dividing the 2007 total inventory by the 2002 inventory and multiplying it by the number of cattle sold in 2002 gives an estimated number of head sold for 2007. This derivation implicitly assumed that the number of head sold in a given year was directly related to the number of beef and dairy breeding animals. To estimate the number of stocker cattle bought for the purpose of backgrounding, known and calculated values of "non-stocker cattle" marketings were subtracted from the 2007-inventory-adjusted 2002 census value of total cattle marketings.

Non-stocker cattle marketings were assumed to be breeding animals (replacements and culls), cattle placed on feed, and fed cattle slaughtered. The total number of beef and dairy breeding animal culls (methods of calculating discussed in the previous sections) were added together and multiplied by a multiplier of 1.5. This adjustment was made to account for cull animals that are sold individually or in small groups to buyers who group them into larger lots and then resell them (i.e., adjustment accounts for culls that are marketed multiple times). The number of cattle brought into beef operations (see Section 4.1.2) was added to this cull number. In 2007, there were 553,900 mature bulls slaughtered (USDA, 2008e); therefore, it was assumed that an equal number of bulls were purchased to replace them. Thus, there would have been 1,107,800 bull marketings in 2007 (half being culls sent to slaughter and the other half being replacements entering the breeding herd). Other "non-stocker" cattle marketings are cattle placed on feed (for a discussion on this, see Section 4.4.1) excluding those in a retained ownership program. Retained ownership cattle are excluded as they would not be considered marketings since ownership does not change when they are placed on feed. The number of cattle placed on feed that were in a retained ownership program was based on the USDA APHIS feedlot management practices report (USDA, 2000). Adjusting total cattle placed on feed by the percentage of retained ownership cattle results in an estimate of net

[6] Because some of the operations in this residual value might actually be something other than backgrounding or stocker operations (e.g., cow/calf and feedlot), the estimated number of backgrounding operations is inflated relative to the actual number of operations. However, this also would imply that the number of other operations (e.g., cow/calf and feedlot) is under-estimated and thus this approach insures that the total number of beef operations is the U.S. is correct.

placements, which represents one of the categories of “non-stocker cattle” marketings.

Taking the total number of fed cattle marketed (USDA, 2008e) and adding the sum of cull cows sold, replacement stock bought by beef operations, cull and breeding bull sales, and net feedlot placements, revealed the total number of head sold by known sectors in 2007. Subtracting this total from the 2007-inventory-adjusted 2002 census value gives an estimate of 17,229,903 head for the number of stockers bought for backgrounding in 2007.

To calculate the number of operations and average inventories for different operation size groups several things were considered. To be consistent with other cattle sectors, the number of operations was assumed to decrease as the average herd size increased. Along with that assumption, the total number of backgrounding operations (50,870) and stocker cattle bought (17,299,903) were allocated over seven size categories. To arrive at a distribution where each successive size category had fewer operations than the previous one and total operations and inventory exactly equaled the target levels, Microsoft Excel Solver was employed. While it is recognized that there are many combinations of operations and inventories that will meet this requirement, the specific breakdown by size group is not as critical as making sure the total number of operations and inventory values match. The resulting number of operations and average animals purchased for the seven operation size categories are reported in table A4.3.1 in Appendix A4.3.

RFID Tags Placed

Under the current proposed NAIS, backgrounding operations will only have to replace RFID tags when they are lost. Therefore, the number of animals that backgrounders sell multiplied by the tag loss rate would give the total number of animals needing to be retagged. Assuming that death loss would be similar to those experienced by feedlots, the average number of calves purchased (i.e., inventory) was reduced by 1.3% (USDA, 2000) giving the total number of stockers sold by the backgrounders. Multiplying the number of cattle sold by 2.5%, the assumed tag loss rate (see Section 4.1.1), gives the number of backgrounded cattle worked (for RFID purposes) and RFID tags needing to be purchased.

RFID Tags and Applicator Cost

Costs of RFID tags varied by purchase volume and the same rates used for the beef cow/calf sector were used for the backgrounding sector. For the discussion of tags costs see Section 4.1.1 in the Beef Cow/Calf section. Similarly, the costs of RFID tag applicators for backgrounding operations were calculated using the same assumptions as for beef cow/calf operations (see Section 4.1.1 for more details). Table A4.3.2 in Appendix A4.3 reports the number of tags and tag applicators required by size of operation for backgrounding operations.

Labor and Chute Costs for Tagging Cattle

Labor and chute costs associated with tagging cattle for backgrounding operations were calculated in the same manner and using the same assumptions as they were for beef cow/calf operations. Thus, for a more detailed discussion of these costs see Section 4.1.1 in the Beef Cow/Calf section.

Injury Costs Associated with Tagging Cattle

Human and animal injury costs associated with tagging cattle for backgrounding operations were calculated in the same manner and using the same assumptions as they were for beef cow/calf operations. Thus, for a more detailed discussion of these costs see Section 4.1.1 in the Beef Cow/Calf section.

Cattle Shrink Associated with Tagging Cattle

The cost of cattle shrink due to tagging cattle for backgrounding operations were calculated in the same manner and using the same assumptions as they were for beef cow/calf operations. Thus, for a more detailed discussion of these costs see Section 4.1.1 in the Beef Cow/Calf Operations section. One assumption that varied for backgrounding operations is that it was assumed that the heavier feeder calves would shrink 2.75 pounds per head (beef calves were assumed to shrink 2.0 pounds per head). Because of the heavier weight cattle, the price used to calculate the cost of shrink was slightly lower than for beef cow/calf ($1.09/lb versus $1.21/lb). Table A4.3.3 in Appendix A4.3 reports the various tagging-related, or working cattle, costs for backgrounding operations.

4.3.2 Reading Costs

The RFID component and reading costs for this study was a function of animals read, ownership and operating costs associated with the RFID technology (e.g., electronic readers (panel and wand), data accumulator, software), and database charges. The following is a brief discussion of each of the relevant components.

Animals Purchased or Transferred

The nature of the backgrounding industry, as defined by this report, was to buy animals for the purpose of adding weight and reselling to a feedlot. Therefore, the average inventory for the different operation sizes reflects the average number of animals purchased. Cattle that are purchased through auction markets are assumed to have their tags read at the time of sale and thus only non-auction market purchases will be required to be read (see Section 4.1.2 in the Beef Cow/Calf section for additional discussion). Based on the assumption that 69.6% of cattle are sold through auctions, backgrounding operations would only have to read the RFID tags on 30.4% of the cattle they purchase annually.

Electronic Reader

See Section 4.1.2 in the Beef Cow/Calf section for discussion.

Data Accumulator and Software

See Section 4.1.2 in the Beef Cow/Calf section for discussion on cost of data accumulator (computer) and related software. It was assumed that a percentage of backgrounders would already own computers. Thus, as was done with beef cow/calf operations, data accumulator and software costs were adjusted to reflect operations that currently own computers. Because information specific to backgrounding operations was not available, proxies were substituted. It was assumed that the five smaller categories would follow an ownership distribution similar to the Cow/Calf sector (USDA, 1997); whereas, the two largest size categories were assumed to follow the percentage of feedlot owners who owned computers (USDA, 2000).

Labor, Chute, and Other Costs Associated with Reading RFID Tags

Costs related to reading RFID tags for backgrounding operations were calculated in the same manner and with most of the same basic assumptions as for beef cow/calf operations (see 4.1.2 in the Beef Cow/Calf section). However, there were several different assumptions used. Unlike beef and dairy operations, it was not assumed that all backgrounding operations would run their cattle through chutes to perform basic animal husbandry practices. Instead, it was assumed that backgrounders would follow the practice of beef feedlots. Less than a fourth (21.9%) of feedlots with an average inventory between 1,000-7,999 head do not work their cattle within 72 hours of receiving them (USDA, 2000). Thus, for a 48-hour traceability system to be realized, these animals would need to have their eID tags read before they are worked.

In order to comply with the 48-hour traceability goal, 21.9% of all backgrounding operations would incur the total cost of reading RFID tags. To calculate this cost, the number of animals that needed to be read on an operation was multiplied by 20 seconds to find the time required to read RFID tags. The total time was then multiplied by the labor rate and the total number of employees to find the total cost of RFID labor. The number of employees required to work the cattle was broken into two groups: 1) the reading employee and 2) other employees. The other employee group had differing amount of people for the different sized operations.

The full chute charge was reduced to 25% of the original charge because it was assumed that producers would not individually catch each animal, but they will take a group of animals and put them in a chute alley and read the tags from the alley via a wand or panel reader system. Animal and human injury costs were added according to the amount of time the animal was in the alley being read. A shrink of 2.25 pounds per head was added to the cost of reading the RFID tags to capture the missed weight gain of stocker animals.

The method of finding the costs for the other 78.1% of the operations (i.e., those that work their cattle upon arrival) are similar to those found in Section 4.1.2 in the Beef Cow/Calf section.

Database Charge

Charges for storing data for backgrounding operations were calculated in the same manner and with the same basic assumptions as for beef cow/calf operations. For a discussion of these costs see 4.1.2 in the Beef Cow/Calf section.

Other/Fixed Charges

Other identification-related costs for backgrounding operations were calculated in the same manner and with the same basic assumptions as for beef cow/calf operations. For a discussion of these costs see 4.1.2 in the Beef Cow/Calf section. Table A4.3.4 in Appendix A4.3 summarizes the costs associated with reading RFID tags by size of operation. Note that the largest size category of backgrounding operations, those purchasing about 3,000 head per year, would own the RFID system for reading tags, whereas the smaller operations would outsource this function. This is because the larger operations have a sufficient amount of tag reads required per year to justify owning readers and other associated computer hardware and software.

Premises Registration Costs

Costs associated with registering backgrounding operation premises were calculated in the same manner and with the same basic assumptions as for beef cow/calf operations. For a discussion of these costs see 4.1.2 in the Beef Cow/Calf section.

Interest Costs

Interest costs for backgrounding operations were calculated in the same manner and with the same basic assumptions as for beef cow/calf operations. For a discussion of these costs see 4.1.2 in the Beef Cow/Calf section.

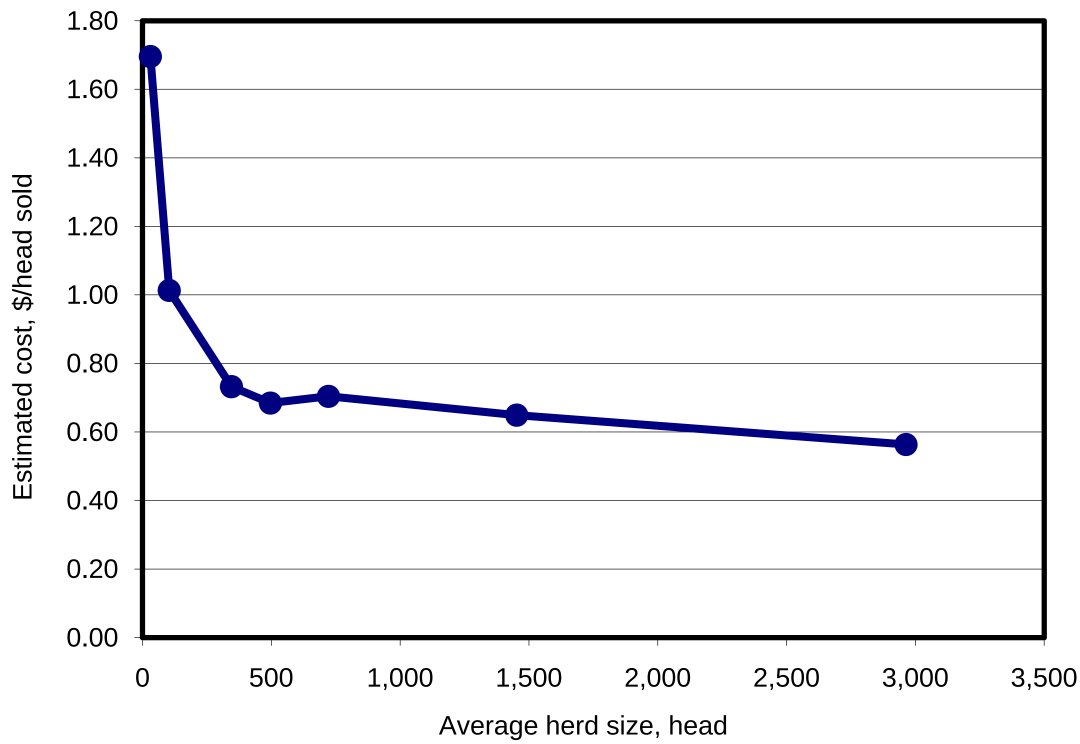
Summary of Backgrounding Costs

Table 4.7 summarize the costs associated with an individual animal ID system that has traceability included (i.e., Scenario 3 discussed in Section 4 above) by size of operation for backgrounding operations. The cost per head sold ranges from a low of $0.56 per head (largest operations) to a high of $1.70 per head (smallest operations). Figure 4.6 shows the cost per head sold graphically for backgrounding operations at the various operation sizes. Two things are readily apparent from this figure. First, cost per head sold for backgrounding operations is considerably lower than for cow/calf operations. This is due to the assumption that calves were tagged prior to coming into the backgrounding phase. Thus, the cost of tags and working cattle was only on cattle needing to be retagged. Second, economies of size exist such that larger operations have lower costs – larger operations have a lower cost of over $1.00/head compared to the smallest operations. However, most of the gains associated with operation size are captured quickly as size increases. That is, medium-sized operations have costs similar to the larger operations.

Table 4.7. Summary of RFID Costs for Backgrounding Operations by Size of Operation

	Size of Operation Size, number of head						
	31	104	345	496	722	1,453	2,963
Total annual cost, $/operation	$51	$104	$250	$335	$502	$931	$1,648
Total annual cost, $/head sold	$1.70	$1.01	$0.73	$0.68	$0.70	$0.65	$0.56
Total annual cost, $/head purchased	$1.67	$1.00	$0.72	$0.68	$0.69	$0.64	$0.56
Total number of operations	21,438	11,334	6,333	4,333	3,329	2,316	1,787
Total industry cost, thousand $	$1,096	$1,175	$1,580	$1,453	$1,670	$2,155	$2,944

Figure 4.6. Cost of RFID Technology for Cattle Backgrounding Operations by Operation Size



4.4 Feedlots

4.4.1 Tags and Tagging Costs

Operation Distributions

USDA NASS reports the total number of feedlot operations as well as the number of operations with 1,000+ head capacity (USDA, 2008e). Using this information, the number of operations with less than 1,000 head was calculated as the difference between total of all operations and the total of 1,000+ head operations (the number of feedlots for all size categories is also reported in the USDA NASS February *Cattle on Feed* report).

Average inventory distributions were found for feedlot operators similar to the other cattle sectors. Because USDA NASS does not report feedlot placements for operations with less than 1,000 head capacity, placements were estimated from fed cattle marketings, which are reported for feedlots with less than 1,000 head (USDA, 2008e). The difference between feedlot marketings and feedlot placements is a disappearance rate (cattlenetwork, 2006). For this analysis, disappearance is defined as any animal placed in a feedlot that (a) dies, (b) was returned to grazing forage, (c) was shipped to another feedlot, (d) was stolen, or (e) lost for other reasons. In 1999, NAHMS conducted a feedlot survey (USDA, 2000) that indicated 3% of animals placed in feedlots disappeared. Using this 3% disappearance rate, marketings were divided by 97% to estimate the total placements for all operations. table A4.4.1 in Appendix A4.4 reports the number of feedlot operations and various production and inventory level values by size of operation.

RFID Tags Placed

Similar to backgrounding operations, it was assumed that feedlots will only have to replace RFID tags when they are lost (see Section 4.1.3). Therefore, the number of animals that feedlots market multiplied by a tag loss rate would give the total number of animals needing to be retagged. Based on a feedlot death loss rate of 1.3% (USDA, 2000), the average number of calves placed on feed (i.e., placements) was reduced by 1.3% giving the total number of fed cattle sold by the feedlots. Multiplying the number of fed cattle sold by 2.5%, the assumed tag loss rate (see Section 1.2), gives the number of feedlot cattle worked (for RFID purposes) and RFID tags needing to be purchased.

RFID Tags and Applicator Cost

Costs of RFID tags varied by purchase volume and the same rates used for the beef cow/calf sector were used for the feedlot sector. For the discussion of tags costs see 4.1.1 in the Beef Cow/Calf section. Similarly, the costs of RFID tag applicators for feedlot operations were calculated using the same assumptions as for beef cow/calf operations (see Section 4.1.1 for more details). Table A4.4.2 in Appendix A4.4 reports the number of tags and tag applicators required by size of operation for feedlot operations.

Labor and Chute Costs for Tagging Cattle

Labor and chute costs associated with tagging cattle for feedlot operations were calculated in the same manner and using the same assumptions as they were for beef cow/calf operations. Thus, for a more detailed discussion of these costs see 4.1.1 in the Beef Cow/Calf section.

Injury Costs Associated with Tagging Cattle

Human and animal injury costs associated with tagging cattle for feedlot operations were calculated in the same manner and using the same assumptions as they were for beef cow/calf operations. Thus, for a more detailed discussion of these costs see 4.1.1 in the Beef Cow/Calf section.

Cattle Shrink Associated with Tagging Cattle

The cost of cattle shrink due to tagging cattle for feedlot operations were calculated in the same manner and using the same assumptions as they were for beef cow/calf operations. Thus, for a more detailed discussion of these costs see 4.1.1 in the Beef Cow/Calf Operations section. One assumption that varied for feedlot operations is that it was assumed that the heavier fed cattle would shrink 3.25 pounds per head (beef calves were assumed to shrink 2.0 pounds per head). Because of the heavier weight cattle, the price used to calculate the cost of shrink was slightly lower than for beef cow/calf ($0.95/lb versus $1.21/lb). Table A4.3.4 in Appendix A4.4 reports the various tagging-related, or working cattle, costs for feedlot operations.

4.4.2 Reading Costs

The RFID component and reading costs for this study was a function of animals read, ownership and operating costs associated with the RFID technology (e.g., electronic readers (panel and wand), data accumulator, software), and database charges. The following is a brief discussion of each of the relevant components.

Animals Purchased or Transferred

All animals placed into a feedlot were considered to be read at either the auction yard or the feedlot premises. Cattle that are purchased through auction markets are assumed to have their tags read at the time of sale and thus only non-auction market purchases will be required to be read (see 4.1.2 in the Beef Cow/Calf section for additional discussion). Based on the assumption that 69.6% of cattle are sold through auctions, feedlot operations would only have to read the RFID tags on 30.4% of the cattle they place on feed annually.

Electronic Reader

See 4.1.2 in the Beef Cow/Calf section for discussion.

Data Accumulator and Software

See 4.1.2 in the Beef Cow/Calf section for discussion on cost of data accumulator (computer) and related software. It was assumed that a percentage of feedlot operations would already own computers. Thus, as was done with beef cow/calf operations, data accumulator and software costs were adjusted to reflect operations that currently own computers. Information regarding computer usage in feedlots came from the 1999 NAHMS Feedlot report (USDA, 2000). Given that the NAHMS feedlot survey was conducted in 1999, it likely underestimates the percentage of feedlots that currently own computers and thus the costs estimated are likely biased upward (i.e., costs based on current computer ownership would likely be lower).

Labor, Chute, and Other Costs Associated with Reading RFID Tags

Costs related to reading RFID tags for feedlot operations were calculated in the same manner and with most of the same basic assumptions as for beef cow/calf operations (see Section 4.1.2 in the Beef Cow/Calf section). However, there were several different assumptions used. Unlike beef and dairy operations, it was not assumed that all feedlot operations would run their cattle through chutes to perform basic animal husbandry practices. According to the 1999 NAHMS feedlot report, 21.9% of feedlot operations with an average inventory between 1,000-7,999 head and 12.5% with more than 7,999 head did not work their cattle within 72 hours of receiving them (USDA, 2000). Therefore, in order to comply with the 48-hour trace-back goal, 21.9% of operations with less than 8,000 head and 12.5% of operations with more than 7,999 head would incur the total cost reading RFID tags.

To calculate this cost, the number of animals read on an operation was multiplied by 20 seconds to find the time required to read RFID tags. The total time was then multiplied by the labor rate and the total number of employees to find the total cost of RFID labor. The number of employees needed to work the cattle was broken into two groups: the reading employee and the other employees. The other employee group had differing amount of people for different operations sizes.

The full chute charge was reduced to 25% of the original charge because it was assumed that producers would not individually catch each animal, but they will take a group of animals and put them in a chute alley and read the tags from the alley via a wand or panel reader system.

Animal and human injury costs were added according to the amount time the animal was in the alley being read. A shrink of 2.75 pounds per head was added to the cost of reading the RFID tags to capture the missed weight gain of the feeder cattle.

The method of finding the costs for the other 78.1% of operations with less than 8,000 head and for the other 87.5% of operations with more than 7,999 head (i.e., those that work their cattle upon arrival) are similar to those found in section 4.1.2 in the Beef Cow/Calf section.

DATABASE CHARGE

Charges for storing data for feedlot operations were calculated in the same manner and with the same basic assumptions as for beef cow/calf operations. For a discussion of these costs see Section 4.1.2 in the Beef Cow/Calf section.

Other/Fixed Charges

Other identification-related costs for feedlot operations were calculated in the same manner and with the same basic assumptions as for beef cow/calf operations. For a discussion of these costs see Section 4.1.2 in the Beef Cow/Calf section. Table A4.4.4 in Appendix A4.4 summarizes the costs associated with reading RFID tags by size of feedlot operation. Note that feedlots with more than 4,000 head capacity would own the RFID system for reading tags, whereas operations smaller than this would outsource this function. This is because the larger operations have a sufficient amount of tag reads required per year to justify owning readers and other associated computer hardware and software.

Premises Registration Costs

Costs associated with registering feedlot operation premises were calculated in the same manner and with the same basic assumptions as for beef cow/calf operations. For a discussion of these costs see 4.1.2 in the Beef Cow/Calf section.

Interest Costs

Interest costs for feedlot operations were calculated in the same manner and with the same basic assumptions as for beef cow/calf operations. For a discussion of these costs see 4.1.2 in the Beef Cow/Calf section.

Summary of Feedlot Costs

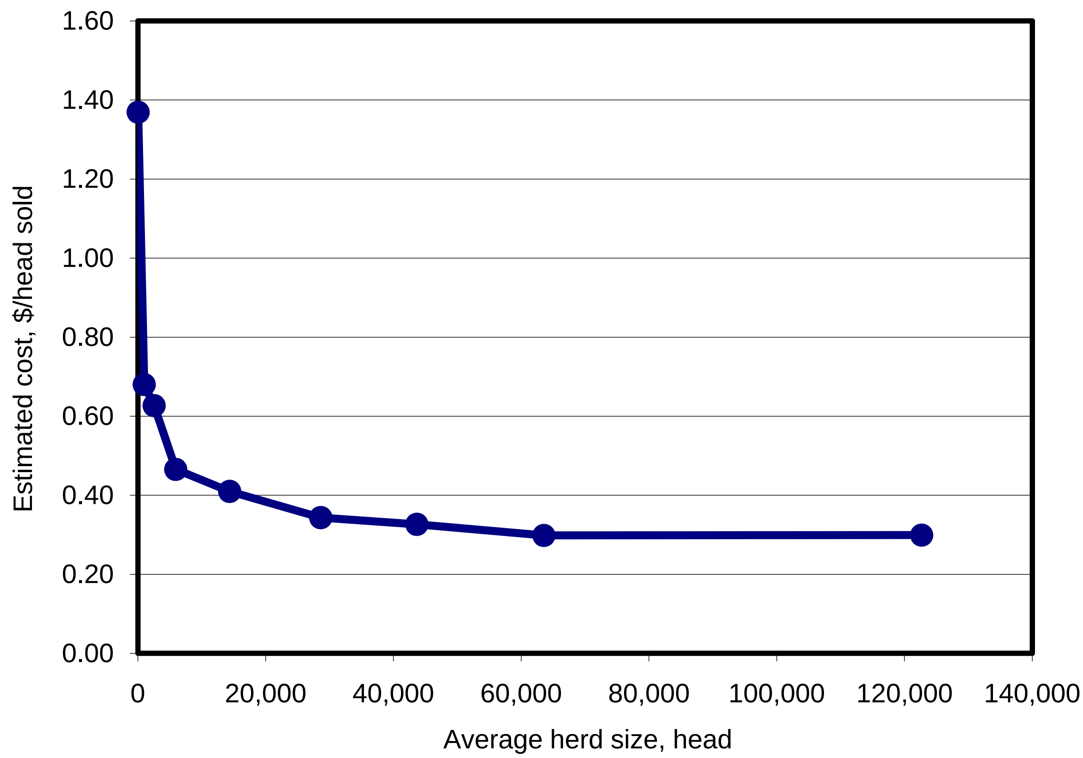
Table 4.8 summarize the costs associated with an individual animal ID system that has full traceability included (i.e., Scenario 3 discussed in Section 4 above) by size of operation for beef feedlot operations. The cost per head sold ranges from a low of $0.30 per head (largest operations) to a high of $1.37 per head (smallest operations). Figure 4.7 shows the cost per head sold graphically for feedlot operations at the various operation sizes. Two things are readily apparent from this figure.

First, cost per head sold for feedlot operations is considerably lower than for cow/calf operations. This is due to the assumption that calves were tagged prior to being placed on feed in the feedlot sector. Thus, the cost of tags and working cattle was only on cattle needing to be retagged. Second, economies of size exist such that larger operations have lower costs – larger operations have a cost advantage of over $1.00/head compared to the smallest operations. However, most of the gains associated with operation size are captured quickly. For example, the cost advantage for the largest feedlots (50,000+ head capacity) decreases to less than $0.40/head when compared to the second smallest size category (1,000-1,999 head capacity).

Table 4.8. Summary of RFID Costs for Feedlot Operations by Size of Operation

	Size of Operation, feedlot capacity (head)								
	1-999	1000-1999	2000-3999	4000-7999	8000-15999	16000-23999	24000-31999	32000-49999	50000+
Total annual cost, $/operation	$61	$670	$1,583	$2,736	$5,805	$9,701	$14,058	$18,706	$36,216
Total annual cost, $/head sold	$1.37	$0.68	$0.63	$0.47	$0.41	$0.34	$0.33	$0.30	$0.30
Total annual cost, $/head purchased	$1.36	$0.67	$0.62	$0.46	$0.40	$0.34	$0.32	$0.29	$0.30
Total number of operations	85,000	809	564	343	182	78	55	71	58
Total industry cost, thousand $	$5,174	$542	$893	$939	$1,057	$757	$773	$1,328	$2,101

FIGURE 4.7. COST OF RFID FULL TRACEABILITY TECHNOLOGY ADOPTION FOR CATTLE FEEDLOTS BY OPERATION SIZE



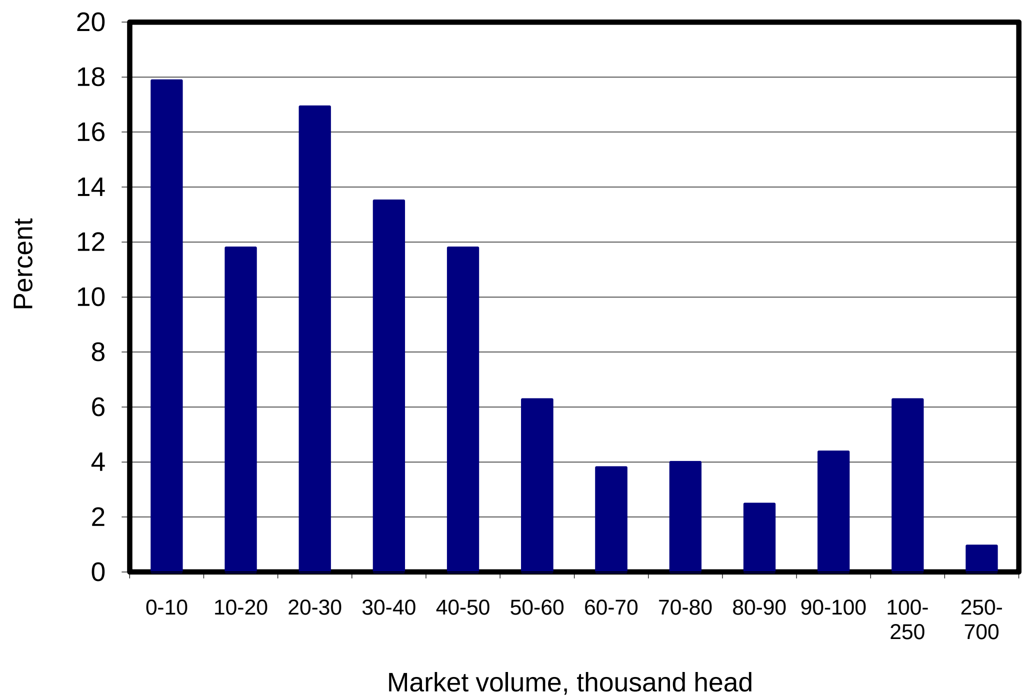
4.5 AUCTION MARKETS

The costs incurred at auction markets will vary depending on many factors, size of auction market, species, services offered, etc. While auction markets may be able to pass increased costs associated with an animal ID system on to their customers (i.e., cattle producers), these costs still have an impact on the industry. Furthermore, if different size auction markets have different costs (i.e., if economies of size exist) some of these added costs may not be able to be passed on to customers due to competition within the industry. For this analysis three costs at the auction market level were considered: 1) cost of tagging calves, 2) cost of reading RFID tags, and 3) cost of data storage.

OPERATION DISTRIBUTIONS

In order to determine how a national animal identification system might impact auction markets of various sizes, a distribution of markets was required. Information on auction market volume was obtained from the Livestock Marketing Association (LMA, 2008). LMA provided 2006 market volume data for 526 auction markets in the US and indicated this was representative of the variability of the estimated 1,050 auction markets in the US. Figure 4.8 shows the distribution of the 526 auction markets identified by LMA. Over 70% of the auction markets sell less than 50,000 head of cattle through their facilities annually.

FIGURE 4.8. DISTRIBUTION OF LIVESTOCK AUCTION MARKETS BY HEAD OF CATTLE SOLD ANNUALLY



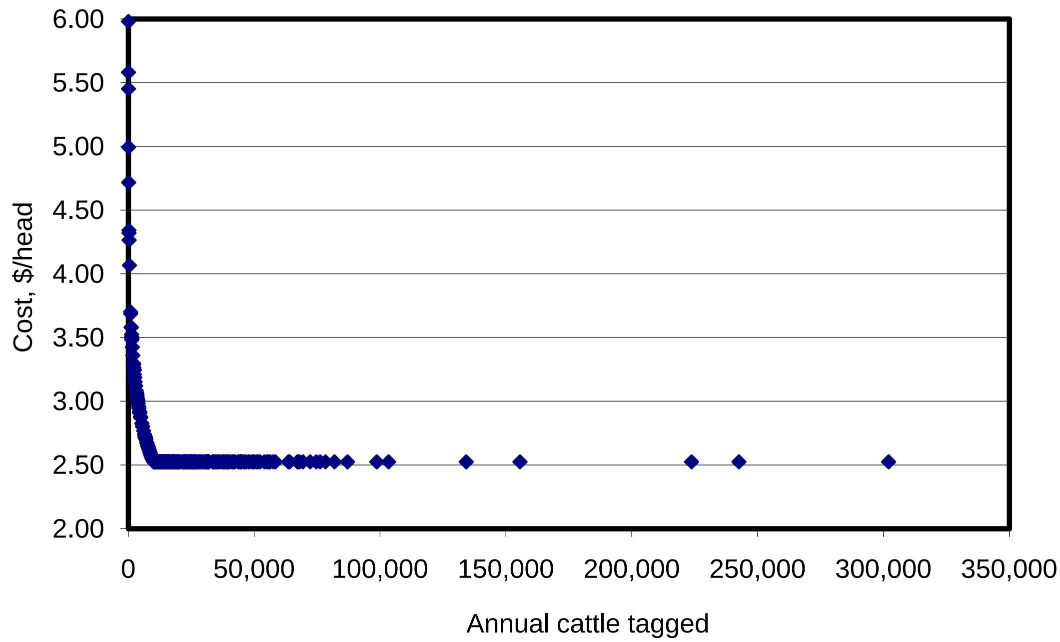
Costs of Tagging Service

It was assumed that auction markets might provide tagging services to their customers if an animal identification system were adopted. The fee charged by an auction market for tagging was estimated as a function of the number of cattle tagged annually based on survey results from auction yards (Bolte, 2007). The estimated relationship between reported fees and market volume was not particularly strong (R^2 of 0.116), but it exhibited a decreasing cost as volume increased as expected and was relatively consistent with values observed in Michigan (Kirk, 2007). Figure 4.9 shows the estimated tagging fees for each of the 526 auction markets depicted in figure 4.8 assuming that 44.8% of cattle going through facility would be tagged (average of responses in Bolte survey). There are large economies of size as the very smallest markets have estimated costs twice as high as larger auction markets. However, the costs decrease rapidly and plateau at approximately 10,000 head of cattle tagged annually). The volume-weighted average of the 526 auction markets is $2.54 per head, which is the value used for this analysis. The cost of tagging was included in the livestock budgets directly and thus this cost shows up as a cost to producers and not to auction markets.

Cost of Reading Tags

It was assumed that cattle marketed through auction markets would have RFID tags read and thus they would not have to be read at another location (see Section 4.1.2). The type of reading system an auction market might use (i.e., wand reader versus panel reader) will depend somewhat on their volume and the actual design and layout of their facilities. The cost associated with reading RFID tags at auction markets was estimated as a function of the number of cattle being read annually based on survey results from auction yards (Bolte, 2007). The estimated cost function represents a mixture of reader types, with the smaller auctions generally using wand readers and the larger auctions using panel readers. Also, these costs did not include backup systems such that 100% reads could be guaranteed. While 100% read rate would be required for a system that relied upon this for inventory control, invoicing and payment, NAIS would not require that level of accuracy. The estimated relationship between tag reading cost and market volume was not particularly strong (R^2 of 0.179). As expected, reading cost per head decreased as volume increased. Figure 4.10 shows the estimated costs of reading RFID tags for each of the 526 auction markets depicted in figure 4.8 assuming that 100% of cattle going through the facilities would be read. There are large economies of size as the very smallest markets have estimated costs significantly higher than larger auction markets.

FIGURE 4.9. ESTIMATED AUCTION MARKET FEE FOR TAGGING CATTLE SOLD THROUGH THE MARKET BY HEAD TAGGED ANNUALLY

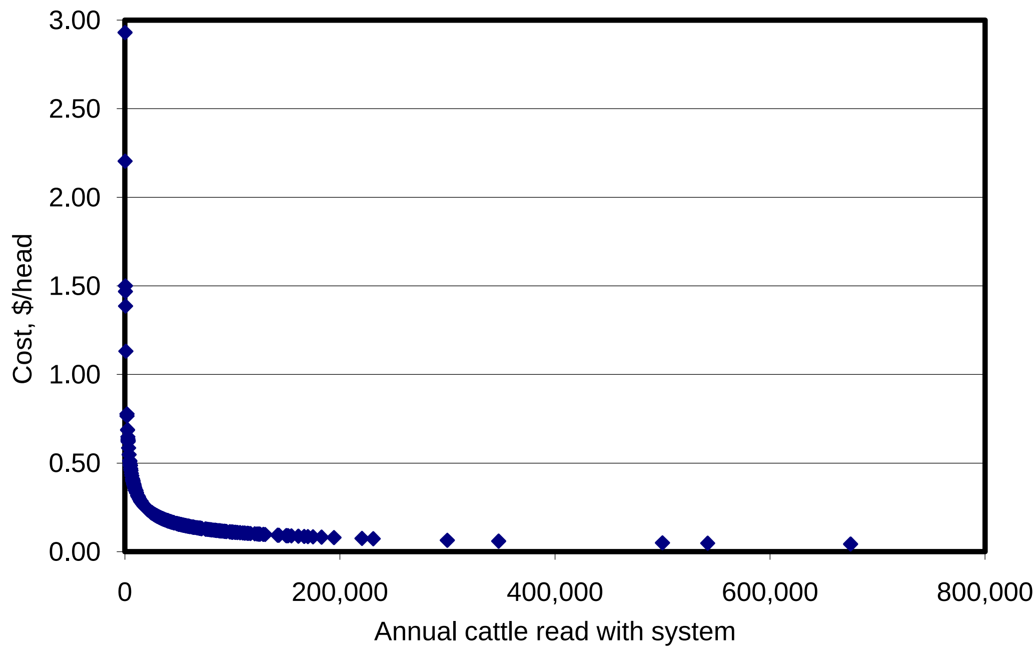


The simple average of the 526 markets is $0.27 per head, however, the volume-weighted average is $0.145 per head. The volume-weighted average is the value used for this analysis to estimate the total cost to the industry. While the cost of reading RFID tags would likely be passed on directly to producers through higher commissions, this cost was not included directly in the livestock budgets and thus is included here.

Cost of Data Storage

A per-head charge of $0.085 was included as a cost to auction markets for every animal read (see Section 4.1.2 for additional discussion of database costs). While the cost of data storage would likely be passed on to producers through higher commissions, this cost was not included directly in the livestock budgets and thus is included in this section.

Figure 4.10. Estimated Cost to Auction Market for Reading RFID Tags by Number of Cattle Read Annually



Summary of Auction Market Costs

Based on 69.6% of cattle being marketed through auctions, it was estimated there would be 38,128,769 cattle marketed through auctions annually. Based on an average cost of reading RFID tags of $0.145 per head and a data storage cost of $0.085 per head, there would be an estimated cost of slightly over $8.7 million. Assuming there are 1,050 auction markets in the US (LMA, 2008), this equates to over $8,000 per auction market per year.

4.6 PACKERS

The costs incurred at cattle packing plants will depend on numerous factors, but primarily on size of the plant. While packing plants may be able to pass increased costs associated with an animal ID system on to their customers (i.e., cattle producers), these costs still have an impact on the industry. Furthermore, if different size packing plants have different costs (i.e., if economies of size exist) some of these added costs may not be able to be passed on to producers because of competition within the industry. For this analysis the costs at packing plants was based on the costs of reading RFID tags.

OPERATION DISTRIBUTIONS

In order to determine how a national animal identification system might impact packing plants of various sizes, a distribution of plant sizes was required. Information on the number and size of steer and heifer, cow and bull, and calf packing plants was obtained from USDA GIPSA (USDA, 2007g). Average values for 2001-2005 were used for the analysis and then adjusted to 2007 marketings. Figures 4.11-4.13 show the distribution of the number of plants and their shares of cattle slaughtered for steer and heifer plants, cow and bull plants, and calf plants, respectively. Patterns in these figures are consistent with the distribution of cattle production operations and auction markets. That is, there are a relatively large number of small operations, but the few largest operations account for the majority of the production.

Figure 4.11. Size Distribution and Market Share of Steer and Heifer Slaughter Plants by Plant Size, 2001-05 Average

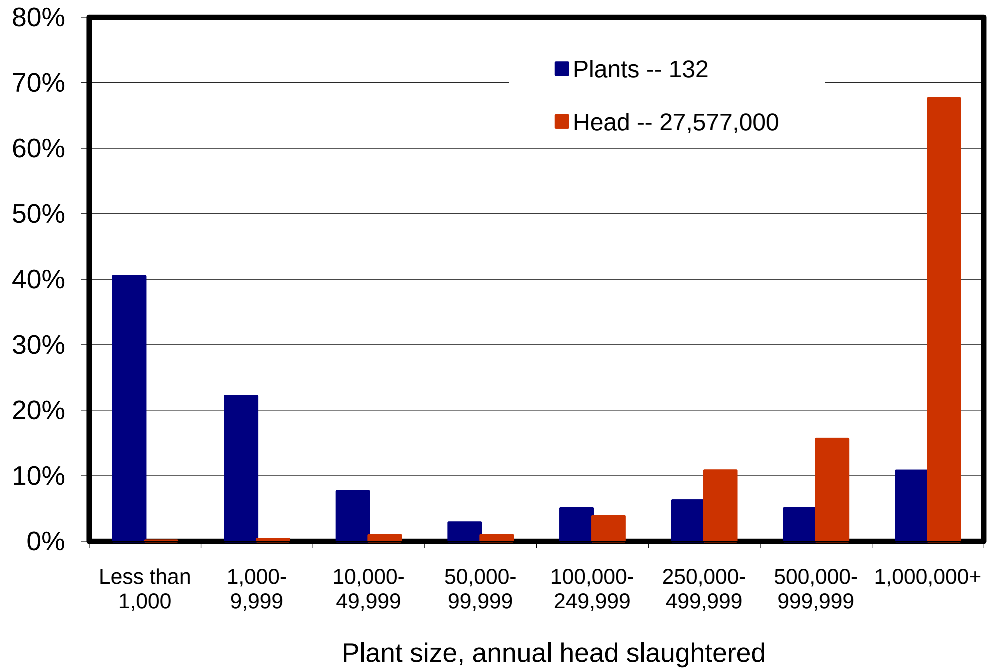


Figure 4.12. Size Distribution and Market Share of Cow and Bull Slaughter Plants by Plant Size, 2001-05 Average

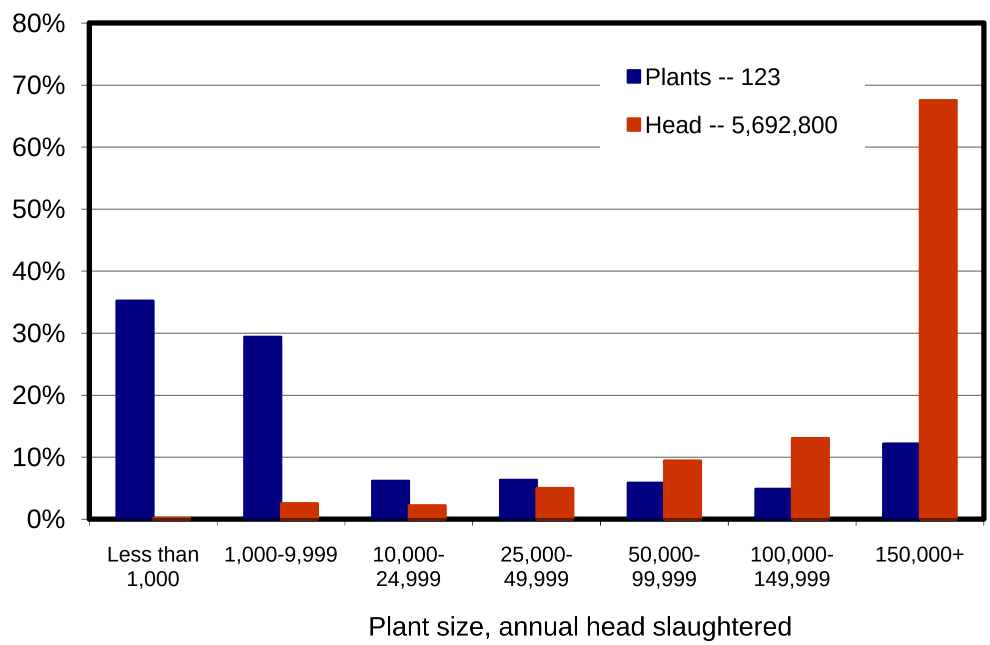
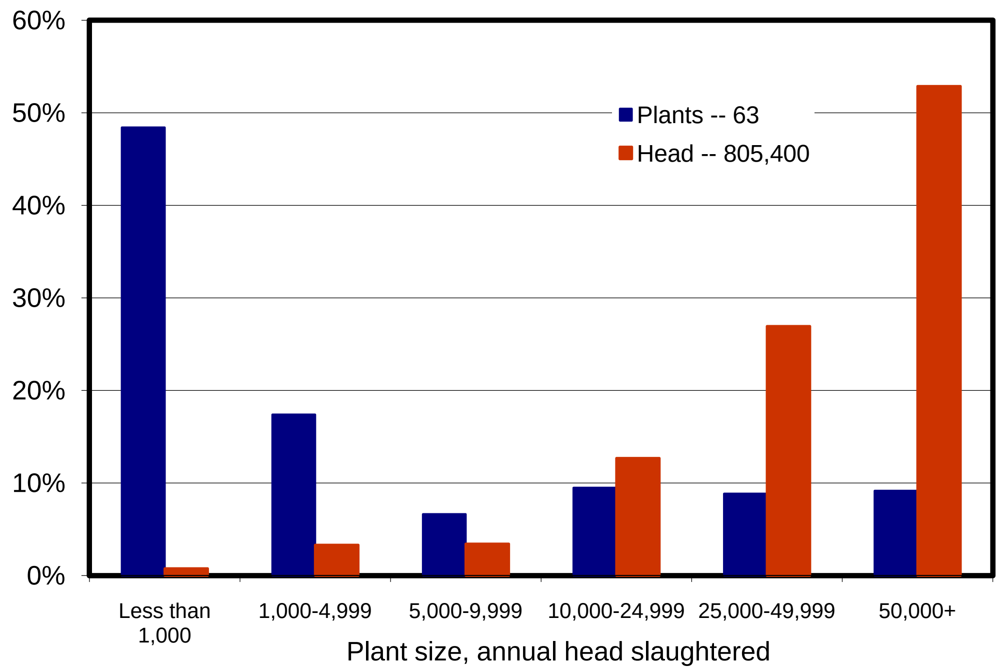


Figure 4.13. Size Distribution and Market Share of Calf Slaughter Plants by Plant Size, 2001-05 Average.



Cost of Reading Tags

It was assumed that all cattle processed through a packing plant would have RFID tags that need to be read. The type of reading system a packing plant would use (i.e., wand reader, panel reader, visual recording of data) will depend somewhat on their volume and the actual design and layout of their facilities. Specifically, very small plants might find it more economical to simply record the 15-digit ID manually rather to invest in an electronic reader. The cost associated with reading RFID tags at packing plants was estimated as a function of the number of cattle being processed annually based on survey results from packing plants of various sizes (Bass et al., 2008). Figures 4.14-4.16 show the estimated costs per head for reading RFID tags for steer and heifer, cow and bull, and calf packing plants, respectively, as size of plant varies. In all cases, costs decrease as volume increases indicating economies of size exist. In addition to the cost per head, the respective figures report the volume-weighted cost per head and the total cost to the industry assuming 2007 slaughter levels. Bass et al. (2008) included a cost of $0.085 per head for data storage in their estimates, however, this cost likely will be covered by the government rather than the plants (USDA, 2008g). That is, packing plants will submit animal ID data they read to the government and they will enter it into a database and incur the cost of data storage. Because it was assumed that data storage was a fixed cost of $0.085 per head, the economies of size relationships estimated would still exist, but costs would simply be lower everywhere (i.e., the lines in figures 4.14-4.16 would simply shift down by $0.085 per head).

Figure 4.14. Annual Cost of Adopting RFID Technology for Steer and Heifer Slaughter Plants by Plant Size

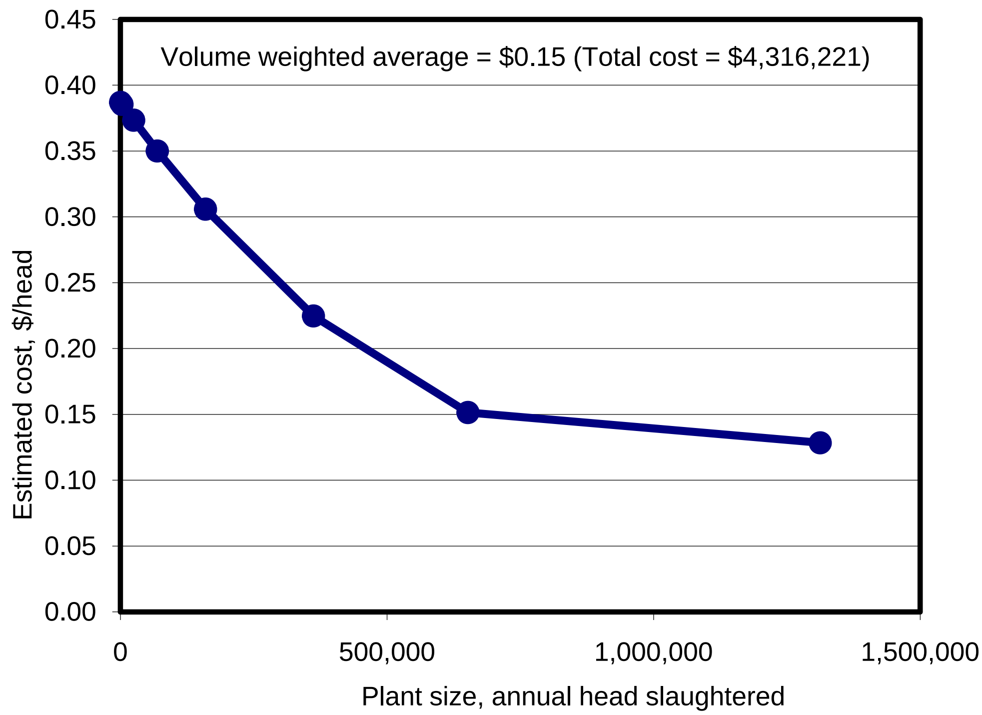


Figure 4.15. Annual Cost of Adopting RFID Technology for Cow and Bull Slaughter Plants by Plant Size

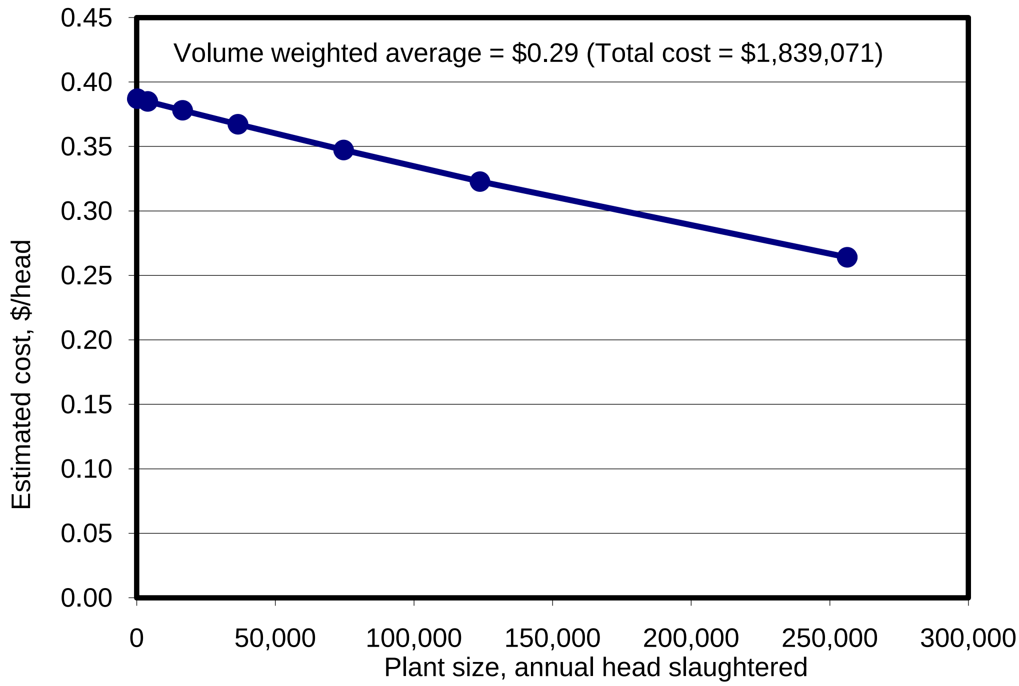
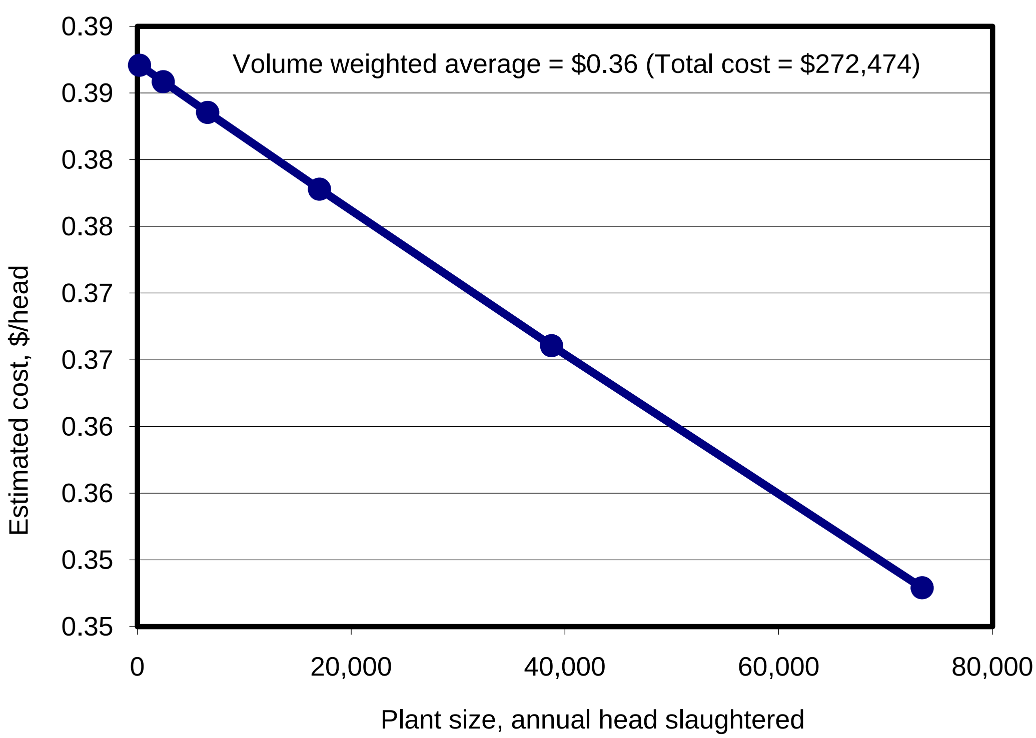


Figure 4.16. Annual Cost of Adopting RFID Technology for Calf Slaughter Plants by Plant Size



Summary of Packing Plant Costs

Based on reading 100% of cattle being slaughtered in 2007 (35,017,500 head), the total costs of reading RFID tags to the 318 beef packing plants in the US is estimated at just under $3.5 million, or an average of almost $11,000 per plant.

4.7 Cattle Industry Summary

Table 4.9 summarizes the total costs to the cattle industry by sector under scenario #3 (full traceability). Total costs are estimated at slightly over $209 million of which two-thirds of that amount is incurred in the beef cow/calf sector. Table 4.10 reports the sector totals with a partial breakdown by type of cost. On a percentage basis, just under half (46.7%) of the total costs to the industry are the costs of RFID tags. Keep in mind as technology increases this cost would be expected to decline (see figure 4.2 in Section 4.1.1). The next largest cost is chute charges, which basically represents working cattle. However, chute costs were not particularly high for operations that currently tag. This indicates that current management practices of a producer can have sizable impact on their cost of adopting an animal ID system. Collectively, about 17% of the costs were due to reading tags (e.g., readers, labor, injuries, data storage). However, this percent varied depending on which sector was considered. For example, reading costs were a big portion of the costs for backgrounders and feedlots because they only had to purchase tags for animals that needed to be retagged. Based on assumptions used in this analysis, a full traceability animal identification program in the cattle industry would add about $5.97 per head to the cost of cattle marketed.

Within each of the sectors in the cattle industry, economies of size associated with an animal identification system were present. Thus, smaller operations likely will be slower to adopt identification systems because they incur higher per unit costs. However, as a general rule for most sectors, most of the economies of size were typically captured quite quickly such that average incremental costs for mid-sized producers were similar to costs of the largest operations.

Table 4.11 reports the total costs to the cattle industry by sector under the three different scenarios: 1) premises registration only, 2) bookend animal ID system, and 3) full traceability ID system for various adoption rates. The costs are reported for both a uniform adoption rate and a lowest-cost-first adoption rate. Given that animal identification is a voluntary program, the lowest-cost-first adoption rate likely better reflects what costs would be to the industry with something less than 100% adoption. Note that at 100% adoption the two methods are equal. The premises registration scenario (#1) reflects only costs associated with registering premises (see Section 4.1.2) for a discussion about how premises registration costs were estimated), which is significantly below the other two scenarios. However, it is also important to recognize that this represents no animal identification and no ability to trace animal movements. It can be seen in the lowest-cost-first adoption column that costs increase at an increasing rate with higher levels of adoption. This suggests that getting lower rates of adoption may not be that difficult with a voluntary program because costs are relatively low. However, to get a high adoption rate will be more difficult because this requires the higher cost operations to also participate.

The premises registration scenario (#1) reflects only costs associated with registering premises (see Section 4.1.2 for a discussion about how premises registration costs were estimated), which is significantly below the other two scenarios. However, it is also important to recognize that this represents no animal identification and no ability to trace animal movements.

Scenario #2 represents an animal identification system that reflects what is referred to as a bookend system. A bookend system simply means the cattle are identified at both ends of their lives (birth and death), but movements in between are not tracked. Because tags were a big portion of the total industry costs (table 4.9) and the bookend system still requires tags (and retags), this system has a total cost of approximately $165 million, which is 79% of the full traceability system (Scenario #3). The bookend system for cow/calf producers requires nearly the same costs (93% of full tracing costs) as the full tracing system because for cow/calf producers the bookend and full tracing systems are nearly identical only differing by reading and recording costs when animals leave the farm.

Table 4.9. Summary of Cattle Industry Costs Under Scenario #3 (full traceability)

	Beef Cow/Calf	Dairy	Background	Feedlot	Auction Yards	Packers	Industry Total
% of Animals	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Number of Operations	757,900	71,510	50,870	87,160	1,050	318	967,440
Average Inventory	33,120,600	9,158,000	17,229,903	26,964,948	38,128,769	35,017,500	100,953,011
Total Annual Cost, $	$139,764,146	$31,437,688	$12,072,978	$13,562,885	$8,765,395	$3,467,081	$209,070,173
Cost Per Animal in Inv.	$4.22	$3.43	$0.70	$0.50	$0.23	$0.10	$2.07
Cost Per Animal Marketed	$4.91	$6.21	$0.71	$0.51	$0.23	$0.10	$5.97
Total Cost Per Operation	$184	$440	$237	$156	$8,348	$10,889	$216

Table 4. 10. Breakdown of Cattle Industry Costs Under Scenario #3 (full traceability)

	Beef Cow/Calf	Dairy	Background	Feedlot	Auction Yards	Packers	Industry Total
Breakdown of Costs ($)							
Tags and Tagging Cost	**$126,277,143**	**$22,287,953**	**$3,722,199**	**$5,038,490**	**$0**	**$0**	**$157,325,784**
RFID Tag	$77,109,181	$17,953,248	$1,090,262	$1,474,334			$97,627,025
Applicator	$5,427,448	$1,041,849	$1,180,971	$1,267,772			$8,918,038
Labor	$3,001,888	$829,613	$581,894	$916,294			$5,329,689
Chute	$29,826,991	$2,073,135	$425,148	$666,169			$32,991,443
Shrink	$8,652,018	$145,099	$318,047	$516,229			$9,631,394
Injury	$2,259,617	$245,009	$125,878	$197,691			$2,828,195
Reading Costs	**$9,971,412**	**$8,831,629**	**$8,114,813**	**$8,120,096**	**$8,765,395**	**$3,467,081**	**$47,270,426**
RFID Capital	$7,520,444	$6,566,466	$5,172,111	$4,137,436			
Labor/Chute	$1,985,228	$2,029,050	$1,703,611	$2,757,631			
Shrink/Injury	$465,741	$236,113	$1,239,091	$1,225,028			
Premises Registration	**$3,515,591**	**$318,106**	**$235,965**	**$404,300**	**$0**	**$0**	**$4,473,962**
TOTAL	**$139,764,146**	**$31,437,688**	**$12,072,978**	**$13,562,885**	**$8,765,395**	**$3,467,081**	**$209,070,173**
Breakdown of Costs (%)							
Tags and Tagging Cost	**90.4%**	**70.9%**	**30.8%**	**37.1%**	**0.0%**	**0.0%**	**75.3%**
RFID Tag	55.2%	57.1%	9.0%	10.9%			46.7%
Applicator	3.9%	3.3%	9.8%	9.3%			4.3%
Labor	2.1%	2.6%	4.8%	6.8%			2.5%
Chute	21.3%	6.6%	3.5%	4.9%			15.8%
Shrink	6.2%	0.5%	2.6%	3.8%			4.6%
Injury	1.6%	0.8%	1.0%	1.5%			1.4%
Reading Costs	**7.1%**	**28.1%**	**67.2%**	**59.9%**	**100.0%**	**100.0%**	**22.6%**
RFID Capital	5.4%	20.9%	42.8%	30.5%			
Labor/Chute	1.4%	6.5%	14.1%	20.3%			
Shrink/Injury	0.3%	0.8%	10.3%	9.0%			
Premises Registration	**2.5%**	**1.0%**	**2.0%**	**3.0%**	**0.0%**	**0.0%**	**2.1%**
TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 4.11. Total Cattle Industry Cost versus Adoption Rate Under Alternative Scenarios

Scenario #1 -- Premises Registration Only

Industry Sector	Premises Registration	Adoption rate	Uniformly adopted	Lowest cost adopted first
Beef cow/calf	$3,515,591	10%	$449,391	$17,923
Dairy	$331,706	20%	$898,782	$78,209
Background	$235,965	30%	$1,348,173	$171,464
Feedlot	$404,300	40%	$1,797,564	$269,120
Auction yards	$4,871	50%	$2,246,955	$369,892
Packers	$1,477	60%	$2,696,346	$576,690
TOTAL COST	$4,493,910	70%	$3,145,737	$853,119
		80%	$3,595,128	$1,724,410
		90%	$4,044,519	$2,915,856
		100%	$4,493,910	$4,493,910

Scenario #2 -- Bookend Animal ID System

Industry Sector	Book End Cost	Adoption rate	Uniformly adopted	Lowest cost adopted first
Beef cow/calf	$129,792,734	10%	$16,526,259	$11,042,459
Dairy	$22,601,817	20%	$33,052,517	$23,173,569
Background	$3,958,165	30%	$49,578,776	$35,408,252
Feedlot	$5,442,789	40%	$66,105,034	$47,857,435
Auction yards	$0	50%	$82,631,293	$61,313,638
Packers	$3,467,081	60%	$99,157,551	$79,128,199
TOTAL COST	$165,262,586	70%	$115,683,810	$98,289,501
		80%	$132,210,068	$118,145,015
		90%	$148,736,327	$140,285,046
		100%	$165,262,586	$165,262,586

Scenario #3 -- Full Traceability Animal ID System

Industry Sector	Traceability Cost	Adoption rate	Uniformly adopted	Lowest cost adopted first
Beef cow/calf	$139,764,146	10%	$20,907,017	$13,269,613
Dairy	$31,437,688	20%	$41,814,035	$28,030,002
Background	$12,072,978	30%	$62,721,052	$43,179,355
Feedlot	$13,562,885	40%	$83,628,069	$58,940,210
Auction yards	$8,765,395	50%	$104,535,087	$76,084,734
Packers	$3,467,081	60%	$125,442,104	$98,847,876
TOTAL COST	$209,070,173	70%	$146,349,121	$122,563,473
		80%	$167,256,139	$147,191,641
		90%	$188,163,156	$175,868,526
		100%	$209,070,173	$209,070,173

5. Direct Cost Estimates: Porcine

DIRECT COSTS OF NAIS ADOPTION WERE ESTIMATED for the swine (porcine) industry by breaking the industry into six main groups (referred to as operation types): 1) Farrow-to-Wean, 2) Farrow-to-Feeder, 3) Farrow-to-Finish, 4) Wean-to-Feeder (Nursery), 5) Feeder-to-Finish (Grow/Finish), and 6) Packers. The first five are referred to as production-type operations. The cattle industry included an auction market sector; however, because the vast majority of hogs are marketed direct this sector is not included for the swine industry. Estimating costs separately for different types of operations makes it possible to see how different sectors of the swine industry would be impacted with the adoption of an animal identification system.

The Farrow-to-Wean group was defined as producers who own gilts and sows and produce baby pigs that are sold as weaner pigs at weaning. Farrow-to-Feeder operations own gilts and sows and produce pigs that are held through the nursery phase and sold as feeder pigs (i.e., they feed the weaned pigs to weights of 50-60 pounds). Farrow-to-Finish operations own gilts and sows and produce pigs that are raised to slaughter weight at which time they are sold as market hogs to packers. Wean-to-Finish operations buy weaned pigs from Farrow-to-Wean operations and feed these pigs until they reach 50-60 pounds at which time pigs are sold to another producer for finishing. Feeder-to-Finish operations buy feeder pigs (either from Farrow-to-Feeder or Wean-to-Feeder operations) and feed them to final weight selling these market hogs to packers. Packers are defined as any operation that slaughters live animals, either market hogs or cull breeding stock, under government inspection to produce meat products for sale to the public.

The three production-type operations that include farrowing sell both pigs raised and cull breeding stock, while the other two production-type operations only market pigs/hogs (either as feeder pigs or market hogs) as they do not own breeding animals. This is an important distinction because consistent with current NAIS guidelines it was assumed that cull breeding stock would be required to be individually identified with a visual premises tag, whereas other pigs (weaned, feeder, or market) are identified with a single group/lot ID.

The following discussion of swine industry costs is partitioned by the different types of costs and according to the six operation types. Also, the following discussion pertains to costs associated with all swine being identified, either individually (cull breeding stock) or as groups (weaned, feeder, and market pigs/hogs) and movements tracked (i.e., Scenario 3 discussed in Section 4). Costs of just premises registration (Scenario 1) and just bookend (Scenario 2) systems are summarized separately later in this section.

5.1 Swine Operations

5.1.1 Operation Distributions and Production Levels

One of the objectives of this study was to determine if the implementation cost of an animal identification system varied by operation type and size. To determine if economies of size exist, costs of adopting animal identification were estimated for various operation sizes. The USDA NASS reports the number of swine operations and the percent of inventory by size groups. However, other data are only reported in aggregate (e.g., pig crop, farrowings, inventories by class). More importantly for this analysis, USDA does not routinely report any of this information specifically by operation type. Thus, rather than using USDA NASS operation size groupings directly, the total number of operations for 2007 (USDA 2008e) which includes contract operations, was disaggregated by operation type and size using data from the 2004 USDA ERS Agricultural Resource Management Survey (ARMS) (Tonsor and Featherstone, 2008). Because of this approach, operation size categories do not match up exactly with those reported by USDA NASS. That is, the four size classes used for operations in this analysis are < 500 head; 500-1,999; 2,000-4,999; and 5000+ head. This compares to six size classes in NASS data. Size classes represent the maximum number of hogs in inventory at any time during the year (McBride, Ney, and Mathews, 2008).

The swine industry has been changing rapidly and thus using the 2004 ARMS data to identify current operation types and sizes may be problematic. For example, Nigel and McBride (2007) pointed out that "In 1992, 65 percent of hogs came from farrow-to-finish operations, while only 22 percent came from specialized hog-finishing operations. By 2004, only 18 percent came from farrow-to-finish operations, while 77 percent came from specialized hog finishers" (p. 14). While using the 2004 ARMS data to disaggregate USDA NASS totals is not without problems, it was the best information that could be obtained that identified the different types of operations.

Because data used to estimate the number and size of operations, by operation type, came from two sources and time periods (2004 ARMS and 2007 NASS), estimating the average inventory and production levels of the different sized operations was not straightforward. This was especially true when trying to get production numbers to reconcile with total marketings. For operations that farrow, a number of breeding sows was "picked" for the first three size categories (i.e., < 500; 500-1,999; and 2,000-4,999), where this number of sows when combined with farrowings/sow/year and pigs/litter resulted in an average inventory on the farm that approximately matched the respective size category. The number of sows for the fourth category was solved for to reconcile the total number of pigs produced in the sector. Using this approach ensured that the total number of pigs produced by sector, and ultimately the number of market hogs slaughtered, exactly matched the NASS reported values for 2007. However, the average inventories of some of the individual size categories deviated slightly from what was expected in some cases. [7]

Average inventories for Wean-to-Feeder and Feeder-to-Finish operations were calculated in a similar fashion as the operations that included farrowing. That is, the number of pigs purchased (weaned or feeders) for the first three size categories was simply "picked" such that the average inventory matched up with the respective size categories while taking

[7] This approach does not explicitly account for pigs (weaners, feeders, and market) that are imported from Canada. However, because we worked from total marketings in 2007 we have implicitly captured the Canadian pigs, but we have possibly over estimated the costs to U.S. swine producers (i.e., some of the data recording and reporting costs would be paid by Canadian producers).

into account the number of turns these operations will have per year (i.e., groups going through facilities annually). The number of pigs purchased by operations in the fourth size category was calculated such that the total feeder pigs (Wean-to-Feeder) and market hogs (Feeder-to-Finish) coming out of the sector reconciled with totals for the industry after accounting for death loss in the nursery and finishing phases. Table 5.1 reports the average death loss rates by production phase and size of operation reported in the 2006 NAHMS swine report (USDA, 2008f) that were used in this analysis.

Table 5.2 reports the number of operations, average inventories, and production levels for the different production-type operations by size. Breeding herd inventories were based on the given number of sows (either "picked" or solved for) and a sow-to-boar ratio of 39.9. This ratio was based on a combination of NASS sows bred and boar slaughter data (USDA, 2008e) and inventory data for sows and gilts versus boars from Canada (Statistics Canada, 2008).[8] Pigs per litter varied by operation size (average sow inventory) and were based on data from the 2006 NAHMS swine report (USDA, 2008f). Farrowings per sow per year were calculated using 2007 data on total farrowings and average breeding herd inventories (USDA, 2008e) and were held constant across operation size. Total pigs produced annually for Farrow-to-Wean operations were calculated as the number of sows × pigs/litter × farrowings/sow/year. To determine feeder pigs produced for Farrow-to-Feeder operations, the number of weaned pigs produced (i.e., number of sows × pigs/litter × farrowings/sow/year) was reduced by death loss in the nursery, which varied by operation size (table 5.1). The annual number of market hogs produced by Farrow-to-Finish operations was calculated the same as feeder pig production in Farrow-to-Feeder operations with an additional adjustment to account for death loss in the grow/finish phase (table 5.1).

5.1.2 Number of Tags and Groups

To adopt NAIS, cull breeding stock (i.e., sows and boars) are assumed to be individually identified with a visual premises tag. This type of tag will have an identification (ID) number that is unique to the premises selling

[8] USDA NASS reports an inventory number for all breeding hogs, but does not report inventory data for sows and boars separately.

the hog, but not necessarily unique to the individual animal. Non culls that are marketed (i.e., weaner, feeder, and market pigs) are assumed to be identified with a unique group/lot ID number.

To determine the annual number of tags purchased, the total number of cull sows and boars needed to be calculated. Cull sow rates by size of operation from the 2006 NAHMS swine report (USDA, 2008f) were adjusted such that the total number of sows culled annually was exactly equal to the total reported sow slaughter for 2007 (USDA, 2008e). The number of cull boars was a proportion of cull sows (similar to inventory) and at a cull rate that resulted in total cull boars being equal to the boar and stag slaughter reported for 2007 (USDA, 2008e). The sum of cull sows and cull boars equaled the total visual premises tags required. It was assumed that cull breeding stock would be tagged as they were marketed and thus there would be a 100% retention rate (i.e., no tags would be lost prior to, or during marketing).

The number of lots for cull breeding stock was based on inventory levels and how often culls would be sold. It was assumed that operations with less than 50 sows would market culls twice per year; operations with 50-150 sows would market culls quarterly; operations with 150-500 sows market culls every eight weeks; and operations with more than 500 sows would market culls monthly. Thus, the number of lots of cull animals was based on the average inventory of the operation. Lot sizes for weaner, feeder, and market pigs in farrowing operations was based on the minimum of pigs produced per group of sows farrowing or 1,200 head, where the pigs produced per group was based on average inventory and pigs/litter.[9] Lot sizes for feeder and market pigs in the non-farrowing operations were based on the number of pigs purchased per turn or 1,200 head, whichever was less. Table 5.3 reports the number of tags and group/lot IDs that would be required for the different types and sizes of operations.

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[9] Sows farrowing as a group were calculated as 18.3% of total sow inventory (Dhuyvetter, Tokach, and Dritz, 2007). The maximum group size was set at 1,200 head as this coincides with the size of many nursery and finishing buildings and it was assumed producers would use an all-in all-out approach if possible.

Table 5.1. Death Loss Rate Assumptions Used in Swine NAIS Adoption Analysis

Farrowing				
Size of operation (number of sows)	Small < 250	Medium 250-499	Large 500+	All sites
Breeding age female death loss, %	2.5%	2.4%	5.0%	4.7%
Preweaning pig death loss, %	8.8%	12.2%	13.2%	12.9%
Feeding				
Size of operation (number of sows)	Small < 2,000	Medium 2,000-4,999	Large 5,000+	All sites
Death loss in nursery, %	3.4%	4.1%	4.0%	3.9%
Death loss in grow/finish, %	4.3%	4.8%	7.8%	6.0%

Table 5.2. Number of Swine Operations and Inventory and Production Levels by Type and Size of Operation

	Size of Operation, number of head				
	< 500	500-1999	2000-4999	5000+	Total/Avg
Farrow-to-Wean					
Number of operations	299	3,348	1,435	897	5,979
Average breeding herd inventory	20.5	184.5	676.6	1,845.7	3,249,807
Average inventory before death loss	55.0	494.7	2,007.6	5,476.6	9,464,705
Pigs/litter	9.2	9.2	10.3	10.3	10.2
Average farrowings/sow/year	1.96	1.96	1.96	1.96	1.96
Total farrowings/year	39.1	352.0	1,290.5	3,520.6	6,199,087
Weaned pigs sold	361.3	3,251.4	13,308.2	36,305.1	62,647,364
Total pigs sold (including breeding stock)	371.4	3,342.2	13,772.4	37,571.3	64,755,701
Farrow-to-Feeder					
Number of operations	1,805	1,418	387	688	4,297
Average breeding herd inventory	20.5	143.5	615.0	1,668.7	1,625,665
Average inventory before death loss	72.2	505.4	2,430.0	6,593.0	6,319,749
Pigs/litter	9.2	9.2	10.3	10.3	10.2
Average farrowings/sow/year	1.96	1.96	1.96	1.96	1.96
Total farrowings/year	39.1	273.8	1,173.2	3,183.1	3,100,997
Feeder pigs sold	349.0	2,442.9	11,602.3	31,511.4	30,246,388
Total pigs sold (including breeding stock)	359.1	2,513.5	12,024.3	32,656.2	31,314,955
Farrow-to-Finish					
Number of operations	8,605	6,761	3,073	2,049	20,489
Average breeding herd inventory	10.3	41.0	123.0	242.1	1,239,516
Average inventory before death loss	91.9	367.6	1,102.8	2,170.4	11,112,720
Pigs/litter	9.2	9.2	9.2	9.2	9.2
Average farrowings/sow/year	1.96	1.96	1.96	1.96	1.96
Total farrowings/year	19.6	78.2	234.6	461.8	2,364,409
Market hogs sold	167.0	668.0	1,979.0	3,775.8	19,771,901
Total pigs sold (including breeding stock)	172.0	688.1	2,039.5	3,894.9	20,381,497
Wean-to-Feeder					
Number of operations	262	1,046	2,302	1,622	5,231
Average inventory before death loss	108.9	522.7	1,519.2	3,081.0	9,068,570
Weaned pigs purchased	750.0	3,600.0	10,500.0	21,284.0	62,647,364
Feeder pigs sold	724.5	3,477.6	10,069.5	20,432.7	60,141,077
Feeder-to-Finish					
Number of operations	3,557	10,079	10,079	5,929	29,644
Average inventory before death loss	31.8	238.3	792.2	3,026.2	28,440,684
Feeder pigs purchased	100.0	750.0	2,500.0	9,698.9	90,614,814
Market hogs sold	95.7	717.8	2,380.0	8,942.4	84,579,799

Table 5.3. Number of Tags and Group/lot IDs Required by Type and Size of Operation

	Size of Operation, number of head				
	< 500	500-1999	2000-4999	5000+	Total/Avg
Farrow-to-Wean					
Cull sows sold, head	8.5	76.3	411.3	1,122.1	1,854,676
Cull boars sold, head	1.6	14.4	52.8	144.1	253,661
Total visual premises tags required	10.1	90.7	464.1	1,266.2	2,108,337
Weaned pigs sold	361	3,251	13,308	36,305	62,647,364
Average lot size, head	33.9	304.9	1,200.0	1,200.0	465.4
Number of lots sold per year	12.7	17.2	24.1	43.3	134,613
Farrow-to-Feeder					
Cull sows sold, head	8.5	59.4	373.9	1,014.6	941,677
Cull boars sold, head	1.6	11.2	48.0	130.2	126,890
Total visual premises tags required	10.1	70.6	422.0	1,144.8	1,068,567
Feeder pigs sold	349	2,443	11,602	31,511	30,246,388
Average lot size, head	33.9	237.1	1,134.3	1,200.0	385.5
Number of lots sold per year	12.3	14.3	23.2	39.3	78,462
Farrow-to-Finish					
Cull sows sold, head	4.2	17.0	50.9	100.2	512,846
Cull boars sold, head	0.8	3.2	9.6	18.9	96,749
Total visual premises tags required	5.0	20.2	60.5	119.1	609,596
Market hogs sold	167	668	1,979	3,776	19,771,901
Average lot size, head	16.9	67.7	203.2	400.0	76.9
Number of lots sold per year	11.9	11.9	13.7	15.9	257,131
Wean-to-Feeder					
Feeder pigs sold, head	725	3,478	10,070	20,433	60,141,077
Average lot size, head	109	523	1,200	1,200	1,081
Number of lots sold per year	6.7	6.7	8.4	17.0	55,628
Feeder-to-Finish					
Market hogs sold, head	96	718	2,380	8,942	84,579,799
Average lot size, head	32	238	792	1,200	732
Number of lots sold per year	3.0	3.0	3.0	7.5	115,537

Tags and Tagging Costs

5.1.3 Visual Premises Tags and Applicator Cost

In determining the cost associated with tagging cull sows and boars it was assumed that operations with average breeding herd inventories greater than 200 head already tag breeding animals for management purposes. To find the cost of visual premises tags, an internet search was conducted resulting in 20 companies located that offered visual tags. The prices ranged from a high of $1.10 to a low of $0.52, with the average cost being $0.75. The average cost was used for farrowing operations with less than 200 breeding animals (sows and boars). Farrowing operations with a breeding herd average inventory greater than 200 head were charged $0.17 per tag, which reflects the incremental cost of the NAIS premises ID tag compared to management tags currently being used (Webb, 2008). That is, because it was assumed that operations of this size are already using management tags, the unique premises ID tag could be used in place of tags currently being used for management purposes and thus only the incremental cost is included.

As this study focused on the additional cost of implementing an animal identification program, the cost of tag applicators were not included if operations were already tagging breeding animals. It was assumed that operations with less than 200 breeding animals (sows and boars) did not currently tag their animals and thus an animal identification program would require the purchase of a tag applicator. On the other hand, operations with average inventories of breeding animals exceeding 200 head were assumed to already tag sows and boars and thus there would be no additional tag applicator required.

An internet search was conducted to obtain cost estimates of conventional, plastic tag applicators. The costs of conventional applicators were obtained from multiple companies with prices ranging from a low of $15.25 to a high of $21.19, with an average of $18.62. It was assumed that the average life span of an applicator was four years and only one applicator would be needed (operations with breeding herd inventories exceeding 200 did not need any additional tag applicators). Based on an investment of $18.62, a useful life of four years, and an interest rate of 7.75%, the annual cost of an applicator was $5.59.

5.1.4 Labor and Costs for Tagging Cull Breeding Hogs

In addition to tag and tag applicator costs, producers who need to tag cull breeding hogs for an animal identification program will incur labor costs and potentially injuries related to tagging animals. It was assumed that it would take 15 minutes to setup for tagging and an additional one minute per animal tagged (Wisconsin Pork Association, 2006). The labor rate used for this study was $9.80 per hour (US Department of Labor, 2007). When tagging hogs there is a risk of injury to both the people doing the tagging and possibly to the hogs. However, because the animals needing to be tagged would typically be in a crate, it was assumed injury to the animals would be minimal and thus is not considered here. The cost of human injury associated with tagging hogs was calculated as the total labor cost times 10% as an estimate of workman's compensation. Table 5.4 reports the incremental costs related to tagging (tags, applicators, and labor) cull breeding sows and boars for the three farrowing operations by size of operation. As expected, total costs per operation increase as operation size increases, but the cost per pig sold decreases for larger operations indicating economies of size exist in tag adoption.

Table 5.4. Tag-Related Costs for Swine Operations by Type and Size of Operation.[1]

	Size of Operation, number of head				
	< 500	500-1999	2000-4999	5000+	Total/Avg
Farrow-to-Wean					
Total tags placed	10.1	90.7	464.1	1,266.2	2,108,337
Tag cost, $/tag	$0.75	$0.75	$0.17	$0.17	$0.29
Annual tag cost, $/operation	$7.58	$68.21	$79.41	$216.65	$615,910
Annual cost of tag applicators	$5.59	$5.59	$0.00	$0.00	$20,389
Setup time for tagging, minutes	15.00	15.00	15.00	15.00	89,679
Time to tag, minutes/animal	1.00	1.00	1.00	1.00	5,979
Total time to tag, hours	0.42	1.52	7.11	18.95	32,414
Total labor cost, $/operation	$4.10	$14.92	$69.64	$185.73	$317,656
Total injury cost, $/operation	$0.41	$1.49	$6.96	$18.57	$31,766
Operations that currently tag, %	0.0%	0.0%	100.0%	100.0%	
Total tagging labor cost, $/operation	$4.54	$16.52	$0.00	$0.00	$56,656
Total costs associated with tags, $/operation	$17.71	$90.32	$79.41	$216.65	$692,955
Total costs associated with tags, $/pig sold	$0.048	$0.027	$0.006	$0.006	$0.011
Farrow-to-Feeder					
Total tags placed	10.1	70.6	422.0	1,144.8	1,068,567
Tag cost, $/tag	$0.75	$0.75	$0.17	$0.17	$0.24
Annual tag cost, $/operation	$7.58	$53.05	$72.20	$195.87	$251,500
Annual cost of tag applicators	$5.59	$5.59	$0.00	$0.00	$18,018
Setup time for tagging, minutes	15.00	15.00	15.00	15.00	64,457
Time to tag, minutes/animal	1.00	1.00	1.00	1.00	4,297
Total time to tag, hours	0.39	1.24	6.48	17.16	16,769
Total labor cost, $/operation	$3.84	$12.15	$63.53	$168.16	$164,335.3
Total injury cost, $/operation	$0.38	$1.21	$6.35	$16.82	$16,434
Operations that currently tag, %	0.0%	0.0%	100.0%	100.0%	
Total tagging labor cost, $/operation	$4.25	$13.45	$0.00	$0.00	$26,736
Total costs associated with tags, $/operation	$17.42	$72.09	$72.20	$195.87	$296,253
Total costs associated with tags, $/pig sold	$0.049	$0.029	$0.006	$0.006	$0.009
Farrow-to-Finish					
Total tags placed	5.0	20.2	60.5	119.1	609,596
Tag cost, $/tag	$0.75	$0.75	$0.75	$0.17	$0.52
Annual tag cost, $/operation	$3.79	$15.16	$45.47	$20.37	$316,589
Annual cost of tag applicators	$5.59	$5.59	$5.59	$0.00	$103,094
Setup time for tagging, minutes	15.00	15.00	15.00	15.00	307,337
Time to tag, minutes/animal	1.00	1.00	1.00	1.00	20,489
Total time to tag, hours	0.32	0.53	1.10	1.92	13,670
Total labor cost, $/operation	$3.14	$5.22	$10.76	$18.81	$133,963.3
Total injury cost, $/operation	$0.31	$0.52	$1.08	$1.88	$13,396
Operations that currently tag, %	0.0%	0.0%	0.0%	100.0%	0.0%
Total tagging labor cost, $/operation	$3.48	$5.78	$11.92	$0.00	$105,644
Total costs associated with tags, $/operation	$12.86	$26.53	$62.98	$20.37	$525,327
Total costs associated with tags, $/pig sold	$0.075	$0.039	$0.031	$0.005	$0.026

[1] Only applies to operations with breeding stock (i.e., operations farrowing)

Data Recording, Reporting and Storage Costs

Because the technology assumed for the swine industry is different than the cattle industry, costs of NAIS adoption will differ. For example, it was assumed that the cattle industry would use radio frequency identification (RFID) and thus hardware and software for reading RFID tags was included. However, in the swine industry it is assumed that individual animal identification will be with visual premises ID tags for cull breeding stock and other pigs/hogs can be identified with group/lot identification. Thus, electronic readers are not required, but there will still be costs associated with recording, reporting, and storing data. The following is a brief discussion of these components.

5.1.5 Data Accumulator and Software

The data accumulator cost represents the average cost of six internet websites prices for laptop computers. This cost was annualized over four years and had a $0 salvage value. Given an initial investment of $692, a 4-year life, and an interest rate of 7.75%, the annual cost is $208. It was assumed that many operations, and especially the larger ones, would already own a computer and thus charging this cost to animal identification would not be appropriate. Data indicating computer usage by type and size of swine operations could not be found. Thus, it was assumed that computer ownership trends reported for the dairy industry in the NAHMS dairy report (USDA, 2007a) might be similar for hog operations. It was assumed that 12% of operations with less than 500 head; 49% of those with 500-1,999; 71% of operations with 2,000-4,999; and 93% of operations with 5,000+ head currently own computers and thus would not need to purchase one. To account for operations that currently own computers, the annual cost of the data accumulator (i.e., computer) was multiplied by one minus the proportion of operations that currently own computers resulting in a weighted-average cost per operation for each size category. The calculated annual cost of computers was multiplied by 50% to account for the fact that the entire cost of the computer likely should not be allocated to an animal identification program (i.e., swine operators would use the computer for other management or personal uses).

Many different software packages are available that would satisfy the software requirement of an eID system. The value used here is the suggested retail price of Microsoft Office Professional (Microsoft, 2008). This software package includes Microsoft Office Word, Office Excel, Office PowerPoint, Office Access, and other programs. While most producers would not use some of the programs included in Office Professional, Microsoft Office Word and Microsoft Office Excel or Microsoft Office Access would need to be employed to keep track of reads and to write the necessary documents. Other software packages that also maintain management information likely would be utilized by producers, but the higher cost associated with these software packages are not appropriate to include in an animal ID system as these are providing value beyond that required by NAIS. In other words, producers might choose to spend more for additional management benefits, but this is not something they would need to adopt NAIS procedures. As with data accumulators, annual software costs were adjusted by the percent of operations currently owning equipment. That is, it was assumed that if computers were already owned, software for managing the data would also be owned. Additionally, when software was purchased (i.e., those operations not currently owning computers), only 50% of the cost was allocated to the animal ID system.

5.1.6 Printing Costs Associated with Recording / Reporting Data

In addition to the hardware and software required for data analysis and reporting, it was assumed bar codes would be printed that could be sent with groups of hogs as they are marketed, i.e., affixed to bills of lading. These preprinted bar codes or labels would contain the group/lot ID required for NAIS. The cost per sheet of paper and labels that could be printed on were obtained from multiple internet sites and averaged \$0.24 per lot, assuming two labels were printed per lot.

5.1.7 Other/Fixed Charges

The time needed to submit the group/lot ID numbers to a central database and internet fees were considered here. To determine clerical costs, the time submitting a group/lot ID number and the number of groups submitted needed to be ascertained. The Wisconsin working group for pork found that it took 15 minutes to submit data (Wisconsin Pork Association, 2006). Thus, it was assumed that each lot would require 15 minutes of time to submit the data. Clerical labor was multiplied by the average secretary wage of $14.60 per hour for the US (US Department of Labor, 2007) to find the total cost associated with recording and reporting a group/lot animal ID number.

In order to be able to achieve a "48 hour trace back system" producers would need to submit their animal identification numbers (AIN) and/or group identification numbers (GIN) via an internet access point. An internet charge of $50 per month was assumed for 12 months. However, because some operations already have a computer, it was assumed they likely also had internet access so a weighted cost of internet was used similar to as done for the cost of data accumulators. As with computers and software, the calculated annual cost of internet fees was multiplied by 50% to account for the fact that the entire cost likely should not be allocated to an animal identification program (i.e., swine operators would use the internet for other management or personal uses).

5.1.8 Database Charge

According to the NAIS business plan, "The most efficient, cost-effective approach for advancing the country's traceability infrastructure is to capitalize on existing resources—mainly, animal health programs and personnel, as well as animal disease information databases" (USDA, 2007f, p. 4). As of May 2008, there were 17 approved Animal Tracking Databases or Compliant Animal Tracking Databases meeting the minimum requirements as outlined in the Integration of Animal Tracking Databases that were participating in the NAIS program and have a signed cooperative agreement with USDA Animal Plant Health Inspection Service (USDA, 2008d).

The research team attempted to contact multiple database providers to obtain costs/head (or lot) of their databases so an average cost for data storage could be ascertained. This information was not readily given out, and the information that was expressed was not specific enough for this study. To find a more accurate estimate, Kevin Kirk from Michigan's Department of Agriculture was contacted. Mr. Kirk, who oversees the Michigan State AID database, provided the total data storage cost for Michigan producers (Kirk, 2007). Based on this information, a per-head charge of $0.085 was estimated and this same value was applied to group/lot records. This charge was included for the total number of lots that were sold by an operation as opposed to the number of animals they sold.

5.1.9 Premises Registration Costs

Currently premises registration is free and many states are trying to make the process as seamless as possible and NAIS reports that 33.8% of all operations with over $1,000 income have been registered (USDA, 2008d). While the premises registration is a free service, there are potential costs incurred with registering an operation's premises (e.g., time, mileage, paperwork). To capture this cost, it was assumed that a producer would incur a cost of $20 associated with management time, travel, and supplies to register his/her premises. Theoretically, once premises are registered the registration lasts for the life of the operation as well. However, many producers will need to renew or modify their premises registration on a regular basis as their operations change. Thus, it was assumed that the lifespan of the premises registration would be three years. The cost of renewing the premises every three years was assumed to be 50% of the initial cost $10 per operation. When accounting for the time value of money, the initial premises registration cost of $20 and the renewal every three years of $10 equates to a cost of $4.64 per operation annually in current dollars.

5.1.10 Interest Costs

Investments required for an animal ID system that have useful lives of more than one year (e.g., tag applicators, computers, premises registration) were annualized using an interest rate of 7.75%. Annual operating costs such as tags for cull sows and boars, labor, internet, etc. were charged an interest cost at this same rate for the portion of the year a producer's money would be tied up.

5.1.11 Summary of Swine Costs

Table 5.5 reports fixed costs related to data recording and reporting that are similar across operation types, but vary by operation size. Fixed costs are defined as costs that do not vary based on the number of groups marketed. Because it is assumed that a higher percentage of larger operations own computers, the costs associated with data accumulator (computer), software, and internet are lower per operation for larger operations. Costs associated with premises registration were the same for all operation sizes. Table 5.6 reports the fixed and variable costs related to data recording, storage, and reporting.[10] Variable costs are defined as costs that increase as the number of groups increase. The variable costs reported in the top portion of the table are constant on a per lot basis across operation types and sizes. In the final analysis, the cost per lot was not allowed to exceed $7.39 as this would represent one-half an hour of clerical time ($14.60/hour) plus the cost of data storage per lot. It was assumed that swine producers likely would not invest in computers, software, etc. if the costs are significantly higher than what they could do manually. Thus, any of the values in the "Total data cost, $/lot" rows in table 5.6 that exceed $7.39 are replaced with $7.39 in the final analysis.

Table 5.7 summarizes total costs, both as dollars per operation and cost per pig sold, by type and size of operation. Also reported are sector totals and average cost per pig sold for each sector. The average cost per pig sold for the different sectors ranges from a low of $0.01 for Wean-to-Feeder operations to a high of $0.13 per pig for Farrow-to-Finish operations. However, within each production sector there are relatively large economies of size. For example, in the three operation types that include farrowing, costs for the largest operations are below $0.04 per pig sold but they increase to about $0.30 to $0.60 per pig sold for the smallest size operations. Likewise, in the operations that feed pigs, costs are approximately $0.01 per pig sold for the largest operations but

[10] No attempt was made to differentiate costs between operations that own swine versus contract operations. To the extent that contract operations are not responsible for data recording and reporting (i.e., this would likely be done by the owner of the pigs) our total costs of data recording/reporting for the industry are likely overestimated.

increase to $0.07 to $0.28 for the smallest Wean-to-Finish and Feeder-to-Finish operations, respectively. Figures 5.1 and 5.2 show this same data graphically for the farrowing and feeding operations, respectively.

Table 5.5. Fixed Costs Related to Data Recording and Reporting for Swine by Size of Operation[1]

	Size of Operation, number of head			
	< 500	500-1999	2000-4999	5000+
Data accumulator (computer)				
Initial investment, $/operation	$692	$692	$692	$692
Ownership adjustment, %	12.0%	48.7%	70.7%	92.7%
Adjusted investment, $/operation	$609	$355	$203	$51
Annual cost, $/operation	$183	$107	$61	$15
Percent to NAIS	50%	50%	50%	50%
Annual cost, $/operation	$91	$53	$30	$8
Software				
Initial investment, $/operation	$400	$400	$400	$400
Ownership adjustment, %	12.0%	48.7%	70.7%	92.7%
Adjusted investment, $/operation	$352	$205	$117	$29
Annual cost, $/operation	$106	$62	$35	$9
Percent to NAIS	50%	50%	50%	50%
Annual cost, $/operation	$53	$31	$18	$4
Internet				
Annual cost	$600	$600	$600	$600
Ownership adjustment, %	12.0%	48.7%	70.7%	92.7%
Adjusted annual cost, $/operation	$569	$332	$189	$47
Percent to NAIS	50%	50%	50%	50%
Annual cost, $/operation	$284	$166	$95	$24
Fixed data cost, $/operation	$429	$250	$143	$36
Premises registration				
Annual cost, $/operation	$5	$5	$5	$5

[1] Applies to all five production-type operations.

Table 5.6. Data Storage and Reporting Costs for Swine by Operation Type and Size of Operation

	Size of Operation, number of head			
	< 500	500-1999	2000-4999	5000+
Cost, $/lot				
Printing cost	$0.24	$0.24	$0.24	$0.24
Data storage cost	$0.09	$0.09	$0.09	$0.09
Clerical labor	$3.93	$3.93	$3.93	$3.93
Total variable data cost, $/lot	$4.26	$4.26	$4.26	$4.26
Farrow-to-Wean				
Number of lots sold per year	12.7	17.2	24.1	43.3
Variable data cost, $/operation	$54	$73	$103	$184
Fixed data cost, $/operation	$429	$250	$143	$36
Total data cost, $/operation	$483	$323	$245	$220
Total data cost, $/lot*	$38.11	$18.82	$10.19	$5.08
Farrow-to-Feeder				
Number of lots sold per year	12.3	14.3	23.2	39.3
Variable data cost, $/operation	$52	$61	$99	$167
Fixed data cost, $/operation	$429	$250	$143	$36
Total data cost, $/operation	$481	$311	$242	$203
Total data cost, $/lot	$39.11	$21.74	$10.41	$5.17
Farrow-to-Finish				
Number of lots sold per year	11.9	11.9	13.7	15.9
Variable data cost, $/operation	$51	$51	$59	$68
Fixed data cost, $/operation	$429	$250	$143	$36
Total data cost, $/operation	$479	$300	$201	$103
Total data cost, $/lot	$40.41	$25.34	$14.65	$6.49
Wean-to-Feeder				
Number of lots sold per year	6.7	6.7	8.4	17.0
Variable data cost, $/operation	$28	$28	$36	$73
Fixed data cost, $/operation	$429	$250	$143	$36
Total data cost, $/operation	$457	$278	$179	$108
Total data cost, $/lot	$68.71	$41.83	$21.27	$6.35
Feeder-to-Finish				
Number of lots sold per year	3.0	3.0	3.0	7.5
Variable data cost, $/operation	$13	$13	$13	$32
Fixed data cost, $/operation	$429	$250	$143	$36
Total data cost, $/operation	$442	$263	$156	$67
Total data cost, $/lot	$146.59	$87.23	$51.78	$9.03

* If this cost exceeds $7.39, it was assumed data recording/reporting would be done manually at a cost of $7.39/lot.

Table 5.7. Summary of ID Costs for Swine Operations by Type and Size of Operation

	Size of Operation, number of head				
	< 500	500-1999	2000-4999	5000+	Total/Avg
Farrow-to-Wean					
Number of lots sold per year	12.7	17.2	24.1	43.3	134,613
Number of pigs sold per year	371	3,342	13,772	37,571	64,755,701
Tag-related costs (table 5.4)	$18	$90	$79	$217	$615,910
Data-related costs*	$94	$127	$178	$220	$905,444
Premises registration costs	$5	$5	$5	$5	$27,732
Total cost, $/operation	$116	$222	$262	$441	$1,549,086
Total cost, $/pigs sold	$0.31	$0.07	$0.02	$0.01	$0.02
Farrow-to-Feeder					
Number of lots sold per year	12.3	14.3	23.2	39.3	78,462
Number of pigs sold per year	349	2,443	11,602	31,511	30,246,388
Tag-related costs (table 5.4)	$17	$72	$72	$196	$296,253
Data-related costs*	$91	$106	$172	$203	$519,906
Premises registration costs	$5	$5	$5	$5	$19,933
Total cost, $/operation	$113	$182	$249	$403	$836,092
Total cost, $/pigs sold	$0.32	$0.07	$0.02	$0.01	$0.03
Farrow-to-Finish					
Number of lots sold per year	11.9	11.9	13.7	15.9	257,131
Number of pigs sold per year	167	668	1,979	3,776	19,771,901
Tag-related costs (table 5.4)	$13	$27	$63	$20	$525,327
Data-related costs*	$88	$88	$102	$103	$1,871,146
Premises registration costs	$5	$5	$5	$5	$95,041
Total cost, $/operation	$105	$119	$169	$129	$2,491,514
Total cost, $/pigs sold	$0.63	$0.18	$0.09	$0.03	$0.13
Wean-to-Feeder					
Number of lots sold per year	6.7	6.7	8.4	17.0	55,628
Number of pigs sold per year	725	3,478	10,070	20,433	60,141,077
Tag-related costs (table 5.4)	$0	$0	$0	$0	$0
Data-related costs*	$49	$49	$62	$108	$382,420
Premises registration costs	$5	$5	$5	$5	$24,266
Total cost, $/operation	$54	$54	$67	$113	$406,686
Total cost, $/pigs sold	$0.07	$0.02	$0.01	$0.01	$0.01
Feeder-to-Finish					
Number of lots sold per year	3.0	3.0	3.0	7.5	115,537
Number of pigs sold per year	96	718	2,380	8,942	84,579,799
Tag-related costs (table 5.4)	$0	$0	$0	$0	$0
Data-related costs*	$22	$22	$22	$55	$853,949
Premises registration costs	$5	$5	$5	$5	$137,506
Total cost, $/operation	$27	$27	$27	$60	$991,455
Total cost, $/pigs sold	$0.28	$0.04	$0.01	$0.01	$0.01

* Based on minimum of $7.39/lot or Total data cost reported in table 5.6 times number of lots sold per year.

Figure 5.1. Estimated Cost of Animal Identification for Swine Farrowing Operations by Operation Size

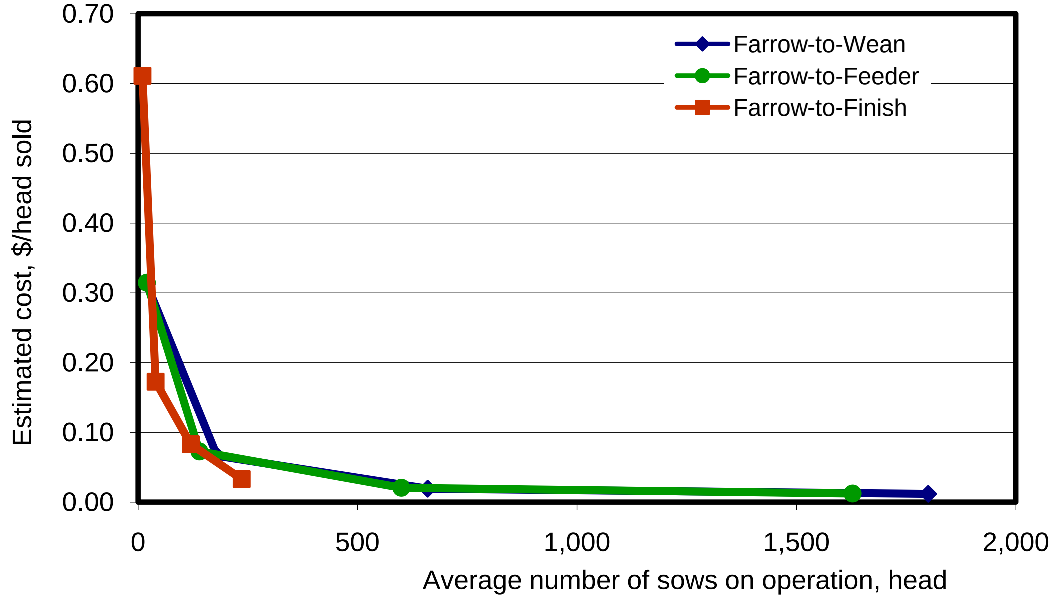
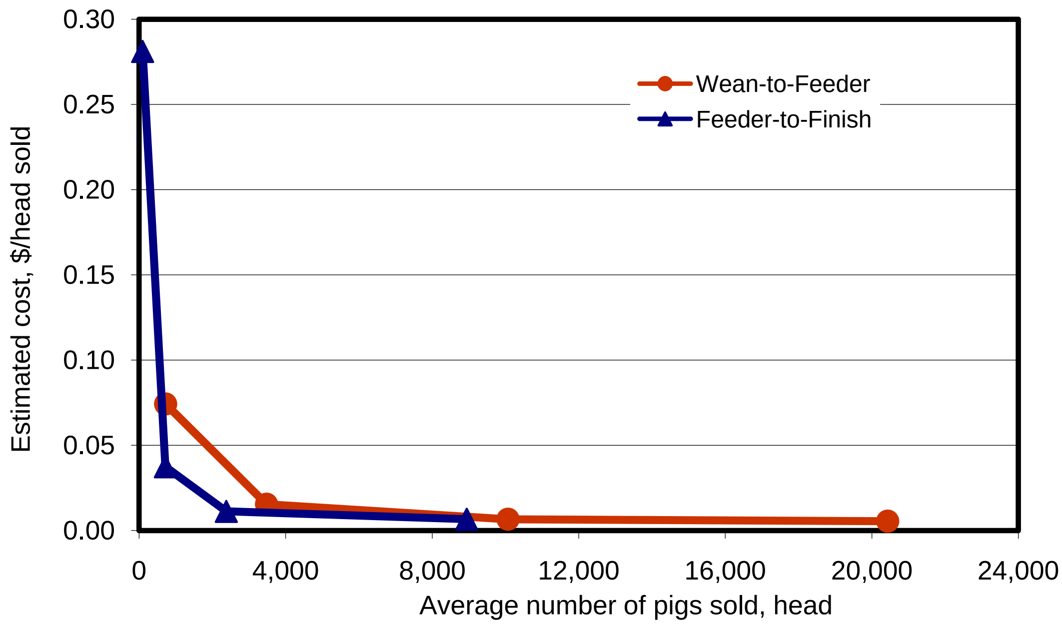


Figure 5.2. Estimated Cost of Animal Identification for Swine Feeding Operations by Operation Size



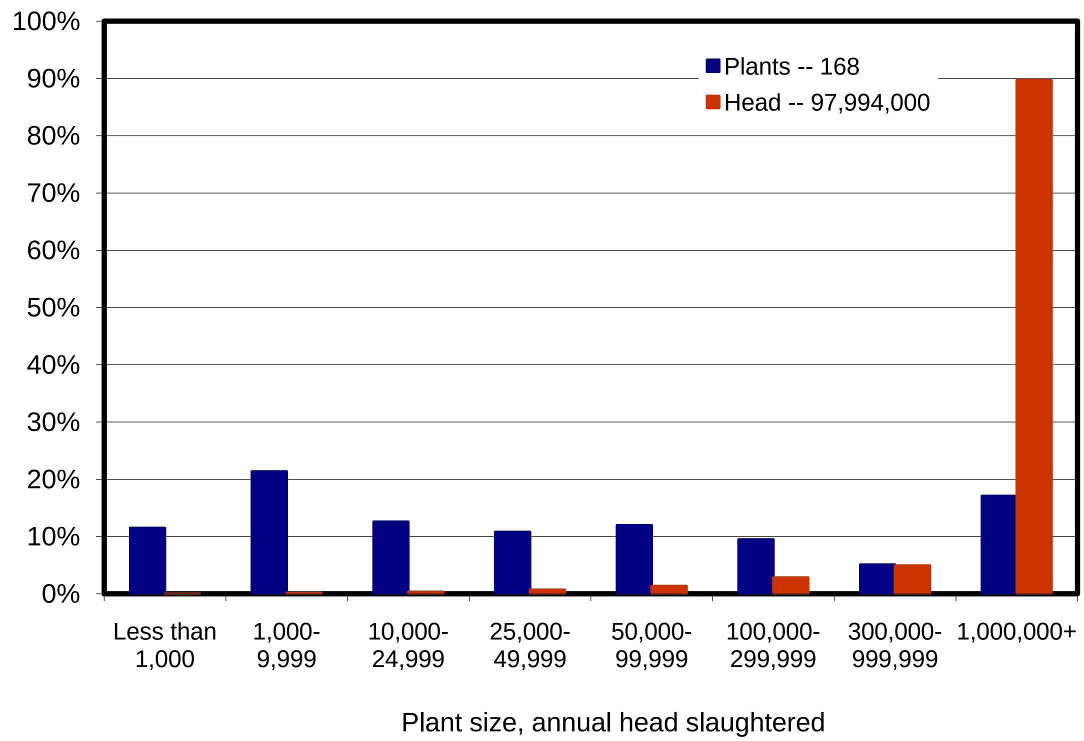
5.2 Packers

THE COSTS INCURRED AT SWINE PACKING PLANTS will depend on numerous factors, but primarily on size of the plant. While packing plants may be able to pass costs associated with an animal ID system on to their suppliers (i.e., swine producers), these costs impact the industry. Furthermore, if different size packing plants have different costs (i.e., if economies of size exist) some of these added costs may not be able to be passed on to producers due to competition within the industry. For this analysis the costs at packing plants were based on the costs of recording and reporting data pertaining to group/lot IDs, however, for very small plants "groups" might actually represent individual hogs.

5.2.1 Operation Distributions

In order to determine how a national animal identification system might impact packing plants of various sizes, a distribution of plant size was required. Information on the number and size of hog slaughter plants was obtained from USDA GIPSA (USDA, 2007g). Average values for 2001-2005 were used for the analysis and then adjusted to 2007 marketings. Figure 5.3 shows the distribution of the number of plants and their shares of hogs slaughtered. The distribution of the number of plants is relatively uniform, i.e., there are a similar number of plants of all size categories. However, the largest plants (those with over a million head slaughtered per year) account for approximately 90% of all hogs slaughtered indicating that market share is heavily skewed to the largest plants.

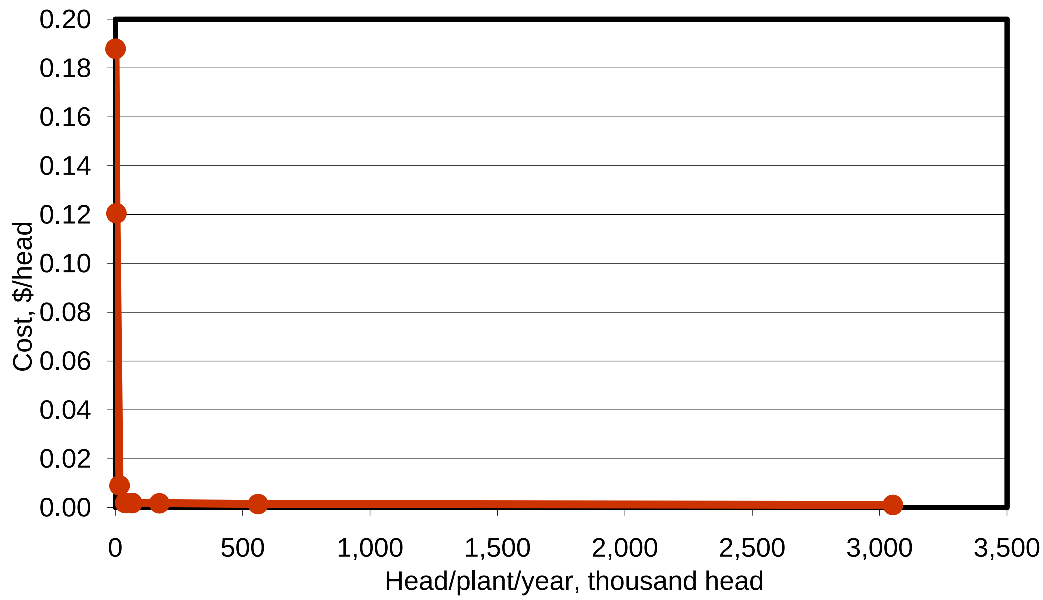
Figure 5.3. Size Distribution and Market Share of Hog Slaughter Plants by Plant Size, 2001-05 Average



5.2.2 Cost of Recording and Reporting Information

It was assumed that swine processed through a packing plant would have identification information that would need to be recorded and reported to a central database. Information can generally be handled on a group basis, but for small packing plants that buy animals individually a group ID is the same as an individual ID. Packing plant costs were estimated as a function of plant size based on survey results from packing plants of various sizes (Bass et al., 2007). For large plants, costs were estimated as a function of the groups of hogs slaughtered per year and for small plants costs were estimated based on the number of head slaughtered per year. Ultimately, the relevant measure is costs per head slaughtered. Figure 5.4 shows how the cost per head associated with reading, recording, and reporting data varies as plant size increases. The impact of plant size on cost (i.e., economies of size) is economically significant. However, most of the gain to plant size is realized at relatively small plants. Basically, for all but the smallest two sized plants (those slaughtering less than 10,000 head per year), the cost is economically insignificant.

FIGURE 5.4. ANNUAL COST OF ADOPTING ANIMAL IDENTIFICATION FOR SWINE SLAUGHTER PLANTS BY PLANT SIZE



5.2.3 SUMMARY OF PACKING PLANT COSTS

Based on recording and reporting group/lot ID information on 100% of swine being slaughtered in 2007 (109,171,600 head), the total costs to the 168 swine packing plants in the US is estimated at under $150,000, or less than $1,000 per plant.

5.3 SWINE INDUSTRY SUMMARY

TABLE 5.8 SUMMARIZES THE TOTAL COSTS to the swine industry by sector under scenario #3 (full traceability). Total costs are estimated at just under$6.5 million of which almost 40% of that is incurred in the farrow-to-finish sector. From the partial breakdown by type of cost, it can be seen that the majority of the cost (72.9%) is associated with recording/reporting data. This is not surprising given that tagging only applies to cull breeding animals using visual tags (as opposed to electronic ID). To the extent that swine operations already have data management systems in place, some of the costs assumed for recording/reporting might already be incurred and thus the actual incremental cost would be lower than the estimate provided here. Also reported in table 5.8 is the cost per pig sold by sector and the total for the industry (based on total slaughter in 2007). Based on assumptions used in this analysis, a full traceability animal identification program in the swine industry would add about $0.06 per head to the cost of hogs produced.

Within each of the sectors in the swine industry, economies of size associated with an animal identification system were generally present. Thus, smaller operations likely will be slower to adopt identification systems because they incur higher per unit costs. However, as a general rule for most sectors, most of the economies of size were typically captured quite quickly such that costs for mid-sized operations were similar to costs of the largest operations.

Table 5.9 reports the total costs to the swine industry by sector under the three different scenarios: 1) premises registration only, 2) bookend animal ID system, and 3) full traceability ID system for various adoption rates. The costs are reported for both a uniform adoption rate and a lowest-cost-first adoption rate. Given that animal identification is a voluntary program, the lowest-cost-first adoption rate likely better reflects what costs would be to the industry with something less than 100% adoption. Note that at 100% adoption the two methods have equal costs. It can be seen in the lowest-cost-first adoption column that costs increase at somewhat of an increasing rate with higher levels of adoption. This suggests that getting lower rates of adoption may not be that difficult with a voluntary program because costs are relatively low. However, to get a high adoption rate will be more difficult because this requires the higher cost operations to also participate.

The premises registration scenario (#1) reflects only costs associated with registering premises (see Section 5.1.9 for a discussion about how premises registration costs were estimated), which is significantly below the other two. However, it is also important to recognize that this represents no animal identification and no ability to trace animal movements.

Scenario #2 represents an animal identification system that reflects what is referred to as a bookend system. A bookend system simply means the swine are identified at both ends of their lives (birth and death), but movements in between are not tracked. Because recording and reporting data were a big portion of the total industry costs (table 5.8) and the bookend system would not require this information, this system has a total cost of less than $2 million, which is less than 30% of the full traceability system (Scenario #3).

Table 5.8. Summary of Annualized Animal ID Costs to Swine Industry

	Farrow-to Wean	Farrow-to-Feeder	Farrow-to-Finish	Wean-to-Feeder (Nursery)	Feeder-to-Finish (Grow/Finish)	Packers	Total
Total Operations	5,979	4,297	20,489	5,231	29,644	168	65,640
Pigs sold per year	64,755,701	31,314,955	20,381,497	60,141,077	84,579,799	109,171,600	109,171,600
Breakdown of costs ($)							
Tagging cost	$615,910	$296,253	$525,327	$0	$0		$1,437,491
Recording/reporting cost	$905,444	$519,906	$1,871,146	$382,420	$853,949	$147,489	$4,680,355
Premises registration	$27,732	$19,933	$95,041	$24,266	$137,506		$304,477
Total Annualized Cost	$1,549,086	$836,092	$2,491,514	$406,686	$991,455	$147,489	$6,422,323
Breakdown of costs (%)							
Tagging cost	39.8%	35.4%	21.1%	0.0%	0.0%	0.0%	22.4%
Recording/reporting cost	58.5%	62.2%	75.1%	94.0%	86.1%	100.0%	72.9%
Premises registration	1.8%	2.4%	3.8%	6.0%	13.9%	0.0%	4.7%
Total Annualized Cost	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Cost per pig sold, $/head*	$0.0239	$0.0267	$0.1222	$0.0068	$0.0117	$0.0014	$0.0588

* Total for industry is based on hogs slaughtered

Table 5.9. Total Swine Industry Cost versus Adoption Rate Under Alternative Scenarios

Scenario #1 -- Premises Registration Only

Industry Segment	Premises Registration	Adoption rate	Uniformly adopted	Lowest cost adopted first
Farrow-to-Wean	$27,732	10%	$30,526	$18,638
Farrow-to-Feeder	$19,933	20%	$61,052	$38,153
Farrow-to-Finish	$95,041	30%	$91,578	$58,248
Wean-to-Feeder	$24,266	40%	$122,103	$82,833
Feeder-to-Finish	$137,506	50%	$152,629	$116,895
Packers	$781	60%	$183,155	$153,609
TOTAL COST	$305,259	70%	$213,681	$190,792
		80%	$244,207	$228,349
		90%	$274,733	$266,447
		100%	$305,259	$305,259

Scenario #2 -- Bookend Animal ID System

Industry Segment	Book End Cost	Adoption rate	Uniformly adopted	Lowest cost adopted first
Farrow-to-Wean	$643,642	10%	$188,946	$115,895
Farrow-to-Feeder	$316,186	20%	$377,891	$238,321
Farrow-to-Finish	$620,368	30%	$566,837	$366,074
Wean-to-Feeder	$24,266	40%	$755,783	$524,582
Feeder-to-Finish	$137,506	50%	$944,729	$707,976
Packers	$147,489	60%	$1,133,674	$915,093
TOTAL COST	$1,889,457	70%	$1,322,620	$1,132,818
		80%	$1,511,566	$1,351,754
		90%	$1,700,512	$1,609,870
		100%	$1,889,457	$1,889,457

Scenario #3 -- Full Traceability Animal ID System

Industry Segment	Traceability Cost	Adoption rate	Uniformly adopted	Lowest cost adopted first
Farrow-to-Wean	$1,549,086	10%	$642,232	$556,877
Farrow-to-Feeder	$836,092	20%	$1,284,465	$1,132,810
Farrow-to-Finish	$2,491,514	30%	$1,926,697	$1,715,790
Wean-to-Feeder	$406,686	40%	$2,568,929	$2,315,409
Feeder-to-Finish	$991,455	50%	$3,211,162	$2,925,519
Packers	$147,489	60%	$3,853,394	$3,572,658
TOTAL COST	$6,422,323	70%	$4,495,626	$4,249,410
		80%	$5,137,859	$4,936,530
		90%	$5,780,091	$5,668,691
		100%	$6,422,323	$6,422,323

6. Direct Cost Estimates: Ovine

Ovine Operations

COSTS OF NAIS ADOPTION WERE ESTIMATED for the sheep (ovine) industry by breaking the industry into two operation types or groups – producers and packers. Attempts were made to break production sectors into those that have breeding flocks and sell lambs and those that primarily feed lambs (feedlots), however, disaggregated data generally were not available to allow this. In addition to producers and packers, the cattle industry analysis included an auction market sector; however, because a large majority of lambs are marketed direct, and due to data availability issues, this sector is not included for the sheep industry.

Producers are defined as any operation that produces sheep or purchases and feeds sheep to slaughter weight. Packers are defined as any operation that slaughters live animals, either market lambs or cull breeding stock, under government inspection to produce meat products for sale to the public.

Because most breeding animals including culls are required to be individually identified under the current scrapie program, it was assumed that breeding sheep including culls would be individually identified and lambs moving to commercial feedlots or direct to slaughter would be identified as group/lots. The following discussion of sheep industry costs is partitioned by the different types of costs and according to the two operation types. Also, the following discussion pertains to costs associated with all sheep being identified, either individually (breeding stock) or as groups (lambs) and movements tracked (i.e., Scenario 3 discussed in Section 4). Costs of just premises registration (Scenario 1) and just bookend (Scenario 2) systems are summarized separately later in this section.

6.1 Operation Distributions

One of the objectives of this study was to determine if the implementation cost of an enhanced animal identification system for sheep beyond what is currently provided by the scrapie program varied by operation size. To determine if economies of size exist, costs of adopting enhanced animal identification were estimated for various operation sizes. The USDA NASS regularly report sheep industry information statistics such as number of operations, inventories, lamb crop, etc. (USDA, 2008e). Additionally, they report a percentage breakdown of operations and total inventory for four different operation sizes: < 100 head; 100-499; 500-4,999; and > 5,000 head (USDA, 2008h). Thus, these four size categories were used as breakpoints in this study. Sheep inventories, by class, for January 2007 and 2007 total lamb crop were extracted from NASS (USDA, 2008e). These data were matched with information on the 2006 and 2007 average percentage of operations and inventory by size group (USDA, 2008h). The total head of sheep per operation for each size category was found by multiplying the total sheep in the US by the respective percentage of inventory by size of operation. A similar procedure was done to determine the number of operations for each of the size categories (i.e., total operations were multiplied by percent of operations within each category). Dividing inventory by the number of operations provided an estimate of the average number of sheep per operation for each size category.

To estimate the number of rams located per premises it was assumed that operators would have the same percentage of the total ram inventory (USDA, 2008e) as they did sheep. Multiplying these together and dividing by the number of operations in each size category the total breeding herd inventory was calculated for the four different size categories.

Table 6.1 reports the number of operations, average inventories, and production levels by size of operation. Inventory values were taken directly from NASS data and allocated to the different size operations as previously discussed. Ewe and ram lambs retained for replacement were based on NASS reported data, but then were adjusted to maintain a static herd size. That is, replacements were set equal to breeding herd disappearance (culls sold and death loss). Pre-weaning death loss on lambs and death loss on breeding stock were based on data reported in *Sheep and Lamb Predator Death Loss in the United States, 2004* (USDA, 2007h). Post-weaning death loss on lambs was imputed to attempt to reconcile total slaughter lamb numbers. Cull ewes and rams sold were calculated from inventories and cull rates reported in *Part I: Reference of Sheep Management in the United States, 2001* (USDA, 2002d).

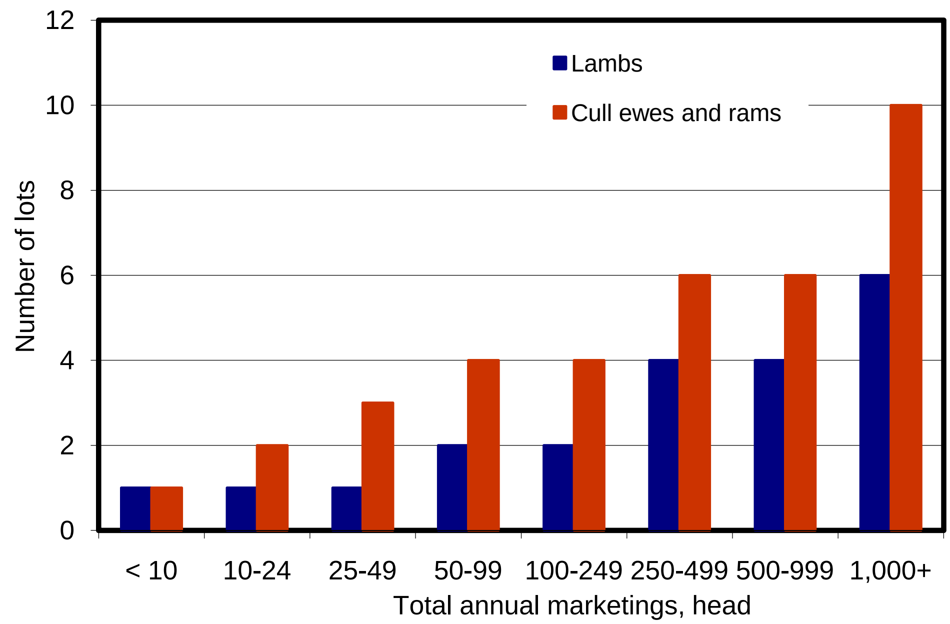
Table 6.1. Number of Sheep Operations, Inventory and Production Levels by Size of Operation

	Size of Operation, number of head				
	<100	100-499	500-4,999	5,000+	Total/Avg
Number of operations	64,202	5,294	1,024	71	70,590
Average sheep and lamb inventory, head	28.6	274.2	1,960.5	12,357.9	6,165,000
Total breeding herd inventory, head	21.4	205.1	1,466.0	9,240.9	4,610,000
Breeding ewes, head	17.1	164.4	1,175.4	7,408.8	3,696,000
Rams, head	0.9	8.7	62.0	390.9	195,000
Lamb crop before death loss, head	18.8	180.2	1,287.9	8,118.4	4,050,000
Ewe lambs retained or bought, head	4.3	40.9	292.1	1,841.5	918,651
Rams held back for replacement	0.3	2.8	19.8	124.9	62,287
Pre-weaning lamb death loss	1.8	16.9	121.1	763.1	380,700
Market lambs sold at weaning	12.5	119.6	854.9	5,388.9	2,688,362
Post-weaning lamb death loss	0.2	2.1	14.7	92.7	46,239
Market lambs sold for slaughter	12.2	117.5	840.2	5,296.2	2,642,123
Total breeding stock sold	3.3	32.2	229.9	1,448.8	722,778
Cull ewes sold, head	3.1	30.1	215.1	1,355.8	676,368
Cull rams sold, head	0.2	2.1	14.8	93.0	46,410
Total death loss, head	1.2	11.5	82.1	517.5	258,160
Total breeding stock left herd	4.5	43.6	311.9	1,966.3	980,938

6.1.2 Number of Tags and Groups

The National Scrapie Eradication Program mandates with some exceptions that any sheep that is sold other than into slaughter channels or that is older than 18 months and may be used for breeding must be individually identified with an official scrapie program identification device or tattoo (Sheep Working Group, 2006). Based on recommendations from the Sheep Working Group (2006), it was assumed that the NAIS program for sheep would follow the same rules when determining if a producer will need to individually identify sheep and the AID tag used would be the metal or plastic scrapie program sheep tag. Thus, it was assumed that breeding stock including culls (i.e., ewes and rams) would be required to be individually identified with a scrapie program tag. It was assumed that all current breeding stock are already identified with scrapie tags and thus tags required would only be for replacement breeding stock and to replace lost tags. Table 6.1 reported the number of ewe and ram lambs held for replacement breeding stock and the average breeding stock inventories by operation size. Estimates of annual loss rate for plastic ear tags in breeding sheep vary widely. Ghirardi et al. (2005) report an annual loss rate of 3.3%; compared to annual losses of 8.3 to 12.8% reported by Saa, et al. (2005). Tags required annually were thus calculated as the total number of lambs held for replacement plus 6.93% (average tag loss rate) times the average breeding herd less an adjustment for death loss. Even though breeding stock needs to be individually identified with tags, cull breeding stock still will typically be sold in groups and thus the number of groups for both culls and lambs also needs to be identified. The number of group/lots was assumed to be a function of the number of sheep (culls and market lambs) sold and was based on producer opinion. Figure 6.1 shows the number of group/lots assumed for lambs (feeder and market) and cull ewes and rams at various levels of annual sheep marketings.

FIGURE 6.1. NUMBER OF GROUP/LOTS OF SHEEP MARKETED BY TOTAL ANNUAL MARKETINGS



TAGS AND TAGGING COSTS

6.1.3 TAGS AND APPLICATOR COST

Currently scrapie program tags and applicators are provided by USDA free of charge to sheep producers. The cost to USDA is approximately $0.08 per tag for metal tags and $0.27 per tag for plastic tags including costs of applicators, shipping and handling (Sutton, 2008). If the scrapie program did not exist or if USDA stopped providing tags, it is expected that tag costs would increase slightly due to increased handling costs and smaller individual orders associated with direct tag purchases by producers. To be consistent with the other species, it was assumed that producers would have to bear the cost of purchasing tags in the future, but they could do so in a similar fashion as the current scrapie program as it is considered compliant with NAIS. An average tag cost of $0.27 per tag was used, which was adjusted for volume of purchases using percentage differences from the cattle tag cost assumptions (see Section 4.1.1 in the bovine cost chapter). It was assumed that lambs (feeder and market) could be identified with unique group/lot ID and thus there were no tag costs for lambs. Because cull breeding animals are currently tagged as part of the scrapie program, the incremental cost in the short-run associated with tag applicators would be zero (i.e., they already own applicators). However, producers would have to buy their own applicators in the future as current applicators provided through the scrapie program wear out. Thus, the cost of a conventional plastic ear tag applicator of $18.62 was included with larger operations owning multiple applicators.

6.1.4 Labor and Costs for Tagging Cull Breeding Sheep

Tagging breeding sheep (replacement and retags) would take time thus incurring labor costs and potentially injuries related to tagging animals. It was assumed that producers would spend 30 minutes to setup and prepare for tagging and one minute per animal tagging. Larger operations were assumed to have more employees involved with the tagging process. Table 6.2 reports the incremental costs related to tagging (tags, applicators, and labor) breeding stock (replacement ewes and ram lambs and breeding stock that lost their tags) by size of operation. The total costs per animal sold decreases as size of operation increases because of slightly lower tag costs, but primarily due to spreading tag applicator and labor costs over more head.

Table 6.2. Tag-Related Costs for Cull Breeding Sheep by Size of Operation.

	Size of Operation, number of head				
	<100	100-499	500-4,999	5,000+	Total/Avg
Total tags placed*	5.9	57.0	407.8	2,570.4	1,282,303
Tag cost, $/tag	$0.31	$0.27	$0.25	$0.23	$0.31
Annual tag cost**	$2.09	$17.79	$116.10	$696.98	$396,678
Annual cost of tag applicators	$6	$6	$11	$61	$404,318
Total tagging labor costs*	$7	$54	$363	$2,158	$1,289,952
Total costs associated with tags, $/operation	$15	$78	$491	$2,917	$2,090,948
Total costs associated with tags, $/animal sold	$0.958	$0.511	$0.452	$0.427	$0.613

* Total tags placed equals number of replacement ewe and ram lambs (table 6.1) and replacement tags on 6.93% of breeding herd inventory (adjusted for death loss).

** Annual tag cost includes an interest charge on tag investment.

DATA RECORDING, REPORTING AND STORAGE COSTS

BECAUSE THE TECHNOLOGY ASSUMED for the sheep industry is different than the cattle industry, costs differ. For example, it was assumed that the cattle industry would use radio frequency identification (RFID) and thus hardware and software for reading RFID tags was included. However, in the sheep industry it is assumed that individual animal identification will be with visual ID tags (e.g., scrapie program tags) for breeding stock and lambs can be identified with group/lot identification. Thus, electronic readers are not required, but there are costs associated with recording, reporting, and storing data. The following is a brief discussion of these components.

6.1.5 DATA ACCUMULATOR AND SOFTWARE

The data accumulator cost represents the average cost of six internet websites prices for laptop computers. This cost was annualized over four years and had a $0 salvage value. Given an initial investment of $692, a 4-year life, and an interest rate of 7.75%, the annual cost is $208. It was assumed that many operations, and especially the larger ones, would already own a computer and thus charging this cost to animal identification would not be appropriate. Data regarding computer usage was based on the 2001 Sheep NAHMS report (USDA, 2002d). This report indicated that 9.6%, 12.1%, 16.3%, and 26.5% of operations from smallest to largest, respectively, used computers. These data were increased by 50% to account for increases over time. To account for operations that currently own computers, the annual cost of the data accumulator (i.e., computer) was multiplied by one minus the proportion of operations that currently own computers resulting in a weighted-average cost per operation for each size category. Additionally, the calculated annual cost of computers was multiplied by 50% to account for the fact that the entire cost of the computer likely should not be allocated to an animal identification program (i.e., operators would use the computer for other management or personal uses).

Many different software packages are available that would satisfy the software requirement of an eID system. The value used here is the suggested retail price of Microsoft Office Professional (Microsoft, 2008). This software package includes Microsoft Office Word, Office Excel, Office PowerPoint, Office Access, and other programs. While most producers would not use some of the programs included in Office Professional, Microsoft Office Word and Microsoft Office Excel or Microsoft Office Access would need to be employed to keep track of reads and to write the necessary documents. Other software packages that also maintain management information likely would be utilized by producers, but the higher cost associated with these software packages are not appropriate to include in an animal ID system as these are providing value beyond that required by NAIS. In other words, producers might choose to spend more for additional management benefits, but this is not something they would need to adopt NAIS procedures. As with data accumulators, annual software costs were adjusted by the percent of operations currently owning equipment. That is, it was assumed that if computers were already owned, software for managing the data would also be owned. Additionally, when software was purchased (i.e., those operations not currently owning computers), only 50% of the cost was allocated to the animal ID system.

6.1.6 Printing Costs Associated with Recording / Reporting Data

In addition to the hardware and software required for data analysis and reporting, it was assumed bar codes would be printed that could be sent with groups of sheep or lambs as they are marketed, i.e., affixed to bills of lading. That is, when selling group/lots, the seller will need to send papers with the shipment of sheep which contain the required information; this information was assumed to be contained both in text and a bar code format. This assumption was made based on the fact that auction yards and feedlots have high transaction volumes and these entities will require sellers to have bar codes on the identification papers to reduce transaction costs and human error.

This cost was calculated by finding label costs via the internet and multiplying by the cost of printing on a conventional printer. It was assumed that the producer would print two labels per group sold: one for the operator's record and one for the buyer's record. The cost per sheet of paper and labels that could be printed on were obtained from multiple internet sites and averaged $0.24 per lot, assuming two labels were printed per lot. This was then multiplied by the number of groups to be sold to find the total bar code cost.

6.1.7 Other/Fixed Charges

The time needed to submit the group/lot ID numbers to a central database and internet fees were considered here. To determine clerical costs, the time submitting a group/lot ID number and the number of groups submitted needed to be ascertained. The Wisconsin working group for pork found that it took 15 minutes to submit data (Wisconsin Pork Association (WPA), 2006). Thus, it was assumed that each lot would require 15 minutes of time to submit the data. Clerical labor was multiplied by the average secretary wage of $14.60 per hour for the US (US Department of Labor, 2007) to find the total cost associated with recording and reporting a group/lot animal ID number.

In order to be able to achieve a "48 hour trace back system" producers would need to submit their animal identification numbers (AIN) or group identification numbers (GIN) via an internet access point. [11] An internet charge of $50 per month was assumed for 12 months. However, because some operations already have a computer, it was assumed they likely also had internet access, so a weighted cost of internet was used similar to was done for the cost of data accumulators and software. Also, as with computers and software, the calculated annual cost of internet fees was multiplied by 50% to account for the fact that the entire cost likely should not be allocated to an animal identification program (i.e., operators would use the internet for other management or personal uses).

[11] It should be pointed out that achieving 48-hour traceback could be difficult for operations with large numbers of individual animal numbers on breeding stock that have to be reported if this information is not available electronically. That is, the internet would allow the information to be submitted timely, however, this would still require somebody to enter the data into computer program. This is not an issue with group lot identification.

6.1.8 Database Charge

According to the NAIS business plan, "The most efficient, cost-effective approach for advancing the country's traceability infrastructure is to capitalize on existing resources—mainly, animal health programs and personnel, as well as animal disease information databases" (USDA, 2007f). As of May 2008, there were 17 approved Animal Tracking Databases or Compliant Animal Tracking Databases meeting the minimum requirements as outlined in the Integration of Animal Tracking Databases that were participating in the NAIS program and have a signed cooperative agreement with USDA Animal Plant Health Inspection Service (USDA, 2008d).

The research team attempted to contact multiple database providers to obtain costs/head (or lot) of their databases so an average cost for data storage could be ascertained. This information was not readily given out, and the information that was expressed was not specific enough for this study. To find a more accurate estimate, Kevin Kirk from Michigan's Department of Agriculture was contacted. Mr. Kirk, who oversees the Michigan State AID database, provided the total data storage cost for Michigan producers (Kirk, 2007). Based on this information, a per-head charge of $0.085 was estimated and this same value was applied to group/lot records. This charge was assessed to every GIN (group identification number) or AIN (animal identification number) stored into the database.

6.1.9 Premises Registration Costs

Currently premises registration is free and many states are trying to make the process as seamless as possible and NAIS reports that 33.8% of all operations with over $1,000 income have been registered (USDA, 2008c). While the premises registration is a free service, there are potential costs incurred with registering an operation's premises (e.g., time, mileage, paperwork). To capture this cost, it was assumed that a producer would incur a cost of $20 associated with time, travel, and supplies to register his/her premises. Theoretically, once premises are registered the registration lasts for the life of the operation as well. However, many producers will need to renew or modify their premises registration on a regular basis as their operations change. Thus, it was assumed that the lifespan of the premises registration would be three years. The cost of renewing the premises every three years was assumed to be $10 per operation. When accounting for the time value of money, the initial premises registration cost of $20 and the renewal every three years of $10 equates to a cost of $4.64 per operation annually in current dollars.

6.1.10 Interest Costs

Investments required for an animal ID system that have useful lives of more than one year (e.g., tags in breeding stock, tag applicators, computers, premises registration) were annualized using an interest rate of 7.75%. Annual operating cost such as tags for breeding ewes and rams, labor, internet, etc. were charged an interest cost at this same rate for the portion of the year a producer's money would be tied up.

6.1.11 Summary of Sheep Costs

Table 6.3 reports fixed costs related to data recording and reporting that are similar across operation types, but vary by operation size. Fixed costs are defined as costs that do not vary based on the number of groups marketed. Because it is assumed that a higher percentage of larger operations own computers, the costs associated with data accumulator (computer), software, and internet are lower per operation for larger operations. Costs associated with premises registration were the same for all operation sizes. Table 6.4 reports the fixed and variable costs related to data recording, storage, and reporting. Variable costs are defined as costs that increase as the number of groups increase. The variable costs reported in the top portion of the table are constant on a per lot basis across operation types and sizes. In the final analysis, the data-related cost per lot was not allowed to exceed $7.39 as this would represent approximately one-half hour of clerical time plus the cost of data storage. It was assumed that sheep producers would not invest in computers, software, etc. if the costs are significantly higher than what they could do manually. Thus, any of the values in the "Total data cost, $/lot" rows in table 6.4 that exceed $7.39 are replaced with $7.39 in the final analysis.

Table 6.5 summarizes the total costs, both as total dollars per operation and total cost per animal (combination of lambs, ewes, and rams) sold, by size of operation. The average cost per animal sold ranges from a low of $0.44 for the largest operations to a high of $2.19 per head for the smallest operations indicating there are relatively large economies of size. Figure 6.2 shows these same data graphically.

Table 6.3. Fixed Costs Related to Data Recording and Reporting for Sheep by Size of Operation

	Size of Operation, number of head			
	<100	100-499	500-4,999	5,000+
Data accumulator (computer)				
Initial investment, $/operation	$692	$692	$692	$692
Ownership adjustment, %	14.4%	18.2%	24.5%	39.8%
Adjusted investment, $/operation	$592	$567	$523	$417
Annual cost, $/operation	$178	$170	$157	$125
Percent to NAIS	50%	50%	50%	50%
Annual cost, $/operation	$89	$85	$79	$63
Software				
Initial investment, $/operation	$400	$400	$400	$400
Ownership adjustment, %	14.4%	18.2%	24.5%	39.8%
Adjusted investment, $/operation	$342	$327	$302	$241
Annual cost, $/operation	$103	$98	$91	$72
Percent to NAIS	50%	50%	50%	50%
Annual cost, $/operation	$51	$49	$45	$36
Internet				
Annual cost	$600	$600	$600	$600
Ownership adjustment, %	14.4%	18.2%	24.5%	39.8%
Adjusted annual cost, $/operation	$514	$491	$453	$362
Percent to NAIS	50%	50%	50%	50%
Annual cost, $/operation	$277	$265	$244	$195
Fixed data cost, $/operation	$417	$399	$368	$294
Premises registration				
Annual cost, $/operation	$5	$5	$5	$5

Table 6.4. Data Storage and Reporting Costs for Sheep by Size of Operation

	Size of Operation, number of head			
	<100	100-499	500-4,999	5,000+
Cost, $/lot				
Printing cost	$0.24	$0.24	$0.24	$0.24
Data storage cost	$0.09	$0.09	$0.09	$0.09
Clerical labor	$3.65	$3.65	$3.65	$3.65
Total variable data cost, $/lot	$3.98	$3.98	$3.98	$3.98
Number of lots sold per year	2.0	5.0	8.0	16.0
Variable data cost, $/operation	$8	$20	$32	$64
Fixed data cost, $/operation	$417	$399	$368	$294
Total data cost, $/operation	$425	$419	$400	$357
Total data cost, $/lot*	$212.50	$83.73	$49.99	$22.33

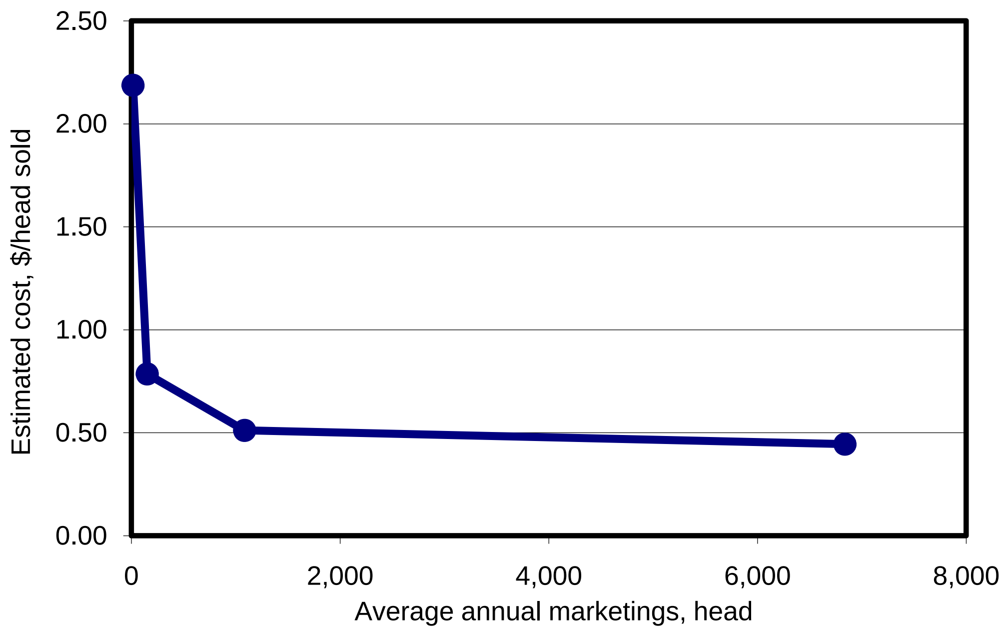
* If this cost exceeds $7.39, it was assumed data recording/reporting would be done manually at a cost of $7.39/lot.

Table 6.5. Summary of ID Costs for Sheep Operations by Type and Size of Operation

	Size of Operation, number of head				
	<100	100-499	500-4,999	5,000+	Total/Avg
Number of lots sold per year	2.0	5.0	8.0	16.0	164,192
Number of sheep sold per year	16	152	1,085	6,838	3,411,140
Tag-related costs (table 6.2)	$15	$78	$491	$2,917	$2,090,948
Data-related costs*	$15	$37	$59	$118	$1,213,562
Premises registration costs	$5	$5	$5	$5	$327,438
Total cost, $/operation	$35	$119	$554	$3,040	$3,631,949
Total cost, $/animal sold	$2.19	$0.79	$0.51	$0.44	$1.06

* Based on minimum of $7.39/lot or Total data cost reported in table 6.4 times number of lots sold per year.

FIGURE 6.2. ESTIMATED COST OF ANIMAL IDENTIFICATION FOR SHEEP OPERATIONS



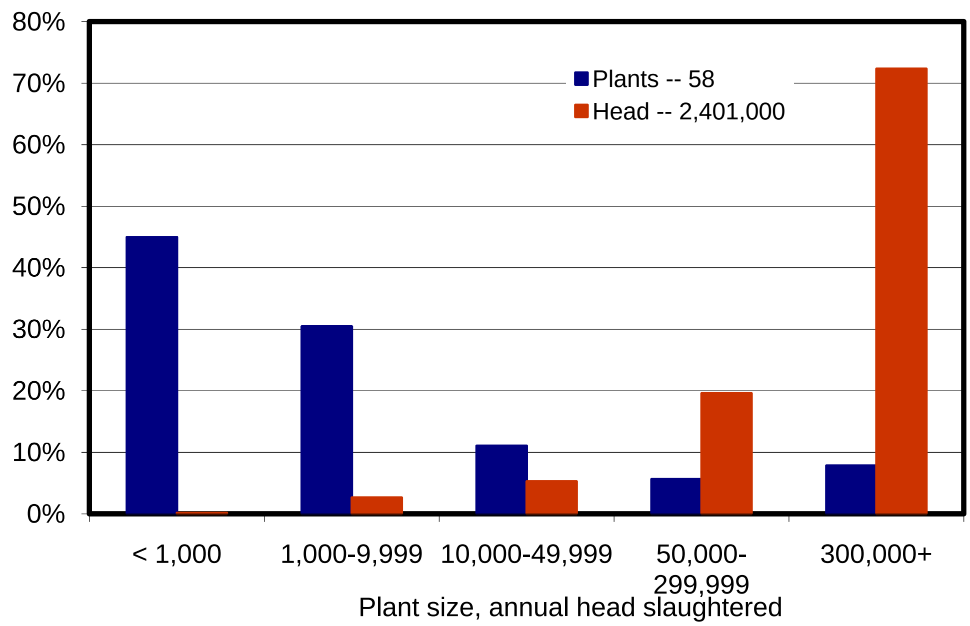
6.2 PACKERS

THE COSTS INCURRED AT LAMB PACKING PLANTS will depend on numerous factors, but primarily on size of the plant. While packing plants may be able to pass costs associated with an animal ID system on to their suppliers (i.e., sheep and lamb producers), these costs impact the industry. Furthermore, if different size packing plants have different costs (i.e., if economies of size exist) some of these added costs may not be able to be passed on to customers due to competition within the industry. For this analysis the costs at packing plants was based on the costs of recording and reporting data pertaining to group/lot IDs, however, for very small plants "groups" might actually represent individual sheep.

6.2.1 OPERATION DISTRIBUTIONS

In order to determine how a national animal identification system might impact packing plants of various sizes, a distribution of plant size was required. Information on the number and size of sheep and lamb slaughter plants was obtained from USDA GIPSA (USDA, 2007g). Average values for 2001-2005 were used for the analysis and then adjusted to 2007 marketings. Figure 6.3 shows the distribution of the number of plants and their shares of sheep slaughtered. Approximately 75% of the plants slaughter less than 10,000 head annually, but they account for only about 3% of total marketings. The largest two plants sizes represent about 13.5% of all the plants, but they account for over 90% of the total slaughter. The distribution of the number of plants is relatively uniform, i.e., there are a similar number of plants of all size categories.

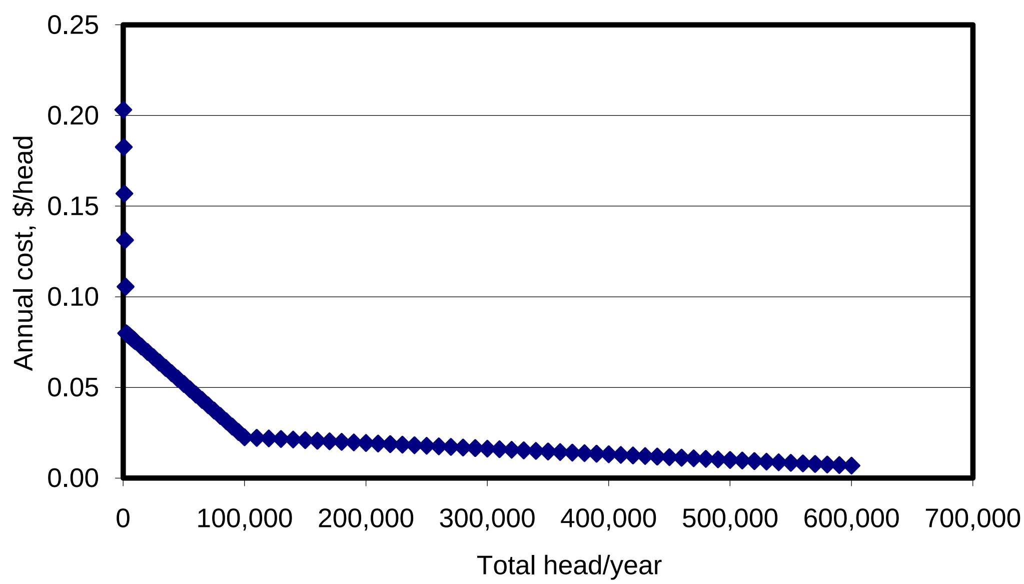
Figure 6.3. Size Distribution and Market Share of Sheep and Lamb Slaughter Plants by Plant Size, 2001-05 Average



6.2.2 Cost of Recording and Reporting Information

It was assumed that sheep processed through a packing plant would have identification information that would need to be recorded and reported to a central database. Information can generally be handled on a group basis, but for small packing plants that buy animals individually a group ID is the same as an individual ID. Packing plant costs were estimated as a function of plant size based on survey results from packing plants of various sizes (Bass et al., 2007). Costs were estimated as a function of the number of animals slaughtered per year (large plants were lambs and small plants tended to be cull breeding stock). Figure 6.4 shows how the cost per head associated with reading, recording, and reporting data varies as plant size increases. The impact of plant size on cost (i.e., economies of size) is economically significant.

FIGURE 6.4. ANNUAL COST OF ADOPTING ANIMAL IDENTIFICATION FOR SHEEP AND LAMB SLAUGHTER PLANTS BY PLANT SIZE



6.2.3 SUMMARY OF PACKING PLANT COSTS

Based on recording and reporting group/lot ID information on 100% of sheep and lambs being slaughtered in 2007 (2,693,700 head), the total costs to the 58 sheep and lamb packing plants in the US is estimated at approximately $32,000, or about $550 per plant.

SHEEP INDUSTRY SUMMARY

TABLE 6.6 SUMMARIZES THE TOTAL COSTS to the sheep industry by sector (producers and packers) under scenario #3 (full traceability). Total costs are estimated at slightly over $3.6 million. From the partial breakdown by type of cost, it can be seen that over half of the cost is based on tagging costs with slightly over a third associated with recording/reporting data. Tagging was only assumed for breeding stock, similar to what currently exists for the scrapie program. However, the costs of the tags, applicators and labor for tagging were included here even though some of these costs are currently provided by the government (e.g., tags and applicators). Costs associated with reading/reporting data were based on group lots and individual animal data handled "manually" as opposed to electronic readers. To the extent that sheep operations already have data management systems in place, some of the costs assumed for recording/reporting might already be in place and thus the actual incremental cost would be lower than the estimate provided here. Also reported in table 6.6 is the cost per head sold by sector and the total for the industry (based on total slaughter in 2007). Based on assumptions used in this analysis, a full traceability animal identification program in the sheep industry would add $1.06 cost per animal (lambs, ewes, and rams) producers sell and $1.39 per animal slaughtered. The reason the producer cost is lower per head is because it reflects the fact that sheep are sold multiple times before being slaughtered. This cost is relevant for producers analyzing how their costs are impacted with an animal identification program. However, from an industry perspective, the $1.39 is the relevant cost as this indicates how the cost of lamb (and mutton) is impacted relative to competing protein sources.

In both the production and packer sectors, economies of size associated with an animal identification system were generally present. Thus, smaller operations likely will be slower to adopt identification systems because they incur higher per unit costs. However, as a general rule for most sectors, most of the economies of size were typically captured quickly such that costs for mid-sized operations were similar to costs of the largest operations.

Table 6.7 reports the total costs to the sheep industry by sector under the three different scenarios: 1) premises registration only, 2) bookend animal ID system, and 3) full traceability ID system for various adoption rates. The costs are reported for both a uniform adoption rate and a lowest-cost-first adoption rate. Given that NAIS is a voluntary program, the lowest-cost-first adoption rate likely better reflects what costs would be to the industry with something less than 100% adoption. Note that at 100% adoption the two methods have equal costs.

The premises registration scenario (#1) reflects only costs associated with registering premises (see Section 6.1.9 for a discussion about how premises registration costs were estimated), which is significantly below the other two. However, it is also important to recognize that this represents no animal identification and no ability to trace animal movements. The scrapie program that currently exists allows for better traceability of sheep than only premises registration.

Scenario #2 represents an animal identification system that reflects what is referred to as a bookend system. A bookend system simply means the sheep and lambs are identified at both ends of their lives (birth and death), but movements in between are not tracked. Because recording and reporting data were a relatively large portion of the total industry costs (table 6.6) and the bookend system would not require this information, the costs of this system are only about two-thirds of the costs of the full traceability system (Scenario #3). Scenario #2 would be similar to the current scrapie program in terms of tracing breeding sheep and it would somewhat enhance the traceability of slaughter lambs, which currently are not identified at all. Scenario #3 would enhance the traceability further for both breeding and slaughter sheep by recording and reporting animal movement.

Table 6.6. Summary of Annualized Animal ID Costs to Sheep Industry Under Scenario #3 (full traceability)

	All Operations	Packers	Total
Total operations	70,590	58	70,590
Sheep and lambs sold per year	3,411,140	2,642,123	2,642,123
Breakdown of costs ($)			
Tagging Cost	$2,090,948		$2,090,948
Reader/Reading Cost	$1,213,562	$32,012	$1,245,574
Premises Registration	$327,438		$327,438
Total Cost, Annualized	$3,631,949	$32,012	$3,663,961
Breakdown of costs (%)			
Tagging Cost	57.6%	0.0%	57.1%
Reader/Reading Cost	33.4%	100.0%	34.0%
Premises Registration	9.0%	0.0%	8.9%
Total Cost, Annualized	100.0%	100.0%	100.0%
Cost per sheep sold, $/head*	$1.06	$0.01	$1.39

* Includes lambs and cull ewes and rams, total for industry is based on total head slaughtered

Table 6.7. Total Sheep Industry Cost versus Adoption Rate Under Alternative Scenarios

Scenario #1 -- Premises Registration Only

Industry Segment	Premises Registration	Adoption rate	Uniformly adopted	Lowest cost adopted first
All Operations	$327,438	10%	$35,945	$14,865
Packers	$32,012	20%	$71,890	$33,298
TOTAL COST	$359,450	30%	$107,835	$70,474
		40%	$143,780	$111,757
		50%	$179,725	$153,039
		60%	$215,670	$194,321
		70%	$251,615	$235,603
		80%	$287,560	$276,886
		90%	$323,505	$318,168
		100%	$359,450	$359,450

Scenario #2 -- Bookend Animal ID System

Industry Segment	Book End Cost	Adoption rate	Uniformly adopted	Lowest cost adopted first
All Operations	$2,418,387	10%	$245,040	$165,603
Packers	$32,012	20%	$490,080	$331,206
TOTAL COST	$2,450,398	30%	$735,119	$496,809
		40%	$980,159	$662,412
		50%	$1,225,199	$828,015
		60%	$1,470,239	$993,618
		70%	$1,715,279	$1,159,220
		80%	$1,960,319	$1,344,147
		90%	$2,205,358	$1,617,275
		100%	$2,450,398	$2,450,398

Scenario #3 -- Full Traceability Animal ID System

Industry Segment	Traceability Cost	Adoption rate	Uniformly adopted	Lowest cost adopted first
All Operations	$3,631,949	10%	$366,396	$286,959
Packers	$32,012	20%	$732,792	$573,918
TOTAL COST	$3,663,961	30%	$1,099,188	$860,877
		40%	$1,465,584	$1,147,837
		50%	$1,831,980	$1,434,796
		60%	$2,198,376	$1,721,755
		70%	$2,564,772	$2,008,714
		80%	$2,931,168	$2,314,996
		90%	$3,297,564	$2,709,481
		100%	$3,663,961	$3,663,961

7. Direct Cost Estimates: Poultry

Poultry Operations

Direct costs of NAIS adoption were estimated for the poultry industry by breaking the industry into three main groups (referred to as operation types): 1) Layers, 2) Broilers, and 3) Turkeys. The vast majority of poultry are marketed direct so an auction market sector is not included in the poultry industry cost estimation. Estimating costs separately for different types of operations makes it possible to see how different sectors of the poultry industry would be impacted with adoption of an animal identification system.

The Layer group was defined as producers who raise hens and produce eggs that are sold to the public. Broiler and Turkey operations raise meat poultry that are either owned privately or contracted by an integrator to feed. Packers are defined as any operation that slaughters live animals, either broilers, turkeys, or cull breeding stock, under government inspection to produce meat products for sale to the public. However, due to the vertically integrated nature of the poultry industry, costs were not estimated separately for packers. Hence the cost of recording and reporting group/lots at the packer level is already accounted for at the production level.

Layer operations market both eggs and cull hens, while the other two production-type operations only market poultry ready to be slaughtered as they do not typically own breeding animals. The game bird industry, family (backyard) flocks, road-side auctions, and hatcheries were not included in cost estimates here as the complexity and lack of information on these types of operations prevented any type of reliable analysis.

The following discussion of poultry industry costs is partitioned by the different types of costs and according to the three operation types. Also, the following discussion pertains to costs associated with all poultry group/lots being identified and movements tracked (i.e., Scenario 3 listed above). Costs of just premises registration (Scenario 1) are summarized later in this section. The bookend scenario (Scenario 2) is not considered for poultry due to the integrated nature of the industry.

7.1 Operation Distributions

Table 7.1 reports the number of operations, average inventories, annual purchases and sales, and average number of lots for the different types of operations by operation size. Data on average lot size were not readily available. Thus birds per lot were estimated by operation size after accounting for death loss, length of production cycle (i.e., inventory turns/year) and based on the assumption that larger layer operations would generally sell spent hens in larger lot sizes.

7.1.1 Layers

The average number of layers a producer had was calculated using data from the 2002 Census (USDA, 2002b). The Census reported the number of poultry operations, which includes contract operations, and the total 20-weeks-or-older inventory of layers for these operations grouped by operation size. To estimate the average number of layers for each size category, total inventories were divided by the respective numbers of operations.

The number of group/lots was estimated based on the number of spent (culled) hens sold and an average turnover rate. To find the number of culled hens sold, the average number of dead hens (NAHMS, 1999) was subtracted from the average laying hen inventory and this was multiplied by the average turnover of layers in a year. Hen turnover was calculated by dividing the number of weeks in a year by the average number of weeks a layer is in production (Meunier and Latour, undated), adding a week to account for downtime. The following rules were used to determine number of lots sold by operation size, where the first value is birds sold per year and the value in parenthesis is maximum birds per lot: 0-499 (100), 500-2,499 (500), 2,500-4,999 (1,000), 5,000-49,999 (5,000), 50,000 and above (10,000). Using these rules the average number of lots sold per operation, by operation size, was estimated.

7.1.2 Broilers

The average number of broilers a producer had was calculated using data from the 2002 Census (USDA, 2002b) along with information on the average length of feeding period. The Census reported the number of operations and the total broilers sold by operation grouped by size. The total number sold was divided by 6.5 turns per year to provide an estimate of the average inventory, where the 6.5 was based on an average feeding period of seven weeks (Jacob and Mather, 2003; National Chicken Council, 2008) plus one week of cleanup time between groups. Dividing the estimated inventory by the number of operations provided an average broiler inventory for each size category.

The average number of lots sold per operation was estimated based on the 6.5 turns per year (52 weeks divided by eight weeks) assumption and setting a maximum lot size of 20,000 birds per lot. This maximum of 20,000 birds per group was based on the size of a typical grow-out house (National Chicken Council, 2008). Therefore, for operations that had more than 20,000 broilers per group, the total number of broilers per group was divided by 20,000 to find the number of lots that would require a unique GIN.

7.1.3 Turkeys

The average number of turkeys a producer had was calculated using data from the 2002 Census (USDA, 2002b) along with information on the average feeding period length. The Census reported the number of operations, which includes contract growers and the total turkeys sold by the operations grouped by size. The total number sold was divided by 2.3 turns per year to provide an estimate of the average inventory, where the 2.3 was based on an average feeding period of 151 days plus allowing one week cleanup time between groups. Dividing this estimated total inventory by the number of operations provided an estimate of the average turkey inventory for each operation size category.

The average number of lots sold per operation was estimated based on the 2.3 turns per year (365 days divided by 158 days) assumption and setting a maximum lot size of 10,000 birds per lot. Thus, for operations that had more than 10,000 turkeys per group, the total number of turkeys was divided by 10,000 to find the number of lots that would require a unique GIN.

7.2 GROUP/LOTS

IT WAS ASSUMED THAT POULTRY OPERATIONS would employ a Group Identification Number (GIN) to adopt NAIS, and that no physical animal identification or group identification tags would be applied to the animals. The average size of group/lots was estimated as described in the preceding section and the average number of lots sold per operation are reported in table 7.1. To estimate the cost of recording/reporting group lot movement information, the number of lots reported in table 7.1 was doubled to account for producers first receiving groups of poultry and then subsequently shipping them to a processor.

Table 7.1. Summary of Poultry Industry Operations and Operation Sizes by Type

Layers (average inventory of 20-weeks old or older layers)

	1-49	50-99	100-399	400 - 3,199	3,200-9,999	10,000-19,999	20,000-49,999	50,000-99,999	100,000 +	Total (thousands)
Number of operations	82,693	7,431	3,684	487	672	1,421	1,127	302	498	98.3
Average inventory	17	60	151	1,041	7,517	14,564	28,098	70,981	507,454	334,435
Average lots sold	1.0	1.0	1.0	4.0	5.8	5.6	10.8	27.2	38.9	147.2
Number sold annually	6.3	22.8	57.9	399	2,878	5,575	10,757	27,173	194,267	128,031
Number purchased annually	7.4	26.7	67.8	467	3,370	6,529	12,595	31,819	227,479	149,919

Broilers (annual broilers sold)

	1-1,999	2,000-15,999	16,000-29,999	30,000-59,999	60,000-99,999	100,000-199,999	200,000-299,999	300,000-499,999	500,000-749,000	750,000 +	Total (thousands)
Number of operations	10,869	406	206	444	1,060	3,311	4,653	5,754	3,092	2,211	32.0
Average inventory	16	1,085	3,292	6,819	12,230	23,094	37,513	58,429	91,148	188,977	1,304,158
Average lots sold	6.5	6.5	6.5	6.5	6.5	7.5	12.2	19.0	29.7	61.6	504.0
Number sold annually	105	7,073	21,459	44,443	79,716	150,525	244,502	380,835	594,087	1,231,727	8,500,313
Number purchased annually	114	7,660	23,242	48,137	86,341	163,035	264,823	412,486	643,462	1,334,097	9,206,780

Turkeys (annual turkeys sold)

	1-1,999	2,000-7,999	8,000-15,999	16,000-29,999	30,000-59,999	60,000-99,999	100,000 +	Total (thousands)
Number of operations	5,590	93	126	290	789	748	800	8.4
Average inventory	17	2,000	5,247	9,681	18,657	32,228	100,045	122,611
Average lots sold	2.3	2.3	2.3	2.3	4.3	7.4	23.1	41.5
Number sold annually	38.9	4,619	12,121	22,365	43,100	74,451	231,116	283,248
Number purchased annually	42.6	5,069	13,302	24,544	47,300	81,706	253,639	310,851

7.3 Data Recording, Reporting and Storage Costs

BECAUSE THE TECHNOLOGY ASSUMED for the poultry industry is different than the cattle industry, costs of NAIS adoption differ. For example, it was assumed that the cattle industry would use radio frequency identification (RFID) and thus hardware and software for reading RFID tags was included. However, in the poultry industry it was assumed that individual animal identification will not be used and the poultry can be identified with group/lot identification. Thus, electronic readers are not required, but there will still be costs associated with recording, reporting, and storing data. The following is a brief discussion of these components.

7.3.1 Data Accumulator and Software

The data accumulator cost represents the average cost of six internet websites prices for laptop computers. This cost was annualized over four years and had a $0 salvage value. Given an initial investment of $692, a 4-year life, and an interest rate of 7.75%, the annual cost is $208. It was assumed that many operations, and especially the larger ones, would already own a computer and thus charging this cost to animal identification would not be appropriate. Data indicating computer usage by type and size of poultry operations could not be found. Thus, it was assumed that computer ownership trends reported for the dairy industry in the NAHMS dairy report (USDA, 2007a) might be similar for poultry operations. Computer ownership rates used by type of operation and operation size are reported in table 7.2 (Ownership adjustment, %). To account for operations that currently own computers, the annual cost of the data accumulator (i.e., computer) was multiplied by one minus the proportion of operations that currently own computers resulting in a weighted-average cost per operation for each size category. Additionally, the calculated annual cost of computers was multiplied by 50% to account for the fact that the entire cost of the computer likely should not be allocated to an animal identification program (i.e., poultry operators would likely use the computer for other management or personal uses).

Many different software packages are available that would satisfy the software requirement of an eID system. The cost of software used here is the suggested retail price of Microsoft Office Professional (Microsoft, 2008). This software package includes Microsoft Office Word, Office Excel, Office PowerPoint, Office Access, and other programs. While most producers would not use some of the programs included in Office Professional, Microsoft Office Word and Microsoft Office Excel or Microsoft Office Access would need to be employed to keep track of group/lots and their movements and to write the necessary documents. Other software packages that also maintain management information likely would be utilized by producers, but the higher cost associated with these software packages are not appropriate to include in an animal ID system as these are providing value beyond that required by NAIS. In other words, producers might choose to spend more for additional management benefits, but this is not something they would need to adopt NAIS procedures. As with data accumulators, annual software costs were adjusted by the percent of operations currently owning computers. That is, it was assumed that if computers were already owned, software for managing the data would also be owned. Additionally, when software was purchased (i.e., those operations not currently owning computers), only 50% of the cost was allocated to the animal ID system.

7.3.2 Printing Costs Associated with Recording / Reporting Data

In addition to the hardware and software required for data recording, analysis, and reporting, it was assumed bar codes would be printed that could be sent with lots of poultry as they are marketed, i.e., affixed to bills of lading. That is, when selling group/lots, the seller will need to send papers with the shipment of birds which contain the required information. These preprinted bar codes or labels would contain the group/lot ID required for NAIS. This assumption was made based on the fact that contract growers and processors have high transaction volumes and these entities will require sellers to have bar codes on the identification papers to reduce transaction costs and human error.

This cost was calculated by finding label costs via the internet and multiplying by the cost of printing on a conventional printer. It was assumed that the producer would print two labels per group sold: one for the operator's record and one for the buyer's record. The cost per sheet of paper and labels that could be printed on were obtained from multiple internet sites and averaged $0.24 per lot, assuming two labels were printed per lot. This was then multiplied by the number of groups to be sold to find the total bar code cost.

7.3.3 Other/Fixed Charge

The time needed to submit the group/lot ID numbers to a central database and internet fees were considered here. To determine clerical costs, the time submitting a group/lot ID number and the number of groups submitted needed to be ascertained. The Wisconsin working group for pork found that it took 15 minutes to submit data (Wisconsin Pork Association (WPA), 2006). Thus, it was assumed that each lot would require 15 minutes of time to submit the data. Clerical labor was multiplied by the average secretary wage of $14.60 per hour for the US (US Department of Labor, 2007) to find the total cost associated with recording and reporting a group/lot animal ID number.

In order to be able to achieve a "48 hour trace back system" producers would need to submit group/lot information via an internet access point. An internet charge of $50 per month was assumed for 12 months. However, because some operations already have a computer, it was assumed they likely also had internet access so a weighted cost of internet was used similar to as was done for the cost of data accumulators and software. Also, as with computers and software, the calculated annual cost of internet fees was multiplied by 50% to account for the fact that the entire cost likely should not be allocated to an animal identification program (i.e., poultry operators would likely use the internet for other management or personal uses).

7.3.4 Database Charge

According to the NAIS business plan, “The most efficient, cost-effective approach for advancing the country’s traceability infrastructure is to capitalize on existing resources—mainly, animal health programs and personnel, as well as animal disease information databases” (USDA, 2007f, p. 4). As of May 2008, there were 17 approved Animal Tracking Databases or Compliant Animal Tracking Databases meeting the minimum requirements as outlined in the Integration of Animal Tracking Databases that were participating in the NAIS program and have a signed cooperative agreement with USDA Animal Plant Health Inspection Service (USDA, 2008d).

The research team attempted to contact multiple database providers to obtain costs/head (or lot) of their databases so an average cost for data storage could be ascertained. This information was not readily given out, and the information that was expressed was not specific enough for this study. To find a more accurate estimate, Kevin Kirk from Michigan’s Department of Agriculture was contacted. Mr. Kirk, who oversees the Michigan State AID database, provided the total data storage cost for Michigan producers (Kirk, 2007). Based on this information, a per-head charge of $0.085 was estimated and this same value was applied to group/lot records. This charge was included for the total number of lots that were sold by an operation as opposed to the number of animals they sold.

7.3.5 Premises Registration costs

Currently premises registration is free and many states are trying to make the process as seamless as possible and NAIS reports that 32.1% of all operations with over $1,000 income have been registered (USDA, 2008d). While the premises registration is a free service, there are potential costs incurred with registering an operation’s premises (e.g., time, mileage, paperwork). To capture this cost, it was assumed that a producer would incur a cost of $20 associated with management time, travel, and supplies to register his/her premises. Theoretically, once a premises is registered it will last for the life of the operation as well. However, many producers will need to renew or modify their premises registration on a regular basis as their operations change. Thus, it was assumed that the lifespan of the premises registration would be three years. The cost of renewing the premises every three years was assumed to be $10 per operation. When accounting for the time value of money, the initial premises registration cost of $20 and the renewal every three years of $10 equates to a cost of approximately $4.64 per operation annually in current dollars.

7.3.6 Interest Costs

Investments required for an animal ID system that have useful lives of more than one year (e.g., computers, premises registration) were annualized using an interest rate of 7.75%. Annual operating cost were charged an interest cost at this same rate for the portion of the year a producer's money would be tied up.

7.4 Poultry Industry Summary

TABLES 7.2-7.4 REPORT FIXED COSTS RELATED TO DATA recording and reporting that vary by operation size for layers, broilers, and turkeys, respectively. Fixed costs are defined as costs that do not vary based on the number of groups marketed. Because it is assumed that a higher percentage of larger operations own computers, the costs associated with data accumulator (computer), software, and internet are lower per operation for larger operations. Costs associated with premises registration were the same for all operation sizes. Tables 7.5-7.7 report the fixed and variable costs related to data recording, storage, and reporting by operation size for layers, broilers, and turkeys, respectively. Variable costs are defined as costs that increase as the number of groups increase. The variable costs reported in the top portions of the tables are constant on a per lot basis across operation sizes. It can be seen that there are large economies of size in the per lot costs based on these assumptions, however, this is being driven by the investment in computers, software, and internet charges which are very high per lot for the small operations. Thus, in the final analysis, the data-related cost per lot was not allowed to exceed the cost associated with one-half hour of clerical time plus data storage (approximately $7.39). That is, it was assumed that poultry producers would not invest in computers, software, etc. if the costs are significantly higher than what they could do manually. Thus, any of the values in the "Total data cost, $/lot" rows in tables 7.5-7.7 that exceed $7.39 are replaced with $7.39 in the final analysis.

Table 7.8 summarizes the total costs, both as total dollars operation and total cost per bird (layers, broilers, and turkeys) sold by type and size of operation. For all three types of operations there are relatively large economies of size in that the smallest operations have significantly higher costs than the large operations. On average for the industry, costs per bird are $0.0195, $0.0007, and $0.0020 for layers, broilers, and turkeys, respectively. Thus, average industry costs are not particularly high, but for the smallest operations that is not the case. Thus, there would be much less incentive for small operations to adopt an animal (group) identification system due to the diseconomies of size that exist.

Table 7.2. Fixed Costs Related to Data Recording and Reporting for Layer Operations by Size of Operation.

	Layers (average inventory of 20-weeks old or older layers)								
	1-49	50-99	100-399	400-3,199	3,200-9,999	10,000-19,999	20,000-49,999	50,000-99,999	100,000+
Data accumulator (computer)									
Initial investment, $/operation	$692	$692	$692	$692	$692	$692	$692	$692	$692
Ownership adjustment, %	12.0%	30.4%	48.7%	56.0%	63.4%	70.7%	78.0%	85.4%	92.7%
Adjusted investment, $/operation	$609	$482	$355	$304	$254	$203	$152	$101	$51
Annual cost, $/operation	$183	$145	$107	$91	$76	$61	$46	$30	$15
Percent to NAIS	50%	50%	50%	50%	50%	50%	50%	50%	50%
Annual cost, $/operation	$91	$72	$53	$46	$38	$30	$23	$15	$8
Software									
Initial investment, $/operation	$400	$400	$400	$400	$400	$400	$400	$400	$400
Ownership adjustment, %	12.0%	30.4%	48.7%	56.0%	63.4%	70.7%	78.0%	85.4%	92.7%
Adjusted investment, $/operation	$352	$279	$205	$176	$147	$117	$88	$59	$29
Annual cost, $/operation	$106	$84	$62	$53	$44	$35	$26	$18	$9
Percent to NAIS	50%	50%	50%	50%	50%	50%	50%	50%	50%
Annual cost, $/operation	$53	$42	$31	$26	$22	$18	$13	$9	$4
Internet									
Initial investment, $/operation	$600	$600	$600	$600	$600	$600	$600	$600	$600
Ownership adjustment, %	12.0%	30.4%	48.7%	56.0%	63.4%	70.7%	78.0%	85.4%	92.7%
Adjusted investment, $/operation	$569	$450	$332	$284	$237	$189	$142	$95	$47
Annual cost, $/operation	50%	50%	50%	50%	50%	50%	50%	50%	50%
Percent to NAIS	$284	$225	$166	$142	$118	$95	$71	$47	$24
Fixed data cost, $/operation	$429	$339	$250	$214	$178	$143	$107	$71	$36
Premises registration									
Annual cost, $/operation	$5	$5	$5	$5	$5	$5	$5	$5	$5

Table 7.3. Fixed Costs Related to Data Recording and Reporting for Broiler Operations by Size of Operation.

	Broilers (annual broilers sold)									
	1-1,999	2,000-15,999	16,000-29,999	30,000-59,999	60,000-99,999	100,000-199,999	200,000-299,999	300,000-499,999	500,000-749,000	750,000 +
Data accumulator (Computer)										
Initial cost, $	$692	$692	$692	$692	$692	$692	$692	$692	$692	$692
Ownership adjustment, %	12%	30%	49%	71%	74%	78%	82%	85%	89%	93%
Adjusted investment, $/Operation	$609	$482	$355	$203	$177	$152	$127	$101	$76	$51
Annual cost, $/Operation	$183	$145	$107	$61	$53	$46	$38	$30	$23	$15
Percent to NAIS	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
NAIS cost, $/Operation	$91	$72	$53	$30	$27	$23	$19	$15	$11	$8
Software										
Initial cost, $	$400	$400	$400	$400	$400	$400	$400	$400	$400	$400
Ownership adjustment, %	12.0%	30.4%	48.7%	70.7%	74.4%	78.0%	81.7%	85.4%	89.0%	92.7%
Adjusted investment, $/Operation	$352	$279	$205	$117	$103	$88	$73	$59	$44	$29
Annual cost, $/Operation	$106	$84	$62	$35	$31	$26	$22	$18	$13	$9
Percent to NAIS	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
NAIS cost, $/Operation	$53	$42	$31	$18	$15	$13	$11	$9	$7	$4
Internet										
Annual cost	$600	$600	$600	$600	$600	$600	$600	$600	$600	$600
Ownership adjustment	12.0%	30.4%	48.7%	70.7%	74.4%	78.0%	81.7%	85.4%	89.0%	92.7%
Annual cost, total $	$569	$450	$332	$189	$166	$142	$118	$95	$71	$47
Percent to NAIS	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
Annual cost, $	$284	$225	$166	$95	$83	$71	$59	$47	$35	$24
Fixed data cost, $/operation	$429	$339	$250	$143	$125	$107	$89	$71	$53	$36
Premises Registration										
Annual cost, $/operation	$5	$5	$5	$5	$5	$5	$5	$5	$5	$5

Table 7.4. Fixed Costs Related to Data Recording and Reporting for Turkey Operations by Size of Operation.

	Turkeys (annual turkeys sold)						
	1-1,999	2,000-7,999	8,000-15,999	16,000-29,999	30,000-59,999	60,000-99,999	100,000+
Data accumulator (Computer)							
Initial cost, $	$692	$692	$692	$692	$692	$692	$692
Ownership adjustment, %	12.0%	49.0%	71.0%	76.5%	82.0%	87.5%	93.0%
Adjusted investment, $/Operation	$609	$353	$201	$163	$125	$87	$48
Annual cost, $/Operation	$183	$106	$60	$49	$37	$26	$15
Percent to NAIS	50%	50%	50%	50%	50%	50%	50%
NAIS cost, $/Operation	$91	$53	$30	$24	$19	$13	$7
Software							
Initial cost, $	$400	$400	$400	$400	$400	$400	$400
Ownership adjustment, %	12.0%	49.0%	71.0%	76.5%	82.0%	87.5%	93.0%
Adjusted investment, $/Operation	$352	$204	$116	$94	$72	$50	$28
Annual cost, $/Operation	$106	$61	$35	$28	$22	$15	$8
Percent to NAIS	50%	50%	50%	50%	50%	50%	50%
NAIS cost, $/Operation	$53	$31	$17	$14	$11	$8	$4
Internet							
Annual cost	$600	$600	$600	$600	$600	$600	$600
Ownership adjustment	12.0%	49.0%	71.0%	76.5%	82.0%	87.5%	93.0%
Annual cost, total $	$569	$330	$187	$152	$116	$81	$45
Percent to NAIS	50%	50%	50%	50%	50%	50%	50%
Annual cost, $	$284	$165	$94	$76	$58	$40	$23
Fixed data cost, $/operation	$429	$248	$141	$114	$88	$61	$34
Premises Registration							
Annual cost, $/operation	$5	$5	$5	$5	$5	$5	$5

Table 7.5. Data Storage and Reporting Costs for Layer Operations by Size of Operation.

	Layers (average inventory of 20-weeks old or older layers)								
	1-49	50-99	100-399	400-3,199	3,200-9,999	10,000-19,999	20,000-49,999	50,000-99,999	100,000+
Cost, $/lot									
Printing cost	$0.24	$0.24	$0.24	$0.24	$0.24	$0.24	$0.24	$0.24	$0.24
Data storage cost	$0.09	$0.09	$0.09	$0.09	$0.09	$0.09	$0.09	$0.09	$0.09
Clerical labor	$3.93	$3.93	$3.93	$3.93	$3.93	$3.93	$3.93	$3.93	$3.93
Total variable data cost, $/lot	$4.26	$4.26	$4.26	$4.26	$4.26	$4.26	$4.26	$4.26	$4.26
Software									
Number of lots sold per year	1.0	1.0	1.0	4.0	5.8	5.6	10.8	27.2	38.9
Variable data cost, $/operation	$4	$4	$4	$17	$25	$24	$46	$116	$166
Fixed data cost, $/operation	$429	$339	$250	$214	$178	$143	$107	$71	$36
Total data cost, $/operation	$433	$344	$254	$231	$203	$167	$153	$187	$201
Total data cost, $/lot*	$433.00	$343.60	$254.20	$58.01	$35.27	$29.87	$14.21	$6.89	$5.18

* If this cost exceeds $7.39, it was assumed data recording/reporting would be done manually at a cost of $7.39/lot.

Table 7.6. Data Storage and Reporting Costs for Broiler Operations by Size of Operation.

	Broilers (annual broilers sold)									
	1-1,999	2,000-15,999	16,000-29,999	30,000-59,999	60,000-99,999	100,000-199,999	200,000-299,999	300,000-499,999	500,000-749,000	750,000+
Cost, $/lot										
Printing cost	$0.24	$0.24	$0.24	$0.24	$0.24	$0.24	$0.24	$0.24	$0.24	$0.24
Data storage cost	$0.09	$0.09	$0.09	$0.09	$0.09	$0.09	$0.09	$0.09	$0.09	$0.09
Clerical labor	$3.93	$3.93	$3.93	$3.93	$3.93	$3.93	$3.93	$3.93	$3.93	$3.93
Total variable data cost, $/lot	$4.26	$4.26	$4.26	$4.26	$4.26	$4.26	$4.26	$4.26	$4.26	$4.26
Software										
Number of lots sold per year	6.5	6.5	6.5	6.5	6.5	7.5	12.2	19.0	29.7	61.6
Variable data cost, $/operation	$28	$28	$28	$28	$28	$32	$52	$81	$127	$262
Fixed data cost, $/operation	$429	$339	$250	$143	$125	$107	$89	$71	$53	$36
Total data cost, $/operation	$457	$367	$278	$171	$153	$139	$141	$152	$180	$298
Total data cost, $/lot*	$70.04	$56.32	$42.61	$26.16	$23.42	$18.48	$11.55	$8.01	$6.06	$4.84

* If this cost exceeds $7.39, it was assumed data recording/reporting would be done manually at a cost of $7.39/lot.

Table 7.7. Data Storage and Reporting Costs for Turkey Operations by Size of Operation.

	Turkeys (annual turkeys sold)						
	1-1,999	2,000-7,999	8,000-15,999	16,000-29,999	30,000-59,999	60,000-99,999	100,000+
Cost, $/lot							
Printing cost	$0.24	$0.24	$0.24	$0.24	$0.24	$0.24	$0.24
Data storage cost	$0.09	$0.09	$0.09	$0.09	$0.09	$0.09	$0.09
Clerical labor	$3.93	$3.93	$3.93	$3.93	$3.93	$3.93	$3.93
Total variable data cost, $/lot	$4.26	$4.26	$4.26	$4.26	$4.26	$4.26	$4.26
Software							
Number of lots sold per year	2.3	2.3	2.3	2.3	4.3	7.4	23.1
Variable data cost, $/operation	$10	$10	$10	$10	$18	$32	$98
Fixed data cost, $/operation	$429	$248	$141	$114	$88	$61	$34
Total data cost, $/operation	$439	$258	$151	$124	$106	$93	$133
Total data cost, $/lot*	$189.85	$111.82	$65.42	$53.82	$24.61	$12.44	$5.74

* If this cost exceeds $7.39, it was assumed data recording/reporting would be done manually at a cost of $7.39/lot.

Table 7.8. Summary of ID Costs for Poultry Operations by Type and Size of Operation

	Layers (average inventory of 20-weeks old or older layers)									
	1-49	50-99	100-399	400-3,199	3,200-9,999	10,000-19,999	20,000-49,999	50,000-99,999	100,000+	Total/Avg
Number of lots sold per year	1.0	1.0	1.0	4.0	5.8	5.6	10.8	27.2	38.9	147,217
Number of layers sold per year	6.3	22.8	57.9	399	2,878	5,575	10,757	27,173	194,267	128,031,003
Data-related costs*	$7.39	$7.39	$7.39	$29.46	$42.54	$41.21	$79.50	$187.10	$201.15	$2,036,425
Premises registration costs	$4.64	$4.64	$4.64	$4.64	$4.64	$4.64	$4.64	$4.64	$4.64	$456,043
Total costs, $/operation	$12.03	$12.03	$12.03	$34.10	$47.18	$45.85	$84.14	$191.74	$205.79	$2,492,469
Total costs, $/layer	$1.9014	$0.5270	$0.2077	$0.0855	$0.0164	$0.0082	$0.0078	$0.0071	$0.0011	$0.0195

	Broilers (annual broilers sold)										
	1-1,999	2,000-15,999	16,000-29,999	30,000-59,999	60,000-99,999	100,000-199,999	200,000-299,999	300,000-499,999	500,000-749,000	750,000 +	Total/Avg
Number of lots sold per year	6.5	6.5	6.5	6.5	6.5	7.5	12.2	19.0	29.7	61.6	504,017
Number of broilers sold per year	105	7,073	21,459	44,443	79,716	150,525	244,502	380,835	594,087	1,231,727	8,500,313,357
Data-related costs*	$48.17	$48.17	$48.17	$48.17	$48.17	$55.63	$90.36	$140.74	$180.02	$298.03	$5,911,451
Premises registration costs	$4.64	$4.64	$4.64	$4.64	$4.64	$4.64	$4.64	$4.64	$4.64	$4.64	$148,463
Total costs, $/operation	$52.81	$52.81	$52.81	$52.81	$52.81	$60.27	$95.00	$145.38	$184.66	$302.67	$6,059,914
Total costs, $/broiler	$0.5008	$0.0075	$0.0025	$0.0012	$0.0007	$0.0004	$0.0004	$0.0004	$0.0003	$0.0002	$0.0007

	Turkeys (annual turkeys sold)							
	1-1,999	2,000-7,999	8,000-15,999	16,000-29,999	30,000-59,999	60,000-99,999	100,000+	Total/Avg
Number of lots sold per year	2.3	2.3	2.3	2.3	4.3	7.4	23.1	41,548
Number of turkeys sold per year	38.9	4,619	12,121	22,365	43,100	74,451	231,116	283,247,649
Data-related costs*	$17.07	$17.07	$17.07	$17.07	$31.86	$55.03	$132.60	$521,342
Premises registration costs	$4.64	$4.64	$4.64	$4.64	$4.64	$4.64	$4.64	$39,131
Total costs, $/operation	$21.71	$21.71	$21.71	$21.71	$36.49	$59.67	$137.24	$560,473
Total costs, $/turkey	$0.5589	$0.0047	$0.0018	$0.0010	$0.0008	$0.0008	$0.0006	$0.0020

* Based on minimum of $15/lot or Total data cost reported in tables 7.5-7.7 times the number of lots sold per year.

Table 7.9 reports the total costs to the poultry industry by sector under two of the three different scenarios: 1) premises registration only and 3) full traceability ID system for various adoption rates. Scenario #2 (bookend only) is not reported here as it would be the same as the full traceability scenario (#3) given the integration assumption (i.e., processors also are producers). The costs are reported for both a uniform adoption rate and a lowest-cost-first adoption rate. Given that animal identification is a voluntary program, the lowest-cost-first adoption rate likely better reflects what costs would be to the industry with something less than 100% adoption. Note that at 100% adoption the two methods have equal costs.

The premises registration scenario (#1) reflects only costs associated with registering premises (see Section 7.3.5 for a discussion about how premises registration costs were estimated), which is significantly below Scenario #3. However, it is also important to recognize that this represents no animal or group/lot identification and no ability to trace animal movements. Scenario #3 is the full traceability system costs given different adoption rates.

Table 7.9. Total Poultry Industry Cost versus Adoption Rate Under Alternative Scenarios.

Scenario #1 -- Premises Registration Only

Industry Segment	Premises Registration	Adoption rate	Uniformly adopted	Lowest cost adopted first
Layers	$456,043	10%	$64,364	$6,388
Broilers	$148,463	20%	$128,728	$13,785
Turkeys	$39,131	30%	$193,091	$27,677
TOTAL COST	$643,638	40%	$257,455	$70,125
		50%	$321,819	$150,181
		60%	$386,183	$233,730
		70%	$450,546	$322,351
		80%	$514,910	$420,178
		90%	$579,274	$531,137
		100%	$643,638	$643,638

Scenario #3 -- Full Traceability Animal ID System

Industry Segment	Traceability Cost	Adoption rate	Uniformly adopted	Lowest cost adopted first
Layers	$2,492,469	10%	$911,286	$629,118
Broilers	$6,059,914	20%	$1,822,571	$1,283,803
Turkeys	$560,473	30%	$2,733,857	$2,020,954
TOTAL COST	$9,112,856	40%	$3,645,143	$2,829,849
		50%	$4,556,428	$3,734,503
		60%	$5,467,714	$4,703,411
		70%	$6,378,999	$5,719,316
		80%	$7,290,285	$6,841,228
		90%	$8,201,571	$7,976,271
		100%	$9,112,856	$9,112,856

8. Government Cost Estimates

8.1 Executive Summary/Chapter Overview

THE PURPOSE OF THIS CHAPTER was to examine governmental benefits and costs of NAIS. The chapter lays out findings regarding past and future federal NAIS budgets and summarizes findings from evaluations of select states. The data necessary to complete a robust empirical analysis were not always available. With that constraint in mind, this chapter provides: a) budgetary information on how NAIS funds have been allocated and utilized, b) a summary of experienced and potential governmental cost savings that may result from use of NAIS resources in animal disease response and surveillance efforts, and c) viewpoints and implications from animal ID coordinators in several key US states regarding NAIS issues and associated costs. The NAIS program is estimated to cost the federal governmental around $23.8 million to $33.0 million and combined state governmental costs total $2.1 to $3.4 million annually. The NAIS program is also estimated to possibly reduce bovine tuberculosis response costs of government animal health agencies by approximately $300,000 annually. In addition to sample estimated "direct cost savings," NAIS is identified to provide the government with an array of other "indirect benefits" that are difficult to empirically value.

8.2 Federal Government Analysis

8.2.1 Historical USDA NAIS Budgets

Our analysis of federal governmental expenditures on NAIS begins with a tabulation of historical governmental expenditures directly appropriated to the NAIS program. We obtained NAIS expenditure information from three data sources: 1) USDA NAIS Business Plan (USDA, 2007e), 2) an updated version (June 2008) of the USDA business plan provided by Mr. Neil Hammerschmidt (USDA, 2008g), 3) and the US Government Accountability Office report on NAIS (GAO, 2007). Collectively, these sources identify the total amount of funds available to NAIS and the NAIS expenditures planned for fiscal years (FY) 2004 through 2009. Furthermore, the actual expenditures incurred for fiscal years 2004 through 2007 were collected. This information is summarized in tables 8.1-8.3.

Over the time period of FY 2004 to FY 2008, approximately $127.7 million was made available to USDA to implement NAIS (table 8.1). These funds are typically sub-allocated in NAIS budgets across four primary activities: 1) Information Technology, 2) Cooperative Agreements, 3) Communications and Outreach, and 4) Program Administration (USDA, 2008g). These four primary activities accounted for 14.4%, 51.2%, 9.9%, and 24.5%, respectively, of the actual NAIS obligations between FY 2004 and FY 2007 (table 8.2). These actual obligation allocations closely reflect the planned allocations of 18.1%, 50.5%, 7.7%, and 23.6%, respectively, made for the FY 2004 – FY 2008 period (table 8.3). Actual expenditures were less than planned expenditures over the FY 2004 – FY 2006 time period. Any unobligated funds were carried over, per Congress stipulation, and remained available to cover future NAIS expenditures (USDA, 2008g). This is why actual expenditures in FY 2007 were able to exceed planned expenditures by approximately $10.7 million. Furthermore, Congressional permission to carry over unobligated funds underlies USDA's ability to have planned obligations in 2008 (totaling $24.7 million) to exceed FY 2008 appropriations of $9.7 million (table 8.1).

Table 8.1. Appropriated Funds Available to Implement NAIS.

Dollars in Thousands

	Fiscal Year				
	2004 (CCC Funds)[a]	2005	2006	2007	2008	Total
Total Funds Available	$18,793	$33,197	$33,007	$33,053	$9,683	$127,732

* Sources: USDA, 2008g

[a]CCC denotes Commodity Credit Corporation

Table 8.2. Actual NAIS Obligations.

Dollars in Thousands

	Fiscal Year					
	2004	2005	2006	2007[a]	Total	% of Total
Actual Obligations						
Information Technology	$1,829	$4,140	$2,466	$6,260	$14,695	14.4%
Cooperative Agreements	$13,666	$12,936	$5,231	$20,311	$52,144	51.2%
Communications and Outreach	$2,134	$2,557	$2,422	$2,951	$10,064	9.9%
Program Administration	$357	$3,948	$6,424	$14,264	$24,993	24.5%
Total	$17,986	$23,581	$16,543	$43,786	$101,896	

* Sources: USDA, 2008g.

[a] FY 2007 actual obligations are as of September 2007 (USDA, 2008g).

Table 8.3. Planned NAIS Obligations.

Dollars in Thousands

	Fiscal Year								
	2004	2005	2006	2007	2008 Approp.	Total Approp.	% of Total Appropriated Funds	2008 Carry Over[a]	2008 Total[b]
Planned Obligations[a]									
Information Technology	$2,009	$6,858	$7,733	$5,224	$1,311	$23,135	18.1%	$2,753	$4,064
Cooperative Agreements	$14,357	$17,050	$13,882	$15,067	$4,182	$64,538	50.5%	$8,787	$12,969
Communications and Outreach	$2,137	$3,474	$1,940	$1,940	$392	$9,883	7.7%	$825	$1,217
Program Administration	$290	$5,815	$9,452	$10,822	$3,797	$30,176	23.6%	$2,635	$6,432
Total	$18,793	$33,197	$33,007	$33,053	$9,682	$127,732		$15,000	$24,682

* Sources: USDA, 2008g

[a] *2008 Carry-Over Funds* are planned expenditures using $15 million in unobligated funds from prior fiscal years (USDA, 2008c).

[b] *2008 Total* planned obligations include both Appropriated Funds ($9.7 million) and carry over funds ($15 million) (USDA, 2008c).

8.2.2 Future USDA NAIS Budgets

Table 8.4 shows three alternative future NAIS budgets. The first budget (columns 2 & 3) presents USDA's current budget plan for fiscal year 2009 (USDA, 2008g). This budget forecasts total expenditures of $24.1 million will be available. Allocations across the four primary budget activity categories are similar to actual expenditures over the FY 2004 – FY 2007 period, with small reductions (increases) in relative funding of cooperative agreements (program management).

As shown in table 8.1, the NAIS program was provided approximately $33 million in FY 2005 – 2007. As a comparison to the current forecast provided by USDA, which assumes a $24.1 million budget, table 8.4 (columns 4 & 5) also presents a budget assuming $33 million are available with allocations made consistent with actual expenditures incurred during the FY 2004 – FY 2007 time period (table 8.2).

As a final budget forecast, table 8.4 (columns 6 & 7) also provides a budget reflective of USDA plans to have NAIS information infrastructure (IT) in a "maintenance phase" by FY 2010 (USDA, 2008g). This will reduce expected IT expenditures to approximately $2 million per year (USDA, 2008g). Given these IT savings, table 8.4 presents a potential future budget of $23.8 million. Allocations to the three other core programs (Cooperative Agreement, Communications and Outreach, and Program Administration) reflect the average expenditures incurred during FY 2004 – 2007 (table 8.2).

It would be advantageous to forecast future federal NAIS budgets for alternative levels of NAIS adoption and goals. For instance, it would be useful to develop and compare NAIS budgets conditional on achieving 30%, 70%, or 90% registration of the nation's premises. However, sufficient budgetary information necessary to accurately generate these differential forecasts is simply not available at this time. Accordingly, we note that this is a subject that should be addressed in future research as a valuable area of focus given ongoing modification of NAIS goals and areas of focus.

Table 8.4. USDA NAIS Future Fiscal Year Planned and Forecasted Expenditures.

Dollars in Thousands

Planned Program Expenditures	FY 2009[a]	% of Total	$33 million budget [b]	% of Total	$23.8 million budget [c]	% of Total
Information Technology	$3,500	14.5%	$4,759	14.4%	$2,000	8.4%
Cooperative Agreements	$10,575	43.8%	$16,887	51.2%	$13,036	54.8%
Communications and Outreach	$800	3.3%	$3,259	9.9%	$2,516	10.6%
Program Administration	$9,269	38.4%	$8,094	24.5%	$6,248	26.3%
Total	$24,144		$33,000		$23,800	

[a] FY 2009 planned expenditures were obtained from USDA (USDA, 2008g).

[b] Forecasted budget of $33 million reflects USDA's forecasts as of December 2007 (USDA, 2007e).

[c] Forecasted budget of $23.8 million reflects potential reduction in *Information Technology* expenditures (USDA, 2008g and author calculations).

8.2.3 Governmental Costs of Disease Response and Surveillance

Careful examination of the costs incurred by governmental agencies in responding to animal disease events is critical in assessing the potential cost savings that NAIS may provide. That is, resources available through implementation of NAIS may be useful in governmental response or surveillance of animal diseases. Since associated response and surveillance are not a component of NAIS budgets (and hence do not fit into the preceding discussions), a separate analysis is warranted.

This animal disease response and surveillance costs section of our analysis is comprised of three main components. The first briefly highlights the magnitudes of select past animal disease events to provide some scope to the governmental costs at discussion. Subsequently, we overview the potential cost savings that may be experienced by leveraging NAIS resources with a new software application developed by APHIS for on-farm disease testing and reporting. Finally, we summarize how differences in governmental costs incurred following a range of hypothetical, simulated animal disease events characterized by varied levels of traceability capabilities should be evaluated in future research and why this was not conducted in our analysis.

8.2.3.1 Scope of Costs

It has been well documented that federal government expenditures can be substantial when responding to domestic animal disease events. While multiple events are provided by the literature, a select sample is highlighted in table 8.5. Table 8.5 documents the diversity in magnitude, duration, geographical location, and disease type that likely require governmental animal health agency responses.

Bovine tuberculosis (TB) is one endemic disease that has had ongoing concerns in the United States. Since 2002, detections of bovine TB in six different states (Arizona, California, Michigan, Minnesota, New Mexico, and Texas) have required the destruction of over 25,000 cattle and corresponding USDA owner indemnification and control expenses of over $130 million (USDA, 2007i). Moreover, since 2004 USDA has tested over 787,000 animals for bovine TB (USDA, 2007i). As evidence of state governmental cost magnitudes; in addition to federal expenditures, the state of Minnesota has spent approximately $1.4 million on TB control and eradication efforts since 2006 (Radintz, 2008).

In addition to bovine TB, USDA-APHIS conducts an ongoing bovine brucellosis eradication program. While the national herd prevalence rate is rather low (0.0001% in fiscal year 2007), APHIS routinely tests a significant number of animals. For instance, in 2007, APHIS tested 835,200 head on farms or ranches, in addition to an estimated 7.995 million head tested as part of the Market Cattle Identification (MCI) program (USDA, 2007j). While some select aggregated cost estimates are available (i.e., $138.9 million in Federal eradication efforts corresponding to the noted Exotic Newcastle event in table 8.5), information at a more allocated (e.g., salary, travel, and indemnification allocations) level of detail is difficult, if not impossible to find. Moreover, multiple USDA-APHIS reports (USDA 2004, 2006c, 2007e, 2008k) have documented the mixed success in the ability to quickly (if at all) identify critical animals and herds in responding to disease events. For instance, despite a 48-day investigation, APHIS was not able to identify the herd of origin in the 2006 BSE response in Alabama (USDA 2006b, 2008g). This is particularly important for our assessment of NAIS costs and benefits as one significant *potential* benefit that NAIS may provide is: a) an increase in the likelihood of identifying critical animals/herds and b) a reduction in governmental costs in responding to animal diseases. To thoroughly appraise these potential cost savings, solid estimates are needed of incurred governmental expenditures over a range of disease types and scopes that are further characterized by inherent differences in the traceability capabilities available in each response. Unfortunately, this detailed historical information simply was not available for this analysis.

Detailed government animal health emergency response cost information is generally not available for two primary reasons. First, traditionally the core priority of governmental responses to animal diseases is containment and eradication, not detailed record-keeping of associated resources used to arrest the disease. While this makes sense, there is certainly value as well in more thorough record-keeping of expenditures and corresponding results during a disease investigation. Second, there is not sufficient historical frequency, nor diversity of events, to facilitate a “detailed, real-world evaluation” of how even aggregate-level governmental expenditures vary when different levels of traceability capabilities are present and utilized.

8.2.3.2 Mobile Information Management (MIM) Cost Savings

A benefit offered by NAIS is a reduction in governmental expenditures associated with animal disease eradication as well as surveillance and testing. We evaluated the potential governmental costs savings at the individual herd level in on-going animal health surveillance programs. Namely, we examined the relative cost differences of conducting animal surveillance activities using technology making use of NAIS resources with surveillance activities not utilizing technology that leverages NAIS resources. One such technology is the Mobile Information Management (MIM) system supported by APHIS. MIM was originally developed by the Michigan Department of Agriculture (under the name of RegTest) to assist with the state’s bovine TB surveillance and eradication efforts (Munger, 2008a). While additional details and visual depictions on the MIM system and its operations are available in Munger (2008a) and Baca (2007), we succinctly note here that MIM is a PDA (personal digital assistant) based application that utilizes RFID (radio frequency identification) or barcode technologies to increase the efficiency and accuracy of bovine TB testing.

Table 8.5. History of Select Government Animal Disease Responses.

Species	*Event*	*Initiation Year*	*Notes**	*Source*
Cattle	BSE – Alabama	2006	Investigation of 37 farms took 48 days.	USDA, 2008g
Cattle	BSE – Texas	2005	Investigation of 1,919 animals (8 herds) lasted 61 days.	USDA, 2008g
Cattle	BSE - Washington	2003	255 animals from 10 premises were destroyed; investigation of over 75,000 animals (189 herds) took 46 days	USDA, 2008g
Cattle	TB – California	2008	Tested over 150,000 animals (105 herds)	Bennett et al. (2008)
Cattle	TB - New Mexico	2007	Tested 20,150 animals (16 herds); 14 State & Federal personnel; $35 million in Federal funds allocated for indemnification	USDA, 2008g
Cattle	TB – Minnesota	2005	Over 3,500 animals have been depopulated; USDA has incurred over $5 million costs ($3.9 million in indemnities)	USDA, 2008g
Cattle	TB – California	2002	875,616 animals (687 herds) tested; 13,000 animals depopulated	USDA, 2008g
Poultry	Exotic New Castle - California, Nevada, Arizona, Texas, New Mexico	2002	2,700 infected premises; nearly 4.5 million birds were euthanized; peak eradication response consisted of 1,600 personnel; total investigation period of 350 days; Federal eradication effort expenses of $138.9 million	CNA Corporation (2004) USDA, 2008g

* Amounts noted are projections/estimates directly obtained from the sources indicated.

Use of the MIM system requires a PDA, RFID wand for animal scanning, and Bluetooth capabilities (Munger, 2008b). Combined, this system allows for disease surveillance to be conducted in an electronic manner. Munger indicates that MIM results in fewer testing errors as the software replaces the need for manually reading and recording data. Moreover, Munger advocates that, while economies of scale may exist in the direct cost saving justification for using MIM, data quality resulting from use of MIM is enhanced regardless of the evaluated herd size. Since the MIM system is currently in use for bovine TB testing in several states including Michigan, Minnesota, and New Mexico, we attempted to obtain additional feedback on the benefits MIM provides from practitioners in these states. Feedback was obtained from three different sources: 1) a weekly status report from Ray Scheierl (State of Minnesota), 2) a direct cost analysis of MIM from Diana Darnell (USDA-APHIS), and 3) email correspondence between Diana Darnell (USDA-APHIS) and three MIM users in Michigan.

On July 24, 2008, Ray Scheierl (State of Minnesota) submitted a report to APHIS following the state of Minnesota's first week of using the MIM system in its TB surveillance efforts. The report estimates the start-up cost of each MIM system to be $3,500 ($850 for a RFID wand reader, $2,500 for a PDA, and $0 for the MIM software provided by APHIS). According to Scheierl's calculations, use of MIM pays for itself in the form of TB test cost savings after use on 1,800 animals. The cost savings underlying MIM's use originate from observed reductions in both veterinarian time (valued at $70/hour) and data entry personnel time (valued at $30/hour) required in test reporting as data entry and results reporting are automated by MIM (Scheierl, 2008). Scheierl also notes that in addition to cost savings of labor reductions, MIM provides indirect value in a reduction in data errors (electronic vs. manual entry) and duration of production interruption imposed on producers of herds being tested.

More specifically, Scheierl estimates that the time of testing on day 2 of a herd's evaluation is reduced by 10-20% relative to TB testing without the MIM system.[12] While these "indirect benefits" of data quality and on-farm production interruption are difficult to empirically estimate, they certainly are noteworthy. As additional evidence that the MIM system provides net benefits to those with MIM experience, Scheierl noted that the state of Minnesota is equipping 10 state veterinarians with the PDA/RFID wand/MIM software systems to conduct the 40,000 TB tests anticipated to be necessary by December 2008.

In addition to the analysis by Ray Scheierl, we obtained an analysis from Diana Darnell (USDA-APHIS). Darnell's analysis was based upon a herd of 3,692 animals that was tested in Michigan in July of 2008 (Darnell, 2008). The National TB MIMS software was used in conducting the TB tests. Comparable manual time of testing calculations was obtained by a survey Darnell conducted of animal health technicians and field veterinarians. Using the assumptions proposed by Darnell (2008), table 8.6 suggests using the MIMS software in a TB test of approximately 3,700 animals results in cost savings of approximately $9,000 (or approximately $2.44/head).[13]

Finally, we supplement the information provided by Scheierl and Darnell by correspondence Darnell has had with Michigan TB test practitioners. Commentary by both Dr. Tom Flynn (USDA-APHIS) and Dr. Dan Robb (Michigan Department of Agriculture) suggests that there is economies of size to the TB cost savings provided by MIM. In particular, Flynn indicates no time savings in creation of TB test charts in herds with less than 20 head while use of MIM on a 100-head herd may reduce test chart creation time from 1 hour (manual) to 15 minutes (MIM). Robb suggests that test charts for 50- and 100-head herds may be conducted 1 and 2.5 hours quicker, respectively, by using MIM. This suggests that not only is there economies of size to MIM's cost savings, but that these cost savings occur at an increasing rate. This corresponds with Robb's proposition

[12] It is worth briefly noting that TB tests typically involve injecting each individual animal initially (day 1) and returning to the herd in question three days later to evaluate and diagnose each individual animal. As such, electronic entry of information on day one may provide benefits in the return visit three days later.

[13] The actual amounts deviate slightly from Darnell's original calculations due to rounding differences.

that test chart creation with MIM takes about 15 minutes regardless of herd size, while manual test chart creation is directly a function of herd size. In addition to the suggested test chart creation time savings, both Flynn and Robb confirmed Scheierl and Munger's points regarding additional benefits provided by MIM in the form of notable data entry error reduction. For instance, Flynn noted that MIM prevents occurrences of a specific experience he had where in evaluating the test chart of a 1,000 head herd, he spent over 1 week correcting mistakes from manual data entry. Regarding accuracy, Robb suggests that using eID tags has increased accuracy of testing from an error rate of 5-10% in reading metal tags to an error rate of about 1% in using eID tags. Moreover, Robb noted that the level of specificity required in federal paperwork accompanying the depopulation is better met and with more confidence when using the MIM system.

Also note that MIM may further reduce cost of testing in situations where the same herd is repeatedly tested as the information from prior tests is available and the herd is already partially (net of reasonable tag loss and herd turnover rates) tagged with RFID ear tags. An example situation is the annual whole herd testing of all animals 12 months of age or older conducted of Michigan producers operating in the MA (Modified Accredited) Zone (MDA, 2006). Discussions with Munger and Scheierl suggest that MIM may provide additional cost savings in these scenarios. That is, the above discussion primarily stems from cost savings gained on the second day of TB testing. In cases of repeated testing of a same herd, additional cost savings on both test days may be experienced. Moreover, Scheierl notes that having a test chart electronically created based upon prior testing of a given herd not only reduced the time of testing a herd, it also enhances the testing procedure quality as specific animals now have to be accounted for.

Our analysis was unable to identify any comprehensive efforts to assess the benefits that MIM may provide at a more aggregated level. The above information obtained from Scheierl, Darnell, Flynn, and Robb is certainly a useful first-step that supports the use of MIM. However, in the future we encourage a more through attempt by animal health officials to conduct analysis similar to that of Darnell's study of one 3,692 head dairy that would better enable a rigorous examination of cost savings experienced for herds of different sizes. This seems particularly relevant as APHIS is considering development of equivalent MIM software packages for other surveillance activities including Pseudorabies, Avian Influenza, and Johne's disease (Baca, 2007).

Nonetheless, for purposes of developing an estimate based upon the current state of knowledge noted above, we believe that use of an automated system like MIM may save the government approximately $1.50 for each TB tested animal. Coupling this estimate with the fact that in recent years approximately 200,000 animals have been TB tested annually (USDA, 2007i), produces a total, annual cost savings estimate of $300,000. Given that MIM appears to work most efficiently with NAIS resources already in place, this can be used as an approximation of the reduction in annual TB testing expenditures afforded by NAIS.

This procedure likely underestimates the cost savings provided by NAIS. For instance, APHIS is considering expansion of MIM to other surveillance programs. As MIM is expanded, the cost savings noted above will be enhanced. Moreover, while not a "direct governmental costs," NAIS and associated use of programs like MIM may provide "indirect benefits" in the form of more content and compliant producers as testing procedures are shorter in duration and likely more tolerable to producers.

8.2.3.3 Simulated Animal Disease Events

In addition to the cost savings of surveillance efforts, NAIS may provide a reduction in governmental expenditures associated with animal disease control and eradication. When this project was initiated, we anticipated using an epidemiological disease spread model to provide associated insights on the cost savings of alternative traceability capabilities. Unfortunately, models available to use were parameterized only for small geographical regions and a limited number of diseases. Accordingly, we were not able to obtain national estimates of government costs associated with mitigating a contagious disease outbreak with or without the impact of animal ID and tracing on such government costs. As such, we strongly encourage future research to use epidemiological disease spread models once data for animal populations and densities are adequately specified for broader, more national consideration of potential animal disease events.

While these limitations unfortunately prohibit current empirical estimation of the benefits NAIS provides in reducing government costs following different animal disease events, a couple points are worthwhile. Namely, by definition, any system that provides additional information on the location of farms (e.g., premises registration) and the movement of animals (e.g., animal tracking) will enhance governmental disease response. That is, NAIS provides benefits in this manner and we leave it to future research, enabled by better data and model capabilities; to empirically estimate these benefits for potential animal disease events. As such, our analysis under-estimates the government benefits, in the form of cost savings, provided by NAIS.

Table 8.6. TB Test Costs Comparisons: MIM vs. Manual*

	MIMS TB Testing		*Manual TB Testing*	
	Costs	Notes	Costs	Notes
Animal ID & Data Collection				
On Injection Day	$1,429	(7.5 hours for 6 AHTs)	$4,572	(12 hours for 12 AHTs)
On Read Day	$1,048	(5.5 hours for 6 AHTs) -- 3 teams of 2 people (1 runs PDA, 1 scan and read tags)	$4,572	(12 hours for 12 AHTs) -- 6 teams of 2 people (1 writes down data, 1 manually reads tags)
Test Chart Creation				
	$16	(0.5 hour for 1 AHT to download herd inventory on injection day)	$2,096	(66 hours for 1 AHT)
	$32	(1 hour for 1 AHT to reload PDA with data prior to re-read day)	$100	(2 hours for 1 V for error checking/signing)
	$50	(1 hour for V to check errors, sign chart)		
	$48	(1.5 hours for AHT to merge PDA data, error check, print charts)		
Data Entry into FAIR	$3	(5 minutes for 1 AHT)	$288	(21 hours for 1 DE)
Total Costs:	$2,624		$11,627	
Cost Savings of MIM**:	$9,003			

Source: Darnell (2008)

* Assumptions: Veterinarian (V), Animal Health Technician (AHT), and Data Entry (DE) wages are $50/hr, $31.75/hr, and $13.75/hr, respectively.
Manual test chart writing takes 1.5 hours per 100 animals, error-checking and correction of 3,700 animal test chart takes 10 hours,
and Data Entry clerk manually enters animals at a rate of 180/hour.

** Values slightly differ due to rounding in Darnell (2008).

8.3 State Government Analysis

8.3.1 Michigan's Experience

Given the state of Michigan's status as the only US state with a mandatory individual animal identification program in operation, Michigan provides a good model to initially evaluate in developing estimates of state expenditures associated with NAIS adoption. Furthermore, between January 1, 2000 and June 1, 2006 over 18,000 herds and 1,191,063 animals (average tested herd size of approximately 66 head) were TB tested in Michigan (MDA, 2006). Accordingly, in October 2007 members of our research team visited with personnel at the Michigan Department of Agriculture (MDA) as well as producers and auction market managers throughout Michigan. The Animal Industry Division of MDA is responsible for the state's animal identification program. The research team held discussions with key MDA personnel including Kevin Kirk (MDA Director's Special Assistant) and Roberta Bailey (MDA accountant) to obtain detailed information regarding expenditures the state has incurred in administering its animal identification program. Bailey provided the research team with detailed summaries of the Michigan Department of Agriculture Animal Identification Program expenditures for fiscal years 2006 and 2007.

These expenditures are shown in table 8.7 and segmented into five categories. Consistent with their name, the *Payroll*, *Travel*, and *Materials, Brochures, and Supplies* categories encompass all salary and benefit; travel; and materials, brochures, and supplies expenditures, respectively. The *Equipment* category includes expenditures incurred in purchasing RFID reading equipment for locations of public animal transactions including auction markets and slaughterhouses. These expenses were incurred in implementing the state-wide program, as Michigan subsidized building the state's infrastructure to expedite the implementation process. The *Grants* category is directly associated with bills the state has received from Holstein Association USA, Inc. (HAUI). The state of Michigan currently uses HAUI to process all RFID transaction reads, to obtain RFID tags (Michigan provided 100% of the tags needed in the state's tuberculosis zone (north-east region) free-of-charge, but required producers outside of this zone to purchase their own tags), and to provide the state with weekly summary reports on the number of RFID reads made in each market. As shown in table 8.7, the majority (approximately 80%) of total funds in fiscal years 2006 and 2007 were allocated to *Payroll* and *Grants*.

Revenue used to cover these expenditures came from two sources: Federal Funds and Michigan Ag Equine Funds. As shown in table 8.7, Federal Funds covered $191,498 and $226,385 (35% - 40% of total expenditures) of MDA's expenditures in fiscal years 2006 and 2007, respectively. The remaining funds (60% - 65%) were covered by revenue allocated to MDA from the state's Ag Equine Funds, which is a resource the state obtains from horse race track revenues.

The preceding paragraphs summarized experiences incurred by Michigan in the most recent two complete fiscal years. In order to project future expenditures for the state, a number of key assumptions must be made including:

- *Payroll expenditures* will remain the same in future years as no adjustments in staff capacity are anticipated.
- *Travel expenditures* will remain the same in future years as no adjustments are anticipated.
- *Materials, supplies, phone charges, etc.* will reduce to an average of $30,000 in futures years. This reduction is based on the assumption that most advertising, promotional, informative flyers and other materials are primarily "up-front" expenditures that will be reduced in frequency and quantity in future years.
- *Equipment expenses* will be $0 in future years. This assumes that future upgrades and maintenance of RFID reading equipment will be the responsibility of owners at those facilities (an assumption consistent with the direct cost estimates for individual industry segments presented in Sections 4-7 of this report).
- *Holstein Association USA, Inc. (HAUI) expenditures* will be reduced to an estimate of $6,300 per month. Over the three-month period of March, April, and June in 2007 these expenses averaged $21,052. However, approximately 70% of these expenses were for RFID tag purchases, shipping of these products, site inspections, and tag order processing fees. All of these expenses

were initially incurred by MDA to facilitate implementation of the program. The assumption of $6,300/month is based on an estimate of future expenditures being 30% of previous values and that future RFID purchases and related HAUI expenses will be the responsibility of cattle owners, regardless of their TB-zone status (an assumption consistent with the direct cost estimates for individual industry segments presented in Sections 4-7 of this report).

Based upon these assumptions and corresponding discussions with MDA personnel, projections were made regarding future expenditures of the Michigan Department of Agriculture Animal Identification Program. Table 8.8 shows a summary of these projections. The total annual expenditure ($287,833) is forecasted to be approximately 51% - 53% of the totals realized in fiscal years 2006 and 2007. Furthermore, cost sharing of the state's expenditures with federal sources is assumed to stop in future projections. This assumption can be reversed if NAIS cooperative agreements are assumed to persist into the future; in which case, it seems the best forecast given current information would be for federal and state sources to each contribute approximately 50% of funding consistent with fiscal years 2006 and 2007.

The final analysis we conducted of MDA Animal Identification Program expenditures was to identify how these expenditures were allocated across the three core NAIS components of Premises Identification, Animal Identification Systems, and Animal Movement Data Access. These allocations are based primarily on an analysis of historical budgets (fiscal years 2006 and 2007) and consultation with MDA personnel. Table 8.9 shows a summary of these allocations based on actual fiscal year 2006 and 2007 expenditures. A general observation is that a significant portion of expenditures in each of the five budget sub-categories were occurred in efforts associated with premises registration and/or animal identification systems. To project future 2008 and onward allocations, we consulted further with MDA personnel and utilized expected future expenditures in table 8.8 allocated them across NAIS components. Table 8.10 presents a summary of these allocations (in 2007 dollars). Relative to fiscal years 2006 and 2007 (table 8.9), a notably higher proportion of expenditures are expected to be incurred in activities regarding animal identification systems and/or animal movement data access. This anticipation is consistent with the notion that as more premises are registered, fewer resources will be needed for premises registration and may be reallocated to animal identification systems or animal movement data access activities.

Table 8.7. Michigan Dept. of Agriculture Animal Identification Program Expenditures: Fiscal Years 2006 and 2007.

	FY 2006			FY 2007		
Description	Total Expenditure	% Paid By MI Funds	% Paid By Federal Funds	Total Expenditure	% Paid By MI Funds	% Paid By Federal Funds
Payroll	$260,485	53%	47%	$231,275	38%	62%
Travel	$5,899	27%	73%	$5,407	38%	62%
Materials, Brochures, Supplies	$87,453	44%	56%	$67,263	31%	69%
Equipment	$18,472	14%	86%	$27,077	35%	65%
Grants	$168,970	100%	0%	$231,493	93%	7%
Totals	$541,279	$349,780	$191,498	$562,515	$336,129	$226,385

Table 8.8. *Projected Future* MDA Animal Identification Program Expenditures.

Description	Projected Annual Expenditures			
	Total Expenditure	% of FY 2006 & 2007 Expenditures	% Paid By MI Funds	% Paid By Federal Funds
Payroll	$245,880	100%	100%	0%
Travel	$5,653	100%	100%	0%
Materials, Brochures, Supplies	$30,000	*NA*	100%	0%
Equipment	$0	0%	100%	0%
Grants	$6,300	30%	100%	0%
Totals	$287,833			

Table 8.9. Allocation of MDA Animal Identification Program Expenditures (2006-2007) by NAIS Component.

Description	*% to Premises Registration*	*% to Animal Identification Systems*	*% to Animal Movement Data Access*
Payroll	35%	60%	5%
Travel	15%	80%	5%
Materials, Brochures, Supplies	45%	50%	5%
Equipment	5%	75%	20%
Grants	15%	75%	10%

Table 8.10. Allocation of *Future MDA* Animal Identification Program Expenditures by NAIS Component.

Description	*% to Premises Registration*	*% to Animal Identification Systems*	*% to Animal Movement Data Access*
Payroll	15%	30%	55%
Travel	0%	45%	55%
Materials, Brochures, Supplies	10%	20%	70%
Equipment	5%	50%	45%
Grants	10%	45%	45%

8.3.2 Other States

In addition to the insights provided by examining the state of Michigan, information was also gathered from other states. In particular, given time and resource constraints prohibiting a thorough evaluation of each individual state, we visited with key personnel in twelve other states (Arkansas, Colorado, Idaho, Indiana, Iowa, Kansas, Minnesota, North Carolina, Oklahoma, Tennessee, Texas, and Wisconsin). These states were identified to both cover a geographic spectrum of states while also including multiple states ranking in the top 5 regarding cattle (Texas, Oklahoma, Kansas), swine (Iowa, North Carolina, Minnesota, Indiana), and broiler/turkey (Minnesota, North Carolina, Arkansas) inventories as recorded by USDA-NASS (2008e).

Contacts at each of these states were interviewed with two main goals in mind. The first goal was to obtain budget information regarding historical expenditures incurred in each state associated with implementation of NAIS. The second goal was to assess benefits that each state may have realized by their participation in NAIS. This information was obtained by phone and email interviews with key personnel, the names and associations of individual contacts interviewed are provided in Appendix A8.1.

Notable variation was identified in the ability of individual states to provide historical expenditure information that conveyed how each year's budget was allocated across key categories such as personnel, travel, and contractual arrangement. Moreover, there was limited ability to provide budgets allocating expenditures across the three NAIS components (Premises Identification, Animal Identification Systems, and Animal Movement Data Access). This, in combination with the confirmed diversity in state-specific issues, resources, and constraints lead us to purposely avoid making any empirical assessment of the "representative state" regarding cost and benefits of NAIS. Moreover, discussions with all contacted states (with the notable exception of Wisconsin) revealed significant reliance on USDA cooperative agreements to fund state-level NAIS activities. In particular, the majority of contacted states noted that, besides those used in recent years to meet USDA cost share requirements, no additional in-state resources have historically been available to conduct NAIS-related activities. This point is especially important for three reasons. First, future decision makers need to be aware of the dependency of state-level NAIS activities on availability of federal NAIS funds. Second, this confirms that the experience in Michigan is *not* representative of many other states.[14] Third, this point suggests that when assessing governmental cost of the national NAIS program, it is reasonable to base much of that analysis on federal government expenditures. One of the core components of past federal NAIS budgets (see tables 8.2 and 8.3 above) has been cooperative agreements. Identification of nearly complete reliance of individual states on cooperative agreement funding leads us to focus on federal governmental budgets and infer implications for states from federal budgets. In this spirit, tables 8.11-8.14 present a summary of premises registration rates (a core focus of most cooperative agreements to date), cooperative agreement amounts, and expenditures to-date for each of the 50 states.

Tables 8.11 and 8.12 provide information regarding the overall success of the NAIS program since 2004 in registering premises. Between January 2005 and August 2008, there have been a total of 453,856 premises registered, representing about 33.8% of premises. Table 8.12 reveals that, as of August 2008, 12 states have over 50% of premises registered, 10 have 25-50%, and 28 states have fewer than 25% of their premises registered. This documents the wide range in success to date of states (characterized by diverse geographic, economic, livestock inventory, and other factors) registering premises.[15]

Returning our discussion to cooperative agreement budgets, we observe in table 8.13 that federal support of efforts in individual states has varied both within and across states over the analyzed 2004-2008 period. More specifically, every year except FY 2006 is characterized by a range of $0 to over $750,000 allocations across states. Moreover, awards allocated within individual states including Colorado, Idaho, Kansas, and Texas have

[14] That is MI is less (+/- 50%) reliant on federal funding than most other states (+/-80%). This is not to suggest valuable inferences cannot be obtained by examining Michigan. Rather this suggests that caution should be exerted in generalizing Michigan's experiences to other states.

[15] We thank a reviewer for noting that more narrowly examining the array of factors leading to differential premises registrations and associated NAIS costs experienced to date was beyond the focus of this national cost-benefit study, but is worthy of future research.

varied by over $800,000 over the 2004-2008 period. This variation was noted in our discussions with key personnel in other states. Namely, multiple personnel suggested that volatility in year-to-year NAIS funding allocations to their state has resulted in ongoing adjustments in personnel that have deviated resources from their intended purpose of enhancing premises registration rates.

Forecasts of state government expenses associated with NAIS can also be developed using information in table 8 13. In particular, recall previous points that most states are heavily dependent on federal NAIS cooperative agreement funding. Given the recent requirement for 20% matching of state funds for every dollar provided federally in cooperative agreements (USDA, 2008g), we can estimate the future costs to individual state governments by assuming: a) the 20% matching requirement is sustained, b) total funding of future NAIS cooperative agreements are consistent with the three alternatives presented previously in table 8.4, and c) allocations to individual states are made consistent with those experienced over the FY 2004-2008 period as shown in table 8.13. Combined, this generates the alternative forecasts summarized in table 8.15.

Table 8.15 suggests that this forecasting procedure results in total state governmental expenditures ranging from $2.1 to $3.4 million dollars and average expenditures across the 50 states ranging from approximately $42,300 to $67,549 depending on whether $10.575 or $16.887 million dollars are made available in federal cooperative agreement funds. Moreover, table 8.15 implies notable differences across states in forecasts expenditures. For instance, while Delaware and Rhode Island are forecasted to experience no expenditures, Texas, California, Nebraska, and Oklahoma are forecasted to have expenditures consistently in excess of $100,000.

It may seem appropriate at first glance to use the information provided in tables 8.11-8.14 to answer questions such as "on average, how many premises have been registered for each additional dollar of cooperative agreement expenditures?" However, we purposely do not make such calculations as we deem them as inappropriate. That is, cooperative agreements were engaged in by both federal and state parties with more than just premises registration enhancement goals. Given the current absence of additional, detailed budget allocation information on every single cooperative agreement (for each state and each year), one can not accurately assess things like "the national, premises weighted-average cost of each additional registration." That is, an attempt based upon the information available (mainly in tables 8.11-8.14) would only generate an "exaggerated upper-bound" estimate of premises registration results from cooperative agreement expenditures as it would over estimate appropriate costs. Moreover, we attempt to more directly assess this in a survey of state ID coordinators discussed in the next section of this report.

Table 8.11. History of Premises Registrations in Each State.

State	*Estimated Number of Premises*	*Jan. 2005*	*Aug. 2005*	*Jan. 2006*	*Aug. 2006*	*Jan. 2007*	*Aug. 2007*	*Jan. 2008*	*Aug. 2008*
Alabama	35,538	125	1,007	1,417	2,385	3,125	4,909	6,501	8,484
Alaska	354	0	2	2	3	41	60	86	111
Arizona	5,170	6	103	172	510	524	617	887	1,049
Arkansas	37,614	0	1,614	4,467	6,284	6,912	7,516	7,573	7,741
California	32,500	0	1,202	1,768	3,325	4,365	5,262	5,682	6,320
Colorado	22,951	46	493	920	5,355	5,569	6,511	6,769	7,583
Connecticut	2,539	0	0	0	0	16	18	19	44
Delaware	1,553	0	74	74	494	651	651	652	652
Florida	28,731	19	835	1,655	3,099	3,735	4,065	4,611	4,923
Georgia	35,431	0	533	857	2,203	2,491	3,980	4,093	4,270
Hawaii	1,391	0	9	72	214	282	291	323	358
Idaho	18,754	1,878	13,860	14,774	15,321	17,915	18,062	18,307	18,524
Illinois	30,046	318	1,108	1,922	5,093	6,213	8,325	10,742	14,355
Indiana	34,790	45	1,674	2,578	11,936	24,613	29,702	30,579	32,068
Iowa	47,273	0	1	473	6,986	11,635	19,062	20,708	23,285
Kansas	39,346	63	1,399	2,076	3,805	4,513	5,187	5,470	6,049
Kentucky	61,251	0	1,726	2,699	7,479	9,909	12,326	12,976	14,094
Louisiana	19,677	0	349	416	620	952	1,157	1,825	2,150
Maine	4,213	2	134	276	376	399	416	419	427
Maryland	7,837	1	2	918	1,178	1,301	1,340	1,355	1,429
Massachusetts	3,555	0	6	8	1,423	1,683	1,685	8,064	8,066
Michigan	29,011	1	180	9,052	14,604	16,223	18,975	19,700	20,509
Minnesota	44,193	0	6,404	8,075	9,547	11,496	11,877	12,126	12,544
Mississippi	29,312	0	0	377	833	1,197	1,472	1,582	4,682
Missouri	79,018	373	3,965	6,680	8,305	12,133	13,600	13,954	14,659
Montana	19,708	1	83	189	567	764	810	837	956
Nebraska	30,841	322	699	3,000	9,212	10,533	13,842	16,099	16,598
Nevada	2,522	0	281	869	1,044	1,132	1,241	1,281	1,385
New Hampshire	2,277	0	2	7	28	36	40	43	51
New Jersey	5,315	0	38	53	475	988	994	997	1,013
New Mexico	11,250	1	92	402	731	834	989	1,168	1,402
New York	25,559	877	9,687	11,551	13,554	13,342	16,753	19,108	20,312
North Carolina	36,142	4	1,843	2,358	3,054	4,837	9,701	10,681	12,168
North Dakota	14,085	4	627	5,878	7,613	7,909	8,313	8,391	8,520
Ohio	48,073	41	535	1,069	1,849	2,180	5,945	6,310	7,066
Oklahoma	71,420	48	1,573	2,428	3,413	4,834	7,342	8,058	9,096
Oregon	28,634	0	0	1,683	2,195	2,332	2,534	2,602	2,672

Table 8.11. History of Premises Registrations in Each State (continued).

State	*Estimated Number of Premises*	*Jan. 2005*	*Aug. 2005*	*Jan. 2006*	*Aug. 2006*	*Jan. 2007*	*Aug. 2007*	*Jan. 2008*	*Aug. 2008*
Pennsylvania	42,302	12,934	15,348	15,788	29,971	26,299	28,206	28,760	29,463
Rhode Island	504	0	0	0	0	5	6	6	8
South Carolina	16,120	75	750	1,090	1,636	1,861	3,734	4,370	4,651
South Dakota	22,356	16	1,086	2,515	4,218	4,694	4,976	5,058	5,134
Tennessee	68,010	0	1,256	6,295	10,557	12,354	14,299	16,253	17,782
Texas	187,118	214	2,606	4,724	18,511	23,312	28,986	29,803	31,953
Utah	12,460	20	5,530	6,538	7,578	8,090	8,671	8,945	9,388
Vermont	4,438	2	54	77	79	293	310	319	360
Virginia	37,673	10	1,278	2,112	3,152	4,001	4,680	5,116	9,100
Washington	22,155	3	722	864	1,154	1,370	1,421	1,539	1,691
West Virginia	17,670	910	6,614	7,114	7,822	8,418	8,738	8,817	9,135
Wisconsin	51,373	4,581	15,844	41,430	53,015	54,133	58,654	59,390	60,728
Wyoming	8,227	0	0	139	400	742	1,540	1,709	1,788
50 State Sum	1,438,280	22,940	103,228	179,901	293,206	343,186	409,791	440,663	476,796
Raw Average	28,766	459	2,086	3,643	5,935	6,940	8,263	8,860	9,557
Premises Weighted Average		670	2,865	5,266	9,743	11,634	14,084	14,820	16,003

Source: John Wiemers

Table 8.12. History of Premises Registrations in Each State (%).

State	*Estimated Number of Premises*	*Jan. 2005*	*Aug. 2005*	*Jan. 2006*	*Aug. 2006*	*Jan. 2007*	*Aug. 2007*	*Jan. 2008*	*Aug. 2008*
Alabama	35,538	0.35%	2.83%	3.99%	6.71%	8.79%	13.81%	18.29%	23.87%
Alaska	354	0.00%	0.56%	0.56%	0.85%	11.58%	16.95%	24.29%	31.36%
Arizona	5,170	0.12%	1.99%	3.33%	9.86%	10.14%	11.93%	17.16%	20.29%
Arkansas	37,614	0.00%	4.29%	11.88%	16.71%	18.38%	19.98%	20.13%	20.58%
California	32,500	0.00%	3.70%	5.44%	10.23%	13.43%	16.19%	17.48%	19.45%
Colorado	22,951	0.20%	2.15%	4.01%	23.33%	24.26%	28.37%	29.49%	33.04%
Connecticut	2,539	0.00%	0.00%	0.00%	0.00%	0.63%	0.71%	0.75%	1.73%
Delaware	1,553	0.00%	4.76%	4.76%	31.81%	41.92%	41.92%	41.98%	41.98%
Florida	28,731	0.07%	2.91%	5.76%	10.79%	13.00%	14.15%	16.05%	17.13%
Georgia	35,431	0.00%	1.50%	2.42%	6.22%	7.03%	11.23%	11.55%	12.05%
Hawaii	1,391	0.00%	0.65%	5.18%	15.38%	20.27%	20.92%	23.22%	25.74%
Idaho	18,754	10.01%	73.90%	78.78%	81.69%	95.53%	96.31%	97.62%	98.77%
Illinois	30,046	1.06%	3.69%	6.40%	16.95%	20.68%	27.71%	35.75%	47.78%
Indiana	34,790	0.13%	4.81%	7.41%	34.31%	70.75%	85.38%	87.90%	92.18%
Iowa	47,273	0.00%	0.00%	1.00%	14.78%	24.61%	40.32%	43.81%	49.26%
Kansas	39,346	0.16%	3.56%	5.28%	9.67%	11.47%	13.18%	13.90%	15.37%
Kentucky	61,251	0.00%	2.82%	4.41%	12.21%	16.18%	20.12%	21.18%	23.01%
Louisiana	19,677	0.00%	1.77%	2.11%	3.15%	4.84%	5.88%	9.27%	10.93%
Maine	4,213	0.05%	3.18%	6.55%	8.92%	9.47%	9.87%	9.95%	10.14%
Maryland	7,837	0.01%	0.03%	11.71%	15.03%	16.60%	17.10%	17.29%	18.23%
Massachusetts	3,555	0.00%	0.17%	0.23%	40.03%	47.34%	47.40%	226.84%	226.89%
Michigan	29,011	0.00%	0.62%	31.20%	50.34%	55.92%	65.41%	67.91%	70.69%
Minnesota	44,193	0.00%	14.49%	18.27%	21.60%	26.01%	26.88%	27.44%	28.38%
Mississippi	29,312	0.00%	0.00%	1.29%	2.84%	4.08%	5.02%	5.40%	15.97%
Missouri	79,018	0.47%	5.02%	8.45%	10.51%	15.35%	17.21%	17.66%	18.55%
Montana	19,708	0.01%	0.42%	0.96%	2.88%	3.88%	4.11%	4.25%	4.85%
Nebraska	30,841	1.04%	2.27%	9.73%	29.87%	34.15%	44.88%	52.20%	53.82%
Nevada	2,522	0.00%	11.14%	34.46%	41.40%	44.89%	49.21%	50.79%	54.92%
New Hampshire	2,277	0.00%	0.09%	0.31%	1.23%	1.58%	1.76%	1.89%	2.24%
New Jersey	5,315	0.00%	0.71%	1.00%	8.94%	18.59%	18.70%	18.76%	19.06%
New Mexico	11,250	0.01%	0.82%	3.57%	6.50%	7.41%	8.79%	10.38%	12.46%
New York	25,559	3.43%	37.90%	45.19%	53.03%	52.20%	65.55%	74.76%	79.47%
North Carolina	36,142	0.01%	5.10%	6.52%	8.45%	13.38%	26.84%	29.55%	33.67%
North Dakota	14,085	0.03%	4.45%	41.73%	54.05%	56.15%	59.02%	59.57%	60.49%
Ohio	48,073	0.09%	1.11%	2.22%	3.85%	4.53%	12.37%	13.13%	14.70%
Oklahoma	71,420	0.07%	2.20%	3.40%	4.78%	6.77%	10.28%	11.28%	12.74%
Oregon	28,634	0.00%	0.00%	5.88%	7.67%	8.14%	8.85%	9.09%	9.33%

Table 8.12. History of Premises Registrations in Each State (continued).

State	*Estimated Number of Premises*	*Jan. 2005*	*Aug. 2005*	*Jan. 2006*	*Aug. 2006*	*Jan. 2007*	*Aug. 2007*	*Jan. 2008*	*Aug. 2008*
Pennsylvania	42,302	30.58%	36.28%	37.32%	70.85%	62.17%	66.68%	67.99%	69.65%
Rhode Island	504	0.00%	0.00%	0.00%	0.00%	0.99%	1.19%	1.19%	1.59%
South Carolina	16,120	0.47%	4.65%	6.76%	10.15%	11.54%	23.16%	27.11%	28.85%
South Dakota	22,356	0.07%	4.86%	11.25%	18.87%	21.00%	22.26%	22.62%	22.96%
Tennessee	68,010	0.00%	1.85%	9.26%	15.52%	18.16%	21.02%	23.90%	26.15%
Texas	187,118	0.11%	1.39%	2.52%	9.89%	12.46%	15.49%	15.93%	17.08%
Utah	12,460	0.16%	44.38%	52.47%	60.82%	64.93%	69.59%	71.79%	75.35%
Vermont	4,438	0.05%	1.22%	1.74%	1.78%	6.60%	6.99%	7.19%	8.11%
Virginia	37,673	0.03%	3.39%	5.61%	8.37%	10.62%	12.42%	13.58%	24.16%
Washington	22,155	0.01%	3.26%	3.90%	5.21%	6.18%	6.41%	6.95%	7.63%
West Virginia	17,670	5.15%	37.43%	40.26%	44.27%	47.64%	49.45%	49.90%	51.70%
Wisconsin	51,373	8.92%	30.84%	80.65%	103.20%	105.37%	114.17%	115.61%	118.21%
Wyoming	8,227	0.00%	0.00%	1.69%	4.86%	9.02%	18.72%	20.77%	21.73%
50 State Raw Average	28,766	1.26%	7.50%	12.78%	20.61%	24.33%	28.24%	33.65%	36.09%
Premises Weighted Average		1.59%	7.18%	12.51%	20.39%	23.86%	28.49%	30.64%	33.15%

Source: John Wiemers

Table 8.13. History of Cooperative Agreements in Each State (Current Award Amounts).

State	CCC (FY 2004)	FY 2005	FY 2006	FY 2007	FY 2008	Total 2004 - 2008
Alabama	$115,000	$245,000	$0	$276,000	$165,630	$801,630
Alaska	$0	$34,710	$0	$60,660	$42,400	$137,770
Arizona	$0	$169,000	$84,351	$160,200	$111,650	$525,201
Arkansas	$115,000	$281,000	$203,000	$249,300	$174,500	$1,022,800
California	$670,072	$625,000	$346,909	$517,500	$361,900	$2,521,382
Colorado	$1,214,579	$255,904	$191,066	$330,087	$263,200	$2,254,836
Connecticut	$0	$0	$0	$20,000	$39,785	$59,785
Delaware	$0	$0	$0	$0	$0	$0
Florida	$531,840	$273,000	$98,721	$184,510	$176,645	$1,264,716
Georgia	$77,480	$42,173	$198,900	$197,891	$134,620	$651,064
Hawaii	$0	$98,316	$0	$61,121	$55,600	$215,036
Idaho	$1,164,000	$230,783	$60,349	$267,826	$194,600	$1,917,557
Illinois	$130,000	$245,000	$141,000	$180,000	$134,620	$830,620
Indiana	$106,493	$150,457	$80,331	$178,090	$133,872	$649,243
Iowa	$130,000	$410,878	$0	$474,000	$481,800	$1,496,678
Kansas	$805,000	$685,000	$0	$396,043	$210,000	$2,096,043
Kentucky	$269,093	$326,276	$0	$375,000	$280,459	$1,250,828
Louisiana	$12,247	$0	$0	$82,704	$78,310	$173,261
Maine	$78,343	$94,000	$21,500	$80,000	$41,250	$315,093
Maryland	$105,000	$85,952	$0	$81,000	$53,915	$325,867
Massachusetts	$0	$95,348	$0	$80,000	$59,831	$235,179
Michigan	$120,000	$206,953	$0	$179,000	$183,872	$689,825
Minnesota	$434,578	$339,140	$202,957	$278,914	$193,814	$1,449,403
Mississippi	$153,327	$170,129	$43,294	$171,883	$133,872	$672,504
Missouri	$484,875	$496,973	$72,931	$0	$0	$1,054,779
Montana	$431,928	$349,000	$0	$251,100	$176,000	$1,208,028
Nebraska	$125,401	$672,000	$448,000	$672,000	$470,400	$2,387,801
Nevada	$97,939	$128,241	$80,000	$76,903	$57,400	$440,483
New Hampshire	$0	$17,547	$0	$35,000	$2,100	$54,647
New Jersey	$100,000	$92,000	$72,108	$80,000	$59,831	$403,939
New Mexico	$0	$244,000	$203,000	$248,400	$246,350	$941,750
New York	$93,000	$204,152	$178,791	$275,980	$183,400	$935,323
North Carolina	$111,630	$196,989	$0	$179,000	$133,872	$621,490
North Dakota	$515,000	$176,225	$0	$160,856	$193,900	$1,045,982
Ohio	$117,135	$192,560	$112,786	$275,283	$206,418	$904,181
Oklahoma	$675,000	$629,000	$166,860	$517,500	$362,200	$2,350,560
Oregon	$0	$169,322	$0	$75,815	$192,194	$437,331

Table 8.13. History of Cooperative Agreements in Each State, (Current Award Amounts) (continued).

State	CCC (FY 2004)	FY 2005	FY 2006	FY 2007	FY 2008	Total 2004 - 2008
Pennsylvania	$614,147	$257,000	$142,238	$199,009	$139,087	$1,351,481
Rhode Island	$0	$0	$0	$0	$0	$0
South Carolina	$186,727	$139,000	$141,000	$177,000	$132,377	$776,104
South Dakota	$505,240	$334,277	$0	$426,000	$298,200	$1,563,717
Tennessee	$130,000	$264,611	$82,678	$251,100	$209,000	$937,389
Texas	$1,000,000	$1,038,975	$201,065	$1,069,302	$756,000	$4,065,342
Utah	$149,586	$194,000	$0	$179,000	$125,300	$647,886
Vermont	$84,059	$104,125	$0	$0	$60,579	$248,763
Virginia	$112,636	$237,831	$0	$249,300	$207,126	$806,893
Washington	$104,313	$206,000	$60,854	$179,000	$240,800	$790,967
West Virginia	$95,090	$108,862	$58,942	$155,488	$132,377	$550,758
Wisconsin	$100,000	$243,605	$0	$378,000	$265,468	$987,073
Wyoming	$361,929	$235,000	$141,000	$248,000	$173,600	$1,159,529
50 State Sum	$12,427,687	$11,995,314	$3,834,630	$11,240,764	$8,730,124	$48,228,520
Raw Average	$248,554	$239,906	$76,693	$224,815	$174,602	$964,570
Premises Weighted Average	$390,894	$400,881	$105,369	$371,957	$277,491	$1,546,592

Source: Neil Hammerschmidt

Table 8.14. History of Cooperative Agreements in Each State (Current Expenditures).

State	CCC (FY 2004)	FY 2005	FY 2006	FY 2007	FY 2008	Total 2004 - 2008
Alabama	$115,000	$245,000	$0	$276,000		$636,000
Alaska	$0	$34,710	$0	$30,225	$0	$64,935
Arizona	$0	$169,000	$84,351	$160,200	$47,801	$461,352
Arkansas	$115,000	$281,000	$203,000	$249,300	$130,875	$979,175
California	$670,072	$492,090	$346,909	$517,500		$2,026,572
Colorado	$1,157,140	$255,904	$191,066	$330,087	$105,848	$2,040,045
Connecticut	$0	$0	$0	$20,000		$20,000
Delaware	$0	$0	$0	$0		$0
Florida	$531,840	$273,000	$98,721	$184,510	$67,446	$1,155,517
Georgia	$77,480	$42,173	$198,900	$191,262		$509,816
Hawaii	$0	$98,316	$0	$61,121	$13,900	$173,336
Idaho	$960,553	$230,783	$60,349	$267,826	$25,095	$1,544,605
Illinois	$130,000	$245,000	$141,000	$134,272	$67,418	$717,690
Indiana	$106,493	$150,457	$80,331	$109,936		$447,218
Iowa	$130,000	$410,878	$0	$474,000	$290,669	$1,305,547
Kansas	$523,531	$527,500	$0	$285,056	$52,500	$1,388,587
Kentucky	$246,002	$326,276	$0	$375,000	$35,160	$982,438
Louisiana	$12,247	$0	$0	$82,704		$94,951
Maine	$78,343	$94,000	$21,500	$64,000	$12,000	$269,843
Maryland	$105,000	$85,952	$0	$81,000		$271,952
Massachusetts	$0	$95,348	$0	$80,000		$175,348
Michigan	$120,000	$206,953	$0	$179,000		$505,953
Minnesota	$430,372	$339,140	$202,957	$278,914	$21,513	$1,272,896
Mississippi	$124,806	$170,129	$43,294	$171,883	$21,809	$531,920
Missouri	$484,874	$496,973	$72,931	$0		$1,054,779
Montana	$431,928	$349,000	$0	$150,000		$930,928
Nebraska	$125,401	$672,000	$448,000	$672,000	$92,885	$2,010,287
Nevada	$97,939	$128,241	$80,000	$76,903		$383,083
New Hampshire	$0	$17,547	$0	$1,395	$0	$18,942
New Jersey	$75,000	$92,000	$72,108	$80,000	$14,958	$334,066
New Mexico	$0	$244,000	$203,000	$248,400		$695,400
New York	$93,000	$204,152	$178,791	$275,980	$28,490	$780,413
North Carolina	$111,630	$196,989	$0	$178,536	$25,698	$512,852
North Dakota	$468,631	$176,225	$0	$160,856	$30,160	$835,873
Ohio	$117,135	$192,560	$112,786	$275,283	$52,435	$750,198
Oklahoma	$548,532	$629,000	$166,860	$517,500	$103,067	$1,964,959
Oregon	$0	$169,322	$0	$75,815	$0	$245,137

Table 8.14. History of Cooperative Agreements in Each State, (Current Expenditures) (continued).

State	CCC (FY 2004)	FY 2005	FY 2006	FY 2007	FY 2008	Total 2004 - 2008
Pennsylvania	$614,147	$257,000	$142,238	$166,856	$12,426	$1,192,667
Rhode Island	$0	$0	$0	$0		$0
South Carolina	$186,727	$139,000	$141,000	$177,000	$7,953	$651,681
South Dakota	$481,032	$334,277	$0	$257,605	$78,223	$1,151,137
Tennessee	$130,000	$264,611	$82,678	$251,100	$99,627	$828,016
Texas	$1,000,000	$1,038,975	$201,065	$1,069,302	$257,261	$3,566,603
Utah	$149,586	$194,000	$0	$179,000		$522,586
Vermont	$84,059	$104,125	$0	$0		$188,184
Virginia	$115,000	$237,831	$0	$249,300	$80,789	$682,920
Washington	$104,313	$206,000	$60,854	$0		$371,167
West Virginia	$95,090	$108,862	$58,942	$155,488	$33,777	$452,157
Wisconsin	$100,000	$243,605	$0	$160,950	$80,027	$584,583
Wyoming	$361,929	$235,000	$141,000	$248,000	$15,549	$1,001,478
50 State Sum	$11,609,832	$11,704,905	$3,834,630	$10,231,065	$1,905,360	$39,285,791
Raw Average	$232,197	$234,098	$76,693	$204,621	$59,542	$785,716
Premises Weighted Average	$370,790	$393,569	$105,369	$350,576	$77,702	$1,298,006

Source: Neil Hammerschmidt

Table 8.15. Future State Governmental Costs Estimates (Dollars in thousands).

State	Estimate 1: $10.575 million in USDA Cooperative Agreements	Estimate 2: $16.887 million in USDA Cooperative Agreements	Estimate 3: $13.036 million in USDA Cooperative Agreements
Alabama	$35.15	$56.14	$43.34
Alaska	$6.04	$9.65	$7.45
Arizona	$23.03	$36.78	$28.39
Arkansas	$44.85	$71.63	$55.29
California	$110.57	$176.57	$136.30
Colorado	$98.88	$157.91	$121.89
Connecticut	$2.62	$4.19	$3.23
Delaware	$0.00	$0.00	$0.00
Florida	$55.46	$88.57	$68.37
Georgia	$28.55	$45.59	$35.20
Hawaii	$9.43	$15.06	$11.62
Idaho	$84.09	$134.29	$103.66
Illinois	$36.43	$58.17	$44.90
Indiana	$28.47	$45.47	$35.10
Iowa	$65.63	$104.81	$80.91
Kansas	$91.92	$146.79	$113.31
Kentucky	$54.85	$87.60	$67.62
Louisiana	$7.60	$12.13	$9.37
Maine	$13.82	$22.07	$17.03
Maryland	$14.29	$22.82	$17.62
Massachusetts	$10.31	$16.47	$12.71
Michigan	$30.25	$48.31	$37.29
Minnesota	$63.56	$101.50	$78.35
Mississippi	$29.49	$47.10	$36.36
Missouri	$46.26	$73.87	$57.02
Montana	$52.98	$84.60	$65.31
Nebraska	$104.71	$167.22	$129.08
Nevada	$19.32	$30.85	$23.81
New Hampshire	$2.40	$3.83	$2.95
New Jersey	$17.71	$28.29	$21.84
New Mexico	$41.30	$65.95	$50.91
New York	$41.02	$65.50	$50.56
North Carolina	$27.25	$43.52	$33.60
North Dakota	$45.87	$73.25	$56.55
Ohio	$39.65	$63.32	$48.88
Oklahoma	$103.08	$164.61	$127.07
Oregon	$19.18	$30.63	$23.64

Table 8.15. Future State Governmental Costs Estimates (Dollars in thousands), continued.

State	Estimate 1: $10.575 million in USDA Cooperative Agreements	Estimate 2: $16.887 million in USDA Cooperative Agreements	Estimate 3: $13.036 million in USDA Cooperative Agreements
Pennsylvania	$59.27	$94.64	$73.06
Rhode Island	$0.00	$0.00	$0.00
South Carolina	$34.04	$54.35	$41.96
South Dakota	$68.57	$109.51	$84.53
Tennessee	$41.11	$65.65	$50.67
Texas	$178.28	$284.70	$219.77
Utah	$28.41	$45.37	$35.02
Vermont	$10.91	$17.42	$13.45
Virginia	$35.39	$56.51	$43.62
Washington	$34.69	$55.39	$42.76
West Virginia	$24.15	$38.57	$29.77
Wisconsin	$43.29	$69.13	$53.36
Wyoming	$50.85	$81.20	$62.68
Sum	$2,115.00	$3,377.47	$2,607.20
Raw Average	$42.30	$67.55	$52.14
Minimum	$0.00	$0.00	$0.00
Maximum	$178.28	$284.70	$219.77

Notes: These cost forecasts assume a) mandated 20% matching of funds by each state and b) individual state allocations are made consistent with allocations of awards during the FY 2004-2008 period (table 8.13).

8.3.3 Survey of Animal ID Coordinators

To supplement the above information, and obtain answers to standardized questions not ascertained in the initial interviews, we also asked key personnel in 14 states (the 12 noted above with the addition of California and Michigan) to complete a short survey (that is included in Appendix A8.2). Summary statistics of answers from 13 respondents (92.9% response rate) are provided in table 8.16.

The first set of questions asked in this survey focused on premises registration details. Responses suggest approximately 19 new applications can be processed per hour by one employee. Assuming a rate of $13.75/hour for a data entry clerk wages (consistent with Darnell (2008) analysis previously discussed), this suggests that the governmental cost of processing new premises registration applications is approximately $0.72/application. WLIC (2006) suggest that 100-125 premises registrations can be processed per work day. Assuming an 8-hour work day and the $13.75/hour wage rate, this provides a higher processing cost estimate of $0.88 - $1.10/application.

The surveyed respondents also suggest that hard-copy applications, relative to internet-based applications, are characterized by a higher need for follow-up activities necessary to complete new applications and maintain data integrity. In particular, the weighted-average error/omission frequency rates are 8.04% (n=13) and 3.65% (n=8), respectively, for hard-copy and internet-based applications. Five of the 13 respondents indicated their state does not currently accept internet-based applications.[16] This appears to be due to requirements in those states for physical, hard-copy signatures to accompany all premises registration applications. Moreover, WLIC (2006) suggest that processing applications with exceptions (application with missing or invalid information) takes approximately four times as long as complete applications to process.

[16] If only the states accepting both hard-copy and internet-based applications are considered, weighted average frequencies are 9.06% and 3.65%, respectively. This suggests that the difference in error rates between hard-copy and internet submissions may be higher than suggested in table 8.16.

To gain additional insight on the total cost of establishing new premises registrations, the survey included the question: *What do you believe is the cost (including all costs of efforts related to soliciting new applications, processing applications, addressing application errors/omissions, etc.) of currently establishing new premises in your state?* Responses to this question varied notably from *$0-$15/premise* to *Over $90/premise*. Without disclosing individual responses, it is important to note that the three respondents indicating cost estimates of over $90 operate in states ranking high in terms of NASS estimated cattle inventories. This finding supports USDA's decision to increase its focus on cattle premises registrations and its planned "*840 Start Up*" campaign for FY 2009 (USDA, 2008g). Conversely, three of the four respondents suggesting cost estimates in the $0-$30 range were from states that have mandatory premises registration. This divergence in responses is consistent with the notion (and corresponding phone interviews) that states with mandatory premises registration have, at least in relation to the magnitude of premises located in their state, superior alignment of resources with premises registration. The weighted-average cost estimate for registering new premises in the 13 states is $45.17 per registration. Valuable information for comparison is also provided by WLIC (2006) suggesting premises registration costs of $128 and $17 per premises, respectively, during the 2004 and 2005 periods. The stark difference in cost estimates is primarily reflective of a surge in registration volume in 2005 as premises registration became mandatory in Wisconsin on January 1, 2006. Overall, the average cost of premises registrations by WLIC between January 2004 and December 2005 is estimated to be $26/premises.

Penny Page (Animal ID Coordinator in North Carolina) provided detailed statistics on a December 2006 mass mailing effort she initiated to enhance premises registrations in North Carolina. This effort targeted 27,332 producers, cost a total of $65,788.60, and resulted in 3,933 premises registrations. This implies a 14.4% registration success rate at an average cost of $16.73 pre premises, not including state processing (Page, 2008). To assess the representativeness of these figures, we included a corresponding question in our survey. The weighted-average response suggests a forecasted 12.9% "success rate" would be experienced by similar mass mailing efforts in other states. That is, if resources were allocated in the surveyed states using similar mass mailing procedures, we would anticipate about 13% of recipients to register their premises. It should be noted that this reflects a wide range of prior mass mailing histories across these states (i.e., this would be at least the 2nd mass mailing in North Carolina). Furthermore, resulting premise registrations would likely diminish over subsequent mailings as each additional effort would inherently be targeting producers previously revealing an unwillingness to register.

Our survey also included questions to further assess the current NAIS infrastructure development and current ability to respond to animal diseases in individual states. When asked *"If tomorrow a livestock disease was identified in your state, to what extent would you use information available to you through your state's current participation in the national NAIS system?"* Two-thirds responded that they *would use NAIS information, but less than other in-state resources* and one-third responded that they *would use NAIS information more than other in-state resources*. Accordingly, we followed this question up to assess perceived abilities to currently respond to animal diseases. As shown in table 8.16, the weighted-average response time to notify all livestock producers within 15 and 30 miles of an outbreak is estimated to be 70.5 and 97.5 hours (approximately 3 and 4 days), respectively. While this weighted-average response time estimate is useful, the range in responses is arguably more telling. For instance, response times for a 15-mile notification circle ranged from less than 5 hours to over 1 week. This finding is consistent with previous comments regarding the diversity in individual state situations (e.g., range in perceived costs of establishing new premises registrations).

Table 8.16 Summary Statistics of Key State Personnel Survey

Questions	Multiple-Choice Options	Frequency of Responses	Weighted Average[a]
# 1: How many new applications for NAIS premises registration can your office typically process in one hour?	0-20	61.54%	19.23
	21-40	30.77%	
	41-60	7.69%	
	61-80	0.00%	
	81-100	0.00%	
	101-120	0.00%	
	Over 120	0.00%	
#2: What is the frequency of premises registration applications that contain some sort of error or omission requiring follow-up investigations?	For hard-copy applications		
	0%-5% frequency	53.85%	8.04%
	6%-10% frequency	7.69%	
	11-15% frequency	23.08%	
	16-20% frequency	7.69%	
	Over 20 %	7.69%	
	For internet-based applications		
	0%-5% frequency	23.08%	3.65%
	6%-10% frequency	38.46%	
	11-15% frequency	0.00%	
	16-20% frequency	0.00%	
	Over 20 %	0.00%	
	Not applicable[b]	38.46%	
#3: What do you believe is the cost (including all costs of efforts related to soliciting new applications, processing applications, addressing application errors/omissions, etc.) of currently establishing new premises in your state?	$0/ - $15/premise	16.67%	$45.17
	$16/ - $30/premise	16.67%	
	$31/ - $45/premise	41.67%	
	$46/ - $60/premise	0.00%	
	$61/ - $75/premise	0.00%	
	$76/ - $90/premise	0.00%	
	Over $90/premise	25.00%	
#4: Assume tomorrow you were provided the necessary funds, with the intent of enhancing premises registration rates in your state, to conduct an extensive mass mailing effort to all known individuals within your state that have not yet registered their premises (but are suspected to have premises that ideally would be registered with NAIS). What do you believe would be the overall response?	0-10% of those contacted would register their premises	46.15%	12.88%
	11-20% of those contacted would register their premises	46.15%	
	21-30% of those contacted would register their premises	0.00%	
	31-40% of those contacted would register their premises	0.00%	
	Over 40% of those contacted would register their premises	7.69%	

Table 8.16 Summary Statistics of Key State Personnel Survey (continued)

Questions	Multiple-Choice Options	Frequency of Responses	Weighted Average[a]
#5: Approximately what portion of the funds received in the USDA cooperative agreements your state has received to date were used primarily for premises registration activities?	0-20%	7.69%	68.46%
	21%-40%	15.38%	
	41%-60%	0.00%	
	61%-80%	30.77%	
	81%-100%	46.15%	
#6: Looking forward over the next three years, what portion of your state's NAIS related activities do you expect to be focused on premises registration?	0-20%	15.38%	54.62%
	21%-40%	23.08%	
	41%-60%	15.38%	
	61%-80%	15.38%	
	81%-100%	30.77%	
#7: If tomorrow a livestock disease was identified in your state, to what extent would you use information available to you through your state's current participation in the national NAIS system?	Not at all, I would not use NAIS information	0.00%	*N/A*
	I would use NAIS information, but less than other in-state resources	66.67%	
	I would use NAIS information more than other in-state resources	33.33%	
	I would rely almost exclusively on NAIS information	0.00%	
#8: Continuing with the prior question, if a livestock disease was identified in your state, how long do you believe it would currently take to notify all livestock producers operating within the following distances of the outbreak?	WITHIN 15 miles:		
	less than 1 hour	0.00%	70.46 (hours)
	1-5 hours	8.33%	
	6-12 hours	0.00%	
	13-24 hours	16.67%	
	25-48 hours	25.00%	
	49-96 hours	25.00%	
	5-7 days	16.67%	
	Over 1 week	8.33%	
	WITHIN 30 miles:		
	less than 1 hour	0.00%	97.45 (hours)
	1-5 hours	0.00%	
	6-12 hours	9.09%	
	13-24 hours	9.09%	
	25-48 hours	27.27%	
	49-96 hours	9.09%	
	5-7 days	18.18%	
	Over 1 week	27.27%	

Notes: See Appendix 8.2 for a copy of the full survey.

[a] The presented averages are weighted using mid-points of the multiple-choice ranges. For open-ended responses to questions 1, 2, 3, 4, and 8, values of 130, 22%, $97, 44.5%, and 8 days, respectively were used in calculations.

[b] The survey did not include a *Not Applicable* option in question #2. This is included in this table to reflect the fact that multiple respondents noted their state does not accept or utilize internet application procedures. These "Not applicable" responses are not included in the mid-point weighted average calculations.

8.4 Conclusions

THE PURPOSE OF THIS CHAPTER was to examine government benefits and costs of NAIS adoption. This chapter provided a summary of past and forecasted future governmental NAIS budgets. Alternative future federal NAIS budgets are presented that range from $23.8 to $33.0 million annually. Moreover, forecasts of future state governmental NAIS expenditures are made with annual combined totals ranging from $2.1 to $3.4 million.

This chapter also provides estimates on the cost savings that NAIS may provide federal and state governments in conducting animal disease surveillance activities. A preliminary estimate of approximately $300,000 is provided of the annual herd level bovine tuberculosis testing cost reductions that NAIS may provide. We also note the need of future work, enabled by improved data and epidemiological modeling abilities, to estimate the impacts of NAIS on animal disease response, rather than surveillance, activities. Moreover, we note that our analysis under-estimates the government benefits, in the form of cost savings, provided by NAIS.

Finally, this chapter provides a summary of results obtained in a small survey of individual state animal ID coordinators and leaders. Results suggest that governmental processing cost of new premises registration applications are approximately $0.72/premises. Moreover, total costs of obtaining new premises registrations are estimated at $45.17/premises. These and other estimates presented throughout this chapter are provided to aid in future NAIS resource allocation decisions.

9. Economic Model Benefit-cost Welfare Impacts: Modeling Market Effects of Animal Identification

Chapter Overview

THE PREVIOUS SECTIONS PRESENTED cost estimates for a variety of animal identification/tracking scenarios. These species-specific costs were also dependent upon the degree of program adoption. A variety of effects are caused by adding costs to a marketing system. In general, added costs are dispersed throughout a vertically-related marketing chain and prices and quantity exchanged in the market are detrimentally impacted. Furthermore, changes in prices for one commodity meat product influences the demand for substitute meat products.

It is also possible that the adoption of an animal identification/tracking program could positively influence the domestic and/or export demand for meat products. However, the extent of these potential changes is difficult to forecast.

This chapter addresses various combinations of these issues. We develop an equilibrium displacement model (EDM) to simulate the effects of non-governmental costs of animal identification/tracking programs on meat/livestock prices, quantities exchanged, and producer/consumer surplus. Various adoption rates of premises identification, bookend identification, and full animal identification/tracking systems are considered. Changes in producer and consumer surplus are estimated because these metrics measure changes in producer/consumer well-being. We focus on the beef, pork, lamb, and poultry industries.

In addition, we simulate the size of export and domestic demand increases that would be necessary to offset increased costs of animal identification/tracking programs. Because we are unable to forecast domestic and foreign consumer responses to such programs, we evaluate the sizes of these potential changes that would be required to cause those in the meat sectors to be indifferent with respect to the implementation of an animal identification/tracking program. It is important to note that we evaluate these impacts in an aggregate environment. That is, while an entire livestock sector may be indifferent (in terms of producer surplus generation) to such programs, it may be the case that individual producers within a sector may not be indifferent. We also evaluate various combinations of domestic and export demand increases on prices, quantities, and producer/consumer surplus.

Finally, an epidemiological disease spread model is used to evaluate a hypothetical foot-and-mouth disease (FMD) outbreak in southwest Kansas under alternative animal tracing strategies. The equilibrium displacement model is used in conjunction with the disease spread model to simulate the economic impacts on the livestock industry.

Equilibrium Displacement Models

An equilibrium displacement model is used to estimate the impacts on meat and livestock prices, quantities, and producer and consumer surplus resulting from the adoption of an animal identification program. The model accounts for interrelationships along the meat marketing chain and the substitutability of meats at the consumer level. This type of modeling technique has been well developed and is widely used in the economics literature to assess net impacts on society of a variety of private technology adoption and/or public policy regulations and initiatives. We estimate cumulative changes in consumer surplus at the retail level and producer surplus at each level of the meat marketing chain associated with an animal identification and tracking program.

Estimates of changes in consumer and producer surplus are useful for evaluating the impacts of policy changes on markets. Consumer surplus is a measure of the difference between what consumers are *willing* to pay for a product and the price that they *actually* pay for a product. That is, at any given product price, some consumers are just willing to pay that price for a product. However, many other consumers are willing to pay more for the product than the current market price. This concept is clearly illustrated by increases in the price of any food product. Suppose the price of a food product increases because poor weather has reduced the supply of an important ingredient. The resulting price increase certainly reduces the quantity sold, but some consumers will continue to purchase the product in spite of the price increase. Clearly, these consumers were willing to pay more for the product prior to its price increase. This difference between willingness to pay for a product and the amount actually paid is a measure of a consumer's gain from a voluntary transaction with a producer. Increases in consumer surplus represent improvements in the collective well-being of consumers in general. This does not mean that every consumer benefits when consumer surplus increases. Rather, consumers in aggregate are better-off when consumer surplus increases.

Producer surplus represents an analog to consumer surplus. That is, at any given market price, some (but not all) producers would be *willing* to produce a product even if prices were lower than that being currently offered by the market. Essentially, aggregate producer surplus is the difference between an industry's total revenue and the total variable costs of producing a product. Note that this is not synonymous with profit because measures of profit must include costs which do not vary with output (i.e., fixed costs). Increases in producer surplus represent an aggregate improvement in the economic well-being of producers within a sector of an industry.

Estimates of total consumer and producer surplus are not heavily relied upon themselves as they contain measurement and methodological error. However, an equilibrium displacement model can be used to effectively measure *changes* in consumer and producer surplus associated with changing economic conditions. The model measures these changes in response to changes in demand for products, supply of products, or both. Consumer demand changes occur for a variety of reasons (e.g., changes in income, prices of substitute goods, tastes and preferences, product attributes, trade policies, etc.). The supply of products may also change for a variety of reasons (e.g., changes in input costs, technology, regulations, etc.). The equilibrium displacement model is used to simulate a number of these impacts caused by the potential implementation of an animal identification and tracking program. By adopting such a program producers will certainly incur direct costs, but adoption could also have a positive effect on international and domestic consumer demand if consumers value this attribute.

Equilibrium displacement models are based on estimates of supply and demand elasticities. Consequently, the model's results are dependent upon those estimates. Our methodology includes a process in which distributions of supply and demand elasticities are used to estimate changes in prices, quantities, and consumer and producer surplus resulting from the implementation of a variety of animal identification program scenarios. Monte Carlo simulations are conducted in which 1,000 sampled sets of related elasticity estimates are drawn from the distributions and used to estimate potential changes in the variables of interest for each scenario.

9.1 Model Development

THIS SECTION DESCRIBES THE MODELING STRATEGY for estimating changes in consumer and producer surplus resulting from the implementation of a variety of animal identification programs. An equilibrium displacement model is presented and used as the primary approach to estimating changes in welfare effects. Later sections describe parameterization of the model and simulation results.

9.1.1 Modeling Strategy

We develop an EDM to estimate the distribution of net societal benefits and costs of an animal identification program among producers, processors, and consumers. For example, the adoption of an animal identification program will impose differential costs on suppliers at each market level. Conceptually, such costs shift relevant supply functions upward and to the left in each affected sector. A reduction in supply at the retail level causes a reduction in quantity demanded at that level. Concurrently, this change causes reductions in derived demand at each upstream level in the marketing chain. In a competitive market, the impacts and distribution of added marketing costs on prices and quantities at each market level are determined by the size of cost impacts and relative supply and demand elasticities at each level.

Figure 9.1 illustrates the relevant market linkages for a simplified case in which, for example, the beef industry marketing chain is separated into a retail and farm sector. To simplify the illustration, fixed input proportions between the farm input (feeder cattle) and marketing services are assumed. Retail demand (D_r) and farm (feeder) supply (S_f) are considered the "primary" relations, while the demand for feeder cattle (D_f) and the retail supply of beef (S_r) are considered "derived" relations (Tomek and Robinson, 1990). The intersection of demand and supply at each level determines relative market-clearing prices (P_r) and (P_f) and market-clearing quantity (Q_0). In this case, the farm-level market-clearing quantity is represented graphically on a retail weight equivalent basis. The difference in equilibrium prices ($P_r - P_f$) represents the farm–retail price spread or marketing margin.

If an animal identification program increased costs only at the retail level, retail supply would shift from S_r to $S_r^{'}$ and the farm-level derived demand for feeder cattle would decline to $D_f^{'}$ (figure 9.1). Retail price would increase to $P_r^{'}$ and farm price would decline to $P_f^{'}$. Marketing cost increases would be reflected by a larger marketing margin ($P_r^{'} - P_f^{'}$), and a new equilibrium quantity would be established at Q_1 . If retail demand were relatively inelastic, consumer expenditures would increase, but farm revenues and producer surplus would decline along with farm price and quantity.

FIGURE 9.1. EFFECTS ON THE BEEF SECTOR OF INCREASED COSTS FROM AN IDENTIFICATION PROGRAM ON THE RETAIL LEVEL

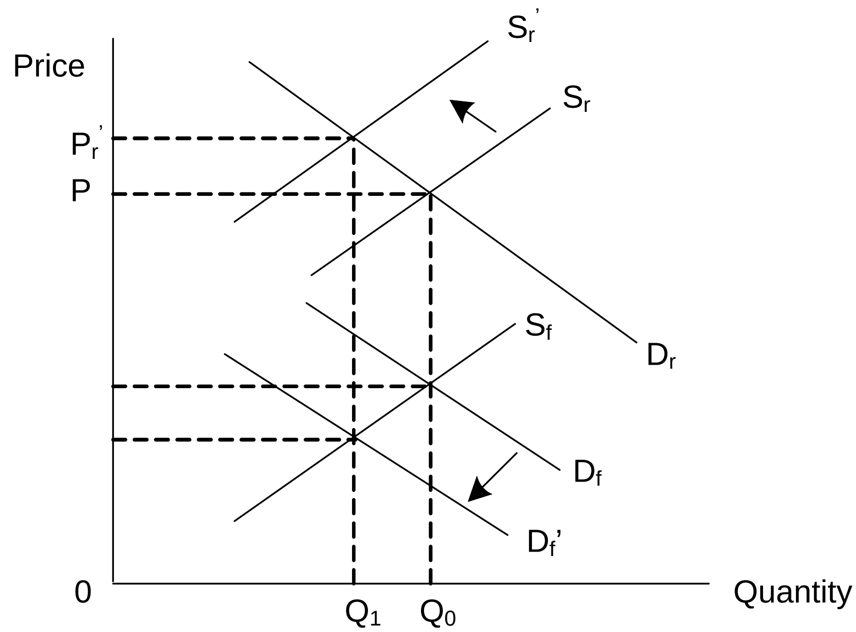


Figure 9.2 extends this simplified case by illustrating a situation in which procurement costs increase at both the retail and farm levels. The initial equilibrium occurs at P_r , P_f , and Q_0 . Increased costs associated with an animal identification program are reflected in reductions in both derived retail supply ($S_r^{''}$) and primary farm supply ($S_f^{''}$). The derived demand for cattle declines to $D_f^{''}$. The new equilibrium prices are at $P_r^{''}$ and $P_f^{''}$, and the new equilibrium quantity is Q_2 . Whether $P_f^{''}$ is higher or lower than P_f depends on relative supply and demand shifts and elasticities at each level. However, Q_2 is unambiguously less than Q_0 . That is, the quantity of cattle traded decreases because of increased marketing costs.

In figure 9.2, the new equilibrium farm price $P_f^{"}$ is higher than the original farm price of P_f. Nonetheless, the higher farm price does not mean that producers are better off because of associated declines in farm output. Producer welfare effects can be measured by the change in producer surplus that results from moving from the original equilibrium (P_f, Q_0) to the new equilibrium ($P_f^{"}$, Q_2). In figure 9.3, shaded area A represents farm-level producer surplus at the original equilibrium price and quantity, and shaded area B represents farm-level producer surplus as a result of increased marketing costs that affect the retail and farm levels. Assuming linear supply and demand functions, elasticity estimates and equilibrium prices and quantities can be used to calculate the sizes of the shaded areas. Absent a consumer demand increase, the change in producer surplus illustrated in figure 9.3 must be negative and is expressed as

$$\Delta PS = B - A = [1/2(P_f^{"} - \alpha_1)Q_2] - [1/2(P_f - \alpha_0)Q_0] \qquad (9.1)$$

where ΔPS represents the change in producer surplus.

FIGURE 9.2. EFFECTS ON THE BEEF SECTOR OF INCREASED RETAIL AND FARM LEVEL COSTS CAUSED BY AN ANIMAL IDENTIFICATION PROGRAM

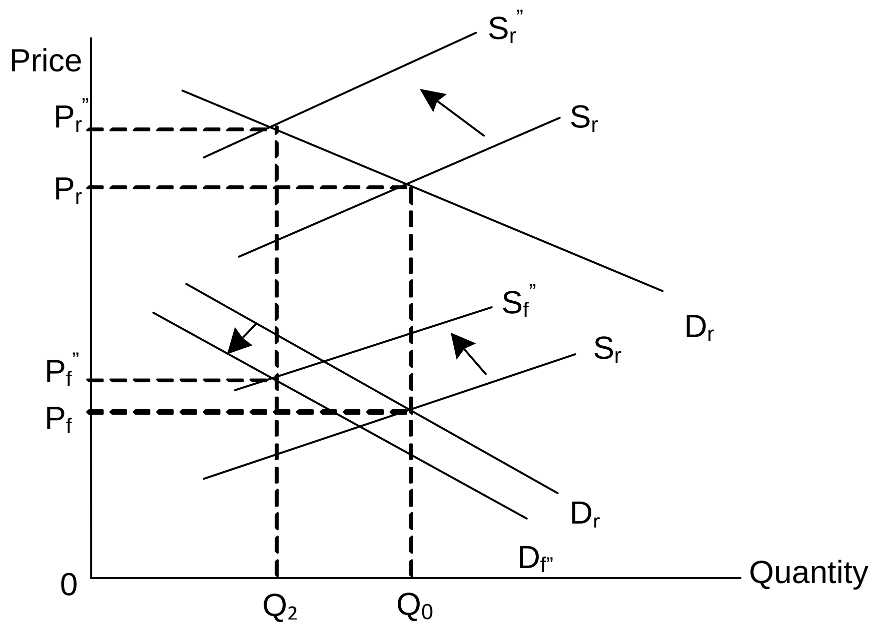
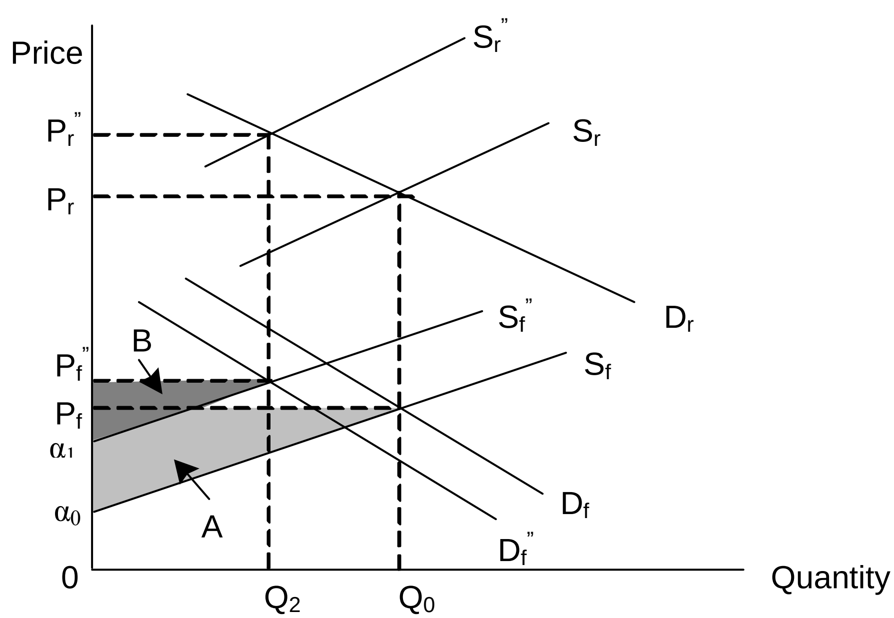


FIGURE 9.3. CHANGES IN FARM-LEVEL PRODUCER SURPLUS RESULTING FROM INCREASED RETAIL AND FARM COSTS CAUSED BY AN ANIMAL IDENTIFICATION PROGRAM



9.1.2 An Equilibrium Displacement Model of the US Meat Industry

An equilibrium displacement model is a linear approximation to a set of underlying and unknown demand and supply functions. The model's accuracy depends on the degree of nonlinearity of the true demand and supply functions and the magnitude of deviations from equilibrium being considered. If these deviations are relatively small, then a linear approximation of the true demand and supply functions should be relatively accurate (Brester, Marsh, and Atwood, 2004; Brester and Wohlgenant, 1997; Wohlgenant, 1993). Although total producer surplus measurements obtained from linear supply functions may or may not reflect actual values, changes in producer surplus caused by shifts in linear supply or demand functions should approximate actual changes provided that such shifts are relatively small.

A general structural model of supply and demand relationships in the US meat industry provides the framework for an equilibrium displacement model. The meat industry is modeled as a series of primary and derived demand and supply relations for the beef, pork, lamb, and poultry industries. The model uses quantity transmission elasticities between the supply and demand sectors to reflect variable input proportions among live animals and marketing service inputs (Brester, Marsh, and Atwood, 2004; Tomek and Robinson, 1990; Wohlgenant, 1993). The transmission elasticities incorporate variable input proportion technologies by allowing production quantities to vary across market levels as input substitution occurs in response to changing output and input prices (Wohlgenant, 1989).

We model the beef and lamb marketing chains by considering four distinct sectors: retail (consumer), wholesale (processor), slaughter (feedlot), and farm (feeder and cow/calf). The pork industry includes three sectors: retail, wholesale, and slaughter. The poultry industry consists of only the retail and wholesale sectors. The pork and poultry industries are modeled with fewer market levels than the beef and lamb industries because of higher degrees of vertical market integration. International trade is included for each industry at various sectors depending upon market structures. For example, beef and pork imports and exports are considered at the wholesale level. Likewise, poultry exports are considered at the wholesale level while poultry imports are not modeled because they are virtually nonexistent. Lamb imports are considered at the retail level because most imported lamb retains its country-of-origin branding. Consequently, domestic lamb and imported lamb are considered distinctly different products at the retail level. However, imported beef and imported pork are generally indistinguishable at the retail level from their domestic counterparts though enactment of country of origin labeling could alter this somewhat in the future. Hence, imports of beef and pork are additions to US wholesale supplies of each. Beef, pork, imported lamb, domestic lamb, and poultry are considered meat substitutes in the primary demand functions.

In general terms, the structural supply and demand model is given by the following equations (error terms have been omitted):

BEEF SECTOR:

Retail Beef Sector:

Retail beef primary demand:

$$Q_B^{rd} = f_1\left(P_B^{rd}, P_K^{rd}, P_{Ld}^{rd}, P_{Li}^{rd}, P_Y^{rd}, \mathbf{Z}_B^{rd}\right) \tag{9.2}$$

Retail beef derived supply:

$$Q_B^{rs} = f_2\left(P_B^{rs}, Q_B^{ws}, \mathbf{W}_B^{rs}\right) \tag{9.3}$$

Wholesale Beef Sector:

Wholesale beef derived demand:

$$Q_B^{wd} = f_3\left(P_B^{wd}, Q_B^{rd}, \mathbf{Z}_B^{wd}\right) \tag{9.4}$$

Wholesale beef derived supply:

$$Q_B^{ws} = f_4\left(P_B^{ws}, Q_B^{ss}, Q_{Bi}^{ws}, Q_{Be}^{wd}, \mathbf{W}_B^{ws}\right) \tag{9.5}$$

Imported wholesale beef derived demand:

$$Q_{Bi}^{wd} = f_5\left(P_{Bi}^{wd}, Q_{B}^{wd}, \mathbf{Z}_{Bi}^{wd}\right) \tag{9.6}$$

Imported wholesale beef derived supply:

$$Q_{Bi}^{ws} = f_6\left(P_{Bi}^{ws}, \mathbf{W}_{Bi}^{ws}\right) \tag{9.7}$$

Exported wholesale beef derived demand:

$$Q_{Be}^{wd} = f_7\left(P_{B}^{wd}, \mathbf{Z}_{Be}^{wd}\right) \tag{9.8}$$

<u>Slaughter Cattle Sector:</u>

Slaughter cattle derived demand:

$$Q_{B}^{sd} = f_8\left(P_{B}^{sd}, Q_{B}^{wd}, \mathbf{Z}_{B}^{sd}\right) \tag{9.9}$$

Slaughter cattle derived supply:

$$Q_{B}^{ss} = f_9\left(P_{B}^{ss}, Q_{B}^{fs}, \mathbf{W}_{B}^{ss}\right) \tag{9.10}$$

<u>Feeder Cattle Sector:</u>

Feeder cattle derived demand:

$$Q_{B}^{fd} = f_{10}\left(P_{B}^{fd}, Q_{B}^{sd}, \mathbf{Z}_{B}^{fd}\right) \tag{9.11}$$

Feeder cattle primary supply:

$$Q_{B}^{fs} = f_{11}\left(P_{B}^{fs}, \mathbf{W}_{B}^{fs}\right) \tag{9.12}$$

PORK SECTOR:

<u>Retail Pork Sector:</u>

Retail pork primary demand:

$$Q_{K}^{rd} = f_{12}\left(P_{K}^{rd}, P_{B}^{rd}, P_{Ld}^{rd}, P_{Li}^{rd}, P_{Y}^{rd}, \mathbf{Z}_{K}^{rd}\right) \tag{9.13}$$

Retail pork derived supply:

$$Q_K^{rs} = f_{13}\left(P_K^{rs}, Q_K^{ws}, \boldsymbol{W}_K^{rs}\right) \tag{9.14}$$

Wholesale Pork Sector:

Wholesale pork derived demand:

$$Q_K^{wd} = f_{14}\left(P_K^{wd}, Q_K^{rd}, \boldsymbol{Z}_K^{wd}\right) \tag{9.15}$$

Wholesale pork derived supply:

$$Q_K^{ws} = f_{15}\left(P_K^{ws}, Q_K^{ss}, Q_{Ki}^{ws}, Q_{Ke}^{wd}, \boldsymbol{W}_K^{ws}\right) \tag{9.16}$$

Imported wholesale pork derived demand:

$$Q_{Ki}^{wd} = f_{16}\left(P_{Ki}^{wd}, Q_K^{wd}, \boldsymbol{Z}_{Ki}^{wd}\right) \tag{9.17}$$

Imported wholesale pork derived supply:

$$Q_{Ki}^{ws} = f_{17}\left(P_{Ki}^{ws}, \boldsymbol{W}_{Ki}^{ws}\right) \tag{9.18}$$

Exported wholesale pork derived demand:

$$Q_{Ke}^{wd} = f_{18}\left(P_K^{wd}, \boldsymbol{Z}_{Ke}^{wd}\right) \tag{9.19}$$

Slaughter Hog Sector:

Slaughter hog derived demand:

$$Q_K^{sd} = f_{19}\left(P_K^{sd}, Q_K^{wd}, \boldsymbol{Z}_k^{sd}\right) \tag{9.20}$$

Slaughter hog primary supply:

$$Q_K^{ss} = f_{20}\left(P_K^{ss}, \boldsymbol{W}_K^{ss}\right) \tag{9.21}$$

LAMB SECTOR:

Retail Lamb Sector:

Domestic retail lamb primary demand:

$$Q_{Ld}^{rd} = f_{21}\left(P_{Ld}^{rd}, P_{Li}^{rd}, P_{B}^{rd}, P_{K}^{rd}, P_{Y}^{rd}, \mathbf{Z}_{Ld}^{rd}\right) \tag{9.22}$$

Domestic retail lamb derived supply:

$$Q_{Ld}^{rs} = f_{22}\left(P_{Ld}^{rd}, Q_{L}^{ws}, \mathbf{W}_{Ld}^{rs}\right) \tag{9.23}$$

Imported retail lamb primary demand:

$$Q_{Li}^{rd} = f_{23}\left(P_{Li}^{rd}, P_{Ld}^{rd}, P_{B}^{rd}, P_{K}^{rd}, P_{Y}^{rd}, \mathbf{Z}_{Li}^{rd}\right) \tag{9.24}$$

Imported retail lamb derived supply:

$$Q_{Li}^{rs} = f_{24}\left(P_{Li}^{rs}, \mathbf{W}_{Li}^{rs}\right) \tag{9.25}$$

__Wholesale Lamb Sector:__

Wholesale lamb derived demand:

$$Q_{L}^{wd} = f_{25}\left(P_{L}^{wd}, Q_{Ld}^{rd}, \mathbf{Z}_{L}^{wd}\right) \tag{9.26}$$

Wholesale lamb derived supply:

$$Q_{L}^{ws} = f_{26}\left(P_{L}^{ws}, Q_{L}^{ss}, \mathbf{W}_{L}^{ws}\right) \tag{9.27}$$

__Slaughter Lamb Sector:__

Domestic slaughter lamb derived demand:

$$Q_{L}^{sd} = f_{27}\left(P_{L}^{sd}, Q_{L}^{wd}, \mathbf{Z}_{L}^{sd}\right) \tag{9.28}$$

Domestic slaughter lamb derived supply:

$$Q_{L}^{ss} = f_{28}\left(P_{L}^{ss}, Q_{L}^{fs}, \mathbf{W}_{L}^{ss}\right) \tag{9.29}$$

__Feeder Lamb Sector:__

Domestic feeder lamb derived demand:

$$Q_{L}^{fd} = f_{29}\left(P_{L}^{fd}, Q_{L}^{sd}, \mathbf{Z}_{L}^{fd}\right) \tag{9.30}$$

Domestic feeder lamb primary supply:

$$Q_L^{fs} = f_{30}\left(P_L^{fs}, \boldsymbol{W}_L^{fs}\right) \tag{9.31}$$

POULTRY SECTOR:

Retail Poultry Sector:

Retail poultry primary demand:

$$Q_Y^{rd} = f_{31}\left(P_Y^{rd}, P_B^{rd}, P_K^{rd}, P_{Ld}^{rd}, P_{Li}^{rd}, \boldsymbol{Z}_Y^{rd}\right) \tag{9.32}$$

Retail poultry derived supply:

$$Q_Y^{rs} = f_{32}\left(P_Y^{rs}, Q_Y^{ws}, Q_{Ye}^{rd}, \boldsymbol{W}_Y^{rs}\right) \tag{9.33}$$

Exported retail poultry derived demand:

$$Q_{Ye}^{rd} = f_{33}\left(P_Y^{rd}, \boldsymbol{Z}_{Ye}^{rd}\right) \tag{9.34}$$

Wholesale Poultry Sector:

Wholesale poultry derived demand:

$$Q_Y^{wd} = f_{34}\left(P_Y^{wd}, Q_Y^{rd}, \boldsymbol{Z}_Y^{wd}\right) \tag{9.35}$$

Wholesale poultry primary supply:

$$Q_Y^{ws} = f_{35}\left(P_Y^{ws}, \boldsymbol{W}_Y^{ws}\right) \tag{9.36}$$

Each of the endogenous price and quantity variables, as well as the exogenous vectors, are presented in the form of X_{kl}^{ij} for which *i* represents a market level (i.e., *r* = retail, *w* = wholesale/processor, *s* = slaughter/feedlot, and *f* = feeder/farm level). In each case, the superscript *j* indicates either a demand function (*d*) or a supply function (*s*). The subscript *k* represents the species being considered (i.e., *B* = beef, *K* = pork, *L* = lamb, and *Y* = poultry). Finally, the subscript *l* represents either an import (*i*) or export (*e*) function where appropriate. This subscript is omitted for domestic market variables. Within each species, market levels are linked by downstream quantity variables among the demand equations and upstream quantity variables among the supply equations (Wohlgenant, 1993). The vectors Z_{kl}^{i} and W_{kl}^{i} represent demand and supply shifters, respectively.

Variable definitions and estimates are presented in table 9.1. It is assumed that market clearing conditions hold for each pair of demand and supply functions. Hence, the superscript *j* is omitted for each price and quantity endogenous variable in table 9.1 and the equilibrium displacement model.

The equilibrium displacement model is developed by totally differentiating equations (9.2) – (9.36). The results were then converted to log differentials so that each relation can be expressed in terms of elasticities. Table 9.2 presents the variable definitions and table 9.3 presents the elasticity definitions and estimates used in the log differential model. Finally, table 9.4 presents the quantity transmission elasticity definitions and estimates.

Table 9.1. Variable Definitions and Estimates for the Structural and Equilibrium Displacement Models, 2007.

Symbol	Definition	Mean[a]
Q_B^r	Quantity (consumption) of retail beef, billions pounds (retail weight)	19.81
P_B^r	Price of Choice retail beef, cents per pound	415.80
P_K^r	Price of retail pork, cents per pound	287.10
P_{Ld}^r	Price of retail domestic lamb, cents per pound	547.92
P_{Li}^r	Price of retail imported lamb, cents per pound	657.67
P_Y^r	Price of retail poultry, cents per pound	165.11
Q_B^w	Quantity of wholesale beef, billions pounds (carcass weight)	26.56
P_B^w	Price of wholesale Choice beef, cents per pound	149.83
Q_B^s	Quantity of beef obtained from slaughter cattle, billions pounds (live weight)	43.64
Q_{Bi}^w	Quantity of wholesale beef imports, billions pounds (carcass weight)	3.05
Q_{Be}^w	Quantity of wholesale beef exports, billions pounds (carcass weight)	1.43
P_{Bi}^w	Price of wholesale beef imports, cents per pound	149.92
P_B^s	Price of slaughter cattle, $/cwt (live weight)	91.82
Q_B^f	Quantity of beef obtained from feeder cattle, billions pounds (live weight)	28.02
P_B^f	Price of feeder cattle, $/cwt	108.23
Q_K^r	Quantity (consumption) of retail pork, billions pounds (retail weight)	15.31
Q_K^w	Quantity of wholesale pork, billions pounds (carcass weight)	21.94
P_K^w	Price of wholesale pork, cents per pound	67.55
Q_K^s	Quantity of pork obtained from slaughter hogs, billions pounds (live weight)	29.32

Table 9.1. Variable Definitions and Estimates for the Structural and Equilibrium Displacement Models, 2007, Continued.

Symbol	Definition	Mean
Q^{w}_{Ki}	Quantity of wholesale pork imports, billions pounds (carcass weight)	0.97
Q^{w}_{Ke}	Quantity of wholesale pork exports, billions pounds (carcass weight)	3.14
P^{w}_{Ki}	Price of wholesale pork imports, cents per pound	42.47
P^{s}_{K}	Price of slaughter hogs, $/cwt (live weight)	47.26
Q^{r}_{Ld}	Quantity (consumption) of retail domestic lamb, billions pounds (retail weight)	0.16
Q^{w}_{L}	Quantity of wholesale lamb, billions pounds (carcass weight)	0.18
Q^{r}_{Li}	Quantity (consumption) of retail imported lamb, billions pounds (retail weight)	0.17
P^{w}_{L}	Price of wholesale lamb, cents per pound	194.31
Q^{s}_{L}	Quantity of lamb obtained from slaughter lamb, billions pounds (live weight)	0.37
P^{s}_{L}	Price of slaughter lamb, $/cwt (live weight)	84.94
Q^{f}_{L}	Quantity of lamb obtained from feeder lamb, billions pounds (live weight)	0.30
P^{f}_{L}	Price of feeder lamb, $/cwt	103.84
Q^{r}_{Y}	Quantity (consumption) of retail poultry, billions pounds (retail weight)	31.07
Q^{w}_{Y}	Quantity of wholesale poultry, billions pounds (RTC)	57.35
Q^{w}_{Ye}	Quantity of retail poultry exports, billions pounds (retail weight)	4.68[b]
P^{w}_{Y}	Price of wholesale poultry, cents per pound	77.14
$\boldsymbol{Z}^{i}_{kl}$	Demand shifters at the *i*th market level for the *k*th commodity and *l*th market (domestic/import)	-[c]
$\boldsymbol{W}^{i}_{kl}$	Supply shifters at the *i*th market level for the *k*th commodity and *l*th market (domestic/import)	-[c]

[a] Source: Livestock Marketing Information Center
[b] We converted wholesale poultry export to retail poultry export by multiplying the wholesale poultry export by 0.74.
[c] Variables without means are inputs to the model and thus do not have data values.

Table 9.2. Variable Definitions for the Log Differential Equilibrium Displacement Model.

z_B^r	Change in consumer demand for retail beef consumption caused by an animal identification program
z_B^w	Change in demand for wholesale beef caused by an animal identification program
z_{Bi}^w	Change in demand for wholesale beef imports caused by an animal identification program
z_{Be}^r	Change in export consumer demand for wholesale beef consumption caused by an animal identification program
z_B^s	Change in demand for slaughter cattle caused by an animal identification program
z_B^f	Change in demand for feeder cattle caused by an animal identification program
z_K^r	Change in consumer demand for retail pork caused by an animal identification program
z_K^w	Change in demand for wholesale pork caused by an animal identification program
z_{Ki}^w	Change in demand for imported wholesale pork caused by an animal identification program
z_{Ke}^w	Change in export consumer demand for wholesale pork caused by an animal identification program
z_K^s	Change in demand for slaughter hogs caused by an animal identification program
z_{Ld}^r	Change in consumer demand for retail domestic lamb consumption caused by an animal identification program
z_{Li}^r	Change in consumer demand for retail imported consumption caused by an animal identification program
z_L^w	Change in demand for wholesale domestic lamb caused by an animal identification program
z_L^s	Change in demand for slaughter lamb caused by an animal identification program
z_L^f	Change in demand for feeder lamb caused by an animal identification program
z_Y^r	Change in consumer demand for retail poultry consumption caused by an animal identification program
z_Y^w	Change in demand for wholesale poultry caused by an animal identification program

Table 9.2. Variable Definitions for the Log Differential Equilibrium Displacement Model, Continued.

z_{Ye}^{w}	Change in export consumer demand for wholesale poultry caused by an animal identification program
w_{B}^{r}	Changes in costs of supplying retail beef caused by an animal identification program
w_{B}^{w}	Changes in costs of supplying wholesale beef caused by an animal identification program
w_{Bi}^{w}	Changes in costs of supplying wholesale beef imports caused by an animal identification program
w_{B}^{s}	Changes in costs of supplying slaughter cattle caused by an animal identification program
w_{B}^{f}	Changes in costs of supplying feeder cattle caused by an animal identification program
w_{K}^{r}	Changes in costs of supplying retail pork caused by an animal identification program
w_{K}^{w}	Changes in costs of supplying wholesale pork caused by an animal identification program
w_{Ki}^{w}	Changes in costs of supplying wholesale pork imports caused by an animal identification program
w_{K}^{s}	Changes in costs of supplying slaughter hogs caused by an animal identification program
w_{Ld}^{r}	Changes in costs of supplying retail domestic lamb caused by an animal identification program
w_{Li}^{r}	Changes in costs of supplying retail imported lamb caused by an animal identification program
w_{L}^{w}	Changes in costs of supplying wholesale lamb caused by an animal identification program
w_{L}^{s}	Changes in costs of supplying slaughter lamb caused by an animal identification program
w_{L}^{f}	Changes in costs of supplying feeder lamb caused by an animal identification program
w_{Y}^{r}	Changes in costs of supplying retail poultry caused by an animal identification program
w_{Y}^{w}	Changes in costs of supplying wholesale poultry caused by an animal identification program

Table 9.3. Elasticity Definitions and Estimates for the Log Differential Equilibrium Displacement Model.

Symbol	Definition	Estimate: Short Run	Estimate: Long Run
η_B^r	Own-price elasticity of demand for retail beef	-0.86[b]	-1.17[b]
η_{BK}^r	Cross-price elasticity of demand for retail beef with respect to the price of retail pork	0.10[a]	
η_{BLd}^r	Cross-price elasticity of demand for retail beef with respect to the price of domestic retail lamb	0.05[c]	
η_{BLi}^r	Cross-price elasticity of demand for retail beef with respect to the price of imported retail lamb	0.05[c]	
η_{BY}^r	Cross-price elasticity of demand for retail beef with respect to the price of retail poultry	0.05[a]	
ε_B^r	Own-price elasticity of supply for retail beef	0.36[d]	4.62[d]
η_B^w	Own-price elasticity of demand for wholesale beef	-0.58[b]	-0.94[b]
ε_B^w	Own-price elasticity of supply for wholesale beef	0.28[d]	3.43[b]
η_{Bi}^w	Own-price elasticity of demand for wholesale beef imports	-0.58[c]	-0.94[c]
ε_{Bi}^w	Own-price elasticity of supply for wholesale beef imports	1.83[e]	10.00[c]
η_{Be}^w	Own-price elasticity of demand for wholesale beef exports	-0.42[f]	-3.00[f]
η_B^s	Own-price elasticity of demand for slaughter cattle	-0.40[b]	-0.53[b]
ε_B^s	Own-price elasticity of supply for slaughter cattle	0.26[g]	3.24[g]
η_B^f	Own-price elasticity of demand for feeder cattle	-0.14[b]	-0.75[b]
ε_B^f	Own-price elasticity of supply for feeder cattle	0.22[h]	2.82[h]
η_K^r	Own-price elasticity of demand for retail pork	-0.69[a]	-1.00[c]
η_{KB}^r	Cross-price elasticity of demand for retail pork with respect to the price of retail beef	0.18[i]	
η_{KLd}^r	Cross-price elasticity of demand for retail pork with respect to the price of domestic retail lamb	0.02[c]	
η_{KLi}^r	Cross-price elasticity of demand for retail pork with respect to the price of imported retail lamb	0.02[c]	
η_{KY}^r	Cross-price elasticity of demand for retail pork with respect to the price of retail poultry	0.02[i]	
ε_K^r	Own-price elasticity of supply for retail pork	0.73[d]	3.87[d]
η_K^w	Own-price elasticity of demand for wholesale pork	-0.71[d]	-1.00[c]
ε_K^w	Own-price elasticity of supply for wholesale pork	0.44[d]	1.94[d]

Table 9.3. Elasticity Definitions and Estimates for the Log Differential Equilibrium Displacement Model, Continued.

Symbol	Definition	Estimate	
		Short Run	Long Run
η^{w}_{Ki}	Own-price elasticity of demand for wholesale pork imports	-0.71[c]	-1.00[c]
ε^{w}_{Ki}	Own-price elasticity of supply for wholesale pork imports	1.41[e]	10.00[c]
η^{w}_{Ke}	Own-price elasticity of demand for wholesale pork exports	-0.89[j]	-1.00[c]
η^{s}_{K}	Own-price elasticity of demand for slaughter hogs	-0.51[k]	-1.00[c]
ε^{s}_{K}	Own-price elasticity of supply for slaughter hogs	0.41[l]	1.80[l]
η^{r}_{Ld}	Own-price elasticity of demand for domestic retail lamb	-0.52[b]	-1.11[b]
η^{r}_{LdLi}	Cross-price elasticity of demand for domestic retail lamb with respect to the price of imported retail lamb	0.29[b]	
η^{r}_{LdB}	Cross-price elasticity of demand for domestic retail lamb with respect to the price of retail beef	0.05[c]	
η^{r}_{LdK}	Cross-price elasticity of demand for domestic retail lamb with respect to the price of retail pork	0.02[c]	
η^{r}_{LdY}	Cross-price elasticity of demand for domestic retail lamb with respect to the price of retail poultry	0.02[c]	
ε^{r}_{Ld}	Own-price elasticity of supply for domestic retail lamb	0.15[b]	3.96[b]
η^{r}_{Li}	Own-price elasticity of demand for imported retail lamb	-0.41[b]	-0.63[b]
η^{r}_{LiLd}	Cross-price elasticity of demand for imported retail lamb with respect to the price of domestic retail lamb	0.78[b]	
η^{r}_{LiB}	Cross-price elasticity of demand for imported retail lamb with respect to the price of retail beef	0.05[c]	
η^{r}_{LiK}	Cross-price elasticity of demand for imported retail lamb with respect to the price of retail pork	0.02[c]	
η^{r}_{LiY}	Cross-price elasticity of demand for imported retail lamb with respect to the price of retail poultry	0.02[c]	
ε^{r}_{Li}	Own-price elasticity of supply for imported retail lamb	10.00[b]	10.00[b]
η^{w}_{L}	Own-price elasticity of demand for wholesale lamb	-0.35[b]	-1.03[b]
ε^{w}_{L}	Own-price elasticity of supply for wholesale lamb	0.16[b]	3.85[b]
η^{s}_{L}	Own-price elasticity of demand for slaughter lamb	-0.33[b]	-0.87[b]
ε^{s}_{L}	Own-price elasticity of supply for slaughter lamb	0.12[b]	2.95[b]
η^{f}_{L}	Own-price elasticity of demand for feeder lamb	-0.11[b]	-0.29[b]
ε^{f}_{L}	Own-price elasticity of supply for feeder lamb	0.09[b]	2.26[b]

Table 9.3. Elasticity Definitions and Estimates for the Log Differential Equilibrium Displacement Model, Continued.

		Estimate	
Symbol	Definition	Short Run	Long Run
η_Y^r	Own-price elasticity of demand for retail poultry	-0.29[i]	-1.00[c]
η_{YB}^r	Cross-price elasticity of demand for retail poultry with respect to the price of retail beef	0.18[i]	
η_{YK}^r	Cross-price elasticity of demand for retail poultry with respect to the price of retail pork	0.04[i]	
η_{YLd}^r	Cross-price elasticity of demand for retail poultry with respect to the price of domestic retail lamb	0.02[c]	
η_{YLi}^r	Cross-price elasticity of demand for retail poultry with respect to the price of imported retail lamb	0.02[c]	
ε_Y^r	Own-price elasticity of supply for retail poultry	0.18[d]	13.10[d]
	Own-price elasticity of demand for retail poultry exports	-0.31[e]	-1.00[c]
η_Y^w	Own-price elasticity of demand for wholesale poultry	-0.22[d]	-1.00[d]
ε_Y^w	Own-price elasticity of supply for wholesale poultry	0.14[d]	14.00[d]

[a]Brester and Schroeder (1995); [b]GIPSA RTI Meat Marketing Study (2007); [c]Authors best estimate; [d]Brester, Marsh, and Atwood (2004); [e]Estimated by authors; [f]Zaho, Wahl, and Marsh (2006); [g]Marsh (1994); [h]Marsh (2003); [i]Brester (1996); [j]Paarlberg et al. (2008); [k]Wohlgenant (2005); [l]Lemieux and Wohlgenant (1989).

Table 9.4. Quantity Transmission Elasticity Definitions and Estimates for the Log Differential Equilibrium Displacement Model.

Symbol	Definition	Estimate[a]	Standard Deviation[a]
γ_B^{wr}	Percentage change in retail beef supply given a 1% change in wholesale beef supply	0.771	0.072
τ_B^{rw}	Percentage change in wholesale beef demand given a 1% change in retail beef demand	0.995	0.095
γ_B^{sw}	Percentage change in wholesale beef supply given a 1% change in slaughter cattle supply	0.909	0.024
τ_B^{ws}	Percentage change in slaughter cattle demand given a 1% change in wholesale beef demand	1.09	0.024
γ_B^{fs}	Percentage change in slaughter cattle supply given a 1% change in feeder cattle supply	1.07	0.351
τ_B^{sf}	Percentage change in feeder cattle demand given a 1% change in slaughter cattle demand	0.957	0.036
γ_K^{wr}	Percentage change in retail pork supply given a 1% change in wholesale pork supply	0.962	0.038
τ_K^{rw}	Percentage change in wholesale pork demand given a 1% change in retail pork demand	0.983	0.037
γ_K^{sw}	Percentage change in wholesale pork supply given a 1% change in slaughter hog supply	0.963	0.039
τ_K^{ws}	Percentage change in slaughter hog demand given a 1% change in wholesale pork demand	0.961	0.037
γ_L^{wr}	Percentage change in retail domestic lamb supply given a 1% change in wholesale lamb supply	0.908	0.103
τ_L^{rw}	Percentage change in wholesale lamb demand given a 1% change in retail domestic lamb demand	0.731	0.058
γ_L^{sw}	Percentage change in wholesale lamb supply given a 1% change in slaughter lamb supply	1.007	0.002
τ_L^{ws}	Percentage change in slaughter lamb demand given a 1% change in wholesale lamb demand	0.993	0.002
γ_L^{fs}	Percentage change in slaughter lamb supply given a 1% change in feeder lamb supply	0.864	0.142
τ_L^{sf}	Percentage change in feeder lamb demand given a 1% change in slaughter lamb demand	0.962	0.025
γ_Y^{wr}	Percentage change in retail poultry supply given a 1% change in wholesale poultry supply	0.806	0.022
τ_Y^{rw}	Percentage change in wholesale poultry demand given a 1% change in retail poultry demand	1.035	0.103

[a]These estimates are obtained from the structural model that is presented later in the report.

BEEF SECTOR:

$$EQ_B^r = \eta_B^r EP_B^r + \eta_{BK}^r EP_K^r + \eta_{BLd}^r EP_{Ld}^r + \eta_{BLi}^r EP_{Li}^r + \eta_{BY}^r EP_Y^r + Ez_B^r \quad (9.37)$$

$$EQ_B^r = \varepsilon_B^r EP_B^r + \gamma_B^{wr} EQ_B^w + Ew_B^r \quad (9.38)$$

$$EQ_B^w = \eta_B^w EP_B^w + \tau_B^{rw} EQ_B^r + Ez_B^w \quad (9.39)$$

$$EQ_B^w = \varepsilon_B^w EP_B^w + \gamma_B^{sw} (Q_B^s / Q_B^w) EQ_B^s + (Q_{Bi}^w / Q_B^w) EQ_{Bi}^w - (Q_{Be}^w / Q_B^w) EQ_{Be}^w + Ew_B^w \quad (9.40)$$

$$EQ_{Bi}^w = \eta_{Bi}^w EP_{Bi}^w + \tau_B^{rw} EQ_B^w + (Q_{Bi}^w / Q_B^w) Ez_{Be}^w + Ez_{Bi}^w \quad (9.41)$$

$$EQ_{Bi}^w = \varepsilon_{Bi}^w EP_{Bi}^w + Ew_{Bi}^w \quad (9.42)$$

$$EQ_{Be}^w = \eta_{Be}^w EP_B^w + Ez_{Be}^w \quad (9.43)$$

$$EQ_B^s = \eta_B^s EP_B^s + \tau_B^{ws} EQ_B^w + (Q_{Be}^w / Q_B^w) Ez_{Be}^w + Ez_B^s \quad (9.44)$$

$$EQ_B^s = \varepsilon_B^s EP_B^s + \gamma_B^{fs} EQ_B^f + Ew_B^s \quad (9.45)$$

$$EQ_B^f = \eta_B^f EP_B^f + \tau_B^{sf} EQ_B^s + Ez_B^f \quad (9.46)$$

$$EQ_B^f = \varepsilon_B^f EP_B^f + Ew_B^f \quad (9.47)$$

PORK SECTOR:

$$EQ_K^r = \eta_K^r EP_K^r + \eta_{KB}^r EP_B^r + \eta_{KLd}^r EP_{Ld}^r + \eta_{KLi}^r EP_{Li}^r + \eta_{KY}^r EP_Y^r + Ez_K^r \quad (9.48)$$

$$EQ_K^r = \varepsilon_K^r EP_K^r + \gamma_K^{wr} EQ_K^w + Ew_K^r \quad (9.49)$$

$$EQ_K^w = \eta_K^w EP_K^w + \tau_K^{rw} EQ_K^r + Ez_K^w \quad (9.50)$$

$$EQ_K^w = \varepsilon_K^w EP_K^w + \gamma_K^{sw} (Q_K^s / Q_K^w) EQ_K^s + (Q_{Ki}^w / Q_K^w) EQ_{Ki}^w - (Q_{Ke}^w / Q_K^w) EQ_{Ke}^w + Ew_K^w \quad (9.51)$$

$$EQ_{Ki}^w = \eta_{Ki}^w EP_{Ki}^w + \tau_K^{rw} EQ_K^w + (Q_{Ki}^w / Q_K^w) Ez_{Ke}^w + Ez_{Ki}^w \quad (9.52)$$

$$EQ_{Ki}^w = \varepsilon_{Ki}^w EP_{Ki}^w + Ew_{Ki}^w \quad (9.53)$$

$$EQ_{Ke}^w = \eta_{Ke}^w EP_K^w + Ez_{Ke}^w \quad (9.54)$$

$$EQ_K^s = \eta_K^s EP_K^s + \tau_K^{ws} EQ_K^w + (Q_{Ke}^w / Q_K^w) Ez_{Ke}^w + Ez_K^s \quad (9.55)$$

$$EQ_K^s = \varepsilon_K^s EP_K^s + Ew_k^s \quad (9.56)$$

LAMB SECTOR:

$$EQ_{Ld}^{r} = \eta_{Ld}^{r}EP_{Ld}^{r} + \eta_{LdLi}^{r}EP_{Li}^{r} + \eta_{LdB}^{r}EP_{B}^{r} + \eta_{LdK}^{r}EP_{K}^{r} + \eta_{LdY}^{r}EP_{Y}^{r} + Ez_{Ld}^{r} \quad (9.57)$$

$$EQ_{Ld}^{r} = \varepsilon_{Ld}^{r}EP_{Ld}^{r} + \gamma_{L}^{wr}EQ_{L}^{w} + Ew_{Ld}^{r} \quad (9.58)$$

$$EQ_{Li}^{r} = \eta_{Li}^{r}EP_{Li}^{r} + \eta_{LiLd}^{r}EP_{Ld}^{r} + \eta_{LiB}^{r}EP_{B}^{r} + \eta_{LiK}^{r}EP_{K}^{r} + \eta_{LiY}^{r}EP_{Y}^{r} + Ez_{Li}^{r} \quad (9.59)$$

$$EQ_{Li}^{r} = \varepsilon_{Li}^{r}EP_{Li}^{r} + Ew_{Li}^{r} \quad (9.60)$$

$$EQ_{L}^{w} = \eta_{L}^{w}EP_{L}^{w} + \tau_{L}^{rw}EQ_{Ld}^{r} + Ez_{L}^{w} \quad (9.61)$$

$$EQ_{L}^{w} = \varepsilon_{L}^{w}EP_{L}^{w} + \gamma_{L}^{sw}EQ_{L}^{s} + Ew_{L}^{w} \quad (9.62)$$

$$EQ_{L}^{s} = \eta_{L}^{s}EP_{L}^{s} + \tau_{L}^{ws}EQ_{L}^{w} + Ez_{L}^{s} \quad (9.63)$$

$$EQ_{L}^{s} = \varepsilon_{L}^{s}EP_{L}^{s} + \gamma_{L}^{fs}EQ_{L}^{f} + Ew_{L}^{s} \quad (9.64)$$

$$EQ_{L}^{f} = \eta_{L}^{f}EP_{L}^{f} + \tau_{L}^{sf}EQ_{L}^{s} + Ez_{L}^{f} \quad (9.65)$$

$$EQ_{L}^{f} = \varepsilon_{L}^{f}EP_{L}^{f} + Ew_{L}^{f} \quad (9.66)$$

POULTRY SECTOR:

$$EQ_{Y}^{r} = \eta_{Y}^{r}EP_{Y}^{r} + \eta_{YB}^{r}EP_{B}^{r} + \eta_{YK}^{r}EP_{K}^{r} + \eta_{YLd}^{r}EP_{Ld}^{r} + \eta_{YLi}^{r}EP_{Li}^{r} + Ez_{Y}^{r} \quad (9.67)$$

$$EQ_{Y}^{r} = \varepsilon_{Y}^{r}EP_{Y}^{r} + \gamma_{Y}^{wr}EQ_{Y}^{w} - (Q_{Ye}^{r} / Q_{Y}^{r})EQ_{Ye}^{r} + Ew_{Y}^{r} \quad (9.68)$$

$$EQ_{Ye}^{r} = \eta_{Ye}^{r}EP_{Y}^{r} + Ez_{Ye}^{r} \quad (9.69)$$

$$EQ_{Y}^{w} = \eta_{Y}^{w}EP_{Y}^{w} + \tau_{Y}^{rw}EQ_{Y}^{r} + (Q_{Ye}^{r} / Q_{Y}^{r})Ez_{Ye}^{r} + Ew_{Y}^{w} \quad (9.70)$$

$$EQ_{Y}^{w} = \varepsilon_{Y}^{w}EP_{Y}^{w} + Ew_{Y}^{w} \quad (9.71)$$

The term *E* represents a relative change operator (e.g., $EQ_B^r = \partial Q_B^r / Q_B^r = \partial \ln_B^r$). Table 9-2 provides definitions for all parameters. In addition, each z_B^i and w_B^i represent single elements of the demand (Z_k^i) and supply (W_k^i) shifters, respectively. Specifically, these elements represent percentage supply or demand changes from initial equilibria caused by an animal identification program. That is, z_k^i

represents potential changes in demand for meat products resulting from an animal identification program. Similarly, w_k^i represents costs that shift supply which may result from an animal identification program. All other elements of (Z_k^i) and (W_k^i) are assumed to be unchanged by implementation of an animal identification program.

The equilibrium displacement model was implemented by placing all of the endogenous variables in equations (9.37) through (9.71) onto the left-hand side of each equation:

BEEF SECTOR:

$$EQ_B^r - \eta_B^r EP_B^r - \eta_{BK}^r EP_K^r - \eta_{BLd}^r EP_{Ld}^r - \eta_{BLi}^r EP_{Li}^r - \eta_{BY}^r EP_Y^r = Ez_B^r \tag{9.72}$$

$$EQ_B^r - \varepsilon_B^r EP_B^r - \gamma_B^{wr} EQ_B^w = Ew_B^r \tag{9.73}$$

$$EQ_B^w - \eta_B^w EP_B^w - \tau_B^{rw} EQ_B^r = Ez_B^w \tag{9.74}$$

$$EQ_B^w - \varepsilon_B^w EP_B^w - \gamma_B^{sw} (Q_B^s / Q_B^w) EQ_B^s - (Q_{Bi}^w / Q_B^w) EQ_{Bi}^w + (Q_{Be}^w / Q_B^w) EQ_{Be}^w = Ew_B^w \tag{9.75}$$

$$EQ_{Bi}^w - \eta_{Bi}^w EP_{Bi}^w - \tau_B^{rw} EQ_B^w = (Q_{Bi}^w / Q_B^w) Ez_{Be}^w + Ez_{Bi}^w \tag{9.76}$$

$$EQ_{Bi}^w - \varepsilon_{Bi}^w EP_{Bi}^w = Ew_{Bi}^w \tag{9.77}$$

$$EQ_{Be}^w - \eta_{Be}^w EP_B^w = Ez_{Be}^w \tag{9.78}$$

$$EQ_B^s - \eta_B^s EP_B^s - \tau_B^{ws} EQ_B^w = (Q_{Be}^w / Q_B^w) Ez_{Be}^w + Ez_B^s \tag{9.79}$$

$$EQ_B^s - \varepsilon_B^s EP_B^s - \gamma_B^{fs} EQ_B^f = Ew_B^s \tag{9.80}$$

$$EQ_B^f - \eta_B^f EP_B^f - \tau_B^{sf} EQ_B^s = Ez_B^f \tag{9.81}$$

$$EQ_B^f - \varepsilon_B^f EP_B^f = Ew_B^f \tag{9.82}$$

PORK SECTOR:

$$EQ_K^r - \eta_K^r EP_K^r - \eta_{KB}^r EP_B^r - \eta_{KLd}^r EP_{Ld}^r - \eta_{KLi}^r EP_{Li}^r - \eta_{KY}^r EP_Y^r = Ez_K^r \tag{9.83}$$

$$EQ_K^r - \varepsilon_K^r EP_K^r - \gamma_K^{wr} EQ_K^w = Ew_K^r \tag{9.84}$$

$$EQ_K^w - \eta_K^w EP_K^w - \tau_K^{rw} EQ_K^r = Ez_K^w \quad (9.85)$$

$$EQ_K^w - \varepsilon_K^w EP_K^w - \gamma_K^{sw} (Q_K^s / Q_K^w) EQ_K^s - (Q_{Ki}^w / Q_K^w) EQ_{Ki}^w + (Q_{Ke}^w / Q_K^w) EQ_{Ke}^w = Ew_K^w \quad (9.86)$$

$$EQ_{Ki}^w - \eta_{Ki}^w EP_{Ki}^w - \tau_K^{rw} EQ_K^w = (Q_{Ki}^w / Q_K^w) Ez_{Ke}^w + Ez_{Ki}^w \quad (9.87)$$

$$EQ_{Ki}^w - \varepsilon_{Ki}^w EP_{Ki}^w = Ew_{Ki}^w \quad (9.88)$$

$$EQ_{Ke}^w - \eta_{Ke}^w EP_K^w = Ez_{Ke}^w \quad (9.89)$$

$$EQ_K^s - \eta_K^s EP_K^s - \tau_K^{ws} EQ_K^w = (Q_{Ke}^w / Q_K^w) Ez_{Ke}^w + Ez_K^s \quad (9.90)$$

$$EQ_K^s - \varepsilon_K^s EP_K^s = Ew_k^s \quad (9.91)$$

LAMB SECTOR:

$$EQ_{Ld}^r - \eta_{Ld}^r EP_{Ld}^r - \eta_{LdLi}^r EP_{Li}^r - \eta_{LdB}^r EP_B^r - \eta_{LdK}^r EP_K^r - \eta_{LdY}^r EP_Y^r = Ez_{Ld}^r \quad (9.92)$$

$$EQ_{Ld}^r - \varepsilon_{Ld}^r EP_{Ld}^r - \gamma_L^{wr} EQ_L^w = Ew_{Ld}^r \quad (9.93)$$

$$EQ_{Li}^r - \eta_{Li}^r EP_{Li}^r - \eta_{LiLd}^r EP_{Ld}^r - \eta_{LiB}^r EP_B^r - \eta_{LiK}^r EP_K^r - \eta_{LiY}^r EP_Y^r = Ez_{Li}^r \quad (9.94)$$

$$EQ_{Li}^r - \varepsilon_{Li}^r EP_{Li}^r = Ew_{Li}^r \quad (9.95)$$

$$EQ_L^w - \eta_L^w EP_L^w - \tau_L^{rw} EQ_{Ld}^r = Ez_L^w \quad (9.96)$$

$$EQ_L^w - \varepsilon_L^w EP_L^w - \gamma_L^{sw} EQ_L^s = Ew_L^w \quad (9.97)$$

$$EQ_L^s - \eta_L^s EP_L^s - \tau_L^{ws} EQ_L^w = Ez_L^s \quad (9.98)$$

$$EQ_L^s - \varepsilon_L^s EP_L^s - \gamma_L^{fs} EQ_L^f = Ew_L^s \quad (9.99)$$

$$EQ_L^f - \eta_L^f EP_L^f - \tau_L^{sf} EQ_L^s = Ez_L^f \quad (9.100)$$

$$EQ_L^f - \varepsilon_L^f EP_L^f = Ew_L^f \quad (9.101)$$

POULTRY SECTOR:

$$EQ_Y^r - \eta_Y^r EP_Y^r - \eta_{YB}^r EP_B^r - \eta_{YK}^r EP_K^r - \eta_{YLd}^r EP_{Ld}^r - \eta_{YLi}^r EP_{Li}^r = Ez_Y^r \quad (9.102)$$

$$EQ_Y^r - \varepsilon_Y^r EP_Y^r - \gamma_Y^{wr} EQ_Y^w + (Q_{Ye}^r / Q_Y^r) EQ_{Ye}^r = Ew_Y^r \quad (9.103)$$

$$EQ_{Ye}^r - \eta_{Ye}^r EP_Y^r = Ez_{Ye}^r \quad (9.104)$$

$$EQ_Y^w - \eta_Y^w EP_Y^w - \tau_Y^{rw} EQ_Y^r = (Q_{Ye}^r \ / \ Q_Y^r) Ez_{Ye}^r + Ew_Y^w \tag{9.105}$$

$$EQ_Y^w - \varepsilon_Y^w EP_Y^w = Ew_Y^w \tag{9.106}$$

For any given set of elasticity estimates, equations (9.72) through (9.106) can be used to determine the relative changes in endogenous quantities and prices for any given exogenous changes in costs and/or consumer demand. In matrix notation, equations (9.72) through (9.106) can be written as:

$$\mathbf{A} \times \mathbf{Y} = \mathbf{B} \times \mathbf{X} \tag{9.107}$$

where A is a 35x35 nonsingular matrix of elasticities; **Y** is a 35x1 vector of changes in the endogenous price and quantity variables; **B** is a 35x35 matrix of parameters associated with the exogenous variables; and **X** is a 35x1 vector of percentage changes in the exogenous supply and demand variables. Relative changes in the endogenous variables (**Y**) caused by relative changes in animal identification costs and benefits (**X**) are calculated by solving equation (9.107) as

$$\mathbf{Y} = \mathbf{A}^{-1} \times \mathbf{B} \times \mathbf{X} \tag{9.108}$$

9.2 DATA

COMPLETE PRICE AND QUANTITY DATA for 2007 were available for all variables included in the model. All price and quantity data were obtained from the Livestock Marketing Information Center.

9.3 Elasticity Estimates

ELASTICITY ESTIMATES ARE REQUIRED to implement the EDM model. When possible, estimates are obtained from the extant literature. In addition, the demand and supply quantity transmission elasticities were estimated from publically-available data. In all cases, Monte Carlo simulations are conducted using random sampling from a range of these elasticities. The Monte Carlo simulations allow the construction of empirical probability distributions for changes in endogenous variables and surplus measures. The Monte Carlo simulations are conducted assuming that elasticity estimates are correlated among vertical demand and supply sectors within each species. Discussion on the Monte Carlo simulations can be found in Appendix A9.1.

9.3.1 Elasticities Obtained From The Literature

The elasticities reported in table 9.3 were generally selected from previously published studies. When several estimates were available, we selected “mid-range” estimates. In other cases, elasticity estimates were unavailable. In these cases, we selected elasticity estimates that were similar to others in the model. For example, the derived demand for imported wholesale beef and imported wholesale pork were assumed to be the same as the derived demand elasticity for domestic wholesale beef and pork, respectively.

Estimates of cross-price elasticities with respect to lamb at the retail level were particularly sparse in the literature. Consequently, the cross-price elasticities of demand for beef with respect to the price of domestic lamb and imported lamb were assumed to be the same as the cross-price elasticity of demand for beef with respect to the price of poultry (0.05). Likewise, the cross-price elasticities of demand for pork with respect to the price of domestic lamb and imported lamb were assumed to be the same as the cross-price elasticity of demand for pork with respect to the price of poultry (0.02).

The cross-price elasticities of domestic lamb to beef, pork, and poultry are assumed to be the same as the cross-price elasticity of beef, pork, and poultry to domestic lamb, respectively (0.05). Similarly, the cross-price elasticities of imported lamb to beef, pork, and poultry are assumed to be the same as the cross-price elasticity of beef, pork, and poultry to imported lamb.

9.3.2 Estimated Demand Quantity Transmission Elasticities

Estimates of demand quantity transmission elasticities are used in the equilibrium displacement model to provide linkages between vertically connected demand sectors. These estimates are obtained from Seemingly Unrelated Regression (SUR) estimation of three equations for both beef and lamb. Because the pork and poultry industries are more vertically integrated compared to the beef and lamb industries, the demand quantity transmission elasticities for pork are obtained from the SUR estimation of two equations while the poultry demand quantity transmission elasticities are obtained from a single ordinary least squares equation. Double log specifications are used so that resulting parameter estimates are interpreted as transmission elasticities. All demand quantity transmission equations are corrected for first-order autocorrelation. Demand quantity transmission elasticity estimates are summarized in table 9.4.

Tables 9.5 through 9.8 present the regression results for the demand quantity transmission regressions. Annual data for the years 1970 through 2007 were used to estimate the transmission elasticities. The quantity data were obtained from the Livestock Marketing Information Center.

Table 9.5. SUR (Double Log) Demand Quantity Transmission Elasticities for Beef.

	Dependent Variables		
Regressors	Wholesale Beef Quantity (Q_B^w)	Slaughter Cattle Quantity (Q_B^s)	Feeder Cattle Quantity (Q_B^f)
Constant	0.34 (0.36)	-0.85 (-3.40)	11.565 (14.2291)
Retail Beef Quantity (Q_B^r)	0.99 (10.44)		
Wholesale Beef Quantity (Q_B^w)		1.09 (44.99)	
Slaughter Cattle Quantity (Q_B^s)			0.96 (26.29)
Regression Statistics:			
Adjusted R^2	0.909	0.992	0.944
Log mean of the dependent variable	10.10	10.18	12.65

[a]These estimates are obtained from the structural model presented later in the report.

Table 9.6. SUR (Double Log) Demand Quantity Transmission Elasticities for Pork.

	Dependent Variables	
Regressors	Wholesale Pork Quantity (Q_K^w)	Slaughter Hogs Quantity (Q_K^s)
Constant	5.39 (18.52)	0.27 (0.74)
Retail Pork Quantity (Q_K^r)	0.98 (26.47)	
Wholesale Pork Quantity (Q_K^w)		0.97 (26.12)
Regression Statistics:		
Adjusted R^2	0.992	0.991
Log mean of the dependent variable	9.70	9.72

[a]These estimates are obtained from the structural model presented later in the report.

Table 9.7. SUR (Double Log) Demand Quantity Transmission Elasticities for Lamb.

	Dependent Variables		
Regressors	Wholesale Lamb Quantity (Q_L^w)	Slaughter Lamb Quantity (Q_L^s)	Feeder Lamb Quantity (Q_L^f)
Constant	4.9 (89.75)	0.05 (5.36)	3.03 (5.76)
Domestic Retail Lamb Quantity (Q_L^r)	0.73 (12.69)		
Wholesale Lamb Quantity (Q_L^w)		0.99 (580.73)	
Slaughter Lamb Quantity (Q_L^s)			0.96 (38.86)
Regression Statistics:			
Adjusted R^2	0.987	0.999	0.991
Log mean of the dependent variable	5.69	5.73	6.23

[a]These estimates are obtained from the structural model presented later in the report.

Table 9.8. OLS (Double Log) Demand Quantity Transmission Elasticity for Poultry.

	Dependent Variable
Regressors	Wholesale Poultry Quantity (Q_Y^w)
Constant	-5.85 (-0.05)
Retail Poultry Quantity (Q_Y^r)	1.035 (10.05)
Regression Statistics:	
Adjusted R^2	0.999
Log mean of the dependent variable	10.28

[a]These estimates are obtained from the structural model presented later in the report.

9.3.3 Estimated Supply Quantity Transmission Elasticities

Estimates of supply quantity transmission elasticities are used in the equilibrium displacement model to provide linkages between vertically connected supply sectors. These estimates are obtained from the SUR estimation of three equations for both beef and lamb. Because the pork and poultry industries are more vertically integrated compared to the beef and lamb industries, the supply quantity transmission elasticities for pork are obtained from the SUR estimation of two equations while the poultry supply quantity transmission elasticities are obtained from a single ordinary least squares equation. Double log specifications are used so that resulting parameter estimates are interpreted as transmission elasticities. All supply quantity transmission equations are corrected for first-order autocorrelation. Supply quantity transmission elasticity estimates are summarized in table 9.4.

Tables 9.9 through 9.12 provide the estimation results for the supply quantity transmission models. Annual data for the years 1970 through 2007 were used to estimate the transmission elasticities. The quantity data were obtained from the Livestock Marketing Information Center

Table 9.9. SUR (Double Log) Supply Quantity Transmission Elasticities for Beef.

	Dependent Variables		
Regressors	Retail Beef Quantity (Q_B^r)	Wholesale Beef Quantity (Q_B^w)	Slaughter Cattle Quantity (Q_B^s)
Constant	2.03 (2.79)	0.84 (3.38)	-3.23 (-0.73)
Wholesale Beef Quantity (Q_B^w)	0.771 (10.77)		
Slaughter Cattle Quantity (Q_B^s)		0.91 (37.35)	
Feeder Cattle Quantity (Q_B^f)			1.07 (3.05)
Regression Statistics:			
Adjusted R^2	0.898	0.991	0.638
Log mean of the dependent variable	9.83	10.10	10.18

[a]These estimates are obtained from the structural model presented later in the report.

Table 9.10. SUR (Double Log) Supply Quantity Transmission Elasticities for Pork.

Regressors	Dependent Variables: Retail Pork Quantity (Q_K^r)	Dependent Variables: Wholesale Hogs Quantity (Q_K^w)
Constant	-4.99 (-10.71)	0.23 (0.58)
Wholesale Pork Quantity (Q_K^w)	0.97 (25.32)	
Slaughter Hogs Quantity (Q_K^s)		0.98 (24.85)
Regression Statistics:		
Adjusted R^2	0.938	0.992
Log mean of the dependent variable	3.93	9.7

[a]These estimates are obtained from the structural model presented later in the report.

Table 9.11. SUR (Double Log) Supply Quantity Transmission Elasticities for Lamb.

	Dependent Variables		
Regressors	Domestic Retail Lamb Quantity (Q_L^r)	Wholesale Lamb Quantity (Q_L^w)	Slaughter Lamb Quantity (Q_L^s)
Constant	-5.99 (-2.87)	-0.05 (-5.24)	0.34 (0.40)
Wholesale Retail Lamb Quantity (Q_L^w)	0.91 (8.82)		
Slaughter Lamb Quantity (Q_L^s)		1.01 (571.09)	
Feeder Lamb Quantity (Q_L^f)			0.86 (6.10)
Regression Statistics:			
Adjusted R^2	0.993	0.999	0.979
Log mean of the dependent variable	0.086	5.72	5.73

[a]These estimates are obtained from the structural model presented later in the report.

Table 9.12. OLS (Double Log) Supply Quantity Transmission Elasticity for Poultry.

Regressors	Dependent Variable: Retail Poultry Quantity (Q_Y^r)
Constant	1.5 (6.49)
Wholesale Poultry Quantity (Q_Y^w)	0.81 (36.62)
Regression Statistics:	
Adjusted R^2	0.999
Log mean of the dependent variable	9.78

[a]These estimates are obtained from the structural model presented later in the report.

9.3.4 Simulated Elasticities

Whether obtained from the literature or estimated, Monte Carlo simulations are conducted after selecting prior distributions for each of the elasticities used in the model. We use Beta (4,4) distributions as priors in all cases. The Beta distribution is used because it allows for truncation while the alpha and beta parameters approximates a normal distribution across the two truncation points. In addition, demand elasticities are constrained to always be negative and supply elasticities to always be positive.

After reviewing the literature, ranges for each short run demand, supply, cross-price, and transmission elasticity were established by multiplying each estimate by 0.50 to establish the lower bound (in absolute value) and by 1.50 to establish the upper bound (in absolute value).

For each Monte Carlo replication, each randomly selected elasticity was allowed to multiplicatively approach its long run elasticity estimate reported above. The approach allows for supply and demand adjustments to occur as both consumers and producers respond to exogenous shocks.

Each simulation includes 1,000 iterations. Empirical probability distributions are generated for each endogenous variable and for all estimates of changes in consumer and producer surplus. We use these empirical distributions to develop reported means (Brester, Marsh, and Atwood, 2004).

9.3.5 Correlations

A sensitivity analysis of an equilibrium displacement model should consider both variations of elasticity estimates and correlations among these estimates (Davis and Espinoza, 1998). We assume that demand elasticities are uncorrelated with supply elasticities. Furthermore, we assume that supply and demand elasticities are uncorrelated across species. Because we obtained supply and demand elasticity estimates from the literature, estimated correlation among supply and demand elasticities are not available. However, estimated correlations among the demand and supply quantity transmissions indicated that vertical correlations averaged about 0.20. In addition, correlation estimates for both the beef sector and lamb sector also indicated correlations of about 0.20 (GIPSA RTI Meat Marketing Study, 2007). Consequently, we selected 0.20 as the correlation coefficient to be used among vertically related supply and demand elasticities.

9.4 SIMULATION SCENARIOS

VARIOUS SIMULATION SCENARIOS ARE PRESENTED below to illustrate the impact of combinations of animal identification policies, adoption rates, and potential export and domestic beef demand responses. The costs on the beef industry are proportionally larger than for the other meat species. Consequently, export and domestic beef demand shocks dominate all others. Thus, the various scenarios focus on shocks to beef demand rather than the potential impacts on demand for other species. Scenarios estimate producer and consumer surplus under 30, 50, 70, and 90% NAIS adoption rates (with few noted exceptions) to illustrate how different adoption rates cause different impacts. The scenarios are separated into five general areas:

1. Effects of Various Adoption Rates of Full Animal Identification/Tracing

The impacts of increased costs of full animal identification/tracing are simulated assuming 30, 50, 70, and 90% adoption rates. This set of simulations are conducted assuming that both export and domestic demand for meat are unaffected by the adoption of a full animal identification/tracing program. In essence these scenarios reflect where costs of NAIS adoption accrue in the short and long run if there are no benefits at all from adoption.

2. Effects of a 50% Adoption Rate for Premises Registration, Bookend, and Full Animal Identification/Tracing

The impacts of a 50% adoption rate of three animal identification programs, 1) premises registration, 2) bookend, and 3) full animal identification/tracing, are simulated. The simulations are conducted assuming that both export and domestic demand for meat are unaffected by the 50% adoption of these three programs. This set of scenarios enables us to compare how additional costs of bookend and full animal tracing alone without any changes in demand would affect producers and consumers. These scenarios again reflect only costs of adoption assuming no benefits.

3. Increases in Export Beef Demand Needed to Offset Various Adoption Rates of Full Animal Identification/Tracing

Regardless of adoption rates, the implementation of a full animal identification/tracing program increases costs. However, it is possible that such systems may increase foreign consumer confidence in the US meat system. Hence, the size of an increase in beef export demand needed to just offset adoption costs is simulated assuming 30, 50, 70, and 90% adoption rates. The focus is on beef exports rather than exports of other meats because the beef sector dominates the simulation model. That is, since costs of adoption are by far largest in the beef sector, it is the sector that is most affected. The simulation involves adjusting the size of the increase in beef export demand to the point where none of the wholesale, slaughter cattle, nor feeder cattle (which includes cow/calf producers) sectors lose any (10-year discounted present value) producer surplus. These sectors were selected because they are the sectors in the beef industry that incur direct costs of an individual animal ID and tracing system with NAIS adoption. In essence, these scenarios measure how much of a beef export demand enhancement would be needed (assuming constant domestic demand) to encourage beef producer adoption of NAIS for each adoption rate.

4. Increases in Domestic Beef Demand Needed to Offset Various Adoption Rates of Full Animal Identification/Tracing

Adoption of an animal identification/tracing program could increase consumer confidence in the US meat system. Hence, the size of an increase in domestic beef demand needed to just offset the costs of such a program is simulated assuming 30, 50, 70, and 90% adoption rates. In these scenarios, the focus is on domestic beef demand rather than the domestic demand for other meats because the beef sector dominates the simulation model. The simulation involves adjusting the size of an increase in domestic beef demand to the point where neither the wholesale beef, slaughter cattle, nor feeder cattle sectors lose any (10-year discounted) producer surplus. In essence, these scenarios measure how much of a domestic beef demand enhancement would be needed (assuming constant domestic demand) to encourage beef producer adoption of NAIS for each adoption rate.

5. Loss of Export Beef Demand if Animal Identification/Tracing is Not Implemented

Animal identification systems are rapidly developing through the world (see Table 12.1 for a summary comparing global cattle identification and traceability systems). World Trade Organization guidelines allow members to maintain higher sanitary and phytosanitary standards than internationally accepted if there is scientific justification to impose such standards. Furthermore, as international adoption of animal identification and tracing systems are adopted, they raise internationally accepted standards. The United States could begin to lose access to international beef export markets if the United States falls behind world standards on adoption of an animal identification/tracing system.

According to USDA-APHIS (2007), the U.S. needs to develop and implement an animal identification system that can "protect U.S. exports and meet the growing international market demand for systems that provide timely animal identification capabilities..." (page 2). Furthermore, Murphy et al. (2008) states that animal identification systems "are becoming prerequisites to international trade" (page 284).

As a result, status quo of doing nothing going forward to increase adoption of NAIS is likely to reduce US access to specific international markets. Exactly how much access and at what timing is not certain, but reduced access is probable. To estimate how such reduced export market access, all else constant, we estimate a set of scenarios where loss of the beef export markets are evaluated at 10%, 25%, and 50% losses assuming the United States does not implement an animal identification/tracing system. These scenarios demonstrate potential losses of not having NAIS as animal identification and tracing becomes an international norm.

9.5 ANIMAL IDENTIFICATION PROGRAM COST ESTIMATES

EXOGENOUS (PERCENTAGE) CHANGES in an animal identification program at the wholesale, slaughter, and farm levels of the beef, pork, lamb, and poultry industries were estimated (see Sections 4-7 for discussion on the animal identification program cost estimates). There are no changes in costs at the retail levels. The annual operation costs estimates resulting from a 90% adoption of an animal identification program for beef, pork, lamb, and poultry would increase by $175.87 million, $5.67 million, $2.71 million, and $7.98 million, respectively.

Of the $192.22 million annual increase in operating costs, the beef industry will bear the largest portion of this with a $175.87 million annual increase in operating costs. Costs associated with several sectors within the beef industry are aggregated for use in the simulation model. For example, Beef cow/calf and Auction yard costs are combined into the feeder cattle sector. Dairy, Background, and Feedlot costs are aggregated into the slaughter cattle sector. Packer costs are referred to as wholesale costs in the simulation model. Thus, beef industry costs are estimated to be distributed as: $126.69 million to the feeder cattle sector, $46.48 million to the slaughter cattle sector, and $2.69 million to the wholesale sector. Using 2007 prices and quantities for each market level, these costs estimates represent the following percentage increases in costs relative to total value: 0.42% at the farm level, 0.12% at the slaughter cattle level, and 0.007% at the wholesale beef level (see column 5, table 9.13). Each of these percentage increases in costs represent upward shifts (reductions in supply) of the respective supply functions [equations (9.47), (9.45), and (9.40)].

Costs associated with the pork industry are aggregated into specific sectors within the simulation model. Identification costs associated with Farrow-to-Wean, Farrow-to-Feeder, Farrow-to-Finish, Wean-to-Feeder, and Feeder-to-Finish are aggregated into the slaughter hog sector. Packer costs are represented in the simulation model by the wholesale level. These costs will be distributed throughout the pork industry as follows: $5.54 million to the slaughter hog sector and $0.13 million to the wholesale pork (packer) sector. These translate to the following percentage increases in costs relative to total value: 0.04% at the slaughter hog level, and 0.0009% at the wholesale pork level (column 5, table 9.13). Each of these percentage increases in costs represents upward shifts of the respective supply functions [equations (9.56) and (9.51)].

One-half of the costs associated with All Operations in the lamb industry are allocated to the feeder lamb level, while the other one-half of All Operations costs are allocated to the slaughter lamb sector. Packer costs are included in the wholesale level in the simulation model. The $2.71 million annual increase in lamb industry costs will be distributed as: $1.34 million, $1.34 million, and $0.029 million to the feeder lamb, slaughter lamb, and wholesale marketing levels, respectively. These costs increases represent the following percentage increases relative to total value at the feeder, slaughter, and wholesale levels: 0.43%, 0.43%, and 0.008%, respectively (column 5, table 9.13). Each of these percentage increases in costs represents upward shifts of the respective supply functions [equations (9.66), (9.64), and (9.62)].

All of the costs incurred by the poultry industry are assigned to the wholesale level in the simulation model. Increased costs to the poultry sector are attributed to the wholesale level and represent a 0.02% increase in wholesale costs relative to total value. This percentage increase represents an upward shift in the respective supply function [equation (9.71)].

The percentage changes in animal identification costs for the alternate scenarios (e.g., 30% adoption for Full Identification/Tracing, 50% adoption for Full Identification/Tracing, etc.) at each market level are estimated in a similar manner. These percentage increases in costs are presented in table 9.13.

Table 9.13. Exogenous Supply Changes Used in the Equilibrium Displacement Model. (%)

	No Change in Demand						
	30% adoption	50% adoption	70% adoption	90% adoption	50% adoption	50% adoption	50% adoption
	Full ID & Tracing	Full ID & Tracing	Full ID & Tracing	Full ID & Tracing	Prem. Registration	Bookend	Full ID & Tracing
Beef Sector:							
Wholesale	0.0019%	0.0032%	0.0046%	0.0068%	0.0000%	0.0032%	0.0032%
Slaughter	0.0303%	0.0538%	0.0815%	0.1160%	0.0001%	0.0319%	0.0538%
Farm	0.0997%	0.1755%	0.2905%	0.4178%	0.0011%	0.1558%	0.1755%
Pork Sector:							
Wholesale	0.0003%	0.0005%	0.0007%	0.0009%	0.0000%	0.0005%	0.0005%
Slaughter	0.0121%	0.0206%	0.0299%	0.0399%	0.0008%	0.0046%	0.0206%
Lamb Sector:							
Wholesale	0.0027%	0.0045%	0.0063%	0.0081%	0.0045%	0.0045%	0.0045%
Slaughter	0.1371%	0.2286%	0.3200%	0.4318%	0.0221%	0.1308%	0.2286%
Farm	0.1350%	0.2249%	0.3149%	0.4250%	0.0217%	0.1287%	0.2249%
Poultry Sector:							
Wholesale	0.0046%	0.0084%	0.0129%	0.0180%	0.0003%	NA*	0.0084%

*There are no costs in the bookend approach for poultry.

9.6 Animal Disease Management

An epidemiological disease spread model is used to evaluate a hypothetical foot-and-mouth disease (FMD) outbreak in southwest Kansas under alternative animal tracing strategies. The disease spread in this exercise is confined to the southwest Kansas region and is not allowed to jump outside of the region, though in all likelihood FMD would spread beyond this region if it occurred. The main reason for confining the disease to this area is that it is the only region for which we have well-calibrated reliable animal location and movement data which are critical inputs into the disease spread model. Restricting the model to this geographic area likely underestimates both the disease spread and its duration. However, the equilibrium displacement model results presented below resulting from a highly contagious FMD outbreak are driven more off of export market losses than animal losses associated with disease outbreak.

The tracing strategies used in the disease spread model are 30, 50, 70, and 90% successful one-step forward traces which we use as a proxy for ID and tracing adoption rates used in other scenarios. However, successful one-step forward traces are not the same as industry animal ID and tracing adoption rates. The specific epidemiological model used is the *North American Animal Disease Spread Model* (NAADSM). NAADSM is a stochastic, spatial, state-transition simulation model that is designed to simulate the spread and control of highly contagious diseases in a population of susceptible animals (Harvey, et al.). Results from the disease spread model are then incorporated into the equilibrium displacement model.

The disease spread model used in this study was developed by the US Department of Agriculture's Animal and Plant Health Inspection Service (USDA/APHIS) in collaboration with Colorado State University, University of Guelph, Canadian Food Inspection Agency, and Ontario Ministry of Agriculture, Food, and Rural Affairs. Several recent studies including Paarlberg et al. (2008), Pendell et al. (2007), Pendell (2006), and Reeves et al. (2006) have used the NAADSM to analyze impacts of FMD outbreaks.

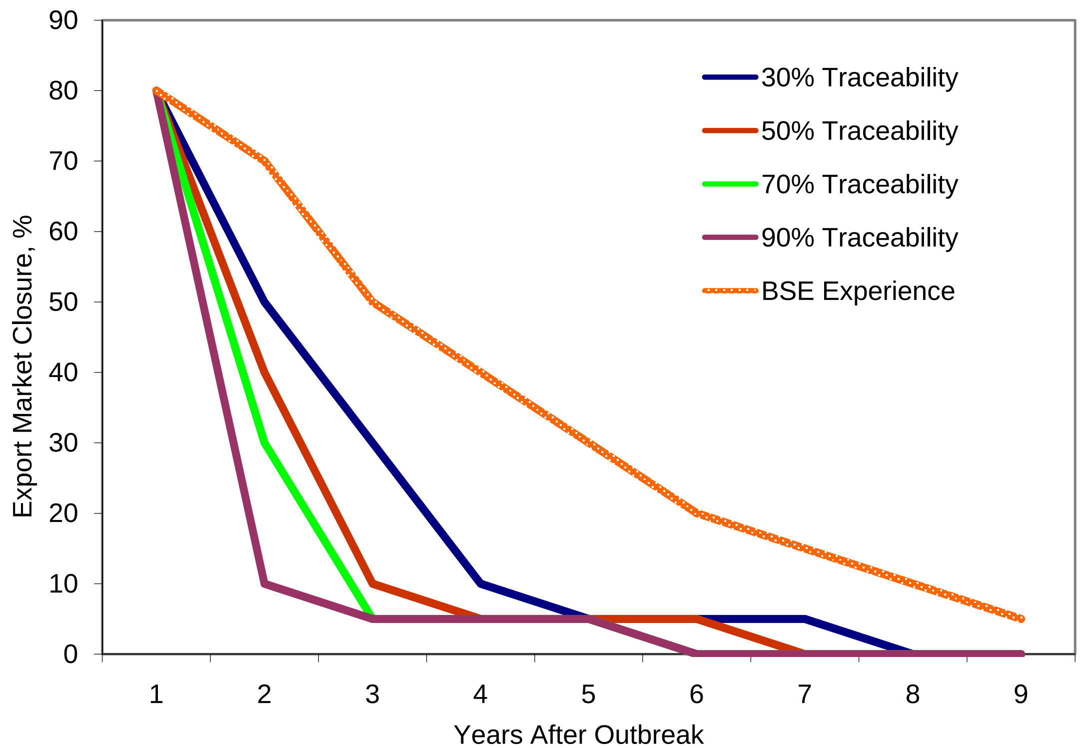
9.6.1 Impacts of Foot-and-Mouth Disease Outbreak with Various Decreases in Export Beef Demand Given Various Adoption Rates of Full Animal Identification/Tracing.

This set of simulations considers increased levels of animal tracing at 30, 50, 70, and 90% tracing adoption rates simultaneously with various changes in export beef demand. In each scenario a first-year reduction in exports of 80% was assumed following an FMD outbreak. The rationale for this is that major export markets would immediately completely close in similar fashion to what the US experienced with the BSE event that resulted in an 80% first-year export market reduction. FMD is a much more well understood and common disease in the world than BSE and is not considered a food safety threat. As such, resumption of trade with an FMD outbreak is assumed to occur faster than the US experienced with BSE. Furthermore, as animal tracing adoption increases, it is assumed that regionalization would enable for more rapid export market re-opening so the export market is assumed to be re-opened more quickly with higher levels of animal tracing adoption.

With 30% tracing adoption, it is assumed that an FMD outbreak would result in an 80% decrease in export beef demand in the first year, a 50% decrease in export beef demand in the second year, a 30% decrease in export beef demand in the third year, 10% decrease in export beef demand in the fourth year, a 5% decrease in export beef demand in years five, six, and seven, and by year eight, the markets would be back to pre-FMD export beef demand levels. A second simulation considers a 50% tracing adoption rate assuming an 80, 40, 10, 5, 5, and 5% loss in export beef demand in years one through six, respectively, with the last four years at pre-FMD beef export levels following the FMD outbreak. A third model simulates a 70% adoption rate tracing adoption rate assuming a 80, 30, 5, 5, and 5% loss in export beef demand in years one through five, respectively, following the FMD outbreak with the last five years at pre-FMD beef export levels. A fourth model considers a 90% adoption rate, and losses of 80, 10, 5, 5, and 5% in export beef demand in years one through five, respectively, with the last five years at pre-FMD beef export levels.

Figure 9.4 presents the alternate tracing adoption rates and the associated export market losses by year following a FMD outbreak and for comparison illustrates the export market losses by year as a result of the BSE event in the US. The BSE event occurred in late 2003, so we have only realized just under five years of export market access since that time. Export market forecasts from the Livestock Marketing Information Center were used for years five, six, seven, eight, and nine, after the BSE event in figure 9.4.

Figure 9.4. Assumed Export Market Loss by Year Following a Foot-and-Mouth Disease Outbreak with Different Bovine and Swine Traceability Levels and Actual and Forecasted BSE Experienced Export Market Loss



9.6 Simulation Results

In this section, we present EDM simulation results for a variety of scenarios that evaluate the cost impacts of implementing an animal identification program on the meat industry. In each case, percentage changes in prices and quantities for livestock and meat prices are presented for both short run (1 year) and long run (10 year) time horizons. Each percentage change is relative to 2007 average prices and quantities. In addition, changes in producer surplus at each market level and for each species are presented as are changes in consumer surplus at the retail level.

Changes in producer and consumer surplus are presented for short run and long run time horizons as well as cumulative effects over a ten-year period. Changes in producer and consumer surplus for the various simulations can be found in the tables in Appendix A.9.2.

9.6.1 Simulated Effects of Various Adoption Rates of Full Animal Identification/Tracing

Table 9.14 presents median percentage changes in prices and quantities for all endogenous variables resulting from a 90% adoption of a full animal identification/tracing program. The first column shows the short run (first year) results. Retail and wholesale beef prices increase by 0.73% and 0.87%, respectively, while quantities decrease by 0.52% and 1.03%. Prices and quantities for imported wholesale beef, slaughter cattle, and feeder cattle all decline. Exported wholesale beef quantities also decline.

Retail, wholesale, and imported pork prices and quantities all increase slightly (but by less than 0.11%). This occurs because the demand for pork increases as the retail price of beef increases. This demand increase is large enough to offset additional costs imposed on the pork sector by the 90% adoption of full animal identification/tracing program. Slaughter hog prices increase by 0.09%, but quantities decline slightly as do quantities of pork exports. Higher domestic pork prices encourages imports which displaces some domestic and export production.

The retail price of domestic lamb increases by 1.1%, while quantity declines by about 0.5%. Thus, retail demand (as a result of higher beef and pork prices) for lamb does not increase enough to offset higher costs of full animal identification/tracing. However, the retail demand for imported lamb increases. The prices of wholesale and slaughter lamb increase while quantities decline. Feeder lamb prices and quantities both decline. Retail and wholesale poultry prices and quantities increase, while poultry exports decline slightly.

In the long run, most of these relationships are similar. However, all of the long run estimates are quite small indicating that the meat industry adjusts to the animal identification/tracing program over time.

Table 9.14. Median Changes from 90% Adoption of a Full Animal Identification/Tracing Program

Endogenous Variables	Short Run	Long Run
Retail Beef Quantity	-0.522%	-0.003%
Retail Beef Price	0.729%	0.003%
Wholesale Beef Quantity	-1.029%	-0.021%
Wholesale Beef Price	0.866%	0.020%
Imported Wholesale Beef Quantity	-0.766%	-0.019%
Imported Wholesale Beef Price	-0.418%	-0.002%
Exported Wholesale Beef Quantity	-0.359%	-0.059%
Slaughter Cattle Quantity	-0.812%	-0.055%
Slaughter Cattle Price	-0.711%	0.061%
Feeder Cattle Quantity	-0.562%	-0.130%
Feeder Cattle Price	-1.469%	0.102%
Retail Pork Quantity	0.104%	-0.001%
Retail Pork Price	0.082%	0.002%
Wholesale Pork Quantity	0.043%	-0.010%
Wholesale Pork Price	0.080%	0.008%
Imported Wholesale Pork Quantity	0.027%	-0.009%
Imported Wholesale Pork Price	0.020%	-0.001%
Exported Wholesale Pork Quantity	-0.073%	-0.008%
Slaughter Hog Quantity	-0.005%	-0.020%
Slaughter Hog Price	0.086%	0.011%
Domestic Retail Lamb Quantity	-0.505%	-0.008%
Domestic Retail Lamb Price	1.126%	0.008%
Imported Retail Lamb Quantity	0.907%	0.006%
Imported Retail Lamb Price	0.090%	0.001%
Wholesale Lamb Quantity	-0.747%	-0.042%
Wholesale Lamb Price	1.057%	0.035%
Slaughter Lamb Quantity	-0.900%	-0.166%
Slaughter Lamb Price	0.511%	0.145%
Feeder Lamb Quantity	-0.609%	-0.191%
Feeder Lamb Price	-2.245%	0.103%
Retail Poultry Quantity	0.080%	0.001%
Retail Poultry Price	0.280%	0.000%
Exported Retail Poultry Quantity	-0.085%	0.000%
Wholesale Poultry Quantity	0.021%	-0.001%
Wholesale Poultry Price	0.276%	0.002%

Table 9.15 presents changes in producer and consumer surplus that occur because of the 90% adoption of a full animal identification/tracing program. As expected, the short run impacts are larger than the long run effects. In the short run, the slaughter and feeder cattle sectors each lose about $570 million. The costs of a full animal identification/tracing program with 90% adoption are approximately $173 million for the slaughter and feeder cattle sectors. These costs cause the supply of both slaughter and feeder cattle to be reduced, thus increasing the price of cattle. However, the increase in price of slaughter and feeder cattle will ultimately raise the price at the retail level causing consumers to substitute away from beef to pork, poultry and/or lamb. This reduction in demand for beef results in a decrease in the derived demand for slaughter and feeder cattle, thus lowering the price and quantity. In year 10, the entire beef industry loses $24 million of producer surplus. Over the entire 10-year period, the discounted present value of producer surplus losses for the beef industry totals $4.52 billion or about 1% of the discounted present value of the 10-year total surplus for the industry.

The pork industry realizes a small gain in producer surplus of $76 million in year 1 as higher beef prices caused by relatively higher animal identification costs causes pork to be a more attractive consumption substitute for beef. Over the entire 10-year period, the pork industry gains only about 0.06% of discounted total producer surplus.

The entire lamb industry loses about $5.3 million of producer surplus in year 1, and a discounted present value of $31.5 million over the entire 10 years. The latter amount represents a 0.35% decline.

The poultry industry gains producer surplus as a result of the implementation of an animal identification program because relatively lower costs are being added to the poultry sector. Thus, as prices for substitute meats increase, the demand for poultry increases. The poultry sector gains $274 million of producer surplus (0.16%) in terms of the discounted present value over the 10-year period.

Assuming that no changes in the domestic or export demand for meats occur as a result of the implementation of an animal identification program, beef consumer surplus declines by 0.45%, pork consumer surplus increases by 0.01%, and domestic lamb consumer surplus declines by 0.55%. Imported lamb consumer surplus increases by 0.35% and poultry consumer surplus increases by 0.01%. In terms of all US meat consumers, consumer surplus declines by $1.33 billion over the 10-year period which represents a 0.11% decline.

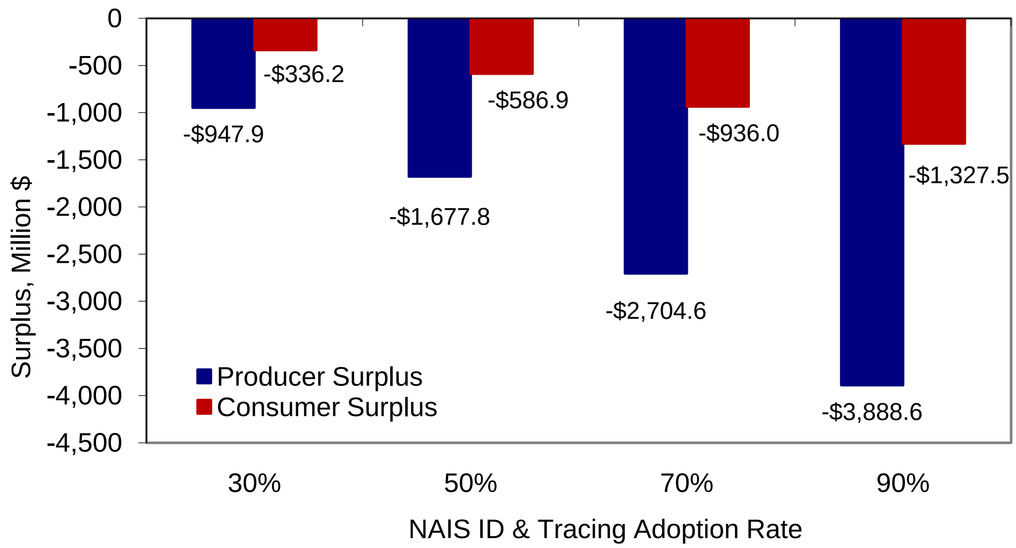
Figure 9.5 presents changes in the total discounted present value of producer and consumer surplus assuming 30, 50, 70, and 90% adoption rates of a full animal identification/tracing program. The losses increase with adoption rates. Of course, each of these scenarios assumes that neither export nor domestic demand for meat are affected by such programs. As such, these scenarios estimate societal impacts of NAIS adoption assuming no benefits accrued.

Table 9.15. Producer and Consumer Surplus Changes from 90% Adoption of a Full Animal Identification/Tracing Program.[a]

Surplus Measure	Short Run	Long Run	Cumulative	Cumulative Present Value	Cumulative Percent Of Total
	million dollars				
Producer Surplus					
Retail Beef	-55.57	-0.50	-613.13	-534.79	-0.177%
Wholesale Beef	-152.95	-2.46	-919.68	-786.85	-0.474%
Slaughter Cattle	-568.31	-6.84	-1,946.61	-1,693.05	-0.862%
Feeder Cattle	-570.12	-13.93	-1,869.94	-1,628.31	-1.038%
Total Beef Producer Surplus	-1,354.51	-23.66	-5,260.73	-4,520.48	-0.991%
Retail Pork	56.29	-0.15	142.13	127.27	0.107%
Wholesale Pork	13.02	-0.75	26.96	25.34	0.041%
Slaughter Hog	6.41	-1.55	-0.78	2.04	0.003%
Total Pork Producer Surplus	76.18	-2.45	167.57	155.70	0.064%
Retail Domestic Lamb	3.84	-0.02	3.99	4.18	0.105%
Wholesale Lamb	0.55	-0.04	-2.50	-1.78	-0.108%
Slaughter Lamb	-1.32	-0.17	-9.45	-7.62	-0.485%
Feeder Lamb	-8.39	-0.27	-30.79	-26.57	-1.539%
Total Lamb Producer Surplus	-5.31	-0.50	-38.41	-31.51	-0.352%
Retail Poultry	160.29	0.03	347.86	314.21	0.171%
Wholesale Poultry	114.25	-0.04	270.96	245.33	0.138%
Total Poultry Producer Surplus	274.28	-0.02	614.87	560.83	0.156%
Total Meat Producer Surplus	-1,018.66	-26.78	-4,537.21	-3,888.63	-0.489%
Consumer Surplus					
Retail Beef	-550.31	-2.19	-1,642.31	-1,448.50	-0.446%
Retail Pork	14.40	-0.74	44.28	39.88	0.019%
Retail Domestic Lamb	-9.00	-0.06	-29.08	-25.66	-0.554%
Retail Imported Lamb	12.29	0.05	34.87	30.89	0.346%
Retail Poultry	-2.16	0.14	69.85	57.70	0.014%
Total Meat Consumer Surplus	-522.82	-2.87	-1,503.37	-1,327.48	-0.109%

[a] Totals are not identical to sums of individual surpluses because they are averages of simulations.

Figure 9.5. Cumulative Present Value of 10-year Total Producer and Consumer Surplus Changes, Full Tracing, with Varying Adoption Rates, with No Domestic or Export Demand Changes*

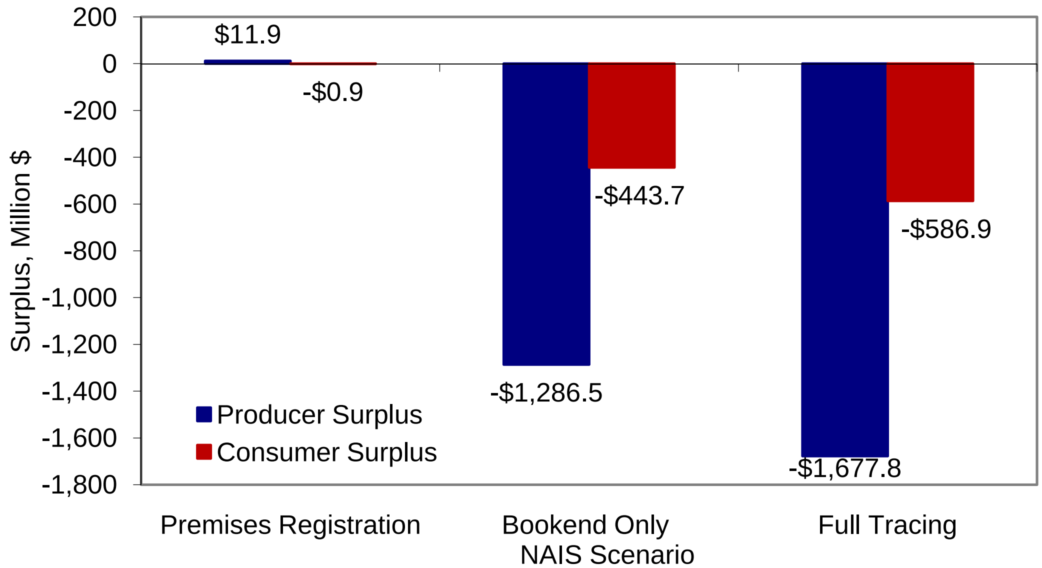


*Information for figure 9.5 can be found in table 9.15 and A9.2.1 – A9.2.3.

9.6.2 Simulated Effects of a 50% Adoption Rate for Premises Registration, Bookend, and Full Animal Identification/Tracing

Simulations were conducted based upon a 50% adoption rate of premises registration, bookend, and full animal identification/tracing programs. Once again, the simulations are conducted assuming that both export and domestic demand for meat are unaffected by a 50% adoption of these three programs. In other words, they assume no direct benefits of adoption. Figure 9.6 illustrates the results in terms of 10-year cumulative total discounted present value of producer and consumer surplus. The impacts on producer and consumer surplus are negligible in the case of premises registration because associated costs are relatively small. However, the costs for bookend and full animal identification/tracing are relatively larger, and cause large changes in total producer and consumer surplus. For the bookend program and full animal identification/traceability program with a 50% adoption rate, total meat producer surplus declines by $1.3 and $1.7 billion, respectively. Of course, each of these scenarios assumes that neither export nor domestic demand for meat are affected by such programs.

FIGURE 9.6. CUMULATIVE PRESENT VALUE OF 10-YEAR TOTAL PRODUCER AND CONSUMER SURPLUS CHANGES, PREMISES REGISTRATION, BOOKEND, FULL TRACING, 50% ADOPTION RATES, NO DEMAND CHANGES*



*Information for figure 9.6 can be found in tables A9.2.4 – A9.2.6.

9.6.3 INCREASES IN BEEF EXPORT DEMAND NEEDED TO OFFSET VARIOUS ADOPTION RATES OF FULL ANIMAL IDENTIFICATION/TRACING

A large and growing body of research suggests that US consumers, as well as those in many other countries, value animal traceability or attributes made available through traceability of food products. Many consumers demand and demonstrate willingness-to-pay for food products that are traceable to the farm or ranch. "The improved food safety from increased traceability increases consumers' willingness to pay for the (safer) product. This creates an additional incentive to improve the food safety reputation of the industry" (Pouliot and Sumner, 2008, p. 25).

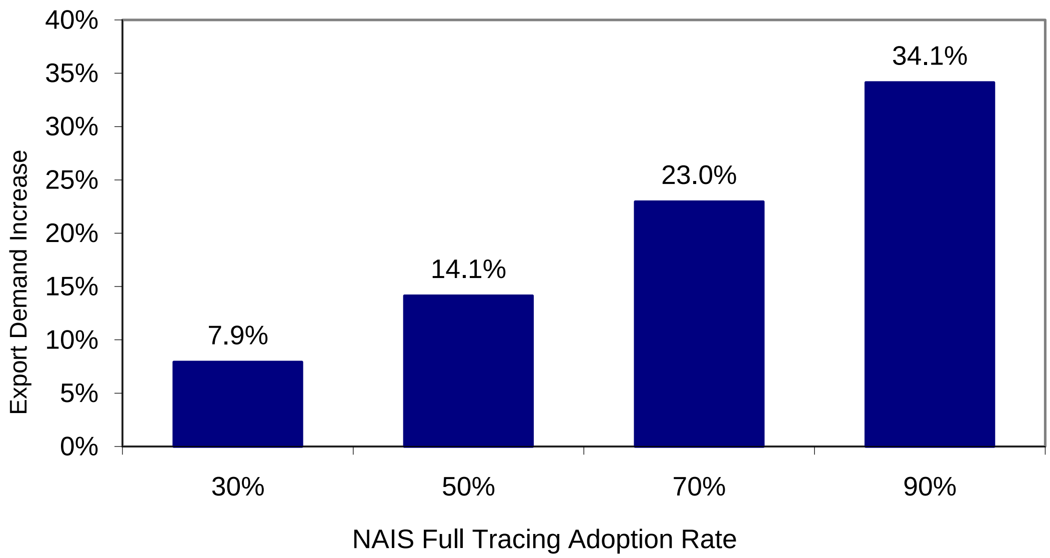
International consumers have demonstrated demand for traceability and/or product attributes (e.g., Buhr, 2003; Cuthbertson and Marks, 2007; Gracia and Zeballos, 2005; Hobbs, 1996; Hobbs et al., 2005; Schroeder et al., 2006;

Tonsor et al., 2005). Dickinson and Bailey (2005) concluded that consumers in Japan, Canada, US, and the UK were willing to pay on average from 7% to 25% more for beef and pork sandwiches containing traceable meat. Japanese consumers, a very important market for US beef and pork, was the highest at 25%. Results from this body of literature reveals that the United States livestock industries lagging behind other major producing regions in animal ID and traceability (as documented in an earlier section of this report), reduces its competitiveness and demand for its product relative to other major exporters in the global market.

Regardless of adoption rates, the advent of full animal identification/tracing increases costs. However, it is possible that such systems may increase foreign consumer confidence in the US meat system. Hence, the size of an increase in beef export demand needed to just offset these costs are simulated assuming 30, 50, 70, and 90% adoption rates. The focus is on beef exports rather than exports of other meats because the beef sector dominates the simulation model. The simulation involves adjusting the size of the increase in beef export demand to the point where none of the wholesale, slaughter cattle, nor feeder cattle (which includes cow/calf producers) sector lose any (10-year discounted) producer surplus.

Figure 9.7 illustrates the simulation results. Assuming a 30% adoption rate of a full animal identification/tracing program, an 7.9% increase in beef export demand over 2007 levels would be required so that the wholesale beef, slaughter cattle, and feeder cattle sectors do not lose producer surplus because of the implementation of an animal identification program. With an 7.9% increase in beef export demand, slaughter and feeder cattle sectors gain $1,037 and $549 million, respectively, while the wholesale sector is virtually no worse off (table A.9.2.7). Given that industry costs increase with adoption rates, a 34.1% increase in beef export demand would be required under a 90% adoption rate to so that none of these three sectors of the beef industry would lose any producer surplus. A 34.1% increase in beef export demand leads to an increase producer surplus in the slaughter and feeder cattle sectors by $4,621 and $2,549 million, respectively (table A.9.2.10). To put such an increase into perspective, South Korea's beef export market share prior to the 2003 US BSE discovery was 23%. Since that time, South Korea's beef market has generally been closed to US beef exports. South Korea's trade negotiators have, at least indirectly, hinted that a lack of a US animal identification system is one of the barriers to the normalization of beef trade between the two countries. Finally, it is likely that adoption rates and export demand increases are likely to be positively correlated.

FIGURE 9.7. CHANGE IN BEEF EXPORT DEMAND NEEDED SO THAT WHOLESALE BEEF, SLAUGHTER CATTLE, AND FEEDER CATTLE SECTORS DO NOT LOSE ANY CUMULATIVE PRESENT VALUE 10-YEAR SURPLUS OF FULL TRACING BY ADOPTION RATES *



*Information for figure 9.7 can be found in tables A9.2.7 – A9.2.10.

9.6.4 Increases in Domestic Beef Demand Needed to Offset Various Adoption Rates of Full Animal Identification/Tracing

Based on the large body of literature demonstrating consumer demand for meat traceability and associated credence and food safety enhancements that are associated with tracing, likely domestic consumer demand would be greater for meat produced under a viable animal tracing system. Exactly how much demand might increase as a result of animal tracking is difficult to determine. However, past research includes willingness to pay premiums for traceability alone of more than 7% (Dickinson and Bailey, 2002).

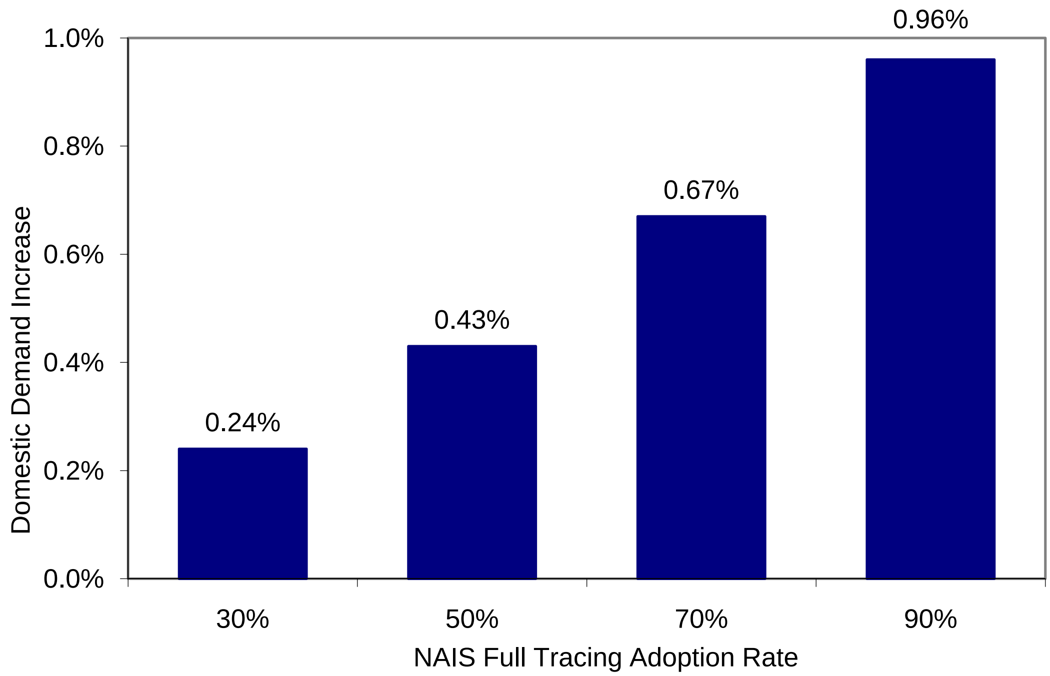
Dickinson and Bailey (2002) conducted binding experiments using beef and pork sandwiches with base prices of $3.00 and actual dollar exchange to determine consumer willingness-to-pay for traceability. Participants were willing-to-pay on average $0.23 more for traceability to the farm for beef and $0.50 for pork. Umberger et al. (2003) concluded that on average consumers in Chicago and Denver were willing to pay from 10% (steak) to 23% (ground beef) more for beef with a US country to origin guarantee. Loureiro and Umberger (2003) determined that consumers were willing to pay $1.53/lb more for steak and $0.70/lb more for ground beef that was "US Certified Beef". Other studies find similar support of US consumers demanding animal and meat traceability (e.g., Loureiro and Umberger, 2004; Ward, Bailey, and Jensen, 2005). Traceability alone appears to be less valuable than what traceability better enables the food supply chain to deliver in regards to food safety assurances, enhanced product quality, origin labeling, and related product credence characteristics (Hobbs et al., 2005; Schroeder et al., 2006; Verbeke and Ward, 2006).

Mennecke et al. (2007) conducted a national survey of 1,171 consumers in addition to surveys of 76 business and animal science students and 221 other students about beef steak attribute preferences. Region of origin was overall the highest ranked important product attribute followed by growth promoters, cost, tenderness, traceability, organic certification, animal breed, steak cut, and animal feed. They concluded "Our results clearly indicate that information about the region of origin, the use or nonuse of growth promoters, guaranteed tenderness, and traceability could all be critical elements of consumer decision making" (p. 2653).

Simulations were conducted to evaluate the potential impacts of increases in domestic consumer demand as a result of various adoption rates of a full animal identification/tracing program. Because the beef industry faces the largest costs, we focus on that sector. The model was used to determine the size of an increase in domestic beef demand that would be required so that none of the wholesale beef, slaughter cattle, nor feeder cattle sectors lose any producer surplus (i.e., 10-year discounted present value) associated with animal identification. Figure 9.8 presents these results, and indicates that a permanent 0.24% increase in domestic beef demand would just offset these costs for the entire industry if a 30% adoption occurred. Under a 90% adoption rate, a permanent domestic demand increase of 0.96% would be required so that no sector of the beef industry would incur any loss of producer surplus based upon the present discounted values occurring over a 10-year time period.

Since 2000, annual beef demand has varied from an increase of 8.9% to a decline of 3.7%. Hence, a 1% increase is certainly within the range of recent demand changes.

FIGURE 9.8. CHANGE IN DOMESTIC BEEF DEMAND NEEDED SO THAT WHOLESALE BEEF, SLAUGHTER CATTLE, AND FEEDER CATTLE SECTORS DO NOT LOSE ANY CUMULATIVE PRESENT VALUE 10-YEAR SURPLUS OF FULL TRACING BY ADOPTION RATES*



*Information for figure 9.8 can be found in tables A9.2.11 – A9.2.14.

9.6.5 IMPACTS OF DECREASES IN EXPORT BEEF DEMAND IF ANIMAL IDENTIFICATION/TRACING IS NOT IMPLEMENTED

This set of simulations considers decreases in export beef demand of 10, 25, and 50% if the US loses access to beef export markets because it does not implement an animal identification/tracing system.

Table 9.16 presents median percentage changes in prices and quantities that would result from a permanent 50% decrease in export demand. The first column shows the short run (first year) results. Retail and wholesale beef prices decrease by 0.79% and 1.03%, respectively, while quantities increase by 0.66% and 1.32%. Imported wholesale beef prices and both import and export quantities decrease. Both slaughter and feeder cattle quantities (0.45% and 0.18%) and prices (2.06% and 1.78%) decline.

With the exception of export pork and poultry quantities, all other pork, lamb and poultry prices and quantities decrease. Because there is a larger supply of beef in the US (because of the decrease in export beef demand), the price at the retail level for beef falls, thus reducing the retail demand for pork, lamb, and poultry.

The long run results are slightly different from the short run results. Specifically, most of the long run results are positive. However, the long run results are much smaller than the short run results.

Table 9.16. Median Changes in the Absence of an Animal Identification/Tracing Program and a 50% Permanent Loss of Beef Export Markets.

Endogenous Variables	Short Run	Long Run
Retail Beef Quantity	0.662%	-0.108%
Retail Beef Price	-0.786%	0.092%
Wholesale Beef Quantity	1.317%	-0.700%
Wholesale Beef Price	-1.025%	0.640%
Imported Wholesale Beef Quantity	-3.383%	-5.879%
Imported Wholesale Beef Price	-1.869%	-0.588%
Exported Wholesale Beef Quantity	-49.581%	-51.920%
Slaughter Cattle Quantity	-0.452%	-3.339%
Slaughter Cattle Price	-2.062%	-0.212%
Feeder Cattle Quantity	-0.180%	-2.511%
Feeder Cattle Price	-1.781%	-0.890%
Retail Pork Quantity	-0.111%	0.016%
Retail Pork Price	-0.051%	0.000%
Wholesale Pork Quantity	-0.068%	0.014%
Wholesale Pork Price	-0.047%	0.001%
Imported Wholesale Pork Quantity0.359%	-0.043%	0.012%
Imported Wholesale Pork Price	-0.031%	0.001%
Exported Wholesale Pork Quantity	0.041%	-0.001%
Slaughter Hog Quantity	-0.028%	0.009%
Slaughter Hog Price	-0.069%	0.005%
Domestic Retail Lamb Quantity	-0.013%	0.004%
Domestic Retail Lamb Price	-0.064%	0.000%
Imported Retail Lamb Quantity	-0.092%	0.005%
Imported Retail Lamb Price	-0.009%	0.000%
Wholesale Lamb Quantity	-0.004%	0.003%
Wholesale Lamb Price	-0.016%	0.000%
Slaughter Lamb Quantity	-0.001%	0.003%
Slaughter Lamb Price	-0.007%	0.000%
Feeder Lamb Quantity	-0.001%	0.002%
Feeder Lamb Price	-0.006%	0.001%
Retail Poultry Quantity	-0.076%	0.016%
Retail Poultry Price	-0.229%	0.000%
Exported Retail Poultry Quantity	0.068%	0.000%
Wholesale Poultry Quantity	-0.029%	0.015%
Wholesale Poultry Price	-0.213%	0.002%

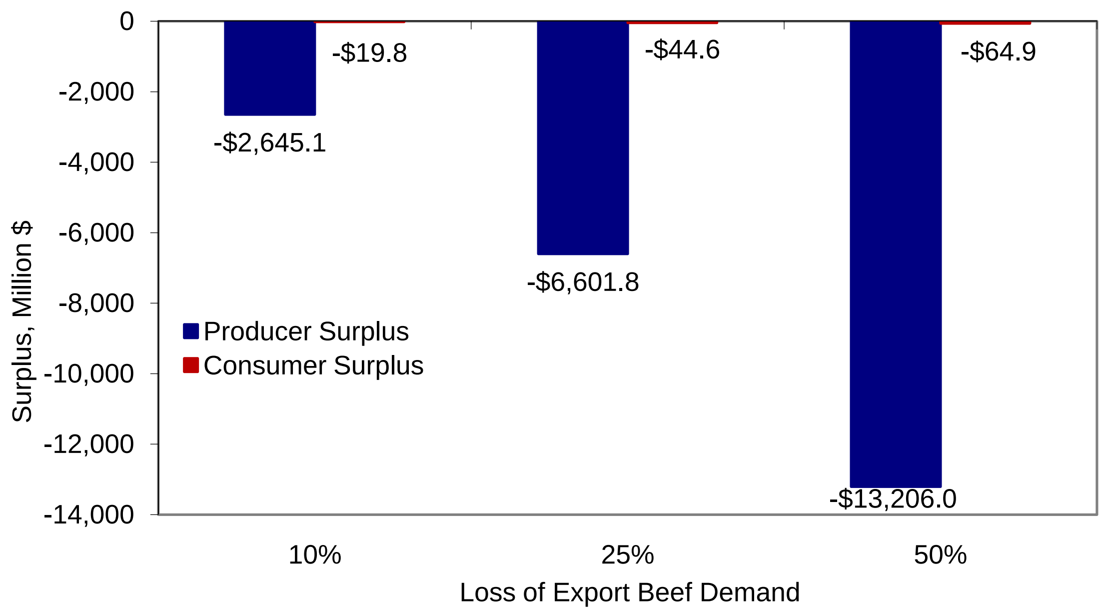
Table 9.17 presents changes in producer and consumer surplus that occur because of a permanent 50% decrease in export demand. The cumulative discounted present value of producer surplus decreases for all sectors. Total beef producer surplus decreases by 2.8%, pork producer surplus by 0.02%, poultry producer surplus by 0.07%, while lamb producer surplus declines by 0.005%. Overall, total meat producer surplus decreases by 1.7%.

Figure 9.9 presents changes in the total discounted present value of producer and consumer surplus assuming 10, 25, and 50% losses in the beef export markets. Given the beef export demand decreases assumed above, producer surplus decreases by $2.6, $6.6, and $13.2 billion for a 10, 25, and 50% loss of demand in beef exports, respectively. Consumer surplus decreases by a much smaller amount, $19.8, $44.6, and $64.9 million for export demand decreases of 10, 25, and 50%, respectively.

Table 9.17. Producer and Consumer Surplus Changes in the Absence of an Animal Identification/Tracing Program and a 50% Permanent loss of Beef Export Markets.

Surplus Measure	Short Run	Long Run	Cumulative	Cumulative Present Value	Cumulative As A Percent Of Total
	million dollars				
Producer Surplus					
Retail Beef	404.48	28.21	706.35	610.00	0.211%
Wholesale Beef	681.50	85.42	962.24	833.61	0.535%
Slaughter Cattle	-1,123.01	-246.75	-10,583.12	-8,579.86	-4.533%
Feeder Cattle	-539.41	-266.60	-7,282.04	-5,774.09	-3.801%
Total Beef Producer Surplus	-556.29	-400.03	-16,056.28	-12,770.44	-2.834%
Retail Pork	-44.81	0.98	-22.82	-29.75	-0.025%
Wholesale Pork	-15.31	0.63	-2.07	-5.66	-0.009%
Slaughter Hog	-9.53	0.67	2.58	-0.72	-0.001%
Total Pork Producer Surplus	-71.25	2.33	-23.37	-36.73	-0.015%
Retail Domestic Lamb	-0.66	0.01	-0.50	-0.54	-0.013%
Wholesale Lamb	-0.07	0.00	-0.02	-0.03	-0.002%
Slaughter Lamb	-0.03	0.00	0.04	0.02	0.001%
Feeder Lamb	-0.02	0.00	0.08	0.05	0.003%
Total Lamb Producer Surplus	-0.79	0.01	-0.40	-0.49	-0.005%
Retail Poultry	-168.46	0.39	-170.41	-166.58	-0.092%
Wholesale Poultry	-94.25	0.67	-67.80	-75.00	-0.042%
Total Poultry Producer Surplus	-264.87	1.10	-247.88	-248.81	-0.070%
Total Meat Producer Surplus	-911.67	-396.57	-16,383.05	-13,206.04	-1.694%
Consumer Surplus					
Retail Beef	640.52	-75.61	-427.37	-112.74	-0.034%
Retail Pork	-20.81	3.41	28.91	15.36	0.007%
Retail Domestic Lamb	0.16	0.02	0.43	0.36	0.008%
Retail Imported Lamb	-1.22	0.04	-0.64	-0.79	-0.009%
Retail Poultry	-6.61	4.10	83.27	57.66	0.014%
Total Meat Consumer Surplus	607.12	-68.01	-324.94	-64.89	-0.005%

FIGURE 9.9 CUMULATIVE 10-YEAR PRESENT VALUE OF TOTAL PRODUCER AND CONSUMER SURPLUS CHANGES, IN THE ABSENCE OF AN ANIMAL IDENTIFICATION/TRACING PROGRAM, WITH PERMANENT LOSS OF ACCESS TO BEEF EXPORT MARKETS *

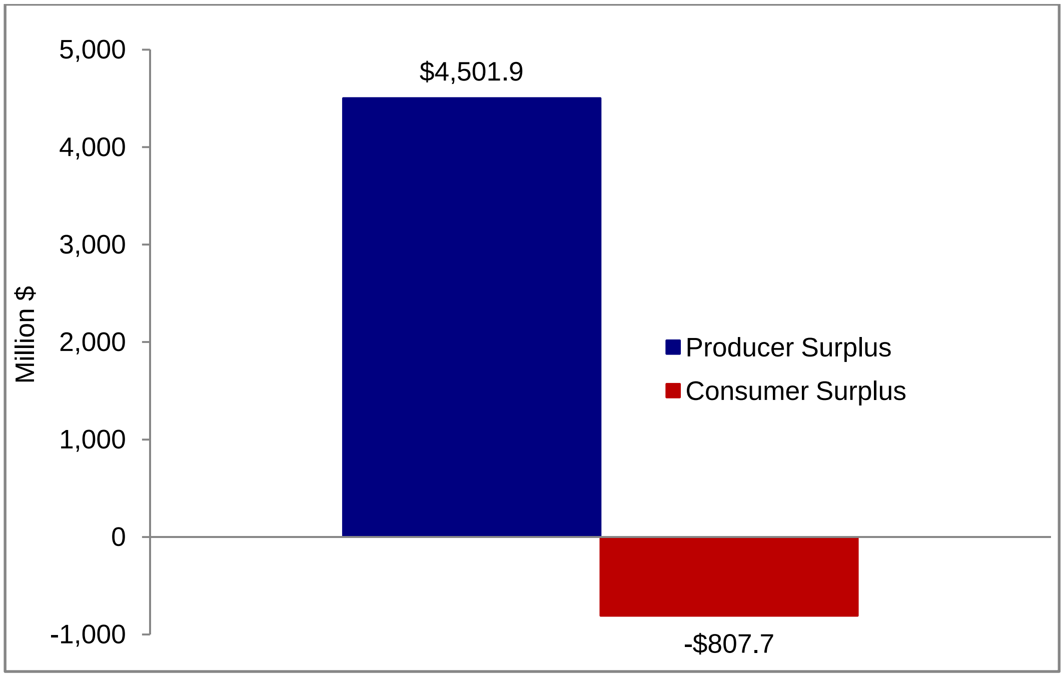


*Information for figure 9.9 can be found in tables 9.17 and A9.2.15 – A9.2.16.

9.6.6 Impacts of Foot-and-Mouth Disease Outbreak with Various Decreases in Export Beef Demand Given Various Adoption Rates of Full Animal Identification/Tracing.

Simulations were conducted to evaluate the potential impacts of closures in the export markets with various animal tracing rates as a result of a FMD outbreak. Figure 9.10 presents the difference in the total discounted present value of producer and consumer surplus between 90 and 30% ID and tracing adoption rates with an FMD. That is, the scenarios presented illustrate potential gains in the event of a FMD (or similar highly contagious disease) at different levels of animal ID. Producer surplus losses for a 90% animal identification/tracing program are $4,501.9 million less than a 30% animal identification/tracing program in the FMD outbreak scenarios with changes in the beef export markets (figure 9.10). Consumer surplus decreases as animal tracing adoption rates rise. The difference between the 90 and 30% animal identification/tracing program is a consumer loss of $807.7 million. The loss in consumer surplus is a result of increased demand in the beef export markets, thus less quantity of beef supplied at the retail level. Combined the societal gain (producer gain less consumer loss) from having 90% vs. 30% tracing is $3,694.2 million.

Figure 9.10. Difference in the 10-Year Cumulative Present Value of Total Producer and Consumer Surplus between 90% and 30% ID and Tracing Adoption Rates with a Foot-and-Mouth Disease Outbreak



9.7 Conclusions

An equilibrium displacement model of the beef, pork, lamb, and poultry sectors was developed to evaluate the impacts on producers and consumers from costs incurred as a result of implementing animal identification/tracking programs. Several programs were evaluated including various adoption rates of premises identification, bookend identification, and full animal identification.

Assuming no changes in either domestic or export demand, the 90% adoption of a full animal identification/tracing program causes a 10-year discounted present value loss of beef industry producer surplus of $4.52 billion (about 1%). Over the entire 10-year period, the pork industry gains about 0.06% of discounted total producer surplus. The gain occurs because the beef industry's relatively larger increase in costs makes pork a more attractive consumption substitute. Conversely, the domestic lamb industry loses about $32 million over the entire 10 years (a 0.4% decline). The poultry industry gains a small amount of producer surplus ($561 million or 0.2%) as a result of the implementation of an animal identification program because relatively lower costs are being added to the poultry sector. Thus, as prices for substitute meats increase, the demand for poultry increases.

Assuming that no changes in the domestic or export demand for meats occur as a result of the implementation of an animal identification program, beef consumer surplus declines by 0.45%, pork consumer surplus increases by 0.02%, and domestic lamb consumer surplus declines by 0.55%. Imported lamb consumer surplus increases by 0.35% and poultry consumer surplus increases by 0.01%. In terms of all US meat consumers, consumer surplus declines by $1.33 billion over the 10 year period which represents a 0.11% decline.

It is possible that export demand for US meat could increase as a result of adopting some type of animal identification system. Because the costs of each of these programs are relatively larger on the beef sector, export demand is the crucial factor that determines changes in producer surplus across all species. Consequently, the simulation model determined the magnitude of an increase in beef export demand increase necessary so that the wholesale beef, slaughter cattle, and feeder cattle sectors would lose no producer surplus for 30, 50, 70, and 90% industry adoption rates. A 23% increase in beef export demand would completely pay for 70% adoption of full animal ID and tracing in the US beef herd over a 10-year period. Parenthetically, South Korea's beef export market share prior to the 2003 US BSE discovery was 23%. No other benefits beyond these would be necessary to make the investment in NAIS economically viable.

Research indicates that domestic beef demand is likely to be greater for products having animal ID and traceability. Small increases in domestic beef demand, with all else constant, would also completely pay for full animal ID and tracing in the beef industry. This scenario was evaluated for a full animal ID and tracing program with 30, 50, 70 and 90% adoption rates. A 0.67% increase in domestic beef demand would be enough to fully pay for 70% adoption of cattle ID and tracing even if no other benefits (i.e., increased export demand) occurred over a 10-year period. This is a relatively modest increase in beef demand relative to changes that have occurred (for a variety of reasons) over the past decade. The overall societal gain under this scenario (producer plus consumer surplus) is a 10-year cumulative net present value of $7.2 billion. In other words, NAIS adoption results in large positive net returns to producers and consumers with even a very small increase in domestic beef demand resulting from NAIS adoption.

If nothing were done in regards to animal identification/tracing, it is possible that we could begin to lose access to export markets as countries around the world adopt animal identification/tracing systems. If the US experiences a 25% permanent loss of the beef export markets, slaughter cattle, feeder cattle, domestic retail lamb, wholesale lamb, all producer sectors of pork and poultry lose economic surplus while retail and wholesale beef and slaughter and feeder lambs gain economic surplus. Consumers of pork, lamb, and poultry gain a small amount of economic surplus while beef consumer surplus declines. The overall societal loss under this scenario (producer plus consumer surplus) is a 10-year cumulative net present value of $6.65 billion.

Finally, simulations were conducted to evaluate the potential impacts of closures in the export markets with various animal tracing rates as a result of an FMD outbreak given 30, 50, 70, and 90% adoption rates of a full animal identification/tracking program. The scenarios illustrate potential gains in the event of a FMD (or similar highly contagious disease) if the different levels of animal ID tracing were already present. Producer surplus losses for a 90% animal identification/tracing program are $4.5 billion less than a 30% animal identification/tracing program. In addition, losses of consumer surplus decline as animal tracing adoption rates rise. Consumers lose $807.7 million more if adoption rates are only 30% adoption relative to 90%. The combined societal gain (producer gain less consumer loss) from a 90% versus 30% adoption rate is $3.7 billion over the 10-year period.

10. EQUINE

10.1 THE EQUINE INDUSTRY

THE EQUINE INDUSTRY, BOTH IN THE UNITED STATES and world-wide, is one that is unique in many aspects and characteristics, making it difficult to describe, classify, and research. The equine industry combines the world of companion animals with the livestock industry – many owners consider their horses to be their pets, while others use them for business. Two main sources of information were used to define the state of the United States equine industry for this project – the NAHMS Equine 2005 project, published in three sections over 2006-2007, and the American Horse Council (AHC) Deloitte Survey, for the calendar year 2003 and published in 2005. In addition to these two major sources, several other sources are noted as discussed. The two primary information sources used greatly differing methods of data collection, with varying results. This is especially apparent in the estimated number of equids in the United States. However, a great deal of important information can still be obtained from these sources.

The actual number of equids in the United States is difficult to ascertain, due to the fact that the USDA Census, conducted every five years, only applies to "on-farm" livestock. As stated in the Equine 2005 project, Part II (p. 18), "The US equine population is difficult to enumerate because of the diversity of the equine industry, the geographic breadth of the equine population, and the suburban areas not included in the traditional livestock enumeration." Horses are different from other livestock because of their companion animal status. Therefore, many horses are not located on "farms," as defined by the USDA as a property that can or has produced more than $1,000 of agricultural goods on an annual basis, and/or (as of 1987) has five or more equids owned by the same owner, not including boarding stables (where horses are owned by multiple individuals) or commercial enterprises such as racetracks. The Equine 2005 Part II Booklet states (p. 7), "There is no accurate estimate of the current total number of equids in the United States because the number of equids on nonfarm operations does not exist." This same source suggests that the on-farm estimation may only constitute 50-60% of the total equine population.

The only USDA estimates for the total number of equids in the United States come from the NASS Surveys in 1998-1999. The January 1, 1998 estimate for horse numbers by USDA was 5.25 million head, with 3.20 million on farms and 2.05 million on non-farms. On January 1, 1999 the estimate was 5.32 million head. The 1997 Census suggested there were 3.02 million head on farms, compared to the 3.20 million head the next year, and the 2002 Census states that there were 3.64 million head. At the very least, we can see an upward trend in on-farm horse numbers, which likely represents an upward trend in total horse numbers, though they are not documented by USDA. If we assume the same percentage of horses are on or off farms in 2002 as in 1998, then we can take the estimated 3.64 million head of horses on farms as 60.95% of the total, and come up with a total number of horses in the US in 2002 as 5.97 million head (which would mean there were approximately 2.33 million off-farm horses in 2002). The USDA-APHIS *Business Plan to Advance Animal Disease Traceability* quotes June 2007 equine population estimate as 5.8 million horses in approximately 570,000 locations.

Another organization which has conducted numerous surveys on the horse population is the American Horse Council (AHC). In 1986, an AHC commissioned study estimated 5.25 million equids in the United States. In 1996, another AHC survey estimated 6.9 million horses and other equine, and the most recent AHC commissioned Deloitte survey for the calendar year of 2003, published in 2005, suggested there were 9.2 million horses. A 2007 Oklahoma State University Extension Publication also lists the American Veterinarian Medical Association (AVMA) estimates since 1986. The AVMA estimates horses that are specifically owned by "households" which do not include those owned by ranches, farms, or other operations – they specifically estimated horses that are treated by their owners more as "pets." The 1986 AVMA estimate was 6.6 million horses, the 1991 estimate was 4.9 million head and the 1996 estimate was only 4 million head. However, the most recent AVMA study mentioned in the publication, from 2001, estimates 5.1 million horses owned as "pets" in the US. The conclusion of this publication states that all the sources seem to agree that the United States horse population has had an annual growth rate of between 3 and 5% over the last decade. The most common breed of horses in the United States is the American Quarter Horse, with the leading registry of these horses being the American Quarter Horse Association (AQHA). The AQHA 2007 annual report states that there were 2.9 million Quarter Horses in the United States. This total is down by just over 28,000, and new registrations were also down by over 26,000. This is the first time in recent history that AQHA registration numbers declined. Most people familiar with the equine industry agree that the market for horses is down currently, and this may be an explanation for the downturn in AQHA numbers. AQHA also keeps track of transfer numbers, and had a total of 188,907 ownership transfers in 2007, some being within the United States and some internationally. There are 902,453 registered owners of AQHA Quarter Horses in the United States. A summary of all equine population estimates obtained can be seen in table 10.1.

Table 10.1. Equine Population Estimates.

Year	Group	Estimate (million head)	Notes
1986	AHC	5.25	All equids
1986	AVMA	6.60	"Pet" equids only
1991	AVMA	4.90	"Pet" equids only
1996	AHC	6.90	All equids
1996	AVMA	4.00	"Pet" equids only
1997	USDA Census	3.02	On farms only
1998	USDA-NASS	5.25	All equids
1999	USDA-NASS	5.35	All equids
2001	AVMA	5.10	"Pet" equids only
2002	USDA Census	3.64	On farms only
2003	AHC	9.20	All equids, published 2005
2007	AQHA	2.90	AQHA Registered Horses
2007	APHIS Business Plan	5.80	All equids

The 2007 AHC Horse Industry Directory listed 125 Breed Organizations in the United States. These are organizations that register horses and usually assign horses a registration number and some sort of certificate of identification. AHC also found 31 educational organizations involved in the equine industry, 29 equine welfare organizations, 23 general interest organizations, 18 health and research organizations, 28 equine veterinary schools, 19 libraries and museums, 70 racing organizations, 6 rodeo associations, 66 show and sport organizations (some of which were the same as breed organizations), 48 state horse councils, and 20 trail organizations. In addition, they listed 40 National Steeplechase Association Meetings, and 177 Pari-Mutuel Racetracks in their directory, which should constitute the majority of race meetings in the United States. All of these organizations have some involvement in the equine industry and could be sources of education and information for studying the equine industry.

The Deloitte survey utilized 13 different show organizations, the Equibase and Project Steering Committee databases for racetracks, and a total of 80 horse related organizations to construct a survey list of horse owners. The survey was sent out in 2004 and respondents were asked to complete it for the year 2003. Deloitte found 4,865 organizations that managed or held horse shows and they identified 122 primary racing tracks in the United States for the survey.

To breakdown the numbers of horses in the United States, the most recent AHC survey had a total population estimate of 9.2 million horses, with 844,531 of those in racing, 2.7 million in showing, 3,9 million in recreation, and 1.8 million horses used for other purposes. A 95% confidence interval on this estimate is + or – 352,989 horses (American Horse Council, 2005b). As mentioned above, Quarter Horses are the most common breed of horses, with 3.3 million in this survey, and the only other breed broken out was Thoroughbreds, with 1.3 million horses. Other horses included other breed's registered horses and grade (non-registered, non-pedigreed) horses (American Horse Council, 2005a).

Equine 2005 reports horses in different (and more numerous) categories than the AHC survey. These reports only looked at farm operations with five or more equids (as meets the definition of "farm" for the USDA

Census). Small operations (5-9 head) had 36.1% of all equids, medium operations (10-19 head) had 34.2%, and large operations with 20 or more equids housed 29.7% of all equids in this survey. The percentage of equids on the property by primary purpose of the operation were as follows: boarding/training, 5.9%; breeding farm, 14.4%; farm/ranch, 40.3%; residence with equids for personal use 37.0%; and other, (including carriage services, guest ranches, and riding stables) was 2.4%. Small operations were most likely to state their primary purpose was having equids for personal use, at 46.0%, while large operations only said this was their primary function 10.4% of the time. Large operations were boarding/training facilities or breeding farms more often than medium and small operations. Broken down by primary use of equids, the percentages were: pleasure, 45.7%; lessons/school, 1.4%; show/competition, 9.6%; breeding, 15.9%; racing, 1.4%; farm/ranch work, 24.8%; and other (such as horse trader, carriage or pony rides, etc.), 1.2%. The comparison of Equine 1998 to Equine 2005 indicates that more horses are on smaller operations than before; the percentage of large operations has decreased while medium and small operations have increased, and 10% less horses are on the large operations in 2005 as compared to 1998. Some of this information is summarized in table 10.2.

Table 10.2. Equine Industry Premises Size and Use.

		Operation Size	
	Small (5-9 head)	Medium (10-19 head)	Large (20+ head)
Premises (%)	66.1	26.1	7.8
Total Equids (%)	36.1	34.2	29.7
Residence w/ Equids for personal use (%)	46.0	22.2	10.4
Boarding/Training Facilities (%)	2.8	10.4	17.2
Breeding Operations (%)	9.2	21.8	34.1

Source: NAHMS Equine 2005 Part I.

Equine age is another unique point for the industry, as horses tend to live much longer than other livestock species. The 2005 NAHMS survey reported that 35.6% of operations overall had a foal under 6 months of age when they received the survey, and 33.6% of operations had an equine birth within the 12-month period the survey queried. More of the large operations (72.7%) had births than small operations (20.4%). From 1998-2005, the percentage of operations having foals on their property decreased from 42.2% to 33.6%. Approximately 0.8% of the equine population is in the age range from birth to 30 days. Foals have a 4.9% mortality rate within 30 days after birth for various reasons. The overall equid death percentage for horses over 30 days of age was 1.8% in the year this study covered. The highest mortality rate by age group was horses over 30 years of age, followed by horses 20-30 years old. In 2005, 10.2% of equids over 20 years of age died.

The 2002 Census of Agriculture reported that the number of horses and ponies sold from farms in their surveys was 470,423, in addition to 17,385 mules, burros, and donkeys. Of the total of 487,808 horses, ponies, mules, burros, and donkeys sold, the value was approximately $1,328,733,000. Using these numbers, we can obtain an average value for the horses sold as approximately $2,724. In the 1998-1999 equine reports, the total equine sales were approximately 539,600 head in 1997 for a value of $1,641,196,000 with an average of $3,042, and in 1998 the equine sales numbers were approximately 557,600 head for $1,753,996,000 with an average sale amount of $3,146. These values are summarized in table 10.3. The Deloitte Survey reported the equine industry generates an estimated $39 billion in direct economic impacts and $102 billion in annual impacts when indirect and induced spending is included. The recreational segment generates most of this total, with $32.0 billion attributed to this branch of the industry. Showing, racing, and other segments generated approximately $28.8, $26.1, and $14.7 billion each, respectively. One important point from a financial standpoint is that of US live animal exports, the equine industry consistently exports several times greater value than any other livestock industry. In 2005, the last estimate conducted showed that live equid exports were approximately $461,541,000, with the closest number to that being live poultry exports at $95,522,000 (USDA, 2006e).

Further information from the most recent AHC survey is also of financial interest. The majority of horse owners (56%) earn under $75,000 per year in household income, with 16% earning between $75,000 and $100,000, 15% between $100,000 and $150,000, $9% over $150,000, and 4% not reporting that information in their survey. The "average" horse in the industry earns $1,172 annually, and costs the owner $2,882 annually – notably, however, the recreational industry only makes $536 per horse and costs $2,319 annually. The two largest expenses in all segments are Feed, Bedding, and Grooming Supplies, and Boarding and Training. Veterinary services annually cost an average across the industry of $251 per horse. The top five states of the 15 breakout states specifically surveyed in the AHC/Deloitte Survey are listed by four different measurements, shown in table 10.4.

The NAHMS Equine 2005 report included a section on how horse owners identified their horses. According to NAHMS, approximately 1.5% of horses are microchipped, approximately 47.8% of horses have registration papers, and other forms of identification include: hot iron brand, freeze brand, tattoos, permanent brand inspection, Coggins test papers, halters/collars with name/number, passport, and other unique identification. According to the data, 49.3% of operations had at least one resident equid that had no unique form of identification, and 28.7% of equids had no form of unique identification in their sample. The comparison between 1998 and 2005 equine identification data shows that both premises using unique identifications and actual number of equines with unique identification had increased. However, the additional options in the 2005 survey (Coggins/EIA test paperwork and Passport) which were not offered in the 1998 survey, and could have reduced the numbers of horses with no unique identification. Overall, fewer horses were being identified using hot iron branding, tattooing, and permanent brand inspections, while freeze branding of individual equids had increased. Microchipping numbers in horses were similar across the years (1.1% in 1998 to 1.5% in 2005), but 3.1% of premises had at least one microchipped horse in 2005, compared to only 2.1% in 1998.

Table 10.3. Equine Sales and Average Value.

Year	Number Sold (head)	Total Value	Average Value ($/head)
1997	539,600	$1,641,196,000	$3,042
1998	557,600	$1,753,996,000	$3,146
2002	487,808	$1,328,733,000	$2,724

Sources: USDA Census Data and NASS Equine 1998 Survey

Table 10.4. Top Five Equine States.

Rank	By Total Effect on GDP	By Number of Horses	By Number of Industry Participants	By Total Effect on Full-Time Equivalent Employment
1	California	Texas	Texas	California
2	Texas	California	Florida	Florida
3	Florida	Florida	California	Texas
4	Kentucky	Oklahoma	Kentucky	Kentucky
5	Louisiana	Kentucky	Ohio	Missouri

Source: American Horse Council Foundation Economic Impact Survey

10.2 Horse Movement and Competition

The Equine 2005 report states that 36.6% of horse properties did not have a horse leave their premises during the year, while premises that reported having equids leave and return to their property had the largest percentage (22.2%) travel between 100 and 499 miles from home, and 19.0% had horses that traveled between 10 and 49 miles. Small operations (5-9 equids) have less horses move off the property, with 41.8% of small operations reporting no equids leaving and returning in the past year, compared to only 27.5% of medium operations (10-19 equids) and 20.6% of large operations (20+ equids). By type of operation, pleasure, farm/ranch operations, and breeding operations were the highest categories reporting no equids moving off and back onto the premises in the past year. Small operations were less likely to have horses leave and return after contact with other equids than large operations. By type of operation, show/competition, lessons/school, racing, and breeding operations had higher percentages of horses that left the property then returned after contact with outside horses than pleasure or farm/ranch work operations. The comparison portion indicates that horses traveled less and for shorter distances when they did travel in 2005 than in 1998. The number of operations not having horses that left the premises increased from 19.3% in 1998 to 36.6% in 2005. The report also states that transporting equine with vehicles had declined, with 73.5% of premises doing this in 1998 versus 58.4% in 2005. The study states that out-of-state travel increased, in-state travel decreased, and contact with outside equids on trips decreased from 1998 to 2005.

The NAHMS 2005 study also included a portion specifically on equine events, though it was specifically from only six states, as it was the first attempt to survey equine events. For all types of horse events, approximately 39.0% of events included horses that came from "beyond adjacent states," while 40.9% were events with only in-state horses. The remaining 20.1% were regional events, or events where horses came from only within the state and adjacent states. Overall, 9.6% of events had horses that came from outside the United States; most of these were race/polo events or western events/fairs/rodeos. The average event lasted 3.3 days, and had 151.0 equids at the event on a typical day during the duration of the event. Race/polo events lasted longer than shows or western events on average. National events and race/polo meets averaged higher numbers than regional or state events and then shows, western events, or "other" events, respectively. Over the entire course of an event, an average number of 270.9 equids attended. National events averaged 499.9 equids attending the event, compared to 124.5 and 123.9 for regional and state events, respectively. The majority of equine events has horses that are 5 to 20 years of age (also the most common age category for horses in the NAHMS studies), with the next most common being 18 months to 5 years, followed by horses more than 20 years old. At these events, cattle were on the premises 28.8% of the time on average. The frequency of events that had other species on the same premises as the equids were goats, 5.7%, sheep 4.7%, pigs 2.4%, camelids (such as alpacas) 1.8%, and “other” animals 2.0%. About half (48.8%) of events required verification of individual animal identification, which is a process that may be simplified with the use of microchips. Some of the forms of individual identification used to verify identity of equids were tattoos, markings, and drawings from registration papers or Coggins papers. “Microchip scanned” and “smart cards” were each used to verify identification at 0.1% of events. Over 90% of events recorded the participant/owner’s name, address, and phone number, with 70.8% of events requiring the horse registration/ID number, as well. On average, 20.3% of events required health certificates for all equids, and 22.4% required certificates from equids from out of state. Events that required health certificates required that they be inspected visually by an official at the event 70.7% of the time. 10.8% of these events received health certificates in electronic form. Only 17.1% of events recorded the information on the certificates as part of the event. EIA testing was required more often, at 64.7% of events overall. State and regional events required EIA tests more often, due to the requirements for Coggins tests in crossing state lines. Vaccinations were required by 14.3% of events overall, and the required vaccines included Herpesvirus, Influenza, Strangles, VEE, Rabies, and to a lesser extent Tetanus, WNV, EEE, and others. Slightly under one-fourth (22.8%) of events hire on-site veterinarians to monitor for illness or provide care to equids. Selected data from this section is summarized in table 10.5.

Table 10.5. Event Requirements/Records

Requirement	Percent Events Requiring
Verification of Animal ID	48.8%
Used Microchips	0.1%
Used Smart Cards	0.1%
Health Certificates - All Equids	20.3%
Health Certificates - Out of State Only	22.4%
EIA Test	64.7%
Vaccinations	14.3%
Recording	
Participant/Owner Name	96.8%
Participant/Owner Address	93.0%
Participant/Owner Phone	91.1%
Horse ID/Registration	70.8%

Source: NAHMS Equine 2005 Events Survey

The actual number of events that occurs on an annual basis is as hard to quantify as equine numbers, but it is safe to say that it's in the tens of thousands, based on numbers we do have from individual organizations. The Professional Rodeo Cowboys Association (PRCA) sanctions approximately 650 rodeos in 12 circuits in North America, which includes approximately 50 rodeos in Canada. The National High School Rodeo Association (NHSRA) sanctions approximately 1,200 rodeos annually nationwide. The United States Equestrian Federation (USEF) licenses approximately 2,500 competitions annually, most of which are dressage, jumping, cross country, eventing, or any combination of the above. They reported holding approximately 2,600 shows with 85,000 unique horses competing at these shows and reported a membership of 92,000 in 2007. AQHA, the largest breed organization in the United States, reports 2,088 approved shows and 537 special events (including organized trail rides and charity events) in 2007. Approximately 250 individuals across the nation are certified as AQHA show managers. AQHA also reports that the average number of entries for all shows in the 49 states holding sanctioned AQHA shows was 329 entries, and the average number of participants in special events, which were held in 34 states, was 63. The AQHA totals for 2007, including international shows and events, were 2,449 shows, 554 special events, 351 average entries per show, 860,529 total show entries, 33,738 total special event entries, for a grand total of 893,991 total show and event entries. In addition to these numbers, American Quarter Horses held 9,274 races in 2007 with 16,607 total starters in those races. Finally, for the recreational segment of AQHA, the AQHA Ride Program organizes trail rides for AQHA members and hosted 110 trail rides with 6,314 participants in 2007. The AQHA horseback riding program, which is a program where individuals record their riding time on AQHA horses to collect prizes, had 13,481 people enrolled (meaning they recorded at least one ride on an AQHA horse in 2007) and additionally had 1,124 people enrolled in the all-breeds category in 2007.

In summary, the equine species in the United States is incredibly difficult to quantify and track. There are anywhere from 5-9.5 million head of horses in the United States according to the most recent available studies. Such a large range of horse population estimates across studies provides motivation for premises registration to better determine animal density and location of equine in the United States to improve surveillance and disease management. Horses tend to be highly valued on an individual basis, have considerable domestic and export market sales, have long lives, and participate in a wide, varied, and growing array of events. Because of their frequent movement around the country and commingling with other horses at competitions, ID and animal tracing is challenging, but also potentially very important for disease management. The current studies only constitute a small portion of the information needed to fully construct a benefit-cost analysis on this industry. In the following sections, we outline the recommendations, lay out the process for constructing a cost-benefit analysis on NAIS in the equine species, show some costs and benefits of this system, and discuss further information and research which needs to be conducted before such a system can be fully evaluated and mandated.

10.3 NAIS IN THE EQUINE SPECIES

TO CONDUCT BENEFIT-COST ANALYSIS of NAIS adoption for equine, guidelines of how the system would work are important to describe. *A Business Plan to Advance Animal Disease Traceability*, by APHIS and the most recent available Equine Species Working Group (ESWG) recommendations are relied upon to formulate assumptions for benefit-cost analysis. The Business Plan outlines the priorities for NAIS in the livestock industry. The plan is currently based on voluntary participation; that the system will only hold limited information to protect confidentiality; if an animal leaves its property and comingles with other livestock, it needs to be officially identified to support disease traceability efforts; and the system is technology neutral on animal identification devices. The three stages, or components, of the NAIS system are Premises ID, Animal ID, and Animal Tracing. The goal of NAIS is to have at least 70% participation for each species. Specific to the equine industry, Tier 1 Medium priority designation horses require either an official EIA test or health certificate when moved. Tier 2 includes horses that do not move around and comingle with other equine as much as the Tier 1 horses. The general plan for the NAIS also notes that Electronic Certificates of Veterinary Inspection (eCVI's) could provide a useful tracking system for livestock, especially horses, since the top priority for horses are those that require health certificates.

Specific to the equine industry, the business plan estimates horse population at 5.8 million in June 2007, and states (p. 24) that a "significant number of horses are individually identified." Estimates on number of horses and the number that are individually identified, based on earlier discussions of other surveys, are debatable. In reference to the equine industry structure, the Business Plan comments on the uniqueness of horses in their lifespan, generally higher value, and greater rates of transportation interstate, internationally, and through importation and exportation. They also note that many horses are already identified, especially if they are competing in racing or the show industry, and that these existing identification programs can be used in disease traceability efforts. Horses are divided into two major categories of priority for identification. Tier one horses are horses that require health documents to travel or compete, including the subgroups of race horses and show horses. The subgroup race horses are defined by The Jockey Club, United States Trotting Association, and AQHA. Show horses are identified through the USEF Horses Identification Program. Tier two includes all other horses.

As far as tracing capabilities already in place in the equine industry, the Business Plan states that EIA tests are done on about 2.2 million horses each year. EIA testing provides an opportunity to check for and institute some level of equine tracking, as well as allowing for some simplification of the CVI, Brand Inspection, and EIA testing process; having a microchip will make it easier to definitively match the right test to the right horse, instead of just going by markings, color, and hair whorls as is commonly done with grade and even registered horses currently. The plan also notes that many horses are registered in the numerous breed registries in the United States. Both the traceability plan and the ESWG recommendations are that horses that need an official EIA test and/or CVI when moved be a priority due to their movement intensity, as well as their often higher values.

The Business Plan further states that developing national EIA testing requirements for interstate movement and change of ownership would be an excellent way to implement a tracking system. Horses have to be identified on the EIA test certificates, and if premises registration was required along with the EIA test, horses and premises identified would both substantially increase. Through show registration information, as well as the information recorded on CVIs prior to a horse traveling interstate, some tracking abilities already exist. With the addition of the EIA testing requirement at change of ownership, EIA tests increased three-fold in the state of Texas, and it is likely that at least some sort of increase would be experienced if change of ownership testing was a nationwide requirement. Finally, the ESWG recommends ISO-compliant microchips to be the required form of ID for horses.

In summary, the Business Plan recommends: implementing and standardizing the use of PIN's on EIA and CVI paperwork for destinations, premises of origin, and exportation; expanding the use of interstate electronic CVI's; work with established equine organizations to integrate the use of the AIN “840” devices (in the case of horses, the 840 microchips); and establish some sort of communication systems between industry efforts for automated data capture at equine events and interfaces with APHIS-VS systems. The Business Plan states that they want 70% of horses linked to an EIA test or interstate CVI to be at a level of 48-hour trace-back by October 2009, and 90% by October 2010. Through utilization of EIA and CVI requirements, they want competition horses identified with NAIS-compliant methods, of which the only currently NAIS approved identification is the ESWG recommended 840 ISO-compliant equine microchips.

The Equine Species Working Group published specific recommendations for the application of NAIS to the equine species. These will be listed and discussed here, and provided part of the guidance for the following benefit-cost analysis. In general, the horse industry agrees that they need a national identification plan for the following reasons: to control disease outbreaks, protect human health, address bio-terrorism threat, protect food industry livestock from zoonotic diseases, stabilize the equine economic environment, provide a 48-hour trace-back capability, prevent diseases from stopping equine movements, sustain the ecological environment, and simply to be a responsible member of the livestock industry. The most recent ESWG recommendations are broken down by categories, Premises Identification, Animal Identification, Data Reporting Recommendations, and General Recommendations. The ESWG presented original recommendations in 2004, and updated them in 2006.

For Premises Identification, they recommend that a firm definition of what a premise is in the equine world is necessary, and that State Animal Health Officials, Area Veterinarians, and producers when necessary should be involved in describing unique geographic identities to the premises. The 2004 Recommendations by the ESWG gave the following list of equine premises that is in order of their priority for identification:

- Ports of Entry
- Quarantine Facilities
- Auctions and Sales
- Breeding Farms
- Boarding Facilities
- Training Facilities
- Equine Clinics and Hospitals
- Racetracks
- Show/Exhibition/Competition Facilities
- Public and Private Stables
- Rodeo Arenas
- Fairgrounds
- National or State Parks
- Universities (Educational/Research Facilities/Diagnostic Laboratories)
- Ports of Exit
- Dude Ranches

For Animal Identification, the ESWG suggests that CVI requirements be standardized across states, with identification including electronic ID and a more complete description of the horse. They recommend that any horse that requires a brand inspection, CVI, VS 127 permit, or ICVI because of traveling to a different location should be a priority for official identification. They also recommend the ISO/ANSI compliant 11784/11785, 134.2 kHz microchip be the recommended standard of equine identification, implanted in the nuchal ligament on the left side of the neck. However, they note that NAIS should incorporate the older 125 kHz microchips and other existing forms of identification as much as possible, but not recommend them. Additionally, they recommend to reader/scanner manufacturers to make all purpose readers for both the ISO compliant chips and the 125 kHz chips, so as to prevent missing a microchip. They recommend that new technologies should be continuously pursued to make the process more efficient, accurate, and cost effective. The current rate of technological advancement in animal ID, coupled with a possible increase in demand for electronic ID, the technologies will advance and costs may decrease as competitors enter the market and veterinarians gain more knowledge and skill with the process. Finally, ESWG recommends that the buyer/seller be responsible to report changes of ownership, as is currently the case with most horses registered with breed associations (the buyer and seller must send in transfer papers if the buyer chooses to keep the registration papers up to date).

The ESWG recommends that movement tracking not be included in the NAIS system for the equine species, but rather that animal health officials rely on current files of CVI's, Brand Inspections, VS-127 permits, and any other current paperwork to find out where horses are or have been if a disease problem arises. Animal Health Officials can look to existing state databases that keep track of CVI and EIA testing information in the case of a disease outbreak. ESWG recommends that animal health data should be electronic so that the speed of tracking can be increased, rather than going through lots of paperwork. They made the recommendation that the equine industry should not have to report any additional movements due to the fact that these systems are already common business practices in the equine species and that reporting all equine movements on and off premises would place a major burden on premises managers at the current levels of technology and reporting capabilities.

The ESWG recommends a voluntary testing period for any NAIS system, that the information is FOIA-exempt, and that no mandated system should be required before 2010. They also note that, "horses are livestock," and list various reasons why the equine industry should stay under that designation. The 2004 ESWG notes that due to the nearly 200 race tracks and tens of thousands of horse shows held across the United States on an annual basis, horses regularly move from their home premises to other locations and regularly comingle with horses and other livestock species. They state that hundreds of thousands of Americans ride every week at shows, tracks, and other equine events. They also note that due to the wide variety of levels of competitions, the ability for some of the horse-related activities to comply with NAIS standards will vary widely. The 2006 ESWG recommendations give the following list of characteristics that differentiate the equine industry from other livestock industries in the NAIS agenda, to highlight reasons that the equine industry must be handled differently than other livestock species when implementing a NAIS. The unique size, scope, and uses of horses create a difficult environment in which to apply an animal identification system. To quote the ESWG list, horses:

- Have longest life expectancy of livestock species (20 – 35 years).
- Are generally more valuable on an individual basis.
- Are transported more often and for greater distances.
- Participate in internationally recognized competitions including the Olympics.
- Require accurate identification to insure the integrity of a multi-billion dollar racing industry with state regulated pari-mutuel wagering.
- Are imported and exported on a regularly basis at significant expense.
- Are at great risk of theft.
- And, are in many instances already properly identified by the appropriate breed registry or horse identification services.

Another general recommendation of the ESWG is that NAIS should provide benefits that outweigh the costs to the horse industry. The system should provide definite benefits which justify the costs to industry stakeholders. NAIS should also be as compatible as possible with other nations, especially Canada and Mexico due to their close nature and common importation/exportation of equines with the United States. ESWG recommends that identification and movement databases should be exempt from the Freedom of Information Act (FOIA), and that only approved state and federal animal health staff be allowed to use and see the information for the express purpose of disease surveillance, monitoring, and prevention.

Recommendations from APHIS and the ESWG provide a guideline for developing a cost-benefit analysis for applying NAIS to the equine species. However, some of the recommendations and comments about the equine industry also suggest needs for further research. In addition to these recommendations, the ESWG has published a list of diseases of concern in the equine species, to emphasize the importance of including the equine species in an animal identification system, which are discussed in the benefits section.

10.3.1 Process of Evaluating NAIS for Horses

The entire process of developing a benefit-cost analysis for the equine species in the United States is challenging. NAIS adoption costs are not readily available and have to be estimated, especially as related to animal movement recording database and labor costs. Benefits of NAIS adoption are difficult to enumerate because many of the benefits are realized in the event of crisis management of events with unknown probability of occurrence. The horse industry is an exceptionally large, diverse industry that is difficult to track or quantify. As the ESWG mentions, horses live longer, travel more, and experience a greater diversity in their life than any other livestock species, and probably than most "pet" species, as well. Horses are also valued higher than most livestock species.

The initial step in benefit cost analysis was to gather articles, publications, studies, and whatever written or online information was available on the horse industry, since one of the biggest problems with researching this industry is a lack of information. Comparisons of the proposed NAIS in the United States to identification systems in place in other nations for the equine industry did not appear to be useful. Most other nations that ID horses have more centralized governments, in some cases going so far as to have horse registries as part of the national government, and the industries are not as diverse as in the United States. Numerous interviews were conducted with various members of the equine industry to define the industry and create a comprehensive list of costs, benefits, and concerns about NAIS adoption in the United States equine industry. This section outlines the information gathered on the costs, benefits, and concerns of NAIS adoption in equine species.

10.4 Equine Industry Costs

THE MAIN COSTS ASSOCIATED with NAIS adoption in the equine industry are:

- The microchip electronic identification mechanism
- Cost of veterinary services to insert the microchip
- Universal readers
- Database costs
- Training and labor costs for each step

These and a few other relatively minor costs are discussed in this section. A couple of general notes are that before a horse can have a microchip implant, the premises where the horse is located must have a premises identification number. Also, the costs discussed here apply to the horse industry as it currently is, as time goes on and older horses are implanted, costs of implanting will decline.

10.4.1 Microchip Costs

A great deal of information was gathered on the equine microchips. Only two microchips are currently approved by NAIS, and are ISO/ANSI Compliant. They are both Destron-Fearing chips, which are also approved by the International Committee for Animal Recording (ICAR). One is the Destron-Fearing Equine Biotherm Lifechip, and the other is the Equine Lifechip. To make and sell the country coded “840” chip, where the first three digits are the code of the nation that the animal originated in, the microchip has to be NAIS approved. If not NAIS approved, the 15-digit chips are coded with the manufacturer’s code for the first three digits. In addition, one microchip called the EZID Transponder Implants by AVID/EZiD is currently listed as “Interim Approved.” Several other companies produce microchips. For example, Allflex has a 134.2 kHz ISO 11784/11785 compliant microchip that is marketed only for pets and coded with the manufacturer code “982” for the first three digits as opposed to the “840” (nation coded) chip. In addition, Crystal Import Corporation and Datamars (the same company) have 134.2 kHz microchips, but these are not NAIS approved for use in the United States.

Datamars is a Swiss company. These, and possibly some other manufacturer's chips, are currently available in Europe and other nations and may eventually apply for NAIS approval in the United States. Some veterinarians have reported clients getting the microchips from another source, such as Warmblood registration associations in Europe or other locations, and calling the veterinarian simply to implant the chips.

The Destron-Fearing chips are 134.2 kHz ISO-compliant microchips. Several studies have been conducted using these chips, some to study the effectiveness of the biotherm chips in reading an equid's body temperature, others for tracking purposes, and some simply utilized the chips as a form of individual animal identification for research purposes. The studies generally have found the chips to have a read range of two inches for the biothermal chip and four inches for the regular identification chip. In a study at Colorado State University, a 100% read rate was found using 82 biotherm chips in Quarter Horses and Welsh Ponies (Robinson, et al., 2008). The University of Kentucky reports using the microchips for numerous studies, and stated that they had used to have minor migration problems with the Avid microchips, but since switching to the Destron-Fearing chips, they have had no failures or migrations (Ennis, 2008). Texas A&M University did a study on broodmares using the biotherm chips, and had no failures in 20 broodmares (Morgan, et al.). Montana State University conducted a study using microchips and found one chip that failed after one week out of 38 microchips – they suspect the chip had been damaged on insertion, and it was later found to intermittently work. The state of Colorado conducted a study on "Smart Cards," which are credit-card sized cards showing a picture of the horse, ownership information, and having a chip or barcode which can contain information about the horse (Heckendorf, 2008). In a study with 61 rodeo horses using a few different brands of microchips, there were no failures (Heckendorf, 2008). The largest microchip study was conducted in California in racehorses (Evans, 2007). In this study, 2,052 horses (including some from overseas that had been microchipped prior to entering the United States) were implanted with microchips. Of these microchips, seven chips failed immediately and two chips failed later in the study. One horse had a minor skin reaction at the injection site of the microchip, and five chips were difficult to read. Most of the chips used in past studies were either the Destron-Fearing biotherm chips or regular microchips, though a few of the studies used chips from Allflex or Crystal as well as Destron-Fearing chips. Combining all these studies, we estimate chip failure rate of 0.44%.

The Colorado project testing Smart Cards also assessed horse reactions to being injected with microchips. Of the horses included in the study, 72.6% showed little or no objection to the microchip implant, 17.6% objected slightly, 5.8% jumped away, and 4% required two injections. No horses required any additional physical restraint devices, such as a twitch. This indicates that the majority of horses will have little or no objection to the microchip implant, and problems only exist at approximately the same rate as with common vaccinations in the equine industry. The Colorado State University study indicated that the chips were extremely helpful throughout the course of the project as a quick, reliable method to identify each animal in the study. They did, however, experience problems with the accuracy of the biothermal chip. This and other studies have indicated that the chip is not always accurate, possibly because of the location of implantation. The nuchal ligament is in a location of exposure to the elements and has very little blood flow; therefore the ability to read an implanted chip can be affected by environmental conditions.

A few industry members estimated the cost of the microchips to be between $5 and $20 per chip. The current retail costs of chips were researched by contacting Destron-Fearing distributors. Two distributors of the Destron-Fearing microchips are Dr. Kevin Owen, in Texas, and Milburn Equine/Webster Veterinary. Dr. Owen sells the regular microchips for $10 and the biotherm microchips for $12 to veterinarians and state agencies. Dr. Owen also said that the failure rates on the chips is <1%. Milburn Equine/Webster Veterinary distributes both the manufacturer coded "985" chips and the "840" country coded chips. The normal microchips are around $15/chip, but come in boxes of ten, or $150 per box. The biotherm chips are around $16/chip and also come in boxes of ten, or $160 per box. Both distributors sell almost exclusively to veterinarians or state agencies. A representative of Destron-Fearing stated that the microchips and readers will remain at approximately the same costs over time, but the technology, such as read range, will improve.

The Jockey Club recently became a microchip distributor of the "840" country-coded chip for Destron-Fearing. The Jockey Club charges $20 per chip to everyone, plus a sales tax in New York and Kentucky, and as of August, 2008 had distributed 120 microchips to mostly Thoroughbred breeding farms. They allow free reporting of the microchip number and microchip lookup features on The Jockey Club website behind a secure login. Sany Thoroughbred foals born in the United States that might race or be breeding stock to produce racehorses must be registered and DNA tested with The Jockey Club. Such foals also must be reported annually in "Mares Bred" and "Live Foals" reports. DNA testing kits are sent out when the foal is born and microchips can be distributed with this testing kit so that the veterinarian can do all the procedures at one time to reduce cost of each individual procedure. The Jockey Club registers over 30,000 foals annually between the United States, Canada, and other territories at a cost of $200 per registration.

Avid Equine markets microchips on the web (http://avidequineid.com/). They market to several different sectors – private owners with 1-4 horses can get kits for $33.50 per kit (which includes one chip and lifetime registration in their database and a few other things). For private owners with five or more horses, they offer a 5-pack kit for $142.50 or $28.50 per kit. For private owners with 25 or more horses, the price is $618.75 for a 25-pack or $24.75 per kit. For large operations, they offer 25-packs of the chips only with no database enrollment for $243.75 or $9.75 per chip. They also offer quick-load cartridges (instead of one chip with one loaded needle) for $173.75 or $6.95 per chip. They have a bulk syringe implanter for $7.50 each for the bulk quick-load kit, and extra needles for $2.00 each. In addition, they offer a HORSEcard that contains horse owner information, a picture of horse, and the horse's microchip number and information, for $12.50.

The safety of implanted microchips is occasionally questioned. Numerous studies have shown them to be safe, highly readable, and highly effective as a form of identification. An ESWG Publication states that microchips have been used in the equine species since the 1980's, and over time have been shown not to migrate if implanted in the nuchal ligament to the proper specifications, have no adverse health effects on the animal, be durable and a virtually fail-safe method of identification that is extremely difficult to tamper with after insertion, and having a failure rate of less than 0.5%. The ESWG Microchip paper stated that at least 600,000 horses had been microchipped successfully in the United States so far, and that approximately 200,000 of those were from Louisiana since the 1994 EIA testing requirement mandates that an equid must be tested for EIA on an annual basis and at that time must have a permanent, individual form of identification. Louisiana encourages the use of microchips as this form of identification, but currently still allows tattoos and individual brands. In Louisiana, the owner bears all costs of microchipping their animals.

10.4.2 Veterinarian costs for insertion

Industry estimates range from $20-$150 for the cost of inserting microchips into horses, depending on many circumstances such as the number of horses, if competition and better technology lowers the cost of the chips or insertion, if fuel charges are included, etc. Two primary sources were used to obtain costs for veterinarians to insert microchips into horses. One source was a survey conducted by Pennsylvania State University researchers, which gave ranges of the costs of microchip insertion from veterinarians. This survey had some problems with the way the question was stated, veterinarians may or may not have included costs such as travel or sedation, and therefore results could be slightly skewed. Due to this uncertainty, a survey of American Association of Equine Practitioners (AAEP) veterinarians was conducted for our study. The survey was designed to separate the costs of the microchip, the implantation including site preparation for the procedure, travel, and any additional costs that the veterinarian chose to include.

The Penn State study posed the question “What do you charge to microchip?” to the veterinarians in their survey. Over half (53%) of the 138 veterinarians who responded were currently microchipping animals. The responses were categorized into price ranges, with 2.7% of veterinarians charging $20 or less, 32.4% charging $21-$40, 36.5%

charging $41-$60, 10.9% charging $61-$80, 2.7% charging $81-$100, and 4.1% charging $101-$150. Using the median values of each of the price ranges ($10, $30, $50, $70, $90, and $125) and multiplying these by the percentages in each range, we can come up with an approximate average cost of $43.43 for the veterinarians to microchip horses.

Due to the inexact nature of the costs in this study, an informal survey was conducted by phone and e-mail to several AAEP practicing veterinarians nationwide (total of 14 surveys sent). We received full or partial responses from 10 veterinarians (71% response rate), including one not originally on the survey list, who was involved in the California racetrack microchipping study. Veterinarians in this survey did not all use the Destron-Fearing microchips which suggests a need for education among veterinarians to encourage uniform microchipping practices. Veterinarians did not generally seem to know a lot about NAIS or microchips in general, with many using the same microchips to identify horses as they use in dogs and cats at their clinic. From this survey we received the following results:

- The cost of the microchip to the veterinarian averaged about $17 per microchip.
- The charge for implanting the chip to the horse owner averaged about $42 per microchip.
- The average travel charge by the veterinarian to the client was a base of $41.96, plus fuel charges ranging anywhere from $1.50-$4.00 per mile. The practices differed widely on the structure of their "farm call" charges.
- Four of the surveyed veterinarians reported that if an individual brought the horse to their office to be microchipped, the office visit would be from $13-$38 ($13, $15, $15, and $38 were the reported charges).
- Two veterinarians also reported sedation costs, if necessary for the horse. One reported a range of $25-$30 for sedation while the other stated a $50 charge for sedation to implant the microchip, if necessary.

In addition to the questions about cost, some general questions about NAIS, the cost and lifespan of microchip readers, and reasons for microchipping were asked. The veterinarians indicated that most of the horses that were microchipped (and most of the benefits, in some opinions) were competition horses or horses that traveled a great deal. However, some people who simply want to protect their pleasure/recreational horses are also getting microchips implanted. One veterinarian stated that they obtained the Destron-Fearing biotherm chips through alpaca organizations at a cost of $25/chip and $400 for the scanner, because the alpaca associations in her area used the biotherm chips at shows (see Section 11 of this report for more information on alpaca chip adoption). Several of the veterinarians indicated that they felt biothermal chips would be a huge benefit, if the temperature readings were accurate, but this needs work before being useful in veterinary practice. One veterinarian indicated receiving a discount for buying over 2,000 microchips. Veterinarians in general felt that there were great benefits in recovering lost or stolen horses, in the event of a natural disaster where the horses were pooled together, and for disease control. In reference to the scanners, veterinarians had scanners from various manufacturers that had lasted from two up to 15 years, and were still being used.

One of the major routes to implement NAIS, or to get horses microchipped, that has been suggested is to use Equine Infectious Anemia (EIA) testing to require individual identification, such as the state of Louisiana has already done. On January 10, 2007 USDA-APHIS published a Uniform Methods and Rules for EIA. This was the first step from APHIS to try to unify the EIA testing requirements across states, by recommending specific regulations. These recommendations included:

- Uniform interstate movements of 12-month intervals are recommended.
- Categories of equines that should be tested include: Horses going to show/competitive events; horses being moved interstate; horses changing ownership; equines entering horse auctions or sales markets.
- Recommend individual animal ID being an important part of an EIA testing program.

EIA Requirements currently are decided by each individual state at the state level. Regulations vary from state to state on both intra- and inter-state requirements. The interstate movement requirements are summarized on an annual basis in an American Horse Council publication, but the intrastate requirements were harder to find. All 50 state veterinarians were contacted and asked what their EIA testing requirements were for instate horses, and for the few state veterinarians who did not respond, the information was researched using state databases and searching state laws and regulations. The following is a brief summary of currently enforced EIA testing regulations in the United States:

- All states require EIA tests within 3, 6 or 12 months of all horses being imported into their state (with the exception that OR and WA do not require tests between states, and Nebraska and North Dakota do not require tests from South Dakota). The only state requiring 3 months is Hawaii. Some states have special requirements of horses going to sales.
- 21 states do not require any testing on instate horses that do not leave the state.
- Of the other 29 states, the level of testing varies from Louisiana, where any horse that has been in the state over 30 days must be tested on an annual basis, to only racehorses and the equids at the state fair being required to have a test.
- Most of the 29 states require testing for comingling groups of equine of any kind, transportation on public highways, prior to or at public auction, or for change of ownership or if the horse is offered for sale.

Standardizing state testing requirements to meet the Uniform Methods and Rules (UMR) in every state would cover nearly every equid in any kind of commerce. Over a period of time, this method could facilitate getting the second step of NAIS accomplished, getting AIN devices into horses, and possibly to start improving the third step of tracking using data that are already recorded on CVI and EIA test forms required for movement of horses.

10.4.3 Universal readers

Veterinarians have indicated various types of scanners last for over a decade, so the longevity of scanners appears robust. Veterinarians likely need a universal reader which can scan both 125 kHz “pet” chips and the 134.2 kHz microchips. The Colorado State University study reported high levels of reliability with their scanners, and they currently are using the same ones they have had for two to three years. The University of

Kentucky has had some scanners fail that have been returned to the manufacturer for repair or replacement, but they indicate that human error (e.g., dropping the reader too many times, leaving it out in the rain) may have caused reader failures. Currently, only the reader manufactured by Destron-Fearing can read the biotherm chip, though other universal readers should be able to read the number on both the biotherm and non-biotherm chips. Some locations, such as major horse import centers and certain show organizations, already have microchip scanners because foreign horses are currently being microchipped due to regulations in their home nations and/or import restrictions. Some industry leaders expressed concerns about the cost of the readers being too high, especially for smaller equine operations or show circuits, especially if the readers end up not being durable. In addition, some operations would need multiple scanners, and the personnel would have to be trained to scan the horses at appropriate times for farm management or for tracking purposes. Destron-Fearing distributor, Dr. Kevin Owen, sells the scanners to veterinarians and state officials for $350 per reader, and Milburn Equine/Webster Veterinary charges approximately $360 per reader. Other universal scanners are available, but costs were not obtained at this time.

10.4.4 Database Costs

Costs to store equine movements are difficult to estimate, as it depends on what level of tracking and which horses are required to be recorded. The ESWG and many other members of the equine community are concerned about the database for a number of reasons. One of the major problems is the locating and tracking of grade horses – horses which are not currently registered with any breed association and in most cases not identified in any form. Some industry members feel that the federal government should keep the database and carry the costs, but are concerned about remaining FOIA exempt if this were to occur. Other suggestions include using a web-service type model where the USDA houses a basic system with only the numbers and where the information is kept, which could then be traced out to already active breed registries such as the AQHA or The Jockey Club for further contact information and tracking records.

InCompass Solutions keeps track of most of The Jockey Club records, and developed and provided the software used in the California race horse tracking study. InCompass provides the database system for all racetracks in the United States, including Arabian, Paint, and Quarter Horse tracks in addition to the Thoroughbred races. They already have a ship in-out module in their software that tracks use, so the infrastructure for tracking horses is already in place. If a racetrack is using their software, which many do, there is no additional charge for using microchip numbers in the ship in-out module. However, InCompass is strictly for racetracks. Another group linked to The Jockey Club, Jockey Club Information Systems, provides farm management software, and they already have the infrastructure in place from a database standpoint for breeding operations to utilize microchip numbers in their management operations. Software design could be a big expense if other segments of the equine industry choose to develop management software around microchip numbers, but it could also be a major benefit in the long run.

Some of the current databases include the Louisiana system, which is tracked by the state veterinary office just like EIA and CVI records are in other states. A student worker is employed to keep track of the database and therefore also keeps track of the equids' individual identifications. PRCA has a system in which all the bucking stock, horses and bulls, are individually identified and can be traced readily. PRCA also estimates that approximately 10% of horses used in timed events at rodeos are currently microchipped, but they do not scan so they do not have a way to confirm this number. AQHA added an alpha-numeric field into their database (to incorporate the older microchips, some of which have letters as well as numbers), but say that less than 1% of their registered horses have reported a microchip number. The Jockey Club estimates that up to 2% of the Thoroughbred population may be microchipped.

One big problem with database management and the current system of registration is grade horses. The United States Equestrian Federation (USEF) has expressed interest in following The Jockey Club's lead and becoming a distributor of the equine microchips as well, as a service to their clients. USEF currently has a registration system called the Performance Horse Registry (PHR) that is open to any grade horse with a registration application and DNA sample. Creating a grade horse registry has been a concern of the equine industry pertaining to NAIS, and the PHR offers one possible place for owners of grade horses to record their equids in a database. Some other registries in the United States make it possible to register cross-bred or non-pedigreed horses (certain color breeds and pony breeds with color or height restrictions, respectively). Registries like this may provide a way to solve the problem of identifying grade horses by allowing private systems to expand to incorporate these grade animals. Many grade horses are not actually unregistered animals, however. Registered horses are often sold in the United States, and as it is left up to the buyer and seller to transfer ownership on the registration papers, in many cases this transfer never occurs. This means that even if a horse is currently in the registration system, the registered owner may not have owned that horse for many years. One interesting note about grade horses is that even The Jockey Club, one of the largest equine registries in the United States, is only focused on the horse information and does not traditionally record ownership information, so when a horse is done with its racing career it is often sold without papers, and possibly renamed and registered with USEF or some other sport horse organization, or sometimes just left as a grade horse. Finding the current owner of the horse is necessary to knowing where that animal has been and who or what it has been in contact with. One suggestion that was brought up is that the United States could create a law like the Canadian pedigreed livestock law to require the transfer of papers if an animal is pedigreed. This would solve the problem of the wrong owner being listed on papers and create an incentive for transfer of papers, ownership updates, and database information updates to occur.

Overall, most current breed organizations feel that there is little to no additional database cost required for NAIS to simply identify all horses. However, the database cost could play a much larger role if tracking is required at all levels. Whereas cattle may move 4-5 times in a lifetime PRCA estimates that horses may attend as many as 4-5 rodeos in one weekend, let alone an entire year. Industry members estimated that horses could feasibly attend as many as 200 events in a given year, though the low end for any serious competitor in the show or racing world would be one to two events per year. Even at the low end, horses will move more times in their lifetime than most other livestock species in the NAIS system, and therefore the database cost associated with tracking these animals will be a much higher total.

10.4.5 Labor Costs

Labor costs are another concern of NAIS adoption to the equine industry, due in part to the number of times a horse moves in its lifetime. Horses that move a lot, if tracking is required, would have to be scanned and reported every time they entered or left a premises, which would mean additional time, personnel, and material costs for these venues. There is an ongoing debate as to whether this system would increase or decrease labor requirements, however. Certain aspects of a NAIS system may allow for quicker check-in processes at shows, rodeos, and racetracks, and more efficient CVI and EIA testing procedures.

A major concern to the industry is the level of enforcement of any NAIS system. There are many current regulations on the movement of horses, though the level of enforcement certainly is not 100%. Having check stations available to enforce laws, having trained personnel who know how to enforce laws, and having punishment for breaking the law large enough to make getting the microchips and reporting horse movements are all important considerations in implementing any NAIS within the equine species. If an NAIS tracking system requires additional labor, major show organizations will require additional job positions, increasing their costs. If the check-in process is not smooth, competitors may also decide to quit showing or only show within their state to avoid needing an individual identification device for their horse. Across the industry, there are concerns with horse movement tracking. USEF, PRCA, and The Jockey Club all stated that horses move in and out of show or racing facilities at all hours of the day or night, and for effective check-in to occur this would require a 24-hour a day position with an individual trained to take and report the information at each major show or racing venue during the times when events are held, and at racetracks even during the off season when they are used as training facilities.

Studies have been conducted to experiment with movement tracking in the equine industry, such as the California racehorse study. This study suggested a need for increased personnel at the tracks to get perfect movement tracking, but suggested there was some value in having even an imperfect tracking system in racehorses. The study also pointed to the fact that the technology for scanners and software needs to be adjusted to make tracking less cumbersome and therefore more useful. Individuals that participated in the study still had to do a great deal of paperwork and data entry; a system with the ability to automatically upload the information would be more ideal. The same issues with a need for additional labor to sort through paperwork are faced in Louisiana with their equine infectious anemia program. Louisiana hires a student worker to keep track of horses when they are Coggins tested and their individual identifications are recorded in the state database.

10.5 Equine Industry Benefits

Benefits of a National Animal Identification System in the equine species are more numerous but much harder to quantify than adoption costs. Generally speaking, most industry members we visited with recognize potential benefits to equine identification, and feel that the industry should be proactive in creating a system. A large segment of the equine industry exists for pleasure and not business creating an array of benefits of animal ID across ownership incentives and animal uses. Major categories of benefits are discussed below.

10.5.1 Premises Registration

The first step of getting equine premises across the nation identified has already proven to be beneficial in some circumstances that have occurred. Wisconsin animal health officials were able to use their premises registration database to send out mailings with West Nile Virus education during the season when outbreaks commonly occur. Currently, animal health officials sometimes go so far as driving door to door to contact individuals in an area about animal disease outbreaks in the equine species; the ability to identify premises allow for better and faster establishment of quarantine regions and find other possibly infected animals. An article from early 2008 stated that so far, over 430,000 premises have registered voluntarily with NAIS (Cordes, Hammerschmidt, 2008). The Jockey Club requires anyone who wants to purchase microchips from them to first have a premises identification number. However, one problem that the equine industry noted with the premises identification system is that it is currently a point location (such as an address) and not an area, so an individual farm can have multiple premises ID numbers if they chose to sign up every address in their area. It would also be extremely valuable to identify premises by type – which are farms, arenas, racetracks, stables, parks, trail riding areas, or other equine event locations – to help with density estimates and event studies.

10.5.2 An Official, Complete, Ideal Trace-Back System

In equine industry meetings, having an official, complete, ideal trace-back system was the most noted benefit of having an equine identification system. Simply having the ability to identify and trace horses contains many benefits within itself, particularly in disease containment, tracking, and possibly eradication. Currently, there is little to no ability to locate and quarantine horses in a given area surrounding a disease outbreak short of driving door-to-door. The ESWG notes that in being a responsible member of the livestock industry, some sort of identification system would aid the equine industry in working with other livestock groups to quickly trace diseases and prevent outbreaks. Premises identification as well as a trace-back system could make this more feasible. Reductions in commerce could also occur, which is discussed further below.

Disease outbreaks in recent years, in Florida, New Mexico, and numerous other states and locations, have indicated the possible benefits of more quickly being able to identify and trace horses when an outbreak occurs. Some individuals stated the number one priority in disease control in horses would be to track down a-symptomatic carrier horses. Numerous diseases in the horse world, including EHV and EIA, can be carried in and shed from a horse for years, sickening other equids without the host ever showing signs. If all horses in an outbreak could trace back to contact with a horse showing no signs, at least that horse could be tested to see if it was a carrier animal. See the section “Equine Diseases of Concern” for more information on these cases.

Some members of the equine industry feel that disease tracking is already done to a high degree through CVIs, EIA testing, and other measures of tracking, but feel that the ability to track international horses in shows and races could prevent foreign animal diseases from entering the US. The Jockey Club stated that in any given year, less than five races are cancelled due to disease outbreaks, but race cancellations do occasionally occur. The Penn State study on veterinarians asked some additional questions about the National Animal Identification system, such as if they felt that NAIS would help stop the spread of foreign animal diseases, to which 55% reported yes and 45% responded no. Of the veterinarians in the survey, 76% reported that they had experienced a contagious disease outbreak, indicating that these outbreaks do occur on a regular basis.

Industry members generally feel that equine identification may help minimize the effects of disease outbreaks. Disease eradication could also save the industry a great deal of money – for example, with over 2 million EIA tests performed annually at a cost of over $25/test; EIA testing alone costs over $50 million dollars on an annual basis. If EIA could somehow be eradicated from the US over time, eliminating the need for testing, the industry could save this money.

10.5.3 Maintaining Equine Commerce and Movements

A proper trace-back system that could identify where a sick animal had been and which horses it had or had not been in contact with could assist the equine community in decreasing the level of quarantines and assist equine commerce with less interruptions and shorter durations. Recent outbreaks in the equine community and other livestock communities have prevented state to state or international commerce from occurring due to a lack of confidence in the state or nation’s ability to track and contain the diseases. If a national system were in place, it may be possible to quarantine only the affected horses and allow other horses within the state or area to continue to move as needed. In addition, as noted in the section “State of the Horse Industry,” live equine exports constitute an annual value of over $460 million. An animal identification system that was in sync with other systems in the world could expedite the process of getting US horses into and out of other countries and bringing foreign horses into the US. If for any reason the US had a disease outbreak that prevented all equine exports from occurring, this could cost the industry millions of dollars.

10.5.4 Monitoring and Prevention of Loss or Theft

Though horse theft is not as common now as in the past due to better identification systems, horse theft does occur in rare instances. When the horse slaughter market was stronger, some members of the equine industry stated that horse theft seemed more common. Horses also occasionally get loose and get lost by breaking out of pastures or getting away on trail rides, and being able to positively identify these horses when they were found would be beneficial. Individuals that do not travel and compete with their horses regularly have less direct incentive to adopt NAIS. However, NAIS gives individuals the opportunity to positively identify their horses, for the lifetime of the animal, and many industry professionals feel that if the idea was properly presented, even backyard horse owners would be accepting. A lack of education is to blame for much of the anxiety over the NAIS in the equine species. USEF has even stated that they may be willing to provide microchips to their members at a reduced cost or free with the registration of the horse and membership, simply as a service to their members and the industry.

10.5.5 Disaster Relief and Recovery

In recent years, hurricanes Andrew, Katrina, and now Ike have shown the equine industry the value of having an animal identification system, or the problems that are caused by the lack of one in the case of Andrew. Hurricane Andrew was evidence to the horse industry of how bad it can be when horses are not identified. It took many weeks for owners to find their horses, if they ever did. On the other hand, hurricane Katrina was evidence of how beneficial unique identification can be. Due to the 1994 EIA testing law requiring unique identification, horses were almost all identified and their owners were able to be found and contacted in a timely manner during the relief efforts. Virtually all horses were returned to their rightful owners following Katrina, which was not the case with many other livestock species in this and other disasters. Hurricane Ike in Texas has ongoing rescue efforts. A state park has become the staging area to collect all the misplaced livestock. Having a horse with unique, individual identification will make it much easier for the rescuers to find and contact owners, and for owners to find their horse if they go to the staging area to look for them. In addition to hurricanes, the same situations have occurred in the California and Colorado wildfires, where horses are pooled together in rescue facilities to get them out of the path of the fire, and then owners have to come to those facilities and attempt to pick their horse out of possibly hundreds of horses. In many cases horses look similar making visual identification problematic.

Severe blizzards in Colorado and Wyoming have also at times isolated horse herds miles from home with no access to food, and hay drops have saved the lives of these animals. Having premises with horses identified could aid in knowing where to look for stranded livestock to drop hay for these relief efforts. The Penn State veterinary survey asked questions about disaster planning in veterinarians' offices; 80% of respondents did not have a plan of action for emergency situations. Some respondents stated that in severe weather zones they do try to provide information to their clients and that they do consider disaster planning to be an important issue.

10.5.6 Organization of Production Records

Breeding operations can utilize microchip identification for tracking embryo recipient mares, to keep track of which mare is having which donor's foal. Some organizations require that recipient mares be identified by microchip prior to implanting an embryo. In addition, when mares go to the breeding shed, especially in the thoroughbred industry, proper identification is essential to ensure they are bred to the right stallion. Occasionally, mares are bred by the wrong stallion, resulting in the DNA not matching when the foal is born and registered with The Jockey Club. Many breeding farms currently use halters or collars on all mares with the name of the horse on it, but these can break, become lost, and occasionally get switched. In addition, some staff on thoroughbred breeding farms cannot speak English, and therefore cannot read the halter tags. Having the ability to scan a number prior to breeding would almost eliminate the potential for mares being switched and allow for easier tracking of production records on the mares and stallions.

10.5.7 Show Check-In & Management

Having individual animal identification at horse shows could aid in the check in process, improving the speed of health checks and verifying that every animal entering the show grounds has an up to date Coggins test and health certificate. Having microchips and possibly electronic CVIs and Coggins tests would allow for faster check in than is currently possible with hard copies of paperwork. At rodeos electronic ID could provide verification that the correct cowboy is riding the correct bucking horses. Though rare, occasionally the wrong animal is brought into the chutes to be ridden. Show organizations could scan horses entering the gate to verify that the correct horse is entering the show ring, because on rare occasions the wrong horse is shown. The value to major show organizations is at the management level for shows: the ability to increase the speed of check-in, verify that the correct individuals are riding the correct horses, track points on the horses and riders during the show season, and assist in speeding up the numerous other small tasks that go into organizing major equine events. It may also help shows to prevent disease at their events and track affected horses if an outbreak were to occur.

10.5.8 "Smart Cards"

The benefits of using Smart Cards are closely related to show management and check in. Smart Cards, or Integrated Circuitry Cards, are credit card sized devices that have the ability to incorporate any desired information on the equine, such as the dates of EIA tests, CVIs, and brand inspections that are commonly required for equids to move interstate or be exhibited at large events. These cards are also capable of allowing an individual to check in a horse for their classes, stalls, and other management issues at a horse show. They can be connected to private databases for farm management or professional organizations such as breed associations or show offices. Utilization of electronic health papers has to be approved by the states; over half of the states in the US have already approved this system. Using electronic paperwork for health papers could also guarantee that the correct horse has the correct health papers and reduce the amount of physical paperwork for the organizations requiring the documents as well as owners and veterinarians.

10.5.9 Racetrack Management and Racehorse Check In

There are numerous benefits of microchips that are specific to the racehorse world. The current system used to individually identify racehorses is a tattoo inside the lip of the horse with an individual code. When horses are checked in and out of the racetracks (if they keep track of this), checked in for races, or checked in for various other procedures such as veterinary examinations or breeding, quite often the lip tattoo is used to verify horse identity. This requires "flipping" the horse's lip to read the tattoo. Though most thoroughbreds get used to their mouths being handled, some object to this procedure, especially right before a race when the horses are amped up and ready to run. Occasionally, during the pre-race checks, horses even flip over in the paddock and can hurt themselves or their handlers. Each track employs a professional horse identifier that checks horses pre-race, though in some cases the grooms are the ones who actually flip the lips.

Tattoos have the issue of sometimes fading or getting smeared. Microchips would allow for a major simplification of this check-in process. If microchips were implemented on a mandatory basis, this form of identification has the potential to replace lip tattoos in the check-in process, avoiding the potential for spreading disease by touching the lips of multiple horses to check tattoos, avoiding wasting gloves to guard against the spread of disease, speeding up the process with the quick scan of a wand as opposed to physically having to touch the horse, and avoiding the potential for the horse objecting to its lip being flipped and hurting itself or its handlers in the process.

Microchips would provide definitive verification that the correct animal is being raced, and cannot be smeared or fade like lip tattoos sometimes do. In addition, horses could be identified when coming on and off the track to verify that the correct horses are working out at their scheduled work out times, and horses could be scanned in and out of the gates to verify their identities and aid in tracking, if a tracking system was implemented. Overall, it would be better for the horse handlers and horses alike. Thoroughbred industry owners would likely be sold on the idea if it would simplify their shipping in and out of racetracks and identity verification in the paddock or saddling enclosure. Occasionally, horses are purposely misidentified when leaving or entering the track. Trainers occasionally bring horses onto the track that are not racing on that track for training purposes, when only horses racing there are supposed to be on the track. Also, some high profile racehorses have been hauled off the track for veterinary procedures and been disguised as a "pony" horse or another racehorse to prevent the public from finding out the horse may have a health problem. The use of microchips could aid in increasing and simplifying security in the entire racehorse industry.

10.5.10 Management of Registries and Other Organizations

Numerous equine industry breed organization members mentioned that horse identification system could help their organization keep better track of their horses. There are more than 200 recognized breeds of horses worldwide, and there are at least 125 breed organizations in the United States according to the American Horse Council in 2007, and some horses are registered in multiple organizations. An example of this is that the AQHA is the primary Quarter Horse registry in the world, but there are several different registries for Foundation Quarter Horses, International Quarter Horse registries, and color registries that any breed of horse can be registered in if they are the right color. This, in addition to the mixing of breeds of horses in boarding stables and often at shows, and with the added issues of horses shifting from owner to owner without registration being transferred or the papers being lost, makes registration papers only partially useful as a tracking device if not directly tied to some physical form of identification on the horse.

The address of the owner is often not where a horse lives. If a horse lives at a boarding stable, the address on registration papers will be the owner's address, not the stable where the horse is located. Microchipping the horse and having some form of movement tracking would aid in all of these struggles faced by breed registrations, by providing a permanent source of information attached to the horse for its lifetime. There are numerous examples of where breed registries have stated NAIS would help when USEF has a problem with horses changing hands and being reregistered under a different name by the new owners, allowing horses that were competing at more advanced levels to come back to lower levels under a new name (and therefore, win at those lower levels). This is not a major problem for the high level horses, but at the lower level shows the problem does occasionally exist. Having a microchip in the horse that is a permanent, tamper proof device identifying the horse, would prevent these issues from happening.

USEF would also like to offer their members the service of looking up a horse's show records via the microchip number in the instance that they are looking to buy the horse to verify that statements the seller makes about the animal are true. They feel that providing microchips to their members, which they have mentioned they are willing to do for free with registrations, may increase registration numbers in their organization. For these reasons, the fact that horses change names, owners, and move around a great deal in their organization, USEF supports NAIS. Having this system could aid the PRCA in verification of ownership and inventory numbers of stock contractors, because they have regulations that require contractors to own a certain number of animals to be recognized by the PRCA.

In the Thoroughbred industry, some breeders already microchip horses when they hit the ground, prior even to pulling a DNA sample for The Jockey Club. This provides permanent identification of the foal from birth, and prevents switching foals or other misidentifications from occurring before paperwork reaches The Jockey Club. Anywhere from 2-

4 foals annually are misidentified or have a DNA discrepancy. Microchips also prevent foals from being switched after the identification has occurred, to avoid issues such as a cheaper foal being switched for a more expensive foal after the expensive foal has died. The Jockey Club would have the ability to identify and manage a horse from the moment it hits the ground throughout its life, including finding out which horses end up at rescue facilities after their race careers.

The English studbook made microchipping mandatory, and numerous other nations are requiring microchips for registration or tracking purposes. Because of this, The Jockey Club felt that selling microchips to their clients would be worthwhile to assist Thoroughbred owners who desire to race or breed internationally. Other groups besides breed organizations feel that microchipping would aid in the management of their organization. Sales organizations feel that it would aid them in numerous ways. For one, it would prevent the need to flip lips at the sales, avoiding the spread of diseases or possible injuries to horses or handlers. Certain veterinary procedures, such as conformation altering procedures, are not allowed to be performed on horses by some sales organizations. Many high end Thoroughbred sales allow prospective buyers to look up veterinary records on the sale horses, and microchips could guarantee that no procedures are hidden from these records. Finally, it would provide permanent and definite identification of the sale horse, so that the right horse was sold in the ring and hauled out by the correct buyer. Additionally, some small show and rodeo circuits could utilize the microchip numbers to keep track of the horses, their owners, and their show records in a quicker electronic form, allowing tracking to be more feasible even at these lower level shows.

10.5.11 Identification for Veterinary Records

One of the veterinarians' biggest time constraints in doing a CVI is taking the time to write out and draw out the markings and color of the horses. Veterinarians do numerous CVIs annually, it is one of the most common calls they receive on horses, and therefore simplifying or speeding up this process in any way could save a great deal of time and money. Using microchips as definite identification and avoiding the time it takes to write and draw out markings or other information would improve the speed and efficiency of EIA tests, CVIs, pre-purchase examinations, and could create a quicker, more organized system with these documents for disease trace back situations. Another benefit to veterinarians is for their own office organization and to identify the horse on health papers and records such as radiographs. When an individual wants to buy a horse internationally, it is important that the correct documents on the horse are received for the buyer's veterinarian's review, so that mistakes are not made when high dollar international purchases occur. Some veterinarians in the European Union put microchip numbers on horse records for management and sales purposes.

10.5.12 Biothermal Chips

If proven accurate, the biothermal chips could eliminate the need for taking temperatures on horses rectally, which can be a dangerous procedure with some horses. It could also lower the need for cross ties, which some veterinarians consider dangerous to the horse; because one individual would be able to read the horse's temperature in its neck rather than having to have it tied and go to the rear end of the animal. It would allow boarding stables, breeding farms, racehorse training stables, or show agencies to monitor horse health every day if desired. It can possibly allow these operations to catch infections before clinical signs are visually apparent helping to avoid transmission of possible disease outbreaks. In a quarantine situation, these chips could also provide a faster method to check temperatures with a lower risk of spreading infections to horses that are not yet affected.

10.5.13 Assist in Research Efforts on the Horse Industry

Several industry members throughout the research process pointed out the fact that statistics on the equine industry are difficult to obtain and accuracy is questionable at times. Having a complete horse identification and tracking system would allow for more accurate and complete census information to be obtained at a lower cost. One statistician stated that it would take an estimated $7 million dollars just to start a full equine census program (Hill, 2008). Having more accurate information on the horse industry would allow for more accurate economic, epidemiological, or other types of studies. Horse densities could aid greatly in knowledge of disease spread and quarantine regions. Veterinarians could also do better marketing and better preventative medicine programs with accurate census data. This information has a value of its own, though it is hard to quantify.

10.5.14 Horse Slaughter

Currently, horses have a direct effect on the food chain, as many are exported to Canada and Mexico for slaughter. Identification that is compliant with slaughter regulations could theoretically assist in ensuring that horses which have been treated with drugs not approved for use in horses for human consumption do not enter the food chain.

10.5.15 Help with Unwanted Horse Problem

It is possible that ownership trace-back could prevent irresponsible horse owners from turning their horses loose or dumping them off on other individuals at auction yards or into empty pastures, which has been occurring recently, by providing a method of positive ownership identification. This way, irresponsible horse owners would have to face the consequences of improperly abandoning their animals. Some organizations are looking to microchip horses simply for the reason of dealing with the unwanted horse issue. However, some problems exist with this idea, because it would be the responsibility of the horse owner to get the horse microchipped and reported into a database somewhere, and they may just not report this information or transfers of ownership to avoid these consequences if they are irresponsible in the first place.

10.6 Equine Diseases of Concern

There are numerous diseases in equid species that are of concern to the horse industry and to other livestock industries. In the US Animal Health Report for 2006, eight “animal health events” were reported, five of which involved horses but affected multiple species of animals, while three of those were equine-specific disease outbreaks (USDA 2007k). As evidenced by this, horses and other equine play an important role in the health status of the livestock sector, and attention to this segment of the industry could help alleviate economic losses and eradicate zoonotic diseases affecting multiple species. These diseases are those that would have a devastating effect on the equine population and in many cases can spread rapidly across species boundaries into the food animal chain, and into humans. The US equine industry has been reasonably safe for many years – in fact, it is difficult to find case studies on major outbreaks of any disease, though they do occur. Some are documented on a state-by-state level, or the show or racing circuits that are affected know about them, but other than that the information is not tracked nor made publicly available, making cost estimates of these outbreaks difficult, if not impossible, to measure. From multiple sources, the following is a list of diseases of concern to the equine species, including both zoonotic and equine-specific diseases. Some are obvious as problems, while others are less known or not currently in the US, but could still have a drastic economic impact if not monitored, or if an outbreak occurred that was not immediately caught and traced:

10.6.1 Anthrax

This disease can affect cattle, sheep, goats, horses, camels, antelopes, other herbivores, and humans. In 2006, Minnesota had an outbreak that killed 91 total animals, including some horses. It is also an OIE-reportable (World Animal Health Organization) equine disease.

10.6.2 Borna Disease (BD)

A neurological disease primarily found in horses and sheep, but also in other warm-blooded animals, including cats, dogs, primates, and cattle. Horses have an 60-95% according to USDA-APHIS (USDA 2002a). Surviving animals may be permanently neurologically impaired.

10.6.3 Brucellosis

Infrequently occurs in horses and humans, more commonly in other livestock species. Horses generally acquire this disease through contact with infected cattle or swine. Many of the wild bison and elk herds in

Yellowstone National Park and other areas are carriers of the bacteria that cause this disease. Brucellosis causes fistulous withers and in some cases abortions or death in horses. Brucellosis is a reportable disease in the US.

10.6.4 Contagious Equine Metritis

Contagious Equine Metritis is a disease that is mentioned in the 2006 US Animal Health Report (USDA, 2007k). Though it is not a zoonotic disease, it can have a devastating impact on a breeding farm or industry, as it is passed through semen by A.I., as well as direct breeding, or contaminated tools, and causes temporary infertility in mares. In most horses, there are no symptoms except for the mare becoming infertile (and therefore, unbreedable, losing a breeding season, which is vital in the equine industry due to the 11 month gestations and small windows for breeding and foaling in some segments, such as racing where older foals are better). Only two horses were reported to have this disease in 2006 – both Lippizzaner stallions imported from Germany into Wisconsin (USDA, 2007k). However, in 1978 and 1979, major outbreaks occurred in Kentucky and Missouri, devastating the breeding industry in those states and prompting efforts to eradicate the disease from the US. This disease is reportable to the OIE (World Animal Health Organization).

10.6.5 Equine Herpes Virus

Equine Herpes Virus (aka Equine Rhinopneumonitis) recently has been under close watch by USDA-APHIS. There have been numerous outbreaks of this disease recorded over the years. It also has some emerging disease concerns: in the 2006 Animal Health Report, Equine Herpesvirus Type 1 (EHV-1) is strongly emphasized due to changes in symptoms, because it is becoming a neurological disease with an increased morbidity/mortality rate and may constitute and emerging disease. This disease is deadly to horses and can cause significant losses to occur. Nearly every horse in the world is exposed to EHV-1 by the time they are two years old, it has long been a cause of respiratory illness and abortion, and in some cases horses that are exposed become latent carriers, never getting sick but never getting rid of the virus and constantly spreading it to other horses. In 2006, there were 12 outbreaks of the neurological form of this disease in nine different states, and numbers of these cases have been increasing and affecting larger facilities. Even vaccinated horses have contracted the disease, and some have died, apparently due to the mutated strain being too strong and too fast acting for the vaccine to work. Increased horse movement may be to blame for this disease occurring more often in recent years. In late 2006, Florida had an outbreak of EHV-1 which prevented movement of horses on Calder racecourse, including two barns where horses were not allowed to leave at all and the prevention of any horses moving into the track's stables during the quarantine period. At least four horses died in this outbreak. Industry members stated that several racetracks have been shut down or quarantined in recent years due to EHV outbreaks. Maryland also recently experienced an EHV outbreak which affected the horse racing industry. This disease is reportable to the OIE.

10.6.6 Equine Infectious Anemia

Equine Infectious Anemia (EIA) is a disease that is still of concern in many states and easily spreads through biting flies and mosquitoes and is often deadly (or the horse must be quarantined for the rest of its life as a carrier or euthanized, depending on state laws). It certainly would be much less costly from a testing standpoint and a cost of equine lives standpoint if this disease was eradicated. As recently as June 2008, three horses in South-Central Indiana were euthanized after testing positive for EIA. Many state laws require the Coggins test, or another official test, for EIA to be conducted before horses are moved. This may also be an opportunity to implement individual horse ID and tracking by requiring horses to be microchipped at the time of their Coggins test. EIA testing has also increased over the years, with over two million EIA tests performed in 2005, creating a possible route to both track these animals and help eradicate a disease that has plagued the horse industry for a number of years. This is up from 1999 tests of 1.6 million to 2.1 million in 2005.

The Equine 2005 Report contains information about Equine Infectious Anemia knowledge and testing, which has been suggested as a method of implementation for NAIS in horses. Slightly less than half (45.6%) of operations overall were knowledgeable of this disease, while 9.8% were unaware of EIA. Larger operations (>20 horses) tended to be more knowledgeable, while small operations (5-9 horses) tended have less knowledge. Overall, 37.6% of equids were tested for EIA in the 12 months of this study and 76.9% of the operations had at least one equid tested; with very high percentages being tested in the south (over 50%) while the west (at 14.7%) had the lowest testing numbers. Show/competition horses, race horses, and lessons/school horses were much more likely to be tested than breeding, farm/ranch, or recreational horses. The average cost of an EIA test across all regions was $27.33 per test including all costs associated with conducting the test, such as transportation, drawing the blood, and the laboratory and paperwork, with larger operations having only slightly lower costs. Reasons for EIA testing were primarily for show/event requirements, interstate movement, and personal knowledge. Familiarity with EIA increased from 1998 to 2005, with only 9.8% of operators indicating they were unaware of EIA in 2005 compared to 16.7% in 1998. The cost of a Coggins test (test for EIA) had increased 19.1% over these years, from $22.95 to $27.33. EIA is a OIE-reportable disease.

10.6.7 Equine Influenza

Equine Influenza is an OIE-reportable disease. It is transmitted by aerosol, and causes the horse to be lethargic, have a cough, depressed appetite, and a fever, and can lose a competing horse such as racehorses a great deal of time in their training and ability to race, but is rarely deadly. A recent outbreak in Australia crippled the entire Australian equine industry, especially for racing and breeding, and costs are estimated to be in the billions of dollars. This is an example of the extreme damage that an equine outbreak can do to an economy of the industry and the long term devastating effects it can have if not caught in time. Unfortunately, no scholarly research articles were found on this outbreak, but numerous popular press articles contained information on this and other equine influenza outbreaks, and gave cost estimates to the industry for such events.

The Australian outbreak appears to be due to improper handling at quarantine facilities of horses entering the country, which had been a concern of the Australian horse industry for a number of years prior to this outbreak. Equine influenza had never previously appeared in Australia, and was greatly feared by the racing industry. Previous outbreaks of equine influenza have affected many nations.

In 1986 and 2003, South Africa experienced major outbreaks of equine influenza, and reported in 2004 that they blamed problems with their quarantine stations for the 2003 outbreak. In 1986, races were cancelled for three months in South Africa due to equine influenza. In 2003, racing stopped in nearly all South African racing regions when an estimated 1,000 racehorses were affected by the equine flu, in an outbreak blamed on horses imported from the US. Estimated losses were R120 million in net betting turnover and R10 million in attributable profits. Japan suffered a 2007 outbreak when 29 horses were diagnosed with the equine flu. Three race meets were cancelled, the first Japanese cancellations for 30 years, and several major races and racehorses were affected. The cost was estimated at A$48 million in lost turnover. The United States experienced an outbreak in greyhound racing dogs in Florida, where eight dogs were killed by a respiratory disease later identified as a strain of equine influenza. This event led to an outbreak of the disease in racing and pet dogs, and represents an event where an equine disease has unexpectedly mutated and crossed species boundaries. Great Britain experienced a 2003 outbreak which did not cancel any race meets but was considered the worst outbreak of equine influenza in more than a decade in Newmarket's racing community. Even with all horses vaccinated against equine influenza, Hong Kong suffered an outbreak in 1992 that affected 75% of horses stabled at the Royal Hong Kong Jockey Club, and caused seven race meets over 32 days to be cancelled. Ireland also experienced an outbreak in 2006 from July to December.

The Australian Equine Influenza Outbreak occurred in August of 2007, and the effects were still being felt through the end of October with race cancellations. The outbreak spread from international horses to recreational horses at Sydney's Centennial Park. All racing across the country was cancelled, and a 72-hour ban was placed on movement of all racehorses. Several major races, including the Sydney Turf Club's A$1 million Golden Rose race and the Melbourne Cup, were delayed or cancelled due to the outbreak. This outbreak affected everyone from breeders and trainers of racehorses to the stock market, due to the effects on bookmaker companies and race track stocks (Wainwright, Moore, 2007).

The horse racing industry in Australia was reported to be an A$8 billion dollar industry with 74,000 jobs in Victoria alone, and it simply came to a halt due to the disease outbreak. No final number on the horses that tested positive for the virus was available, but an August 27th estimate reported 47 horses positive at that time, and another report stated that 200 hacks at a park near the quarantine area were showing signs. Racehorse owners were not allowed to move their horses, in many cases not even allowed to exercise their racehorses. Pony clubs and other shows and events were voluntarily cancelled in many cases. The cost of the delayed breeding season is also extremely important, because the age of racing horses is important in how well they perform on the track, and entire crops of foals could be lost or of reduced quality due to effects on the breeding season. Job losses have occurred, and trainers have lost time with their horses because of their inability to work out and to race. One source estimated the economic loss from a three-month cancellation of events in Victoria would be more than A$57.5 million dollars (Eddy, et al., 2007). This same source stated that the Victorian Government could lose up to A$3 million per week in revenues from betting on horse races. Another source reported that the cost of a three-day halt on wagering in Victoria and New South Wales would be A$70 million, and that all bets for that time period would have to be refunded (Eddy, et al., 2007). In addition, because the equine flu is an emerging disease in Australia, a vaccination program should be started in racehorses, which for the first year at three doses of vaccine per horse would cost A$5.4 million, excluding veterinary administration charges. In 2001, the cost of a response to an outbreak in Victoria was estimated by another organization as A$775,840 with a limited outbreak (using three infected premises as an example) and A$3,740,540 if all race horses in training in the area were vaccinated (Eddy, et al., 2007). Though all of these costs are only estimates, and it is hard to quantify the economic loss of horses that lost training days or missed a breeding cycle, it is easy to see from this example that a major disease outbreak has a significant cost.

10.6.8 Equine Piroplasmosis

Equine Piroplasmosis (EP) is a disease APHIS is working to eradicate, and was believed to be eradicated in 1988 until a recent 2008 outbreak. It has only been found in the US in one state, Florida, and is a parasitic disease believed to be spread by tropical ticks. It was first noticed in “backyard” horses (not horses that moved around much). It causes anemia, jaundice, fever, and weight loss, and death in up to 20% of affected horses. In a paper written prior to the current outbreak, it is mentioned that eradicating this disease from south Florida in 1988 took 25 years and $12 million dollars. As of September 10, 2008, 20 horses have tested positive (Ryder, 2008b). Five have been “removed” from the area via euthanasia or been moved to a research laboratory, 15 are still in Florida on five different premises. As of September 12, 2008, some of the quarantines were being lifted while leads on horses that had been in contact with the positive horses were still being followed. All imported horses must be tested for this disease. EP is a OIE-reportable disease.

10.6.9 Equine Viral Arteritis

Equine Viral Arteritis (EVA) is listed as an infectious disease of concern in the 2006 Animal Health Report due to a recent outbreak. EVA can be spread both through the respiratory system and breeding practices, and causes both flu-like symptoms and abortions (in some cases, “abortion storms”) in pregnant mares. Stallions can carry the disease in glands for many years and are a significant source of infection. The costs to the industry are lost breeding, unhealthy animals and the veterinary costs associated with treatment, and the loss of use of stallions and loss of broodmares for a season or sometimes more. This is a serious disease and one that is costly to the industry.

In 2006, a farm in New Mexico suffered up to 50% losses from mares aborting due to EVA, and two of its stallions were found to test positive from their semen. One of the breeding stallions and any mares that had visited the property were traced back to 18 states – six states, Kansas, Montana, New Mexico, Oklahoma, Utah, and Alabama, had horses that showed recent EVA infection, and four more states had horses showing suggestions of recent EVA infection, but not definite proof (California, Colorado, Idaho, Texas) (USDA, 2007k).

In New Mexico, a total of 23 premises housing 1,081 horses were either voluntarily or officially quarantined, and the last of these was lifted from quarantine on December 5, 2006. Utah also experienced 21 premises and 591 horses being put under quarantine, with an additional six premises and 350 horses being temporarily quarantined before testing clean, and the last of these quarantines was lifted on November 26 of 2006 (Timoney, et al., 2007). This outbreak showed the need for a national system, or at least common programs among the states, to find and control this economically harmful disease. It also pointed out the fact that embryo transfer and A.I., as well as the common practice of pasturing numerous mares together on breeding farms, allowed the disease to spread readily and rampantly by both respiratory and reproductive routes. EVA is a OIE-reportable disease.

10.6.10 Encephalomyelidities

Encephalomyelidities (West Nile, Eastern Equine Encephalitis, Western Equine Encephalitis) are all are currently in the US. Not spread from horses to humans, but humans and horses can both get these diseases. Horses serve as a kind of watch animal for these diseases – when horses in the area start coming down with them, humans often follow. West Nile recently emerged in the US; the other two have been around for many years. All three can be deadly to the equine species and are OIE (World Animal Health Organization) reportable diseases.

The West Nile Virus outbreak in 2002 affected 15,257 reported horses in 43 states. A study was done on the specific impacts of this outbreak to the North Dakota equine industry (Ndiva Mongoh, et al., 2008). They used estimates of a 15 year useful life of a horse, a $2,000 average value for a horse, maintenance costs of $339 per month, and the monthly cost of purchasing a horse at $13.72 per horse. Disease recovery time varied from one day to three weeks and from three weeks to six months for a horse to fully recover to its normal usefulness, with an average of four months until total recovery. The cost of West Nile Virus treatment ranged from $190 to $380 per month for horses that stayed on their feet, and $3,000 to $6,000 per month for downer horses. Some isolated cases outside of North Dakota were reported to cost up to $100,000 for treatment.

A study prior to this one estimated the costs of the WNV outbreaks in Nebraska and Colorado at $2.75 million (USDA, 2003), and another study estimated the 2003 economic loss due to fatalities in the state of Texas at $7.46 million (Galvan, et al., 2004). In the case of the North Dakota outbreak, 569 horses were affected with a 22% mortality rate. The total cost to North Dakota was $1.9 million, with $1.5 million dollars incurred by horse owners, and a $400,000 expense to the state of North Dakota for monitoring, control, and surveillance of the disease. The costs incurred by horse owners included $781,203 due to medical costs, with $4,803 for vaccinating 152 horses and $524,400 for the treatment costs of 345 horses, and $802,790 due to the inability to use animals. The cost of the 126 horses that died was estimated to be $252,000. They also stated that these cost estimates are most likely conservative.

10.6.11 Glanders

Glanders affects horses, mules, and donkeys, though it is not currently in the US. It can be spread from horses to humans, and was used in biological warfare in WWI. All imported horses must be tested for this disease. Glanders is an OIE-reportable disease.

10.6.12 Hendra Virus Disease

Hendra Virus Disease is a new emerging disease which is seen in humans and horses. It has only been documented in Australia so far, and has a high mortality rate.

10.6.13 Japanese Encephalitis

Japanese Encephalitis (JE) has been documented in humans, swine (which are amplifiers), and horses. Horses and humans are considered dead-end hosts, but horse-to-horse transmission is possible. JE is an OIE-reportable disease.

10.6.14 Leptospirosis

Leptospirosis affects humans, many domestic and wildlife species, cattle, pigs, horses, dogs, rodents, wildlife species. It usually spreads from fecal/urine contaminated water. Using a disease tracking database to discover spots of major outbreaks of this disease could prevent some individuals or livestock from getting infected. Leptospirosis is an OIE-reportable disease.

10.6.15 Rabies

Rabies is a well known disease that affects horses, humans, and many other mammals. It may be possible to use an animal tracking database with this disease to indicate regions of major outbreaks and send out recommendations for updating vaccinations in horses for this particular vaccine, which in most states is only available from a veterinarian and not always administered for that reason. Rabies is an OIE-reportable disease.

10.6.16 Screwworm

Screwworm was originally eradicated from the US in 1966, and restrictions exist on horses coming in to the US from countries where it is known to exist. Screwworms can affect humans, horses, and other livestock, and feed on the flesh of these animals usually after hatching from their eggs laid by flies near open wounds. Screwworm is an OIE-reportable disease.

10.6.17 Strangles

Although neither APHIS-VS nor ESWG mentions this disease as a recognized disease of concern, Strangles (aka Equine Distemper, aka Streptococcus equi) is common and can be costly to the horse industry, and has been written up in the American Quarter Horse Magazine recently. Internal or “Bastard” Strangles (where the infection spreads to lymph nodes other than those in the head and neck) is often deadly, and can occur in a low percentage of cases, though there is no definite estimate on the percentage rate of occurrence. If treated, horses are generally recover, but if left untreated horses can die, mainly from secondary infections such as pneumonia. Even though the mortality rate is low and it is not zoonotic, it can have major economic ramifications due to its highly contagious nature and long recovery periods. It can also occasionally leave permanent scaring, limiting some horses time in the show ring for certain disciplines. Strangles is mentioned in one of the AHC press releases as having recently negatively affected horse owners and the equine industry, and in some cases caused restrictions on the movement of horses (AHC, 2005b). An industry source also mentioned an outbreak on the backside of Churchill Downs a couple years ago which occurred because of a two-year-old that was on the track against regulations (horses stabled on the track are only supposed to be racing there, and the horse was there for training purposes only).

10.6.18 Tetanus

Horses and humans are most susceptible of all animal species to tetanus. It is a bacterial disease which causes toxins affecting the nerves that control muscles. The bacteria are common in the soil and environment, and horses are commonly affected due to the environments they live in and how common injuries to horses are.

10.6.19 Venezuelan Equine Encephalomyelitis

Venezuelan Equine Encephalomyelitis (VEE) is fatal to horses and humans, and horses do play a role in transmission to humans. The last US outbreak was in 1971. South American countries still have this disease, and outbreaks are also occasionally seen in Mexico. Highly infectious, and considered a biosecurity threat. VEE is an OIE-reportable disease.

10.6.20 Vesicular Stomatitis

Vesicular Stomatitis (VS) affects cattle, sheep, swine, horses, humans, and presents similar symptoms as FMD in ruminants. The 2006 US Animal Health Report states that only one state (Wyoming) had a VS outbreak in 2006, affecting 17 horses. The previous year, however, there was an outbreak affecting nine states and 584 horses. The PRCA stated that two rodeos in the last six years have been cancelled due to VS outbreaks. VS is an OIE-reportable disease.

10.6.21 Other Diseases

Other equine diseases listed as OIE-reportable (World Animal Health Organization) in the United States are: African Horse Sickness (Never Occurred), Dourine (hasn't occurred since 1934), and Surra (never occurred). Many of these diseases are transmissible between horses and other livestock species, and in some cases even to humans. For many of the other diseases, horses are a dead-end host. However, for diseases such as JE and WNV, horses often act as sentinels of the disease: when it is seen in horses, human cases often follow, even though horses are not the vector through which they are spread. In some cases, such as with West Nile, prevention methods can be instituted at that time such as mosquito control to prevent further horse and human cases from developing. A few of the other diseases on this list, such as Tetanus and Strangles, are specific to the equine species. The value that a national animal identification system would bring with species-specific diseases is to find out more about prevalence and spread, and learn more about prevention as well. Some equine-specific diseases are extremely costly to the industry, and even if they do not affect the food sector or human health, they do have an economic cost and therefore prevention and tracking would be beneficial.

10.7 Industry Concerns and Recommendations

SEVERAL CONCERNS WERE SHARED with our research team during interviews with horse industry stakeholders that are important to mention, but that do not fit directly into the benefit and cost analysis of the system. NAIS may or may not have any effect on these industry concerns, but numerous individuals and organizations mentioned these issues as important considerations. The equine industry is a unique, diverse industry that is challenging to define and develop an NAIS benefit-cost analysis for. This section summarizes issues of concern with design and adoption of NAIS in the equine sector that were revealed from the research conducted for this study.

10.7.1 Horses are Already Identified

Numerous organizations question the value an additional form of identification would have for horses that are already registered and tracked using CVIs and EIA tests. They want to know what the specific benefits are for microchipping a horse that they feel is already identified by other methods. Utilizing the existing breed registries will be an important part of NAIS, as they know a lot about where their major show and race horses are and what disease problems exist. AQHA even has a horseback riding program that keeps track to some extent of horses and individuals on private trail rides, where people report the location and trail they rode on and the hours they rode to get rewards for hours in the saddle. In the thoroughbred racing industry, saying they need to both tattoo and microchip would cost extra money to the breeder to perform both procedures to identify the horse, and would not be well accepted. Thoroughbred breeders also have a concern with the confidentiality of microchipping and the database records. They do realize there is a problem with papers not always being sold with horses, but recommend that no one buys a horse without papers. The concerns about costs to breeders for identifying their horses are related to the need to make sure people do not have to register their horse in multiple places; they need to have one registry to send paperwork to and get into the NAIS system. This suggests the involvement of breed associations for record keeping.

Additionally, several industry members suggested that microchipping still needs to be only one part of the permanent identification of a horse. Counterfeit chips exist, and therefore photographs, written descriptions, tattoos, brands, and other forms of identification will still be necessary for positive identification of horses.

10.7.2 Problems with Current Identification and Registration

Numerous documents in the equine industry indicate that many horses are already individually identified, making NAIS implementation easier. However, even though a horse is registered with an association does not mean the horse's information is current, or even that the ownership information is correct. The horse may also be at a different address than listed on the registration, as the papers may state the location of the owner, not the horse if it is boarded or in training. Registration is currently left up to the owners to transfer, and many horses are sold without papers, or the seller charges an additional fee to the buyer to get the papers. Even when a horse is sold with the transfer forms, many buyers do not bother to send in transfer forms because of transfer fees registries charge for this service. Off-the-track thoroughbreds are also a major issue, because they are often sold without papers, and since their papers are not linked to ownership, their location is often lost in the system. Because of the fact that registration papers have no direct physical link with the animal, they are simply a pedigree, drawings of markings, and in some registries a photograph, it is easy for papers to be lost or never transferred and for the identity of a horse to be lost.

Some registries keep DNA information on their horses, but that is a process which takes time and would not be capable of meeting 48 hour trace-back goals. That procedure also must be performed by a lab, and most owners do not send in a DNA sample just to see if it matches some record in a registry. Part of the reason the estimates for horse population numbers range so drastically may be because horses registered with one registry under one name may also be in a different registry under a different name due to papers being lost during the lifetime of the animals. Recreational horses especially are not well tracked and often get lost in current systems. One suggestion has already been mentioned – to enact a pedigreed livestock law similar to Canada to require papers to be transferred with a change of ownership. Another option could be to require EIA testing at changes of ownership, and have the veterinarian or another official record the microchip number under a different premise ID, so that even if breed registration papers are not immediately transferred, at least local animal health officials can find out where the horse is located. In this way, the horse's microchip number could be linked to the correct premises, and the horse could be tracked even if not registered. However, the options for dealing with these issues would all depend on how the database for the equine industry is organized.

10.7.3 Education Needs and Information Concerns

There are concerns with education and current information available about NAIS in the equine world. There is a lot of misinformation and or misunderstanding regarding the intentions of the system, some of which are raised by concerns about confidentiality of movement tracking. Most major equine organizations recognize many concerns are not founded, but misunderstanding can contribute to resistance in NAIS adoption. Breed registries and other equine organizations are concerned about what the USDA expects from the equine industry in an NAIS system. Costs and difficulty in implementing the system will depend on what the exact parameters of the system end up being.

The Penn State survey of veterinarians assimilated some excellent data on veterinarian's knowledge of NAIS. Many equine owners receive the majority of their healthcare information from veterinarians, so educating veterinarians would be a start to educating all equine owners (Dreschel, et al., 2008). The study found that only 21% of veterinarians felt they were very familiar with NAIS, while 17% stated that they were not at all familiar. Forty-one percent of veterinarians stated they were concerned about finding an improved identification method for equids. Some equine groups recommended that starting an education program with breeders would be the best way to implement NAIS, as if horses were microchipped from birth, eventually the whole population would be microchipped. The breeders will also be the ones to bear this cost over time; after all older horses are microchipped, they are the ones adding new horses to the population. According to the AHC 2007 Horse Industry Directory, there are 31 educational organizations involved in the equine industry. Youth organizations such as the National 4-H Council and the National FFA Organization would be a great place to start educating groups on microchipping and tracking their horses, and encouraging the youth involved in these programs to have their parents or boarding stables get premise identification numbers.

Numerous survey results have exhibited the need for further education programs on equine healthcare, especially on the smaller premises in the industry. The NAHMS Equine surveys found that 41.7% of operations had not heard of NAIS prior to the survey and only 14.4% considered themselves knowledgeable about the topic. Large operations tended to be more knowledgeable about NAIS than small operations. Operations that were more knowledgeable about NAIS tended to use microchips more often, and operations that at least recognized the term EIA (Equine Infectious Anemia) were 2.8 times more likely to have some level of NAIS knowledge. Vaccination practices are also an area where education could be useful. The use of some level of vaccination on a given premises were approximately the same between 1998 and 2005, with the notable difference being the West Nile Virus vaccine being approved and used in approximately 60% of equine populations. Overall, about 75% of operations vaccinated at some level in both 1998 and 2005. However, 29% of operations that stated they did not vaccinate any equids on their property also transported animals by trailer off of the premises, indicating that unprotected horses are leaving their properties and possibly interacting with other horses or areas where horses have been.

For traveling and interacting with other equids, 60.6% of operations that had horses that left the premises and returned after direct contact with outside animals never isolated or quarantined these animals upon return, and only 10.6% routinely isolated these equids. Operations required a non-resident equine coming on to their premises to have an EIA test 42.1% of the time, and 18.0% required a CVI form. Of the 21.5% of operations that added new horses to their operation in the last 12 months, excluding newborn foals, 58.6% always required an EIA test for horses being added to their property, and 27.4% required a CVI. Only 63.0% of operations where the horses left the premises sometime within the last five years have ever been asked to present health papers (EIA test results or CVI). Most of these cases were at a show/event or at a sale. Premises in the southern region were asked more often (70.7% of the time) than the north, east, or west. The western region had the lowest percentage of operations being asked to present health papers, at 47.5% of operations that traveled in the last five years, but had the highest numbers for interstate and international movement, suggesting the state laws about papers being checked on livestock traveling between these western states have not been well enforced.

10.7.4 The Issue of Recreational Horses

Some equine stakeholders feel the industry should not be separated in two different priority levels (horses that require CVI/EIA tests and horses that do not) because: 1) the different levels are the same species and diseases can easily be transmitted between them; 2) horses that are not often moved and not highly valued tend to have lower health care standards, be vaccinated less, and are more vulnerable to exposure or to be a non-expressing disease carrier; and 3) horses from the different levels interact regularly. There is not complete separation and segregation between recreational horses and show horses. A lot of premiere show horses are shown in small schooling shows as practice, where recreational horses are also shown by their owners. The different classes of horses also interact at playdays, gymkhanas, trail rides, or boarding stables. Recreational horses may not travel as much as business competition horses, but there is frequent direct and indirect contact. Also, as noted in the case study on EVA, shipped semen and other breeding horses and issues in the breeding industry can and has carried diseases across state lines, whether physical horses are moved or not.

Evidence of the lower healthcare standards on smaller operations is provided by statistics in the NAHMS Equine 2005 studies. On average, 75.9% of operations administered some form of vaccinations in the last 12 months, but large operations (20+ equids) were more likely (87.2%) to administer at least one vaccination to their horses as compared to small operations(5-9 equids), at 73.6%. Veterinarians were the source of the vaccinations 76.0% of the time, and a higher percentage of small operations used a veterinarian as a source for the vaccinations as opposed to the large operations. This could provide a route for these smaller operations to get microchips inserted by the veterinarian. A higher percentage of large operations also required CVIs, EIA tests, or other health records for new horses coming on to their premises than did small operations, and large operations quarantined new horses more often.

Farm/ranch and personal use horse operations are much less likely to have any kind of written or computerized health records on their animals than boarding/training or breeding farms (USDA, 2006e). Small farms were also less likely than large farms to keep health records of any kind. In regards to quarantining or isolating equids returning to the farm after traveling off-premises and interacting with other equids, large operations quarantined a greater percentage of the time than did small operations. Residences with horses for personal use and farm/ranch operations were less likely than breeding or boarding/training operations to routinely isolate horses upon returning to the operation.

10.7.5 Movement Tracking

Throughout the industry, many stakeholders do not favor complete movement tracking of horses for various reasons. One group stated that where a steer could move 3-4 times in a lifetime, a horse would move 3-4 times in a day. Many horses move frequently to shows, events, other farms, sales, or even trail rides – all of these movements would be difficult and costly to track at a high degree of accuracy. Some members of the industry also comment that due to health care regulations in the equine world such as EIA tests and CVIs, equine diseases are already well traced and horses carrying diseases are found in many cases simply by talking to owners and finding the horses they have been in contact with. “Herd records” in the business plan, requiring the owners to keep accurate records of where the horse has been, and when, is currently the only way to track a specific horse’s movements. However, even if owners did this, they have no system to report the information to, and the current level of record keeping evidenced by the NAHMS report would not indicate that owners are prepared to keep records of their horses' movements (USDA, 2006e; USDA, 2006f). The NAHMS report only discussed health records, but it stated that the use of computerized methods and the veterinarian keeping records have both increased, while 23.5% of operations still have no written or recorded health records. There is also an issue with horses that stay at home being comingled with the horses that are traveling regularly, so it is difficult to limit the horses that need to be traced to only the animals that are moving regularly.

10.7.6 What to do with Positive Horses

Some horse owners have major concerns about what will happen to their horses in the case of a disease outbreak. Several equine diseases, including EHV and EIA, can cause some horses to be carriers and spread disease to other equids while never showing signs themselves. These diseases are difficult to cure and often the horse must be placed in permanent quarantine or euthanized. Many smaller horse owners fear that their horse may be euthanized in the event of a disease outbreak, and would rather hide their horses from a disease tracking system than to risk losing them.

10.7.7 Decreasing Attendance at Events

Two of the major equine organizations expressed concerns that the movement tracking would increase the cost to horse owners, which would in turn increase the cost of their events (especially with movement tracking) and therefore increase entry fees or ticket prices, which may decrease public attendance at events. In addition, with movement tracking, they were concerned that if reporting was too difficult, numerous exhibitors would not participate or only show close to home rather than out of their states or regions. If the NAIS system simplifies the check in process or management at shows or rodeos, these concerns may be eliminated.

10.7.8 European Union and Other Nations Requiring Microchips

The European Union has adapted a program to give every equine a Unique Equine Life Number (UELN) which is a 15 character code, the first three digits representing the country, the second three representing the breed of the horse, and the final nine being random numbers to identify the individual horse. At least 12 European nations, as well as Australia, New Zealand, and many of the South American nations already have microchipping regulations in the equine species. Many of these regulations are specific to the racehorse industry or horse movement, but some nations require all horses to be microchipped, and others require certain breeds to be microchipped to be allowed into registries or studbooks.

In the US, many of the equids in Louisiana are already microchipped due to their EIA testing program requirements. Great Britain microchips race horses at three months when DNA and hair samples are taken by the veterinarian. This is a similar process to what The Jockey Club requires in the United States for Thoroughbred foals. Some equine industry individuals suggested that the tracking of international horses was particularly important, and that all horses going through US quarantine should be chipped, but expressed concerns that placing a requirement on other nations to do something the US does not do would not be well received. In addition, the recent discussion of adding reining as an Olympic equestrian sport could increase the number of Quarter Horse or Stock-Type horses exported from the United States, and cause a greater need for US horses to meet the identification requirements of foreign nations.

10.7.9 Desire to make It Mandatory

Some members of the equine industry suggested that some in the equine industry are just waiting around to see what happens. They suggest that someone needs to make a National Equine ID program mandatory, with a timeline to allow the industry to adjust and learn the best way to go about implementing a system by trying it out. Currently, owners are not sure where to report their microchip numbers to, microchip scanners are not used regularly at events, and therefore the owners currently chipping their horses are not enjoying many of the potential benefits. They stated that the only way to get an effective level of participation in an equine NAIS would be to make it mandatory. Certain things need to occur to make the system more effective, such as extending the read range on scanners and getting veterinarians to use microchip identification in their practices, and they feel it is likely these things will occur if more horses were microchipped. The equine industry has been talking about and meeting to discuss the idea of NAIS for years, discussing the possible benefits including health records, tracking horses, day-to-day farm operations, and disaster recovery, but what it comes down to is they just feel they need to implement the system and find out where horses are, then the benefits will come with time.

10.7.10 Making sure USDA does not put regulations on the Industry they cannot handle

The equine industry initially felt that horses were an afterthought to be included in the NAIS, and then horses that moved a lot became a high priority in the plan. They are concerned about the USDA making regulations that the horse industry cannot conform to, and want to make sure they are involved in the planning and implementation of any system. That way, the horse industry will be able to develop a system that fits well into the current structure of the industry and hopefully meets the goals set out by the USDA.

10.7.11 Are horses pets or livestock?

The question of horses being a “pet” or a “livestock” animal is one that continuously raises issues in the equine world. Many individuals treat their horses as pets, but they are a part of the livestock industry in some locations. Parts of the equine industry do behave more like the pet industry, and recognizing this fact is important to learning how to implement an identification system in the equine species.

10.7.12 Certainty that the horse and chip are properly matched in the system

Horse registries are concerned about when and how to microchip horses to be certain that the correct microchip number is reported with the horse that receives that microchip. The Thoroughbred industry usually has veterinarians out for a neonatal exam and to do a hair pull for a DNA test, which are two possible times to identify horses. Taking the human error out of reporting microchip numbers will be important in being certain that the system works properly.

10.7.13 Enforcing current laws

Many members of the equine industry pointed out that enforcing current regulations on the equine industry is a major issue, and that any additional system would have to be enforced at a stricter level. The punishment for breaking a regulation and the level of enforcement both must be strict enough to encourage individuals to actually follow the rules. Enforcing the laws we already have was a major concern for members of the industry, though it is possible that a tracking system could assist in the level of enforcement. In addition, to use CVIs and EIA tests for tracking purposes, it is important that veterinarians turn these documents in to the state office on a timely basis, which is not currently the case. Education could help fix this particular issue. Numerous industry members felt that current CVI and EIA testing regulations required for traveling interstate and intrastate are not enforced at a reasonable level. Producer opinion suggests that numerous events and locations that claim to have regulations on EIA tests at events and places where equids comingle do not enforce these regulations. The Business Plan recommends standardizing disease programs, and in the equine species this could mean getting states to standardize and enforce EIA testing regulations. Working on the assumption that we are currently able to track horses using CVI and EIA testing requirements as the state level is good, if these current regulations are enforced. If they are not, this will not be a useful or effective form of disease tracking, because if even one sick horse is missed, the disease could slip through the quarantine region and spread. If a horse needs an EIA test for traveling purposes, a good recommendation on the national level would be to have a program similar to the state of Louisiana's, requiring a horse to have a permanent form of identification, preferably a microchip, before the test will be performed.

10.7.14 Cost concerns in certain equine industry segments

Industry members commented that the cost of an NAIS system probably will not have much of an effect on the high end of the horse industry. For high dollar race horses and show horses, getting the horse microchipped and scanned at shows would constitute such a small percentage of the horse's value and the annual costs that it would not affect them very much. However, it will affect the smaller racehorse trainers or show horse owners who are either just entering the business or struggling to keep going, and will also affect recreational horse owners who do not normally spend great amounts of money on their horses and just occasionally haul to parks, trail rides, rodeos, or small shows. However, these are also the horses that the USDA is less concerned about identifying initially, so it is possible that by the time they need to microchip their animals the system will be working well and the benefits will outweigh their costs.

10.7.15 Create disease spread models and costs for disease outbreaks

One recommendation is that disease spread models be created and studied to better predict costs associated with potential equine disease outbreaks and benefits identification and movement tracking systems could have in disease eradication and prevention.

10.7.16 Unreliable information

Throughout this project, statements and statistics have been quoted that do not necessarily match industry and producer opinion. The number of equids with no unique form of identification, as listed in the NAHMS studies, may be much higher than indicated by this study because, based on producer opinion, many of the horses left out of the NAHMS study (horses located on premises with four or less horses) would be in the recreational industry were registration is not always important or necessary. Horse movement numbers, when compared from 1998 to 2005, indicated that horse movement had decreased rather than increased. Industry members are perplexed by this result, when the numbers of events and organizations, including recreational events, are increasing annually. In addition, the 2006 Animal Health Report sites increases in horse movement to possibly explain the spread of equine diseases such as EHV-1.

10.8 Industry Opinion on NAIS

Both the Penn State study and the Colorado Smart Card study asked survey questions on people's attitudes towards an NAIS system in the equine species. The Colorado study found that 85% of participants agreed or strongly agreed with having an animal identification system for the equine species, while 15% were neutral and none disagreed. The majority of participants, 98%, also felt that the project was worthwhile, and 100% wanted to see national acceptance of the equine passport as proof of the EIA test, CVI, and brand inspection. Of the animal healthcare providers in the Penn State study, only 47% were in favor of NAIS, while 4% were opposed and the rest were neutral or unsure. Fifty-six percent of respondents felt that NAIS would be useful in stopping a contagious disease while the rest disagree with this statement. Industry opinion obviously differs greatly on NAIS, and further education could also assist in helping people understand and accept such as system.

10.9 Benefit-Cost Analysis for NAIS for Equine

10.9.1 Costs

The costs of NAIS adoption in equine are quantified for Premises Registration, Animal Identification, and Animal Tracking. Because of lack of data in the equine species, some estimates used here are based on quantities obtained through studies on other species of livestock, and others are producer estimates.

The cost for Premises Registration is shown in table 10.6. The number of premises where equids are housed as quoted in the NAIS Business Plan, is 570,000. In addition to this, the ESWG listed some premises that would not be included in this number as they would not permanently house horses. Estimates for the numbers of these additional facilities, including almost 4,000 State and National Parks (where trail riding areas may exist) and 3,077 counties in the United States (estimate of number of county or state fair/event grounds), constituted adding an additional 9,975 premises (1.75% of the equine premises). So the number of equine premises needed to register is 579,975 if there was 100% adoption of premises registration. Using the net present value of annualized premises registration cost of $4.64 (see Section 4 of this report), this means that the total cost to the industry of 100% premises registration is $2.9 million.

Table 10.6. Cost of Premises Registration in Equine Industry

	Number	$/premises	Industry cost
Equine operations	570,000	$4.64	$2,643,999
Other premises*	9,975	$4.64	$46,270
Total	579,975		$2,690,269

* Includes locations where horses will be comingled and estimated to be 1.75% of equine operations.

Costs for Animal Identification are exhibited in table 10.7. The total costs are based on a total number of equids in the United States being, as listed in the Business Plan, 5.8 million head (USDA, 2008g). This number is then adjusted up by 0.44% to account for the failure rates of microchips obtained in various studies. We assumed that the equine population is staying constant over time and that the average lifespan of a horse is 20 years (the low end of the range of lifespan indicated by the ESWG in their recommendations). The ESWG mentioned in their recommendations that one of the things that make horses unique is that they have the longest life expectancy of any livestock species, and stated a range of 20-35 years.

For replacement horse annual cost of NAIS, the cost of the microchip is an average of five prices obtained for the Destron-Fearing regular and biotherm microchips from distributors to veterinarians ($10, $12, $15, $16, and $20), and this average cost was charged to 100% of replacement horses. A veterinary charge for inserting the chip was based on the veterinary survey results for cost of the microchip and insertion, minus the cost of the chip as this is included separately, and this cost was also charged to 100% of replacement horses. The cost of veterinary travel assumes that 35.6% of the 570,000 premises, or 202,920 locations, where equines are housed would have a foal during the year, as reported in the Equine 2005 survey results.

The estimated annual number of foals, 290,000, was divided by 202,920 premises to get an estimate of 1.4 foals microchipped per veterinarian visit. However, this cost would only apply if the veterinarian was coming out for no other reason than to microchip the foal. The majority of horse owners having foals will have a veterinarian out to check the foal for neonatal exams or first vaccinations within the first year, so we did not charge a travel cost for new foals being microchipped annually. Finally, a cost of $4.15 was charged for the time and materials the owner would spend recording the data on the horse and reporting this data to a government database. Producer estimates indicated that filling out the paperwork on an equine would take an average of 15 minutes, at a cost of $14.60/hour (see Section 4 for wage rate assumptions). In addition, we assumed a $0.50 charge for materials such as postage, printing, or copying as may be necessary for government or equine owner records.

For horses that are currently in the equine population and would initially need to be microchipped, we included an annual interest cost of 7.75%. The NAHMS Equine 2005 survey reported that approximately 1.5% of equids are already microchipped and we assumed they therefore are also recorded in a database. The ESWG Microchip Paper reported an estimate of 600,000 horses already being microchipped, or approximately 10% of the horse population estimate we are using. However, we chose to assume the NAHMS Equine 2005 study was correct for this estimate. Therefore, the percentage of the equine population the microchip, veterinary charge, and recording/reporting data charges are applied to have been reduced to 98.5% with 100% adoption. Based on information included in the NAHMS Equine 2005 survey, such as the percentage of horses vaccinated by veterinarians and the percentage of horses tested for EIA, as well as producer estimates, we also assumed that 30% of horses currently would not see a veterinarian on an annual basis. Therefore, an interest charge on veterinary travel is applied to 30% of the current equine population.

If an equine owner needs a horse microchipped, it is likely that they will add this procedure to another routine veterinary call to mitigate travel costs. We also assume that if a horse is being hauled to the veterinarian to get microchipped, it is probably being hauled in for additional reasons, and therefore we are not charging travel or an office call fee to any percentage of these horses. Once again, the veterinary travel charge assumes that multiple horses are microchipped on each trip, and to obtain an average number of horses microchipped per trip, we assumed that all horses on a given premises would be microchipped in one trip if the veterinarian was coming out for that explicit purpose. Therefore, we took the estimated 5.8 million horses in the United States divided by the estimated 570,000 premises these animals are located on, to come up with an average number of horses per premises of 10.2 head. The veterinary travel charge was then divided by this number of horses.

Using the assumptions and data noted above, we obtain an annual cost of microchipping horses, veterinary charges for insertion, veterinary travel charges, and recording/ reporting data. The sum of all these annual costs comes to a total of $34.5 million for 100% Animal

Identification phase of implementing NAIS in the equine species (table 10.7).

The final phase of the Business Plan for NAIS, Animal Tracking, is by far the hardest to quantify for the equine species. The Business Plan suggests that events, such as shows, races, sales, or other exhibitions, where horses are comingled with equids from different premises, should be a priority in a tracking system (USDA, 2008g). They identify show horses through the USEF Horses Identification Program, and racehorses are identified through The Jockey Club, the United States Trotting Association, and the American Quarter Horse Association. Additional exhibitions or events where horses from across the state or from out of state comingle could include AQHA shows, PRCA and NHSRA rodeos, and numerous other events. The AHC identified 66 Show and Sport Equine Organizations, all or any of which may host their own state, regional or national shows. In addition, some educational organizations such as 4-H host horse shows, as well. The Equine 2005 Event Survey suggested that an average of 151.0 equids would be at an event on a typical day, and that 270.9 equids would attend the event over the entire course of the event. Local lessons, shows, and jackpot roping, where only a small number of local equids are expected to attend, were excluded from this study.

Table 10.7. Estimated Annual Cost of Identifying Horses Individually with Microchips

				Actual Number	Number to Chip**
Replacement horses*				290,000	291,276
Horses in current inventory				5,800,000	5,825,520
	Replacement horse, $/head	Percent applies to	Current inventory horse, $/head	Percent applies to**	Total industry cost
Microchip	$14.60	100.0%	$1.13	98.5%	$10,745,332
Vet charge	$27.40	100.0%	$2.12	98.5%	$20,165,897
Vet travel	$29.36	0.0%	$0.32	30.0%	$558,522
Recording/reporting data	$4.15	100.0%	$0.32	98.5%	$3,054,324
Total	$75.51		$3.90		$34,524,074

*Based on an average horse life of 20.0 years and assuming a constant inventory.

**Assuming that .44% of horses must be re-chipped due to microchip failure.

***The 98.5% accounts for the 1.5% horses that are already chipped, 30.0% is based on an estimate that 70.0% of horses will be chipped by a veterinarian at the same time they are being tested/treated for some other reason.

To illustrate the horse numbers that attend events held by large show organizations, we obtained some event information from equine organizations. From AQHA and USEF, we were able to obtain an approximate number of annual shows and also other equine event numbers from AQHA, which included an average number of horses attending these events. In 2007, AQHA held 2,449 shows with an average of 351 entries per show, and 554 special events with 63 entries per event. USEF estimated they hold 2,500 shows annually with 150 entries per show. Estimates were obtained on the number of PRCA and NHSRA rodeos, of 650 and 1,200 rodeos annually, respectively. In the NAHMS Equine 2005 Event survey, Western Events/Fairs/Rodeos had an average number of equids attending over the entire course of the event of 608.3 head. Unfortunately, this number also has a standard deviation of 262.2, indicating a high level of variability across these types of events.

As it is impossible at this time to quantify the number of equine events per organization and obtain an actual number of equine events, number of equines per event, and movement numbers, we chose to go a different route to quantify the tracking charges. The NAHMS Equine 2005 survey recorded information about the number of operations that transported equids off the premises by vehicle and later returned with them, which was a total of 58.4% of operations. Of these, 94.8% transported the equids within the state (53.1% for 1-9 trips, 37.7% for 10-99 trips, and 4.0% for 100 or more trips). Premises that hauled horses to adjacent states constituted 34.3% of operations (26.8% for 1-9 trips, 7.2% for 10-99 trips, and 0.3% for 100+ trips), 11.9% of operations transported within the US but beyond adjacent states (with 10.9% for 1-9 trips, 0.9% for 10-99 trips, and 0.1% for 100+ trips), and 1.1% transported equids out of the US (1.0% for 1-9 trips and 0.1% for 10-99 trips). These numbers indicate that 332,880 operations (58.4% × 570,000) transported equids off the premises and returned on an annual basis.

If we make the assumption that an individual reporting between one and nine trips is hauling the median amount of times, meaning 5 hauls, and that between 10 and ninety-nine trips is the median number of 54.5 hauls, and that horses hauled more than 100 times would be hauled 125 times, then we can come up with a total number of times horses were hauled by vehicle off premises and returned on an annual basis.

Therefore, 91.8% of the operations that hauled horses off premises by vehicle hauled 5 times, 45.9% hauled 54.5 times, and 4.4% hauled 125 times. This equates to ((332,880 × 0.918) × 5 = 1,527,919.2 hauls + (332,880 × 0.459) × 54.5 = 8,327,159.64 hauls + (332,880 × 0.044) × 125=1,830,840 hauls = 11,685,919 total hauls. The number of horses hauled on each of these trips would vary, but if we estimate two horses per haul, and estimate that for each haul, the horse would be scanned twice (once at the destination and once upon return to the original location), we can get a total number of scans for the equine industry, not including horses that left the property and did not return because of sale, of 46,743,675 necessary scans.

We can estimate the total horses sold using USDA Census data, and assume that when horses are sold they also move to a new property. Whether they are sold privately or through a public venue such as an auction, we will assume they are scanned twice during this process, once into the auction yard or when leaving their former residence, and once upon arriving at their new residence. The USDA 2002 Census reported a total of 487,808 equids sold. Therefore, if we estimate two scans per sale, we can estimate 975,616 scans due to horses moving because of change of ownership and therefore changing premises. Adding this quantity to the scans necessary for equine movement on and off premises, we get a total number of annual scans of 47.7 million.

The cost of the reader was quantified by taking the prices of Destron-Fearing readers ($350 and $360) which do not have the ability to store data, and an estimated cost of $885 for an Allflex wand reader, which is able to store information, and averaging them. The reasoning behind this is that the readers which have storage capabilities in the other livestock sectors tend to be much higher priced than the Destron-Fearing reader, and some reports, such as the California Racehorse movement study, have reported using Allflex readers with storage capability greatly simplified the movement tracking process. However, horses also tend to be handled in smaller numbers most of the time, so for small farms, breeding operations, veterinarians, anyone using the biothermal chip in horses, or show check in (checking horses one at a time), a reader without storage capability would be perfectly reasonable and less costly. Therefore, we assumed that 50% of the operations requiring readers would purchase the Destron-Fearing reader, and 50% would purchase the Allflex, or some other more expensive reader with storage capabilities. This average reader cost of $620 was then allocated over an estimated three year lifespan, as was used for the other livestock industries, with interest applied. It is possible that in some segments of the equine industry, where the readers are not shipped around and always are kept in protective cases, that the readers will last much longer than this, as is evidenced by the reports from veterinarians of readers lasting more than 10 years. However, as we have no definite estimate of reader longevity for the specific types of scanners used in the equine industry, the three year estimate of the other livestock species seems to be a reasonable assumption. Based on these parameters, the total annual cost per reader is $239.50.

We estimated that 108,870 readers would be required in the equine industry. Each of the 9,975 estimated additional premises would require at least one reader, and additionally large farms (as defined by the NAHMS Equine 2005 Study as those with 20+ horses) would probably desire a reader to keep track of horses traveling on and off of their premises. Large operations were more likely to have horses travel on and off of their premises, according to the Equine 2005 study, as 77.0% of large operations transported equids off the premises and back by vehicle as opposed to 66.3% of medium operations and 53.1% of small operations. Large operations represented 7.8% of all operations with over five horses on the premises as of July 1, 2005. Since we do not have an estimate for the number of operations with less than 5 horses, we will use this 7.8% to get an approximate number of large premises that may choose to purchase a reader. Therefore, the number of large premises requiring readers would be approximately $0.078 \times 570{,}000 = 44{,}460$. We realize that this may not be the best estimation method for the number of readers required by the equine industry. It is likely that the premises themselves will not purchase the readers, but instead the organizations hosting the shows, races, and events. However, we have no way of quantifying the number of shows and events held annually by each of the breed, show/sport, or educational organizations in the equine world. For future research efforts, focusing on quantifying the number of equine events held nationwide by all of the equine organizations may provide better estimates for scanning and tracking expenses.

Using the data we currently have, with approximately 9,975 premises where equids comingle, and 44,460 large equine farms where readers may be desirable for management purposes, we estimate a total number of 54,435 premises requiring readers. Using a requirement of two scanners per premises, to allow for the need for multiple scanners at one moment in time, we come up with a total requirement of 108,870 readers in the equine industry. If we take the total number of reads required by the industry, of 47,719,291, divided by this number of readers, we get an average number of reads per scanner of 438 annually. The annual cost per reader was divided by the average number of reads per scanner to get the cost per scan for an individual horse, which was $0.546 (table 10.8).

Table 10.8. Estimated Cost Per Scan in Equine.

Description		
Reader Cost/Scan		$0.55
Annual Reader Cost	$239.50	
Average Reader Cost	$620.00	
Estimated Lifespan (yrs)	3	
Interest Rate	7.75%	
Annual Scans/Reader	438.31	
Database Charge		$0.09
Labor		$0.18
Avg time, seconds	60	
Cost, $/hour	$9.80	
Workmen's comp, %	10.00%	
Annual Cost Per Read/Scan		$0.81

Next, we estimated the amount of time it takes to scan a horse and get a positive identity by checking the information. Based on producer estimates, considering the fact that some horses will be more skittish than others, we will use a number of 60 seconds, or one minute, per scan on a horse. This is applied to a labor cost of $9.80 per hour and a workmen's compensation percentage of 10.0% (for explanation, see Section 4 on labor costs), to get a labor cost per scan of approximately $0.180. This cost was added to the database charge per scan of $0.085 per scan (see Section 4 for explanation of database costs) and the charge for the reader per scan of $0.546 to get a total annual cost per scan of $0.811, which is reported in table 10.8. Based on an estimate of 47.7 million scans required by the industry, the total annual cost to the equine industry for 100% equine movement tracking is estimated at $38.7 million (table 10.9).

Table 10.9. Estimated Horse Movements and Scanning Cost.

Number of operations	570,000
Percent of operations that transported equids off the premises and later return by vehicle	58.4%
Number of operations that transported equids off the premises and later returned by vehicle	332,880

Number of trips per year	Percent of operations	Median trips	Total trips	Total scans*	Industry cost
1-9	91.8%	5	1,527,919	6,111,677	$4,954,237
10-99	45.9%	54.5	8,327,160	33,308,639	$27,000,593
100+	4.4%	125	1,830,840	7,323,360	$5,936,450
Total			11,685,919	46,743,675	$37,891,280
Annual equine sales			Head	Total scans**	Industry cost
Total			487,808	975,616	$790,852
TOTAL				47,719,291	$38,682,132

* Total scans is based on 2.0 horses per trip and 2.0 scans per horse per trip.
** Total scans is based on 2.0 scans per horse sold.

Based on the stated assumptions and parameters, our estimated total cost to the equine industry to implement NAIS in the equine species is $75.9 million, as shown in table 10.10. Animal tracking is found to be the greatest expense to the equine industry on an annual basis, however, the cost of the individual animal identification with microchips is only slightly less.

Table 10.10. Total Annual Cost of NAIS Adoption to the Equine Industry.*

Premises Registration	$2,690,269
Animal Identification	$34,524,074
Animal Tracking	$38,682,132
Total	$75,896,475

*Assuming 100% Compliance based on the stated parameters

10.9.2 Benefits

Benefits of NAIS adoption in equine are much more difficult to quantify than costs, but we can view benefits to the equine industry in terms of what the system could save under certain scenarios. Though potential benefits are numerous, they are difficult to quantify. One way to look at it is to take the estimated value of a horse as $2,733, based on the USDA Census for equids sold as described in the introduction of this section, and divide the cost of NAIS in the equine species by this amount. This would constitute the loss of approximately 27,946 equine lives; therefore, if having an NAIS system could save this number of horses from a disease outbreak in a given year, the system would be paid for. This number seems high, but only constitutes 0.48% of the current equine population.

According to the NAHMS report, 1.8% of equids greater than 30 days of age die annually (USDA, 2006e; USDA 2006f). Of this 1.8%, 0.8% die from Strangles, 2.2% from other respiratory issues (which could include infectious diseases), and 3.2% from neurological disorders including WNV and EPM. Unknown causes of death also constituted 6.6% of equine deaths. Taken together, Strangles, other respiratory deaths, and neurological deaths constitute 0.1116% of the entire equine population, and unknown causes constitute 0.1188% of the equine population. Thus, if animal ID and tracking helped to eradicate some of these diseases, the value in animals saved annually would pay for nearly one-fourth of NAIS adoption costs for horse owners.

Benefits of NAIS associated with animal disease surveillance and control and disaster assistance are also important. Labor costs will certainly be saved in some of these situations, in theory USDA or state animal health officials would no longer have to drive door-to-door in the case of a disease outbreak to check for other equids to test for illness. In disaster recoveries, the cost of labor and feed to take care of horses while searching for owners, could be reduced if horses were simply scanned and owners identified from database records. In addition, veterinarians could save time and hassle by having a microchip identification number for the equine on all of the veterinary records, including health and EIA test certificates, as opposed to drawing out and describing color and markings. Though this saved time may add up to only minutes per exam, over the course of a year with over 2 million EIA tests and likely a similar or greater amount of CVIs performed, it would save a great deal of labor expense. If EIA testing requirements were perfected and every horse tested, the disease could be eradicated from the United States. If this scenario were to happen, pending repeal of the laws requiring EIA testing, US horse owners could save over $50 million per year in from EIA testing expenses. Based on the NAHMS Equine 2005 Survey, the total cost of EIA testing in 2005 was approximately $57,464,741 (2,102,625 tests at an average of $27.33 per test). This value would constitute approximately 75% of the cost of NAIS in the equine species.

Research could also be aided by an equine NAIS. One statistician stated approximate estimates of $7 million dollars simply to start a full equine census. Many in the horse industry feel would be valuable for research and marketing purposes, and others feel full census data could aid in disease tracking, control, and prevention through increased knowledge of equine population densities and disease spread rates. At least partial census data could be obtained by an animal identification system in horses. Additionally, prevention in the loss of equine commerce is of value, though once again precise values cannot be applied at this time. However, if live equine exports constitute approximately $460 million annually (as estimated in 2005), any effect on the ability to import or export equids could have a great financial impact of the industry. Due to the fact that these horses may still be moved or sold within the United States, we cannot conclude that a total ban on exports would cost the equine industry this full amount, but the cost of NAIS only constitutes approximately 17% of this total value of exports. Therefore, it is easy to see that keeping horse movement open internationally is important, and though state numbers are not available, equine commerce between states is also valuable.

Taking a brief look at overseas disease outbreaks that have occurred, the 2003 influenza outbreak in South Africa cost that nation R130 million, which (using September 2008 exchange rates) equates to approximately $15.8 million US dollars. Japan's 2007 outbreak, costing them $48 million Australian dollars equates to approximately $37.9 million US dollars using September 2008 exchange rates. Australia, which has an $8 billion dollar horse racing industry, approximated its losses during the 2007 equine influenza outbreak as between $57.5 and $70 million Australian dollars, a range of $45.4-$55.3 million US dollars. These estimates all include the loss from betting revenue and direct costs due to losses of breeding, equine movement, cancelled race events, and equine healthcare expenses. Considering that the United State's horse racing industry is worth an estimated $26.1 billion dollars, according to the AHC survey, outbreaks of a disease similar to what has happened in other countries could have a much greater financial impact on the US industry. Equine influenza already exists in the United States, and major outbreaks usually do not occur due to regular vaccinations, but other diseases could have the same far reaching affects.

The only US economic study on equine disease outbreaks discovered in the research for this project was the study on the North Dakota WNV outbreak (Ndiva Mongoh, et al., 2008). The outbreak cost the state of North Dakota approximately $1.9 million in one year, and it was written in the conclusions that this was likely an underestimate of actual economic impacts. In addition, the North Dakota study mentioned other studies which had concluded losses of $2.75 million in Colorado/Nebraska in a given year and losses from equid deaths in the state of Texas as $7.46 million in one year. The expenses for disease treatments on a monthly basis ranged from $190-$380 if the horse remained on its feet to $3,000-$6,000 for downer horses. In addition, $802,790 was estimated to be the cost for the simple loss of use of the animal for a number of months for the equine to fully recover. The cost of these single-state outbreaks alone being prevented would cover or nearly cover the expense of premises registration for the equine industry. Though hard to quantify, it can be seen that having some sort of prevention and quarantine system for equine disease outbreaks, which would aid in maintaining commerce and preventing further loss of equine use or life, could provide enormous benefits to the equine industry.

One of the industry concerns is enforcement of current laws, and the implementation of NAIS is one way to help enforce laws, including the animal neglect and abandonment regulations, which may assist in preventing irresponsible horse owners from simply dumping or leaving their animals. These owners could be identified through the horse's microchip number. Even if they did not report ownership of the animal, the previous owner could report who the animal was sold to (or the auction it was sold through) and the abandoning owner could be traced and charged.

The specific benefits of premises registration, theft, disaster relief, and the added ability to manage large farms, shows, or exhibitions are difficult to enumerate and these are private benefits that are not a direct part of NAIS adoption. Nonetheless, these benefits are important for adoption as they are what encourage private individuals to adopt. We can assume that there will be some benefit in all these categories. Shows, farms, and exhibitions may save on labor and materials charges if records could be made electronic rather than on paper. However, these are all theoretical costs that are not possible to quantify at this time. The value of solving the problem of "unwanted horses" is also difficult to quantify. Additionally, though no values were assigned, the prevention of injury to racehorses or handlers when being checked in to the racetrack or for designated race or warm-ups constitutes a value for human injury, labor time, and possible loss of use of the animal if it was injured by flipping over in the paddock. Veterinarians and large farms could also save a great deal of time and labor if the biothermal chip was perfected and other methods of reading temperatures on horses were no longer required.

10.10 Conclusions

THE EQUINE INDUSTRY, which that has an estimated $102 billion dollar impact on the US economy annually with $39 billion of that in direct impacts according to the AHC survey, is a complex industry which is difficult to define and analyze. A precise estimate for the number of horses in the United States or the number of premises they reside on is difficult to obtain, and the information surrounding implementation of a national identification system in the equine industry is constantly growing with changes in technology and ongoing studies. Using the best available current information, this analysis suggests a total cost to the industry of $76.1 million for 100% industry compliance on all levels – premises ID, animal ID, and movement tracking. This amount constitutes a small percentage, 0.075%, of the industry's total economic impacts to the United States and approximately 0.20% of the industries direct economic impacts. The benefits of NAIS adoption are more difficult to enumerate, but given limited disease outbreak information and other data we were able to collect, at least a portion of the cost of NAIS in the equine species would be offset by benefits to the industry. At this time, we cannot definitively conclude from our analysis and available data whether benefits of full NAIS adoption in equine exceed costs of adoption. More research is needed to fully quantify benefits of NAIS adoption that we have omitted in the equine industry. If diseases such as EIA could be eradicated through improved surveillance and testing, or if equine export markets were not able to avoid major lengthy disruption during a possible disease outbreak, such accomplishments would make benefits of NAIS adoption quickly exceed costs.

11. MINOR SPECIES

11.1 BISON

11.1.1 SIZE OF INDUSTRY

According to the National Bison Association, there are approximately 250,000 bison currently in the United States, including those on public lands. The 2002 Census of Agriculture counted approximately 232,000 bison on about 4,000 farms. Of these bison, 30% are located in South Dakota and North Dakota and 37% are in Montana, Nebraska, Oklahoma, Wyoming, Minnesota, and Colorado.

11.1.2 DISEASES OF BISON

On public lands bison comingle with each other as well as with deer and elk. Bison are naturally hardy animals and are not susceptible to many of the diseases that plague wild animals and other livestock. For example, deer and elk suffer from Chronic Wasting Disease (CWD) yet there have been no incidents of this disease among bison. However, bison are vulnerable to diseases that have been introduced from Europe. Malignant catarrhal fever or MCF, is one important infectious disease affecting bison. Sheep carry and transmit MCF but do not succumb to it. The disease is spread through nasal secretions and when bison share the same pasture, feed, or water as sheep, they often contract the disease.

Another disease introduced from Europe to which bison are susceptible is brucellosis. The management of brucellosis in Yellowstone National Park has been a controversial topic for decades. While there have been no documented cases of brucellosis being transmitted from bison to cattle, if such a transmission would occur, the impact on the livestock economy of Montana could be substantial. Controversy surrounds park manager techniques to control the number of bison leaving Yellowstone National Park. These techniques include public hunting, hazing bison back into the park, capture, testing for brucellosis exposure, and shipping bison to slaughter (Cheville, McCullough, Paulson, 1989).

11.1.3 Identification Systems Place

Due to the smaller size of the industry in general and processing facilities specifically, the bison industry has the ability to track animals more easily than does the beef industry.

The North American Bison Registry is maintained by National Bison Association (NBA). However, the membership in the registry is small so its usefulness as an identification system is limited. Another identification system used by some bison producers is a source-verified program. The NBA currently offers the National Bison's Source Verification Program as a tool to promote a natural product that can be traced to the ranch of origin. This program is similar to what is required for bison identification under the National Animal Identification System (Carter, 2008). Currently, approximately 23,000 animals are involved in this program, representing close to 10% of the total number of bison in the United States.

11.1.4 Priority of Bison

The bison industry has far less impact on the United States livestock industry as a whole than do other species examined in more detail in this project. In 2002, the number of bison represented 0.2% of total cattle in the United States. Because of the relatively small size of the industry and the nature of bison production, comingling, and thus chance of disease spread, among bison is less than that among cattle. However, near public lands containing bison herds, concerns of disease spread across species remains an important issue. Unlike cattle, bison are wild animals and so they are moved around the country infrequently. In addition, the industry already uses a source-verified program that provides traceability, so the structure for a more wide-spread animal identification system is already in place. Because of the relatively small size of the bison industry, we do not estimate specific benefits and costs of NAIS adoption by the industry in this report. Costs of registering premises in the bison industry would be similar to those of other species. We expect costs of adopting individual animal ID for those who are not already involved in programs similar to the NAIS requirements would be similar to those for beef cattle (assuming the operation has facilities to work the bison).

11.2 Camelids

11.2.1 The Camelid Industry

The US alpaca industry has been growing rapidly over the past twenty years. The animals were first imported into the United States from South America in 1984 and their numbers in 2006 exceeded 86,000 head. The four top alpaca farming states are Ohio, Washington, Oregon and California (Baird, 2008). The long term goal of the alpaca industry in the US is to develop a domestic textiles industry. However, there are not currently enough alpacas in the US to support an industry, so the majority of those in the alpaca industry are breeders (Anderson, 2008). Live animal shows are an important part of the alpaca industry.

The US Llama population in 2006 exceeded 157,000. Llamas are farmed in similar areas as alpacas. The top llama farming states are Oregon, California, Texas and Washington (Baird, 2008). While some llamas are shown, much of the industry is a companion animal industry. Most of the shows that alpacas and llamas attend are sponsored by the Alpaca Owners and Breeders Association (AOBA) or the Alpaca and Llama Show Association (ALSA).

11.2.2 Diseases of camelids

Camelids are susceptible to certain viruses and parasites, however, the viruses they carry do not cross species lines. Mange and parasites are likely the biggest problems for camelids currently. Mange is species specific while camelids share internal parasites with other ruminants such as cattle, sheep and goats. In general, Brucellosis, Blue Tongue, and Foot and Mouth Disease do not survive well in camelids. The industry monitors for Tuberculosis and Brucellosis, but there has never been a positive test for these in camelids. Likewise, a test exists for Bluetongue, but it is not a clinical entity in camelids. (Anderson, 2008)

11.2.3 Identification Systems in Place

In July 2005, the AOBA began requiring all animals at AOBA-sponsored shows to be microchipped. It is estimated that approximately 85-90% of the US alpaca population is registered through the Alpaca Registry. When an alpaca is registered, it is DNA fingerprinted and microchipped. A smaller percentage of llamas are registered than alpacas because fewer are shown. Approximately 55-65% of llamas are registered (Anderson, 2008).

11.2.4 Priority of Camelids

Both the size and the nature of the camelid industry in the United States make it less of an identification priority than cattle, swine, sheep and poultry. In 2006 there were an estimated 243,000 llamas and alpacas in the United States. This is approximately 4% of the number of sheep in the United States in 2006 and 0.2% of the number of cattle. While the industry is relatively small and highly identified, much breeding movement occurs in the alpaca industry because no AI or embryo transfer is allowed. Therefore alpacas cross state lines frequently, making identification potentially an important issue. The alpaca industry is similar in nature to the equine industry in many ways, just much smaller in overall size. Due to the small size of the camelid industry and the fact that alpacas are predominantly registered, DNA fingerprinted, and have microchips, the industry has already largely adopted NAIS types of animal ID systems. Thus, we do not estimate specific benefits and costs of NAIS adoption by the industry in this report.

11.3 Cervids

11.3.1 The Cervid Industry

Although settlers in the United States farmed elk as early as the 1800's, the practice became popular in the United States in the 1960's. Both elk and white-tailed deer are native to North America. Velvet, a common ingredient in Chinese medicine, is the main product obtained from elk.

Most velvet produced in the United States is sold to China or used by Asian populations residing in the United States. Elk meat is consumed to a limited extent in the United States. Minnesota has a meat cooperative that sells 80,000 pounds of elk meat per year to upscale Orlando markets (Zebarth, 2008). Elk meat is also consumed at mountain resorts. The most common species of cervid raised in North America is white-tailed deer. Most people own these animals to hunt or raise them for breeding stock.

11.3.2 Size of Industry

In 2002 in the United States there were approximately 286,900 captive deer and 97,900 captive elk in a total of about 7,200 facilities (USDA 2002b). A majority of the deer population (52%) was in Texas. Wisconsin and Michigan, the second and third most populated states, each housed 8%. The elk population was more dispersed with the highest percent of animals in any one state being 17% in Minnesota. Wisconsin was the second most populated state with 13% of captive elk and Colorado and Texas follow with 10% and 6%, respectively.

11.3.3 Diseases

Cervids are susceptible to many of the same diseases as cattle. Perhaps the most troubling disease for the captive cervid industry has been CWD, a form of BSE. Cases of CWD have been found in white tail deer, mule deer, elk, and moose. CWD was first discovered in 1978 in Colorado wildlife research animals. It was not discovered in farmed animals until 1996 in Canada and 1997 in South Dakota. The most recent case in the US farmed industry was a whitetail deer in Minnesota. Wyoming has the highest incidences of CWD in the free-ranging population. Population reduction has been tried as a means of disease control, but the tactic has not been very successful (i.e. concentration of the cervid population does not seem to affect percentage of animals infected with CWD).

11.3.4 Identification Systems in Place

Producers need a license and a permit from the state to raise cervids. This is commonly controlled by each state's Department of Agriculture. Farmed cervids are classified as livestock according to APHIS regulation, so producers are subject to livestock regulations with additional fencing requirements. One purpose of cervid identification is to keep the captive population separate from the wild population.

In 2006, APHIS completed a Chronic Wasting Disease Herd Certification Program in coordination with the states and the farmed cervid industry. If states have programs in place that match the requirements for the national program, producers can enroll in the state programs. Otherwise they can enroll directly in the national program. Premises registration is required by the program and every animal is required to have two forms of permanent identification. The regulations of this program meet the requirements of the National Animal Identification System (Zebarth, 2008).

11.3.5 Priority of Cervids

In hopes of controlling CWD, APHIS and the captive cervid industry have been proactive in creating programs and methods to monitor the disease among cervids. The CWD Herd Certification Program is in place and much of the industry complies with its requirements. As such, the industry is highly regulated and far ahead of others in its level of identification and traceability. Thus, we do not explicitly complete a benefit and cost analysis of NAIS adoption for the cervid industry.

11.4 Goats

11.4.1 The Goat Industry

Several factors have contributed to the recent growth of the goat industry in the United States. The meat sector of the goat industry has seen marked growth while the angora and dairy sectors have declined.

The phasing out of the government wool program in 1995 caused a rapid decrease in mohair production. Since goat meat is a staple in many Hispanic and Muslim cultures, as ethnic populations in the US have grown, the demand for goat meat for consumption has increased (Faris, 2008).

The number of goats in the United States in January 2008 was approximately three million head according to NASS. Of these, 42% were located in Texas. The second most populous state was California with 4.4% of the goat population (134,000 goats). The meat goat population was 2.5 million head, approximately 83% of the total US goat population. The geographic distribution of the meat goat population is similar to the total goat distribution. Texas is home to approximately 44% (1 million) of meat goats in the US. Tennessee is a distant second with 4.7% of the meat goat population. (USDA, 2002b).

The number of Angora goats in the US as of January 2008 was 210,000, down 10% from the previous year. A majority of these goats are located in Texas (71%). Arizona comes in a distance second with 8% of the Angora goat population. The US had 305,000 dairy goats as of January 2008, a slight increase from January 2007. About 11% of these are in Wisconsin while California and Texas are home to 10% and 8%, respectively (USDA, 2002b).

While the goat industry is relatively small (sheep inventory as of January 2008 is over twice as large as goat inventory), meat goat numbers in the United States are growing.

11.4.2 Diseases and Identification Systems

As the goat industry grows, the knowledge of diseases that affect goats is also growing. Parasites are more of a health concern for goats than are diseases. Internal parasites can be managed by maintaining a low stocking density in pastures. As more animals graze on the same pasture, parasite problems increase because animals are grazing closer to the ground and the amount of fecal matter on the pasture increases. Diseases that affect the goat industry include caprine arthritisencephalitis (CAE), footrot, caseous lymphadenitis (CL), soremouth, and scrapie. Of these diseases, CAE is the most serious.

Although scrapie rarely affects goats, many goat producers are enrolled in the National Scrapie Eradication Program (NSEP). According to APHIS, as of December 2007, 52% of the goat herds are registered in the program (USDA, 2007e). The NSEP has been successful in tracking animal across the United States.

11.4.3 Priority of Goats

APHIS assigned goats a medium priority designation in their Business Plan to Advance Animal Disease Traceability. Several characteristics of goats and the goat industry make the species less of a priority for this research project. First, the small size of the industry, relative to the major species industries, lessens its importance with regard to the livestock industry as a whole. The number of goats in the US as of January 2008 was less than half the number of sheep. Next, the industry's participation in the NSEP coupled with the low incidences of the disease found in goats provide a relatively high level of traceability for the risk of disease spread associated with the species. Finally, the geographical concentration of the industry allows a possible disease outbreak to be more easily managed. However, as previously mentioned, the industry appears to be becoming less geographically concentrated than in the past. Costs of adopting NAIS for goat producers would likely be similar to those of the sheep industry.

12. Other Benefits Of NAIS Adoption

PREMISES REGISTRATION, ANIMAL IDENTIFICATION, and animal movement tracking offer a number of benefits to industry stakeholders, government health professionals, food safety regulators, and consumers. The types of benefits that accrue range from enhanced animal health surveillance to improving consumer demand because of food product credence attributes associated with food and animal traceability. The economic impact of several of the benefits discussed here are estimated directly or indirectly and presented in previous sections of this report. The benefits estimated in our report are those that are directly affected by NAIS adoption. However, the economic values of numerous benefits noted here are not estimated in this study because they are benefits that NAIS adoption would enable or make more efficient, but are *not* directly a part of the confidential NAIS premises registration or animal ID system. As a result, we know that our current benefit-cost analysis understates potential benefits of NAIS adoption. In addition to the summary that follows, see Smith et al. (2005) for an excellent discussion of several benefits of traceability.

12.1. Enhancing Animal Health Surveillance and Disease Eradication

ONE OF THE MOST IMPORTANT DIRECT BENEFITS of premises registration, animal ID, and animal movement tracking is the impact on animal health. To conduct appropriate, statistically sound, animal health surveillance requires knowing where animals are located, their densities, and animal movements. Developing sampling procedures of animals to determine statistically valid measures of the extent of diseases in populations require knowing where animals are located.

A number of state and national animal identification programs have been used in the United States in attempts to eradicate a variety of animal diseases. Examples include the national brucellosis eradication program, with roots back to 1934 (Bradt, 1959), in which vaccinated heifers are identified with an official tattoo in the ear. Ironically, this program has been so successful at eradicating the disease that vaccinations have greatly declined over time going from 45% of heifers being vaccinated in 1995 to only 20% by 2003 (Wiemers, 2003). The result is far fewer cattle having a brucellosis animal ID for any type of traceability in the event of a health crisis. The swine pseudorabies (PRV) eradication plan was successful in getting all states designated as free from the disease. However, large populations of feral swine in certain regions of the country raise concerns regarding PRV reintroduction. Thus, the new targeted surveillance program integrates with swine premises registration data to develop "a robust database to allow targeted sampling based on associated risks" (Korslund, 2008, p. 2). The National Scrapie Eradication Program started in 2001 identifies animals using an ear tag that are over 18 months of age entering the sheep breeding herd indentifying each animal by flock of origin and each having a unique herd management number.

Animal disease management and eradication programs provide an immediate benefit from integration with NAIS. Standardization of premises identification systems; uniformity in a nationally recognized animal, lot, or flock identification numbering system; and standardized methods and devices for livestock ID utilization (Wiemers, 2003) all speak to the ability on a national level to rapidly identify premises, trace animals, and respond with appropriate actions in the event of an animal disease outbreak. Preparedness before an outbreak is essential in reducing the economic impact.

12.2 Reducing Economic Impact of Disease Outbreaks

THE TYPE OF ANIMAL IDENTIFICATION and traceability system in place in an industry can significantly impact the duration, spread, and economic consequences of a foreign animal disease (Saatkamp et al., 1995 and 1997). Disney et al. (2001) analyzed the economic impacts of improved animal identification systems for cattle and swine using a hypothetical foot-and-mouth disease (FMD) outbreak in the United States. Improved animal identification systems in cattle could provide economic benefits with average benefit-cost ratios for cattle ranging from 1.24 to 3.15 depending upon the time planning horizon and the traceability situation. However, economic benefits (in terms of reduced economic consequences of an FMD outbreak) were not justified in swine with improved animal identification systems and most benefit-cost ratios were less than one. Zhao, Wahl, and Marsh (2006) investigated the economic consequences of an FMD outbreak in the US with increased levels of animal traceability and surveillance. They concluded that total consumer and producer combined surplus losses from an FMD outbreak would decline from $266.3 billion to $50.3 billion with a depopulation rate that went from 30% to 60% of latent infectious herds, which the authors attributed to increased animal traceability.

12.3. Regionalization and Compartmentalization to Re-establish Market Access

In management of any animal disease outbreak one critical issue regarding the economic impact of the outbreak is the ability to contain the disease and restore market access for at least part of the industry as soon as possible. This brings to the forefront the concept of regionalization (or zoning) in which a subpopulation, based on geographic region, can be demonstrated as an isolated area free of disease incidence enabling the region to have international market access. Paarlberg et al. (2007) examine the economic impact of regionalization in the United States of a highly pathogenic avian influenza outbreak. They concluded that such an outbreak in the United States would have substantial economic impacts with about a $718 million reduction in returns to capital and management in the poultry meat production sector with no regionalization over a 4-year time horizon. With regionalization, poultry meat producer losses would reduce to around $500 million because regionalization dampens export market losses.

Compartmentalization is further refined relative to zoning and involves isolating one or more establishments with common biosecurity management measures "that provide distinct disease risk separation from animals or birds at higher risk for the disease(s) in question" (Scott et al., 2006, p. 875). The World Organization for Animal Health (Office international des epizooties – OIE) officially recognizes regionalization and compartmentalization animal disease management procedures as conditions that may enable resumed international market access in unaffected areas following a disease discovery. Animal ID, movement tracking, inflow, and outflow documentation are essential in demonstrating such an auditable biosecurity management system is present.

12.4. Reducing Producer Costs Associated with Animal Disease Testing

ANIMAL DISEASE TESTING IS PART of on-going animal disease surveillance and eradication programs. Having individual animal identification can significantly reduce the costs to both the producer and the state veterinarians of testing a herd for a particular animal disease. In Michigan for example between January 1, 2000 and June 1, 2006 over 18,000 herds and 1,191,063 animals (average tested herd size of approximately 66 head) have been tested for bovine tuberculosis (Michigan Department of Agriculture, 2006). Michigan, currently the only state with a mandatory individual animal identification program in operation, provides a specific example of the producer cost savings that may be realized by having individual animal identification and associated electronic technologies available to increase testing efficiency. Discussions with Dr. Tom Flynn and Dr. Dan Robb (both experienced veterinarians in Michigan) suggest that use of MIM (a software technology that leverages electronic animal identification in animal disease testing) leads to quicker TB testing of cow herds. In particular, Robb suggests that creation of herd testing for 25, 50, and 100 head herds may be conducted 0, 1, and 2.5 hours quicker, respectively, by utilizing MIM software on animals with RFID animal identification. These reduced times of testing herds of more than 25 head correspond to reduced periods of on-farm production interruption and hence reduced lost value of production for participating farmers.

12.5. Enhancing Animal Welfare in Response to Natural Disasters

DURING NATURAL DISASTERS there are times when having premises registration and/or animal identification can greatly assist officials in identifying and assisting animals in distress or finding owners for displaced animals. A recent example of premises registration improving animal health surveillance occurred in southeast Colorado during the December 2006 blizzards. Colorado Department of Agriculture used premises registration information to check on the welfare of ranchers and their livestock which substantially accelerated the rate and expanded the scope, of issue assessment and assistance needs (Colorado Department of Agriculture, 2007). Following hurricane Katrina in New Orleans, 163 horses and mules were returned to their owners, mostly identified with microchips or lip tattoos in 2005 (New Orleans City Business, 2005).

12.6 Facilitating Meeting Country-of-Origin Labeling Requirements

WITH COUNTRY-OF-ORIGIN LABELING OF MEAT being enacted in September 2008, retailers are required to label fresh beef, pork, lamb, chicken, and goat, as well as other products, according to its country of origin. All retailers and suppliers are required to maintain origin information for one year for covered products that they sell. Under this law, producers must maintain records that can link animals sold to production records documenting animal origin. If animals are comingled from multiple sources of origin, for example, cattle stockers and feedlots, they will need to be able to link the animals in a pen to their origins. If animal sorting and co-mingling from multiple sources occurs, the burden of maintaining origin records could be reduced with individual animal ID.

In particular, animals having NAIS compliant forms of ID (e.g., “840” tags) can use this to verify origin. Thus, NAIS compliant individual animal identification eliminates the need for maintaining multiple affidavits for lots of animals comingled from a variety of sources.

12.7 Reducing Information Asymmetry by Increasing Transparency in Supply Chain

AN IMPORTANT IMPLICATION OF ANIMAL TRACEABILITY is that it can reduce information asymmetry leading to greater transparency in the vertical supply chain. Animal identification is a direct link to where an animal originated and with movement tracking provides an efficient way to identify sources of and quickly solve animal production problems that affect overall value of animals throughout production and processing. For example, Resende-Filho and Buhr (2008) demonstrate that even with low levels of animal traceability (39%), a beef packer can induce a cattle feeder to adopt quality control practices to reduce incidence of injection-site lesions in fed cattle. Animal tracing would provide similar incentives to reduce information asymmetry related to up to date vaccination programs, feeding regimens that might lead to meat residues, or tracking other animal treatments such as growth promoting implant programs.

12.8 Reducing Risk of Unfounded Responsibility in Liability Claims

TRACEABILITY SYSTEMS CREATE INCENTIVES for firms to do things that increase food safety because such systems increase the possibility of legal action upon responsible parties. As such, traceability enables parties in the vertical supply chain to more easily document that they are not responsible for harm associated with a food safety event (Pouliot and Sumner, 2008).

12.9 IMPROVING EFFICIENCY OF VALUE ADDED AND CERTIFIED PROGRAMS

THE USDA AGRICULTURAL MARKETING SERVICE (AMS) has several voluntary marketing programs such as USDA Process Verified, Quality Systems Assessment, and Non-Hormone Treated Cattle that require animal identification and traceability. The AMS has integrated their auditing of these certification programs to enable NAIS to meet the animal identification requirements.

NAIS can also be used to help verify requirements for USDA Export Verification programs to be eligible for products to be exported to specific countries such as Japan or EU. Global certification programs, such as International Standardization Organization (ISO) guidelines, are another growing source of food safety and hygiene systems entailing traceability (Meuwissen et al., 2003).

Some industry stakeholders told us they were concerned that NAIS adoption could reduce premiums associated with source and age verification programs. This is possible, if NAIS animal ID makes such voluntary AMS programs easier and cheaper to comply with. However, if industry adoption of NAIS animal ID and tracing increases domestic and/or export demand in ways described in Section 9, then the industry would still garner significant net benefits from adoption. However, some individuals could be made worse off, or certainly benefit less, from NAIS adoption than the average firm.

12.10 SOCIAL BENEFITS OF ANIMAL TRACING

SOCIAL VALUE OF TRACEABILITY in general is very well presented by Golan et al. (2004b, pages 37-38):

Social benefits may also include the avoided costs to firms that produce safe products but lose sales because of safety problems in the industry. A firm's traceability system not only helps minimize potential damages for the individual firm, it also helps minimize damages to the whole industry *and to upstream and downstream industries as well. For example, a series of widespread ground meat recalls has the potential to hurt the reputation and sales of the entire meat industry, including downstream industries such as fast food restaurants and upstream suppliers such as ranchers. The benefits to the industry of a traceability system pinpointing the source of the bad meat and minimizing recall (and bad publicity) could therefore be much larger than the benefits to the individual firm.*

Though their example refers specifically to a meat traceability issue, similar arguments certainly apply to animal traceability.

12.11. Enhancing Global Competitiveness

In case studies of poultry, beef, pork, lamb, and fish firms employing traceability located in France, Holland, Germany, Norway, and Scotland, Buhr (2003) states, "When case participants were asked why they adopted traceability, the first response in every case was, "Consumers demanded to know where their food came from and how it was produced" (p. 14). Following the BSE events in the United States in December 2003, the vast majority of the beef export market was completely closed. Five years later, only about 75% of beef export market volume movement prior to the BSE event has been regained. Murphy et al. (2008) in review of animal identification systems in North America argue that animal identification systems are becoming "prerequisites to international trade" (p. 284).

Liddell and Bailey (2001) argue that the United States pork industry lags behind major world producers of United Kingdom, Denmark, Japan, and Australia in animal traceability. Meisinger et al. (2008) also demonstrate how much more advanced the EU, UK, Denmark, New Zealand, and Australia are relative to US in swine and pork traceability. Bass et al. (2008) discuss how major lamb producing countries of Australia and EU have advanced mandatory sheep traceability systems beyond the voluntary system present in the United States. Tonsor and Schroeder (2006) present similar arguments comparing the United States and Australian beef tracing systems. Souza-Monteiro and Caswell (2004) present evidence that EU, Japan, Australia, Brazil, Argentina, and Canada lead the United States in beef traceability systems. Table 12.1, taken from Bowling et al. (2008), illustrates how many of the major cattle producing countries have animal ID and traceability systems that are mandatory. Bailey (2007) demonstrates the US has a weaker beef traceability system than Uruguay, Argentina, EU, and Australia. He concludes that consumer concerns about credence attributes provided through animal ID and traceability could become more important threatening the ability of the United States industry to compete effectively. Meat and Livestock Australia (2008) consider cattle ID in their country as an insurance policy in the event of a trade disruption.

Table 12.1. Comparison of Cattle Population and Identification and Traceability Systems.

Country	Cattle Population (1,000 hd)[1]	Premises ID[2]	Individual Cattle ID[2]	Group / Lot Cattle ID[2]	Electronic Cattle ID[2]	Record Animal Movement[2]	Retire Animal Number[2]
Australia	28,560	M	M	V	M	M	M
Botswana	3,100	V	M	NA	M	M	V
Brazil	207,157	M	V	M	V	M	V
Canada	14,830	V	M	NA	M	V	M
European Union	90,355	M	M	V	V	M	M
Japan	4,391	M	M	V	V	M	M
Mexico	28,648	V	V	V	V	V	V
Namibia	2,384	M	M	V	V	M	M
New Zealand*	9,652	V	V	V	V	V	V
South Korea*	2,484	M	M	V	V	M	M
Uruguay	11,956	M	M	V	M	M	M
United States*	96,702	V	V	V	V	V	V
World	1,383,157						

[1]All numbers are for cattle populations in 2006 as reported by the Food and Agriculture Organization of the United Nations (FAOSTAT, 2008).

[2] M = Mandatory, V = Voluntary, NA = Not Allowed

* Indicates a voluntary program. The requirements listed are for those who choose to participate

Source: Bowling et al. (2008). Reproduced with permission from Editor-in-Chief, *Professional Animal Scientist.*

13. Information Gleaned from Industry Meetings and Lessons Learned

DURING THE COURSE OF OUR DISCUSSIONS with industry stakeholders, in addition to information and data that were used directly in our benefit-cost analysis, several related sentiments were revealed. Here we summarize some of these sentiments. This particular section of our report, unlike most of the rest of our analysis, is not meant to represent a scientific survey response and does not therefore have associated robust statistical properties in terms of whose opinions it does or does not represent. However, our discussions were broad in terms of industry organizations and representatives that we visited and thus represent views expressed by a significant segment of industry (see appendix A3 for list of organizations we visited). The information we share here is a synthesis of comments and does not represent any single entity or person.

13.1 Cost of animal ID is just a cost of doing business

IN OUR INDUSTRY DISCUSSIONS we often heard sentiments reflecting that animal ID and tracing are part of a well-functioning and efficient vertical food production and marketing chain. This sentiment was reflected in reference to numerous aspects of what animal ID and movement tracing brings to animal health management, crisis management, adding credence attributes to food labels, enhancing trade, and various other potential benefits. Making NAIS practices a part of business reflects the idea that many in industry perceive a need and are moving forward with evaluating how to adopt systems most efficiently.

13.2 Mandate, tell us the rules, and we'll adjust

The sentiment relating to mandating animal ID was especially voiced by market participants who recognize economies of scale associated with fixed investment in ID scanning and recording equipment. A voluntary ID system, with moderate or low levels of adoption, is costly for firms that must make facility modifications and procure information technology equipment in order to offer animal ID and recording services. If mandated, the investment must be made by all firms and will be fully utilized in each establishment. If left voluntary, establishments must figure out whether to make investments necessary to adopt NAIS practices in the presence of uncertainty about their ability to fully utilize the equipment. This makes adoption of such equipment a strategic decision that can either make a firm more or less competitive with other firms in the industry. The "tell us the rules" segment of this statement was a reflection of developing guidelines over time in NAIS including what some perceived as a change in direction from what some believed appeared to be a system that was headed toward being made mandatory to a voluntary system.

13.3 Not mandating will result in low animal movement tracking

A concern that was similar to the sentiment of "mandate and we will adjust," was that without mandating, producers will be slower to adopt and fewer will adopt ID and tracing technology. Again, the concern was that slow and small adoption rates, makes it difficult, especially for smaller firms in industry, to know what direction to head in terms of adding or not adding animal ID and recording services.

13.4 Stakeholders do not largely support a NAIS national data bank

Numerous organizations told us that an NAIS national data bank was not preferred. Instead industry organizations often times told us their preference was for the individual industry to maintain their own data bank(s) while allowing USDA access on an as needed basis. This sentiment was at times motivated by a group that might be capturing more information than that specified by NAIS and using it for other purposes making dumping parts of the data to another data bank simply an added cost without perceived additional value or because the industry preferred to keep the data internal. This preference was revealed across numerous species and industry sectors.

13.5 But, not having a coordinated national data base is problematic

Despite preferences for maintaining animal ID and movement records internal within an industry, many that we visited with admitted that having multiple individual data banks, may make coordination and communication across data banks problematic. The feeling was that the lack of a centralized data base will either slow or curtail successful tracing. Centralized data banks in Australia and Canada, where animal ID systems are mandatory and more mature, were often noted examples of how such systems have been designed.

13.6 Do not know animal density or location making surveillance hard

Benefits of animal ID resulting from improved animal surveillance were presented in Section 12. Our research team heard from several in a variety of settings that not knowing the locations, densities, or movements of animals makes disease surveillance much more difficult.

13.7 Larger firms need common technology

Having ID and animal movement recording occur at the speed of commerce is a very important dimension of acceptability and adoption of ID systems. Furthermore, larger firms that have large numbers of animals flow through their operations, indicate common technology that will operate effectively at the speed of commerce is essential for efficient ID and movement tracking. This suggests that if a technology neutral position remains for NAIS adoption, the resulting adoption will be more expensive and have a lower rate of adoption than if specific technology specifications were defined at points in time. In contrast, smaller operations often have preference for a variety of animal ID and recording systems that may not be compatible with recording large numbers of animal movements rapidly. Thus, we heard conflicting opinions as to the value of "technology neutral" systems such as are currently being suggested in the NAIS plans.

13.8 Do not add redundancies to current practices

We heard several times from several organizations across species that an animal ID and movement tracking system, whether group/lot or individual animal, needs to complement, not add redundancy and added layers of work to current industry practices. The reality of whether and how this can be accomplished is well beyond the scope of our project, but it was revealed often enough to merit noting.

13.9 NAIS ENABLES US TO REGIONALIZE AND PERHAPS COMPARTMENTALIZE ISSUES

ANOTHER FREQUENTLY MENTIONED comment by stakeholders was the opportunity for NAIS to regionalize and compartmentalize animal health issues to more quickly and more fully re-establish market access in the wake of an animal disease or food safety event. Again, this was discussed more fully in Section 12, but it is well recognized by stakeholders as something NAIS should be designed to enhance.

13.10 BREEDING HERDS ARE BIGGEST CHALLENGE AND NEED FOR NAIS

SEVERAL STAKEHOLDERS REVEALED the greatest need and the greatest challenge for NAIS adoption is in the animal breeding herd. Focusing effort on this segment of each species appears well justified.

13.11 NEGATIVE EXTERNALITY ON NON-ADOPTERS, SOCIAL VALUE EXCEEDS PRIVATE

WHILE WE OFTEN HEARD sentiments about supporting mandated NAIS by many stakeholders we also often heard concerns that related to non-adopters gaining at the expense of adopters of the technology. From an animal health management perspective someone who does not adopt the technology gains from those who do by the overall animal herd health being improved. Thus, individual producers that believe others will adopt have less incentive themselves to adopt. In economics this is referred to as a 'free rider' problem meaning that adopters essentially subsidize non-adopters. Industry ID management systems such as compartmentalization (discussed in Section 12) can negate much of the 'free rider' problem. There is some sentiment that there might a significant public value of animal ID that justify public support for such programs as adoption rates might be lower than desired without such support.

13.12 First breach of confidentiality will be disaster

The issue of confidentiality of data and information collected in NAIS has long been a concern voiced by some industry participants (Bailey and Slade, 2004). Stakeholders told us that a breach of such confidentiality would be a disaster for development of NAIS. This concern was not unexpected, but speaks volumes to industry demand for confidentiality of NAIS data.

13.13 Technology needs to be error free

Operating at the speed of commerce and error free are commonly stated characteristics of an NAIS system that industry participants indicate will greatly affect adoption rates. Tonsor and Schroeder (2006) discussed how components of the Australian animal ID system required troubleshooting and solving problems as they occur. This is true of NAIS as well. However, the United States livestock industries operate with considerably more animal movement than many other countries resulting in lower tolerance for technology problems and reading errors by US industry participants. Bottom line, the technology needs to be as error free as possible. Related to this, many participants reiterated the need for one system, at least within a species, such that they did not have to work with and/or support multiple technologies.

13.14 Packers will benefit but do not pay the costs

Several industry participants voiced concern that with full animal ID and tracing adoption growers incur the major costs, but packers gain the major benefits. Our results indicate that indeed growers incur the largest share of NAIS adoption costs, especially in the beef sector (Section 4). However, as our economic analysis shows (Section 9), growers as well as packers gain if modest domestic beef demand and/or export demand enhancements occur from NAIS full animal ID and tracing adoption.

13.15 NAIS IS A GOOD THING FOR GLOBAL INDUSTRY

THE FEELING THAT NAIS IS NEEDED to ensure consumer confidence in our products was a widely, though not unanimously, held sentiment among stakeholders of all species and sectors.

14. Limitations

As with any such benefit-cost analysis of this scale and scope, the limitations of this study are too large in number to fully illuminate. However, several limitations of this project deserve elaboration.

14.1 Lack of data necessary for precise estimation

Estimating benefits and costs of adoption of NAIS is much like doing so for any new technology; many of the benefits and costs have to be estimated based on projections and assumptions made having less than ideal data. For example, our study relies on surveys of industry adoption rates of numerous management practices such as computer use and animal ID and other management practices that are often dated, subject to weaknesses of the survey methods used to collect primary data, and may not be representative of the entire industry. Furthermore, often data from different sources do not match up well and often data in the form needed simply do not exist. We tried to address this chronic shortcoming by using the most current and reliable published data available, supplementing public data with industry expert opinion, and where feasible and important to outcomes, performing sensitivity analyses.

Our study team's way of dealing with data uncertainty or unavailability in direct cost estimation was to generally err on the upper end of cost estimate range. As such, the NAIS adoption cost estimates in this study are more likely biased upward than being understated. As a result of data challenges present, it is difficult to assign precise statistical confidence levels to our overall estimates. Instead, our estimates represent a culmination of the best information we could collect given a large number of constraints using the most appropriate methods available to complete the analysis.

14.2 Benefit-cost estimates are based on current technology and prices

The analysis of benefits and costs of adoption of NAIS hinges heavily on current technology available to ID animals and record their movements. Over time the technology is improving and will continue to become cheaper as it is more fully adopted around the world and as additional refinements are made. Furthermore, the full benefits of NAIS have not been fully discovered as is typical of such new technology developments. There are likely benefits from such adoption that industry has not yet realized. For example, an improved animal identification and information system might enhance a beef cow/calf producer's ability to manage his cowherd (e.g., culling and genetic selection decisions) and thus lower costs of production. While benefits such as this will undoubtedly exist, they tend to be operation specific and are hard to predict and thus they have not been included in our analysis. As such, our benefit-cost analysis, even though completed with appropriate discounting and net present value analysis and annualizing methods, uses current values for benefit and cost parameterization. Likely these understate future benefits and overstate future costs.

14.3 Costs are *probable* and benefits are *potential*

One issue apparent from the start of this project was that quantifying direct costs of adopting animal ID systems was markedly different from determining benefits. Quantifying direct costs of adopting NAIS, though very involved and requiring many assumptions, judgments, and estimates is an exercise in evaluating highly probable outcomes. That is, costs of adoption reflect well-defined actions and investments that need to be made by industry participants if they elect to adopt NAIS practices.

In sharp contrast, most of the benefits of NAIS adoption are potential benefits that have some largely unknown probability of occurrence and/or are conditional on how industry participants elect to utilize NAIS

ID and tracing technology. Typically the probability of events that provide apparent benefits of having a widely adopted NAIS, is not known with any reasonable degree of certainty. For example, no one has a reliable estimate of any particular highly contagious foreign animal disease outbreak in the United States where having NAIS might greatly reduce costs of disease management and eradication. Even if we had an estimate of the probability of a disease outbreak, the epidemiology of disease spread is uncertain and can at best be simulated numerous times to obtain a distribution of possible outcomes. Furthermore, potential diseases and their probability of occurrence are dynamic. There are no reliable estimates of the type or frequency of natural disasters that might occur where having NAIS would substantially reduce adverse impacts. How market access will be affected by having a traceability system present and having regionalization and compartmentalization in the event of an industry crisis is subject to global trade policies and political relationships that often times, at best, lag scientific knowledge. In other words, while few would question the benefits of having NAIS in the event of a major disease outbreak, what is often debated is the probability of a major disease outbreak occurring.

Because of the challenge with estimating direct benefits, our study relied heavily upon scenario analyses that are not predictions, but reflect *what if* assessments using our best judgment to design relevant scenarios to help provide useful information for decision making. Anytime scenarios are relied upon, there are always going to be preferences for more and different scenarios to be presented. We selected what we felt were the most useful scenarios for making sound industry and public policy decisions. Certainly, more scenarios can be considered than what we present.

We also included a section in the report on other potential benefits (Section 12) specifically to highlight that many benefits of NAIS adoption are not explicitly estimated in our study. For example, our overall benefit-cost estimation ignores most private firm direct benefits NAIS adoption may provide including improved supply chain coordination, enhancing value-added opportunities, and enabling more intensive production management. As a result, overall benefit estimates associated with NAIS adoption quantified in our analysis are undoubtedly underestimated.

14.4 Synergism and substitution of NAIS adoption is largely ignored

NAIS adoption by one species affects benefits and costs of adoption in other species. For example, having individual animal ID and animal traceability in cattle, has a direct positive impact on the swine industry in the event of a contagious disease outbreak that crosses species. Such cross-species affects can have substantial economic impact when it comes to things such as market access. One way we address part of this species cross-over is through our equilibrium displacement model where beef, pork, poultry, and lamb markets are directly linked to, and affect, each other. However, our study does not fully address cross-species impacts with respect to disease management and eradication that could increase or reduce the net benefit of NAIS adoption in one species or another.

14.5 Lack pet and hobby data

Throughout our benefit-cost analysis the focus was on NAIS adoption in commercial agriculture with much less emphasis on individuals who have animals as pets or raise them for hobbies. We relied upon USDA NASS and Census data for the number of livestock operations by species when estimating costs and thus we do not account for livestock owners that do not meet the official classification of an operation. For example, we do not have specific data on club calves, sheep, or pigs; animals raised by youth for competition or show events; backyard poultry flocks; and many other small non-farm livestock or poultry caretakers. Though we do not have detailed data, the number of animals included in these segments is a very small proportion of the total industry, so excluding these animals is not a major omission in animal numbers. Some pet or hobby animals have very little cross-premises movement during their lifetimes, so premises registration might be sufficient to have information about animal locations for these operations. Thus, the omission of operations and animals of this type likely is not a critical issue impacting the benefit-cost analysis. However, animals that are involved in county and state fairs and other livestock shows, could have considerable animal movement and co-mingling. Largely omitting such animals (except in equine where we attempted to capture more of these) and individuals from our analysis is a weakness of our study. If reliable data existed on such individuals, we expect our overall industry costs of NAIS adoption would increase very little by their inclusion (because the animal numbers are very small relative to the population). However, benefits of having animal movement tracking for these animals might be a bit larger and a more important omission because of the amount of movement and co-mingling involved with some of these animals.

14.6 We assume the rest of the world is static

OUR BENEFIT-COST ANALYSIS IS SPECIFIC TO the United States. Our equilibrium displacement modeling exercise includes import and export equations, however, the model assumes nothing else in the rest of the world changes as we change NAIS adoption rates and run various scenarios. This is not realistic, but on the other hand, neither are any other assumptions of what specific global adjustments might occur outside of our model under various scenarios. This is simply the reality of any economic model. When we make an exogenous supply and/or demand shock and evaluate the outcome, we assume *ceteris paribus* (all else constant). Indeed, all else is never constant.

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16. Appendices

Appendix A3: Industry Association Representative Meetings

1. American Association of Meat Processors
2. National Renderers Association
3. Darling International
4. Seaboard Farms
5. Superior Lamb
6. Southwest Meat Association
7. Smithfield Beef
8. National Milk Producers Federation
9. National Livestock Producers Association
10. Livestock Marketing Association
11. Michigan Department of Agriculture
12. United Producers Inc. (Auction Network in Michigan)
13. Michigan cow/calf, feedlot, and dairy producers
14. National Meat Association
15. American Sheep Industry Association
16. American Meat Institute
17. National Cattlemen's Beef Association
18. United States Meat Export Federation
19. Meat and Livestock Australia
20. Canadian Cattle Identification Agency
21. APHIS Risk Analysis Team members
22. Pro Rodeo Cowboys Association
23. Meat and Livestock Australia
24. National Pork Board
25. National Pork Producers Association
26. Colorado State University Veterinary Hospital
27. American Horse Council
28. Destron Fearing
29. R-CALF U.S.A.
30. American Quarter Horse Association
31. National Bison Association

32. American Boer Goat Association
33. North American Elk Breeders Association
34. The Jockey Club
35. United States Equestrian Federation
36. Thoroughbred Owners and Breeders Association
37. Kentucky Department of Agriculture
38. American Association of Equine Practitioners
39. Penn State University – Animal & Dairy Science Department
40. National Horseman’s Benevolent and Protective Association
41. Kentucky Thoroughbred Association
42. Broseco Ranch
43. Agri Beef Company
44. APHIS
    a. Center for Emerging Issues
    b. National Surveillance Unit
    c. National Animal Health Monitoring System
45. Office of the Chief Information Officer
46. Policy and Program Development
47. National Center for Animal Health Programs
48. National Chicken Council
49. American Boer Goat Association
50. Kansas State University—Animal Sciences & Industry Department
51. Kansas State University—Clinical Sciences Department
52. California Department of Food and Agriculture
53. University of California-Davis, NAIS cost and benefit research team
54. Center for Animal Disease Modeling and Surveillance (CADMS), Univ. of California-Davis

Appendix A4: Bovine Cost Appendices

Appendix A4.1: Beef Cow/Calf Operations

Table A4.1.1 Number of Beef Cow/Calf Operations and Inventory and Production Levels by Size of Operation.

	Size of Operation, number of head						
	1-49	50-99	100-499	500-999	1000-1999	2000-4999	5,000+
Number of operations	585,050	94,490	72,855	4,180	980	290	55
Percent of operations currently tagging	35.1%	54.3%	61.0%	61.4%	61.4%	61.4%	61.4%
Average herd size, head	15.7	65.2	175.9	633.9	1,182.90	2,512.60	7,828.50
Bulls in herd, head (500+ lbs)	0.6	2.6	7	25.1	46.8	99.3	309.4
Calving rate, %	95.6%	95.6%	95.6%	95.6%	95.6%	95.6%	95.6%
Calving rate adjusted for twinning, %	94.3%	94.3%	94.3%	94.3%	94.3%	94.3%	94.3%
Calf death loss before 24 hours, %	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%
Calf death loss after 24 hours, %	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%
Replacements retained, %	15.1%	15.1%	15.1%	15.1%	15.1%	15.1%	15.1%
Replacement animals, head	2.4	9.8	26.6	95.7	178.6	379.3	1,181.80
Cow death (disappearance) loss, %	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%
Cull rate, %	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%
Cows culled, head	1.7	7.2	19.4	69.7	130.1	276.4	861.1
Bulls culled, head	0.2	0.6	1.7	6.3	11.7	24.8	77.4
Total animals sold, head	13.4	55.9	150.7	543.1	1,013.50	2,152.70	6,707.30
Calves born and alive at 24 hours, head	14.6	60.6	163.5	589.2	1,099.50	2,335.40	7,276.50
Calves dead after 24 hours, head	0.7	2.7	7.3	26.4	49.2	104.6	325.9
Total calves available for sale, head	13.9	57.9	156.2	562.8	1,050.2	2,230.8	6,950.5

Table A4.1.2 Tags and Tag Applicators per Cow/calf Operation by Size of Operation that Currently Tags Cattle.

	Size of Operation, number of head						
	1-49	50-99	100-499	500-999	1000-1999	2000-4999	5,000+
Number of calves to retag, head	0.3	1.4	3.9	14.1	26.3	55.8	173.8
Total cows and bulls tagged, head	0.4	1.7	4.6	16.5	30.7	65.3	203.4
Total tags purchased	15.3	63.7	172	619.7	1,156.50	2,456.50	7,653.70
Tag loss rate, %	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
RFID button tag cost, $/tag	$2.50	$2.30	$2.20	$2.00	$2.00	$2.00	$2.00
Total RFID tag cost, $/operation	$41	$155	$400	$1,312	$2,447	$5,199	$16,197
RFID tag applicator cost, $/unit	$11.83	$11.83	$11.83	$11.83	$11.83	$11.83	$11.83
Number of tag applicators	1	1	2	4	5	6	7
Years of RFID tag applicator	4	4	4	4	4	4	4
Annual cost of tag applicator, $/operation	$4	$4	$7	$14	$18	$21	$25

Table A4.1.3 Tags and Tag Applicators Required per Cow/calf Operation by Size of Operation Currently Not Tagging Cattle.

	Size of Operation, number of head						
	1-49	100-499	500-999	1000-1999	2000-4999	5,000+	5,000+
Number of calves to retag, head	0	0	0	0	0	0	0
Total cows and bulls tagged, head	0	0	0	0	0	0	0
Total tags purchased	13.4	55.9	150.7	543.1	1,013.50	2,152.70	6,707.30
Tag loss rate, %	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
RFID button tag cost, $/tag	$2.50	$2.30	$2.20	$2.00	$2.00	$2.00	$2.00
Total RFID tag cost, $/operation	$36	$136	$351	$1,149	$2,145	$4,556	$14,194
RFID tag applicator cost, $/unit	$11.83	$11.83	$11.83	$11.83	$11.83	$11.83	$11.83
Number of tag applicators	0	0	0	0	0	0	0
Years of RFID tag applicator	4	4	4	4	4	4	4
Annual cost of tag applicator, $/operation	$0	$0	$0	$0	$0	$0	$0

Table A4.1.4 Tagging-Related (Working) Costs per Cow/Calf Operation by Size of Operation that Currently Tags Cattle.

	Size of Operation, number of head						
	1-49	50-99	100-499	500-999	1000-1999	2000-4999	5,000+
RFID Tag Labor Cost							
Labor rate, $/hour	$9.80	$9.80	$9.80	$9.80	$9.80	$9.80	$9.80
Time to tag 2X / animal, seconds	30	30	30	30	30	30	30
Cost of tagging animal 2X, $/head	$0.08	$0.08	$0.08	$0.08	$0.08	$0.08	$0.08
Cost of tagging, $/operation	$1	$5	$14	$51	$95	$202	$629
Labor and Chute Costs							
Setup time for retag, hours	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Hours required to re-tag / sort	0.26	0.31	0.41	0.81	1.29	2.47	7.17
Number of employees	1	3	4	5	6	6	6
Labor cost to retag, $/operation	$3	$10	$17	$42	$81	$154	$446
Chute charge, $/head	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00
Total chute cost, $/operation	$1	$3	$9	$32	$60	$128	$399
Cattle Shrink Costs							
Average calf weight, lbs/head	524	524	524	524	524	524	524
Shrink, lbs/head	2	2	2	2	2	2	2
Average calf price, $/lb	$1.21	$1.21	$1.21	$1.21	$1.21	$1.21	$1.21
Percent of price to assign to shrink	25%	25%	25%	25%	25%	25%	25%
Average cow weight, lbs/head	1,274	1,274	1,274	1,274	1,274	1,274	1,274
Shrink, lbs/head	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Average cow price, $/lb	$0.48	$0.48	$0.48	$0.48	$0.48	$0.48	$0.48
Percent of price to assign to shrink	25%	25%	25%	25%	25%	25%	25%
Total shrink costs, $/operation	$1	$6	$15	$54	$100	$213	$663
Miscellaneous Costs							
Human injury, $/operation	$0	$1	$2	$6	$12	$23	$70
Animal injury, $/operation	$0	$1	$1	$5	$9	$19	$60
Total Working Costs, $/operation	$7	$25	$58	$190	$357	$739	$2,268

Table A4.1.5 Tagging-Related (Working) Costs per Cow/Calf Operation by Size of Operation Currently Not Tagging Cattle.

	Size of Operation, number of head						
	1-49	100-499	500-999	1000-1999	2000-4999	5,000+	5,000+
RFID Tag Labor Cost							
Labor rate, $/hour	$9.80	$9.80	$9.80	$9.80	$9.80	$9.80	$9.80
Time to tag 2X / animal, seconds	0	0	0	0	0	0	0
Cost of tagging animal 2X, $/head	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Cost of tagging, $/operation	$0	$0	$0	$0	$0	$0	$0
Labor and Chute Costs							
Setup time for retag, hours	0	0	0	0	0	0	0
Hours required to re-tag / sort	0	0	0	0	0	0	0
Number of employees	0	0	0	0	0	0	0
Labor cost to retag, $/operation	$0	$0	$0	$0	$0	$0	$0
Chute charge, $/head	$2.54	$2.54	$2.54	$2.54	$2.54	$2.54	$2.54
Total chute cost, $/operation	$34	$142	$384	$1,382	$2,578	$5,477	$17,065
Cattle Shrink Costs							
Average calf weight, lbs/head	524	524	524	524	524	524	524
Shrink, lbs/head	2.62	2.62	2.62	2.62	2.62	2.62	2.62
Average calf price, $/lb	$1.21	$1.21	$1.21	$1.21	$1.21	$1.21	$1.21
Percent of price to assign to shrink	25%	25%	25%	25%	25%	25%	25%
Average cow weight, lbs/head	1,274	1,274	1,274	1,274	1,274	1,274	1,274
Shrink, lbs/head	2.75	2.75	2.75	2.75	2.75	2.75	2.75
Average cow price, $/lb	$0.48	$0.48	$0.48	$0.48	$0.48	$0.48	$0.48
Percent of price to assign to shrink	25%	25%	25%	25%	25%	25%	25%
Total shrink costs, $/operation	$10	$41	$109	$394	$735	$1,561	$4,863
Miscellaneous Costs							
Human injury, $/operation	$0	$0	$0	$0	$0	$0	$0
Animal injury, $/operation	$2	$9	$24	$86	$161	$343	$1,068
Total Working Costs, $/operation	$46	$192	$517	$1,862	$3,475	$7,381	$22,996

Table A4.1.6 Costs Associated with Reading Tags per Cow/Calf Operation by Size of Operation.

	Size of Operation, number of head						
	1-49	50-99	100-499	500-999	1000-1999	2000-4999	5,000+
Animals Bought and Number of Reads							
Average cattle bought	6	18	44	135	135	135	135
Animals sold through auction, %	69.60%	69.60%	69.60%	69.60%	69.60%	69.60%	69.60%
Non-auction cattle bought, head	1.8	5.5	13.3	41.2	41.2	41.2	41.2
Misread percentage	2.80%	2.80%	2.80%	2.80%	2.80%	2.80%	2.80%
Total reads of electronic tags	1.8	5.7	13.6	42.3	42.3	42.3	42.3
RFID System is:	Outsourced	Outsourced	Outsourced	Outsourced	Outsourced	Outsourced	Outsourced
RFID capital cost per read	$4.35	$1.96	$1.62	$1.14	$1.14	$1.14	$1.14
Labor/chute costs per read	$1.38	$0.47	$0.22	$0.17	$0.17	$0.17	$0.17
Shrink/injury cost per read	$0.22	$0.08	$0.04	$0.02	$0.02	$0.02	$0.02
Total RFID cost, $/read	$5.95	$2.51	$1.88	$1.33	$1.33	$1.33	$1.33
Total RFID cost, $/operation	$11	$14	$26	$56	$56	$56	$56

Appendix A4.2: Dairy Operations

Table A4.2.1 Number of Dairy Operations and Inventory and Production Levels by Size of Operation.

	Size of Operation, number of head						
	1-49	50-99	100-199	200-499	500-999	1,000-1,999	2000+
Number of operations	33,435	20,980	9,325	4,555	1,700	920	595
Percent of operations currently tagging	86.50%	86.50%	86.50%	86.50%	86.50%	86.50%	86.50%
Average herd size, head	20.3	67.2	131.6	299.6	673.4	1,323.90	3,555.50
Bulls in herd, 500+ 17, Dairy 9	0.2	0.7	1.4	3.2	7.3	14.3	38.3
Calves per cow, %	92.50%	92.50%	90.10%	90.10%	86.30%	86.30%	86.30%
Calving rate adjusted for twinning, %	89.50%	89.50%	87.20%	87.20%	83.50%	83.50%	83.50%
Calf death loss before 48 hours, %	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%
Calf death loss after 48 hours, %	8.30%	8.30%	9.20%	9.20%	6.50%	6.50%	6.50%
Replacements retained, %	44.80%	44.80%	44.80%	44.80%	44.80%	44.80%	44.80%
Replacement animals, head	9.1	30.1	59	134.3	301.8	593.4	1,593.70
Cow death (disappearance) loss, %	4.80%	4.80%	5.80%	5.80%	6.10%	6.10%	6.10%
Cull rate, %	24.10%	24.10%	23.70%	23.70%	23.40%	23.40%	23.40%
Cows culled, head	4.9	16.2	31.2	71	157.6	309.8	832
Bulls culled, head	0.1	0.2	0.4	0.8	1.8	3.6	9.6
Total animals sold, head	11.8	39.2	72.5	165.1	363.1	714	1,917.40
Calves born and at 48 hours, head	18.1	60.2	114.8	261.2	562.3	1,105.50	2,968.80
Calves dead after 48 hours, head	1.6	5.3	11.3	25.7	39.1	76.9	206.4
Total calves available for sale, head	16	53	100	227.6	505.6	994	2,669.50

Table A4.2.2 Tags and Tag Applicators per Dairy Operation by Size of Operation that Currently Tags Cattle.

	Size of Operation, number of head						
	1-49	50-99	100-199	200-499	500-999	1,000-1,999	2000+
Number of calves to retag, head	0.4	1.3	2.5	5.7	12.6	24.9	66.7
Number of cows and bulls to retag, head	0.5	1.7	3.3	7.6	17	33.5	89.8
Total tags purchased	19.1	63.2	120.6	274.5	591.9	1,163.80	3,125.40
Tag loss rate, %	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
RFID button tag cost, $/tag	$2.50	$2.30	$2.20	$2.10	$2.00	$2.00	$2.00
Total RFID tag cost, $/operation	$51	$157	$286	$621	$1,276	$2,508	$6,735
RFID tag applicator cost, $/unit	$11.83	$11.83	$11.83	$11.83	$11.83	$11.83	$11.83
Number of tag applicators	1	1	2	3	4	5	6
Years of RFID tag applicator	4	4	4	4	4	4	4
Annual cost of tag applicator, $/operation	$4	$4	$7	$11	$14	$18	$21

Table A4.2.3 Tags and Tag Applicators Required per Dairy Operation by Size of Operation Currently Not Tagging Cattle.

	Size of Operation, number of head						
	1-49	50-99	100-199	200-499	500-999	1,000-1,999	2000+
Number of calves to retag, head	0	0	0	0	0	0	0
Number of cows and bulls to retag, head	0	0	0	0	0	0	0
Total tags purchased	11.8	39.2	72.5	165.1	363.1	714	1,917.40
Tag loss rate, %	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
RFID button tag cost, $/tag	$2.50	$2.40	$2.30	$2.20	$2.10	$2.00	$2.00
Total RFID tag cost, $/operation	$32	$101	$180	$391	$822	$1,539	$4,132
RFID tag applicator cost, $/unit	$11.83	$11.83	$11.83	$11.83	$11.83	$11.83	$11.83
Number of tag applicators	0	0	0	0	0	0	0
Years of RFID tag applicator	4	4	4	4	4	4	4
Annual cost of tag applicator, $/operation	$0	$0	$0	$0	$0	$0	$0

Table A4.2.4 Tagging-Related (Working) Costs per Dairy Operation by Size of Operation that Currently Tags Cattle.

	Size of Operation, number of head						
	1-49	50-99	100-199	200-499	500-999	1,000-1,999	2000+
RFID Tag Labor Cost							
Labor rate, $/hour	$9.80	$9.80	$9.80	$9.80	$9.80	$9.80	$9.80
Time to tag 2X / animal, seconds	30	30	30	30	30	30	30
Cost of tagging animal 2X, $/head	$0.08	$0.08	$0.08	$0.08	$0.08	$0.08	$0.08
Cost of tagging, $/operation	$2	$5	$10	$23	$49	$97	$261
Labor and Chute Costs							
Setup time for retag, hours	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Hours required to re-tag / sort	0.27	0.31	0.36	0.49	0.79	1.32	3.12
Number of employees	1	1	1	1	1	1	1
Labor cost to retag, $/operation	$3	$3	$4	$5	$8	$14	$33
Chute charge, $/head	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00
Total chute cost, $/operation	$1	$3	$6	$13	$30	$58	$157
Cattle Shrink Costs							
Average calf weight, lbs/head	524	524	524	524	524	524	524
Shrink, lbs/head	0	0	0	0	0	0	0
Average calf price, $/lb	$1.21	$1.21	$1.21	$1.21	$1.21	$1.21	$1.21
Percent of price to assign to shrink	25%	25%	25%	25%	25%	25%	25%
Average cow weight, lbs/head	1,274	1,274	1,274	1,274	1,274	1,274	1,274
Shrink, lbs/head	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Average cow price, $/lb	$0.45	$0.45	$0.45	$0.45	$0.45	$0.45	$0.45
Percent of price to assign to shrink	25%	25%	25%	25%	25%	25%	25%
Total shrink costs, $/operation	$0	$0	$1	$2	$5	$9	$25
Miscellaneous Costs							
Human injury, $/operation	$0	$1	$1	$2	$4	$7	$19
Animal injury, $/operation	$0	$0	$1	$2	$5	$9	$25
Total Working Costs, $/operation	$6	$13	$22	$48	$101	$195	$520

Table A4.2.5 Tagging-Related (Working) Costs per Dairy Operation by Size of Operation Currently Not Tagging Cattle.

	Size of Operation, number of head						
	1-49	50-99	100-199	200-499	500-999	1,000-1,999	2000+
RFID Tag Labor Cost							
Labor rate, $/hour	$9.80	$9.80	$9.80	$9.80	$9.80	$9.80	$9.80
Time to tag 2X / animal, seconds	0	0	0	0	0	0	0
Cost of tagging animal 2X, $/head	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Cost of tagging, $/operation	$0	$0	$0	$0	$0	$0	$0
Labor and Chute Costs							
Setup time for retag, hours	0	0	0	0	0	0	0
Hours required to re-tag / sort	0	0	0	0	0	0	0
Number of employees	0	0	0	0	0	0	0
Labor cost to retag, $/operation	$0	$0	$0	$0	$0	$0	$0
Chute charge, $/head	$2.54	$2.54	$2.54	$2.54	$2.54	$2.54	$2.54
Total chute cost, $/operation	$30	$100	$185	$420	$924	$1,817	$4,878
Cattle Shrink Costs							
Average calf weight, lbs/head	524	524	524	524	524	524	524
Shrink, lbs/head	0	0	0	0	0	0	0
Average calf price, $/lb	$1.21	$1.21	$1.21	$1.21	$1.21	$1.21	$1.21
Percent of price to assign to shrink	25%	25%	25%	25%	25%	25%	25%
Average cow weight, lbs/head	1,274	1,274	1,274	1,274	1,274	1,274	1,274
Shrink, lbs/head	2.75	2.75	2.75	2.75	2.75	2.75	2.75
Average cow price, $/lb	$0.45	$0.45	$0.45	$0.45	$0.45	$0.45	$0.45
Percent of price to assign to shrink	25%	25%	25%	25%	25%	25%	25%
Total shrink costs, $/operation	$2	$5	$10	$22	$49	$97	$260
Miscellaneous Costs							
Human injury, $/operation	$0	$0	$0	$0	$0	$0	$0
Animal injury, $/operation	$2	$6	$12	$26	$58	$114	$305
Total Working Costs, $/operation	$34	$111	$206	$469	$1,031	$2,027	$5,444

Table A4.2.6 Costs Associated with Reading Tags per Dairy Operation by Size of Operation.

	Size of Operation, number of head						
	1-49	50-99	100-199	200-499	500-999	1,000-1,999	2000+
Animals Bought and Number of Reads							
Average cattle bought	3	10	19	44	134	264	710
Animals sold through auction, %	69.60%	69.60%	69.60%	69.60%	69.60%	69.60%	69.60%
Non-auction cattle bought, head	0.9	2.9	5.9	13.4	40.9	80.3	215.7
Misread percentage	2.80%	2.80%	2.80%	2.80%	2.80%	2.80%	2.80%
Total reads of electronic tags	23.8	78.9	154.7	352.2	802.9	1,578.60	4,239.50
RFID System is:	Outsourced	Outsourced	Outsourced	Outsourced	Owned	Owned	Owned
RFID capital cost per read	$1.26	$0.96	$0.90	$0.88	$0.64	$0.33	$0.13
Labor/chute costs per read	$0.26	$0.20	$0.14	$0.13	$0.12	$0.12	$0.12
Shrink/injury cost per read	$0.04	$0.03	$0.02	$0.02	$0.02	$0.02	$0.02
Total RFID cost, $/read	$1.57	$1.18	$1.05	$1.03	$0.78	$0.46	$0.26
Total RFID cost, $/operation	$37	$93	$163	$362	$622	$732	$1,106

Appendix A4.3: Backgrounding Operations

Table A4.3.1 Number of Backgrounding Operations and Inventory and Production Levels by Size of Operation.

	Operation Size Category						
	1	2	3	4	5	6	7
Number of operations	21,438	11,334	6,333	4,333	3,329	2,316	1,787
Average animals purchased, head	30.5	103.7	345.3	496.4	722	1,452.60	2,963.30
Death loss, %	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%
Total calves available for sale, head	30.2	102.3	340.8	490	712.6	1,433.70	2,924.80

Table A4.3.2 Tags and Tag Applicators Required per Backgrounding Operation by Size of Operation

	Operation Size Category						
	1	2	3	4	5	6	7
Average animals purchased, head	30.5	103.7	345.3	496.4	722	1,452.60	2,963.30
Tag loss rate, %	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Number of calves to retag, head	0.8	2.6	8.5	12.2	17.8	35.8	73.1
Total tags purchased	0.8	2.6	8.5	12.2	17.8	35.8	73.1
RFID button tag cost, $/tag	$2.50	$2.50	$2.50	$2.50	$2.50	$2.40	$2.30
Total RFID tag cost, $/operation	$5	$13	$28	$38	$55	$98	$184
RFID tag applicator cost, $/unit	$11.83	$11.83	$11.83	$11.83	$11.83	$11.83	$11.83
Number of tag applicators	1	2	2	2	3	3	3
Years of RFID tag applicator	4	4	4	4	4	4	4
Annual cost of tag applicator, $/operation	$3	$6	$6	$6	$9	$9	$9

Table A4.3.3 Tagging-Related (Working) Costs per Backgrounding Operation by Size of Operation.

	Operation Size Category						
	1	2	3	4	5	6	7
RFID Tag Labor Cost							
Labor rate, $/hour	$9.80	$9.80	$9.80	$9.80	$9.80	$9.80	$9.80
Labor and Chute Costs							
Setup time for retag, hours	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Hours required to re-tag / sort	0.26	0.3	0.41	0.47	0.58	0.91	1.59
Number of employees	2	2	2	3	3	3	4
Labor cost to retag, $/operation	$5	$6	$8	$14	$17	$27	$62
Chute charge, $/head	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00
Total chute cost, $/operation	$1	$3	$9	$12	$18	$36	$73
Cattle Shrink Costs							
Average calf weight, lbs/head	700	700	700	700	700	700	700
Shrink, lbs/head	2.75	2.75	2.75	2.75	2.75	2.75	2.75
Average calf price, $/lb	$1.09	$1.09	$1.09	$1.09	$1.09	$1.09	$1.09
Percent of price to assign to shrink	25%	25%	25%	25%	25%	25%	25%
Total shrink costs, $/operation	$1	$2	$6	$9	$13	$27	$55
Miscellaneous Costs							
Human injury, $/operation	$0	$0	$1	$1	$1	$2	$4
Animal injury, $/operation	$0	$0	$1	$2	$3	$6	$12
Total Working Costs, $/operation	$7	$11	$25	$38	$52	$97	$206

Table A4.2.4 Costs Associated with Reading Tags per Backgrounding Operation by Size of Operation.

	Operation Size Category						
	1	2	3	4	5	6	7
Animals Bought and Number of Reads							
Average cattle bought	30.5	103.7	345.3	496.4	722	1,452.60	2,963.30
Animals sold through auction, %	69.60%	69.60%	69.60%	69.60%	69.60%	69.60%	69.60%
Non-auction cattle bought, head	9.3	31.5	105	150.9	219.5	441.6	900.8
Misread percentage	2.80%	2.80%	2.80%	2.80%	2.80%	2.80%	2.80%
Total reads of electronic tags	10.7	36.4	121.4	174.5	253.8	510.6	1,041.50
RFID System is:	Outsourced	Outsourced	Outsourced	Outsourced	Outsourced	Outsourced	Owned
RFID capital cost per read	$1.61	$1.13	$0.99	$0.97	$0.95	$0.93	$0.84
Labor/chute costs per read	$0.22	$0.23	$0.25	$0.24	$0.29	$0.28	$0.29
Shrink/injury cost per read	$0.24	$0.23	$0.22	$0.22	$0.22	$0.22	$0.22
Total RFID cost, $/read	$2.07	$1.59	$1.47	$1.43	$1.46	$1.44	$1.35
Total RFID cost, $/operation	$22	$58	$178	$249	$371	$736	$1,407

Table A4.3.1 Number of Feedlot Operations and Inventory and Production Levels by Size of Operation.

	Size of Operation, feedlot capacity (head)								
	1-999	1000-1999	2000-3999	4000-7999	8000-15999	16000-23999	24000-31999	32000-49999	50000+
Number of operations	85,000	809	564	343	182	78	55	71	58
Fed cattle marketings, head	43.5	964.2	2,473.40	5,755.10	13,928.60	27,769.20	42,345.50	61,633.80	118,982.80
Disappearance, %	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%
Estimated placements, head	44.9	994	2,549.90	5,933.10	14,359.40	28,628.10	43,655.10	63,540.00	122,662.60
Death loss, %	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%
Total fed cattle marketed, head	44.3	981.1	2,516.80	5,856.00	14,172.70	28,255.90	43,087.60	62,714.00	121,068.00

Table A4.3.2 Tags and Tag Applicators Required per Feedlot Operation by Size of Operation.

	Size of Operation, feedlot capacity (head)								
	1-999	1000-1999	2000-3999	4000-7999	8000-15999	16000-23999	24000-31999	32000-49999	50000+
Estimated placements, head	44.9	994	2,549.90	5,933.10	14,359.40	28,628.10	43,655.10	63,540.00	122,662.60
Tag loss rate, %	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Number of calves to retag, head	1.1	24.5	62.9	146.4	354.3	706.4	1,077.20	1,567.80	3,026.70
Total tags purchased	1.1	24.5	62.9	146.4	354.3	706.4	1,077.20	1,567.80	3,026.70
RFID button tag cost, $/tag	$2.50	$2.50	$2.30	$2.20	$2.10	$2.00	$2.00	$2.00	$2.00
Total RFID tag cost, $/operation	$6	$73	$165	$349	$788	$1,482	$2,253	$3,272	$6,303
RFID tag applicator cost, $/unit	$11.83	$11.83	$11.83	$11.83	$11.83	$11.83	$11.83	$11.83	$11.83
Number of tag applicators	1	3	5	5	5	5	5	5	5
Years of RFID tag applicator	4	4	4	4	4	4	4	4	4
Annual cost of tag applicator, $/operation	$3	$9	$15	$15	$15	$15	$15	$15	$15

Table A4.3.3 Tagging-Related (Working) Costs per Feedlot Operation by Size of Operation.

	Size of Operation, feedlot capacity (head)								
	1-999	1000-1999	2000-3999	4000-7999	8000-15999	16000-23999	24000-31999	32000-49999	50000+
RFID Tag Labor Cost									
Labor rate, $/hour	$9.80	$9.80	$9.80	$9.80	$9.80	$9.80	$9.80	$9.80	$9.80
Labor and Chute Costs									
Setup time for retag, hours	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Hours required to re-tag / sort	0.27	0.7	1.4	2.93	6.75	13.2	20	28.99	55.74
Number of employees	3	3	4	5	6	6	6	6	6
Labor cost to retag, $/operation	$8	$21	$55	$144	$397	$776	$1,176	$1,705	$3,277
Chute charge, $/head	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00
Total chute cost, $/operation	$1	$25	$63	$146	$354	$706	$1,077	$1,568	$3,027
Cattle Shrink Costs									
Average calf weight, lbs/head	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Shrink, lbs/head	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25
Average calf price, $/lb	$0.95	$0.95	$0.95	$0.95	$0.95	$0.95	$0.95	$0.95	$0.95
Percent of price to assign to shrink	25%	25%	25%	25%	25%	25%	25%	25%	25%
Total shrink costs, $/operation	$1	$19	$49	$113	$275	$547	$835	$1,215	$2,345
Miscellaneous Costs									
Human injury, $/operation	$1	$1	$4	$10	$26	$52	$78	$113	$218
Animal injury, $/operation	$0	$4	$10	$23	$56	$112	$172	$250	$482
Total Working Costs, $/operation	$11	$69	$180	$436	$1,108	$2,194	$3,338	$4,851	$9,349

Table A4.3.4 Costs Associated with Reading Tags per Feedlot Operation by Size of Operation.

	Size of Operation, feedlot capacity (head)								
	1-999	1000-1999	2000-3999	4000-7999	8000-15999	16000-23999	24000-31999	32000-49999	50000+
Animals Bought and Number of Reads									
Average cattle bought	44.9	994	2,549.9	5,933.1	14,359.4	28,628.1	43,655.1	63,540.0	122,662.6
Animals sold through auction, %	69.60%	69.60%	69.60%	69.60%	69.60%	69.60%	69.60%	69.60%	69.60%
Non-auction cattle bought, head	13.6	302.2	775.2	1,803.7	4,365.2	8,702.9	13,271.2	19,316.2	37,289.4
Misread percentage	2.80%	2.80%	2.80%	2.80%	2.80%	2.80%	2.80%	2.80%	2.80%
Total reads of electronic tags	15.8	349.4	896.2	2,085.3	4,678.0	9,326.5	14,222.0	20,700.1	39,961.1
RFID System is:	Outsourced	Outsourced	Outsourced	Owned	Owned	Owned	Owned	Owned	Owned
RFID capital cost per read	$1.44	$0.95	$0.93	$0.46	$0.45	$0.27	$0.20	$0.17	$0.12
Labor/chute costs per read	$0.31	$0.35	$0.34	$0.34	$0.31	$0.31	$0.31	$0.30	$0.30
Shrink/injury cost per read	$0.26	$0.24	$0.24	$0.24	$0.15	$0.15	$0.15	$0.15	$0.15
Total RFID cost, $/read	$2.00	$1.53	$1.51	$1.04	$0.91	$0.73	$0.66	$0.62	$0.58
Total RFID cost, $/operation	$32	$534	$1,352	$2,163	$4,264	$6,764	$9,396	$12,880	$23,237

Appendices A8: Government Costs

Appendix A8.1: List of Individuals Contacted/Interviewed

List of Individuals Contacted/Interviewed:

Federal Government Personnel:

- Diana Darnell – USDA-APHIS (based in Milo, MI)
- Dr. Tom Flynn – DVM, USDA-APHIS
- Dr. Neil Hammerschmidt – USDA-APHIS
- Dr. Tom Kasari – USDA-APHIS
- Dr. David Morris – USDA-APHIS
- Randy Munger – DVM, USDA-APHIS (based in Fort Collins, CO)
- Dr. John Wiemers – USDA-APHIS

Individual State Contacts:

- Dr. Paul Anderson – Minnesota Board of Animal Health
- Matthew Ankney – Interagency Bovine TB Eradication Coordinator, Michigan Department of Agriculture
- Roberta Bailey – Accountant, Michigan Department of Agriculture
- Delores Clausen – Animal ID Coordinator, Iowa Department of Agriculture and Land Stewardship Animal Industry
- Linda Cope – Animal ID Integration Analyst, Idaho State Department of Agriculture
- Kenny Edgar – Animal ID Coordinator, Texas Animal Health Commission
- Dr. Charlie Hatcher – Animal ID Coordinator, Tennessee Department of Agriculture
- Dr. Dave Fly – New Mexico State Veterinarian, New Mexico Livestock Board
- Charles Gann – Animal ID Coordinator, Arkansas Livestock & Poultry Commission
- John Heller – Former Animal ID Coordinator, Colorado Department of Agriculture
- Kevin Kirk – Special Assistant to the Division Director, Michigan Department of Agriculture
- Brad Klaassen – Animal ID Coordinator, Oklahoma Department of Agriculture, Food, and Forestry
- Paul McGraw – DVM, Assistant State Veterinarian, Wisconsin Department of Agriculture, Trade, and Consumer Protection
- Doug Metcalf – Chief of Staff, Indiana Board of Animal Health

- Penny Page – Animal ID Coordinator, North Carolina Department of Agriculture
- Ted Radintz – Animal Health Response Outreach Coordinator, Minnesota Department of Agriculture
- Brian Rickard – Animal ID Coordinator, Kansas Animal Health Department
- Dr. Dan Robb – DVM, Michigan Department of Agriculture
- Ray Scheierl – State of Minnesota
- Victor Velez – California Department of Food and Agriculture

Appendix A8.2: Survey of Select Animal ID Coordinators

The following email message was sent on August 29th to animal ID coordinators/leaders in fourteen states (included in Appendix 8.1).

I have one more request for your IMMEDIATE attention to kindly make of you as I wrap up the national NAIS benefit/cost assessment.

Attached is a short, 8 question survey that I would like you to complete. I am using this as a follow-up to diverse discussions I have had over the past few months. This will help me get answers to some standardized questions and hence improve our analysis.

As in our phone discussions, I will not report individual results, or provide direct citations on comments; rather I will present summary statistics of the entire set of responses I receive. Please also provide any comments/background that you feel might be useful in interpreting your responses. Moreover, if you have specific values for each multiple-choice question, please provide them as well.

While I don't typically do this, I would like for you to respond to this by next Tuesday (September 2nd) if at all possible as I am required to submit my report by next Thursday. Accordingly, please complete it and return to me electronically I don't believe the survey will take much of your time.

Thanks again for your assistance and enjoy your weekend, Glynn

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Glynn T. Tonsor
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317-B Agriculture Hall
Michigan State University
East Lansing, MI 48824
Phone: 517-353-9848
Fax: 517-432-1800

The survey document contained the following set of questions:

PREMISES REGISTRATION QUESTIONS:

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1. *How many new applications for NAIS premises registration can your office typically process in one hour?*

a. *Please choose one of the following ranges that best encompasses your professional assessment:*
   i. *0-20*
   ii. *21-40*
   iii. *41-60*
   iv. *61-80*
   v. *81-100*
   vi. *101-120*
   vii. *Over 120*

2. *What is the frequency of premises registration applications that contain some sort of error or omission requiring follow-up investigations?*

For hard-copy applications

i. *0%-5% frequency*
ii. *6%-10% frequency*
iii. *11-15% frequency*
iv. *16-20% frequency*
v. *Over 20 %*

For internet-based applications

i. *0%-5% frequency*
ii. *6%-10% frequency*
iii. *11-15% frequency*
iv. *16-20% frequency*
v. *Over 20 %*

3. *What do you believe is the cost (including all costs of efforts related to soliciting new applications, processing applications, addressing application errors/omissions, etc.) of currently establishing new premises in your state?*

a. *Please choose one of the following ranges:*
i. *$0/premise - $15/premise*
ii. *$16/premise - $30/premise*

iii. $31/premise - $45/premise
iv. $46/premise - $60/premise
v. $61/premise - $75/premise
vi. $76/premise - $90/premise
vii. Over $90/premise

4. Assume tomorrow you were provided the necessary funds, with the intent of enhancing premises registration rates in your state, to conduct an extensive mass mailing effort to all known individuals within your state that have not yet registered their premises (but are suspected to have premises that ideally would be registered with NAIS). What do you believe would be overall response?
a. 0-10% of those contacted would register their premises
b. 11-20% of those contacted would register their premises
c. 21-30% of those contacted would register their premises
d. 31-40% of those contacted would register their premises
e. Over 40% of those contacted would register their premises

BUDGET QUESTIONS:

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5. Approximately what portion of the funds received in the USDA cooperative agreements your state has received to date were used primarily for registration activities?
a. Please choose one of the following ranges:
i. 0-20%
ii. 21%-40%
iii. 41%-60%
iv. 61%-80%
v. 81%-100%

6. Looking forward over the next three years, what portion of your state's NAIS related activities do you expect to be focused on premises registration?
a. Please choose one of the following ranges:
i. 0-20%
ii. 21%-40%
iii. 41%-60%
iv. 61%-80%
v. 81%-100%

USE OF NAIS INFORMATION:

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7. *If tomorrow a livestock disease was identified in your state, to what extent would you use information available to you through your state's current participation in the national NAIS system?*
   a. *Please choose the most appropriate response:*
      i. *Not at all, I would not use NAIS information*
      ii. *I would use NAIS information, but less than other in-state resources*
      iii. *I would use NAIS information more than other in-state resources*
      iv. *I would rely almost exclusively on NAIS information*

8. *Continuing with the prior question, if a livestock disease was identified in your state, how long do you believe it would currently take to notify all livestock producers operating within the following distances of the outbreak?*
   a. *WITHIN 15 miles:*
      i. *less than 1 hour*
      ii. *1-5 hours*
      iii. *6-12 hours*
      iv. *13-24 hours*
      v. *25-48 hours*
      vi. *49-96 hours*
      vii. *5-7 days*
      viii. *Over 1 week*

   b. *WITHIN 30 miles:*
      i. *less than 1 hour*
      ii. *1-5 hours*
      iii. *6-12 hours*
      iv. *13-24 hours*
      v. *25-48 hours*
      vi. *49-96 hours*
      vii. *5-7 days*
      viii. *Over 1 week*

Thanks again for your assistance in making this project more complete,

Glynn Tonsor

Appendices A9: Modeling Market Effects of Animal Identification

Appendix A9.1: Stochastic Equilibrium displacement models

Elasticity-based computable equilibria (equilibrium displacement models) or partial equilibria models are commonly used when assessing the effects and/or the costs of potential changes in economic policy or structure. Elasticity-based computable equilibria models are attractive in that they are obtained by simple manipulation or row operations of differential approximations to economic models and are accurate to the degree that the underlying system can be linearly approximated (Davis and Espinoza, 1998; Brester, Marsh, and Atwood, 2004).

In economic modeling, the system's actual parameters are usually unknown and must be estimated or assumed. Most studies use some combination of assumed, previously published, and/or statistically estimated shares and elasticities. In all cases, it should be recognized that uncertainty exists with respect to the model's actual parameters and, as a result, with respect to the policy effects derived using estimated parameters. Davis and Espinoza (1998) illustrate the importance of examining the sensitivity of changes in prices and quantities (as well as producer and consumer surplus) relative to variations in selected elasticity estimates. Also, as a practical matter, the amount of uncertainty with respect to model parameters may vary across parameters. For example, if a number of researchers and statistical methodologies have obtained similar estimates for a given elasticity, the degree of uncertainty with respect to the given elasticity will be less than for a parameter for which published estimates have varied widely across researchers and methodologies.

An additional complication in policy models is that subsets of the model's economic parameters are likely to be correlated, non-normally distributed, and possibly intractable. For example, elasticities of supply in a vertically structured model might be positively correlated and restricted to be positive, while own-demand elasticities might be positively correlated and restricted to be negative (Davis and Espinoza, 1998). Brester, Marsh, and Atwood (2004) use Monte Carlo simulations of an equilibrium displacement model in which elasticities among vertical demand and supply sectors are correlated.

As indicated below, if independent marginal distributions of a model's parameters can be approximated, Monte Carlo simulation techniques can be used to introduce correlation between marginal pseudo-samples from possibly widely divergent statistical families of distributions. However, in such cases, the common methods for generating correlated multivariate normal random variates are inappropriate if applied directly to the marginal pseudo-samples themselves.

We use a variant of the Iman-Conover (1982) process for generating correlated random variables. The Iman-Conover process is attractive in that marginal distributions can be simulated independently from most continuous distributions. Each of the independently generated marginal samples is then merely reordered to obtain a rank correlation similar to the desired correlation structure. The Iman-Conover process is straightforward and easy to implement in most common spreadsheets and statistical packages. The following examples were developed in "R"—a free public source statistical modeling software package.

We first demonstrate why traditional procedures for generating correlated multivariate normal random variates are inappropriate for a general set of marginal distributions. We then demonstrate the use of Iman-Conover procedures for introducing correlation while preserving all marginal pseudo-samples.

A9.1.1 Generating Multivariate Normal Pseudo-Samples

The most commonly used procedures for generating correlated multivariate normal samples exploit the fact that linear combinations of normal random variates are themselves normally distributed. Assume that an n by k multivariate normal "sample" Z_C with covariance matrix Σ is desired. A common procedure to generate such a sample matrix is to initially populate an n by k matrix Z_1 with randomly and independently generated normal (0,1) random variates. If the random variates in Z_1 are independently generated, the expected covariance matrix of Z_1 is a k by k identity matrix I_1. However, for finite samples the realized sample covariance matrix is computable as

$$\hat{\Sigma}_{Z_1} = Z_1' \left[\frac{1}{n-1} \left(I_n - \frac{1}{n} \underline{1}_n \underline{1}_n \right) \right] Z_1' \hat{C} Z_1 \qquad \text{(A9.1)}$$

and may not equal I_k. In the above expression, $\underline{1}_n$ is an n by 1 vector with each element equal to 1, and $\hat{C}$ is the sample covariance operator. Procedures similar to those presented in Greene (2003) can be used to easily demonstrate that $Y' \hat{C} Y$ is the sample covariance matrix of any corresponding sample matrix Y.

Before proceeding, we apply an Iman-Conover “whitening” process by factoring $\hat{\Sigma}_{Z_1} = U'U$ using a Cholesky or similar factorization algorithm. If Z_1 was generated randomly, the matrix U will be nonsingular and a “whitened” sample matrix Z_W can be constructed as $Z_W = Z_1 U^{-1}$. Because the columns of Z_W are linear combinations of the columns of Z_1, the n by k sample Z_W will be multivariate normal with sample covariance matrix:

$$\hat{\Sigma}_{Z,W} = Z_W' \hat{C} Z_W = \left(U^{-1}\right)' Z_1' \hat{C} Z_1 U^{-1} = \left(U^{-1}\right)' \hat{\Sigma}_{Z_1} U^{-1} = \left(U'\right)^{-1} U' U U^{-1} = I_k . \qquad \text{(A9.2)}$$

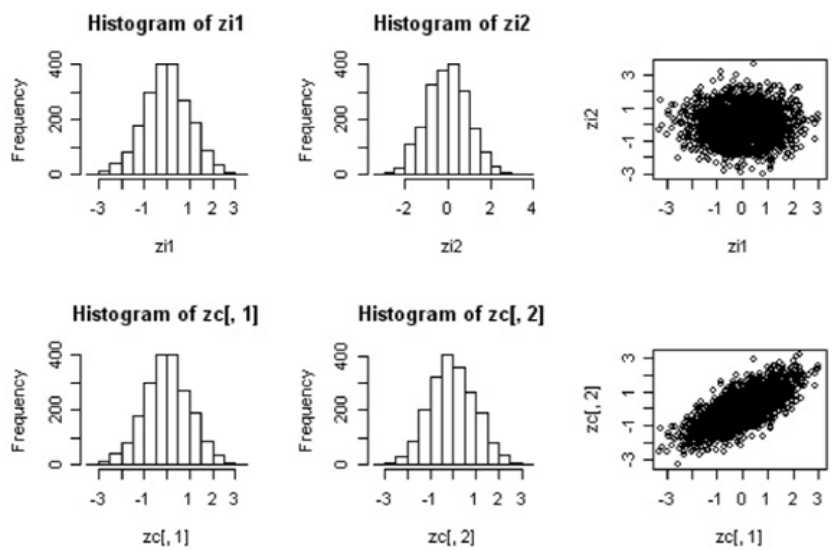
Obtaining a multivariate normal sample Z_C with sample covariance matrix Σ is accomplished by factoring $\Sigma = V' V$ and generating $Z_C = Z_W V$, which has sample covariance matrix:

$$\hat{\Sigma}_{Z_C} = Z_C' \hat{C} Z_C = V' Z_W' \hat{C} Z_W V = V' \hat{\Sigma}_{Z_W} = V'V = \Sigma . \qquad \text{(A9.3)}$$

Because each column of Z_C is generated as linear combinations of the columns of Z_W, the columns in Z_C are distributed multivariate normal while having a sample covariance equal to the desired covariance matrix Σ. The panels in figure A9.1 plot the results of applying the above process with 2,000 observations on two normal variates with a target correlation of 0.7. The top three panels are histograms and a joint scatter plot of the two independently generated normal (0,1) variates. The bottom three panels in Figure A9.1 present histograms and a joint scatter plot of the two marginals after the above transformations were applied. The resulting correlation between the two marginals is 0.7.

In the following discussion we return to the multivariate normal matrix Z_C because it is integral to the variant of the Iman-Conover procedure that we use. In the next section, we demonstrate why the above process for generating correlated random variables (taking linear combinations of independently generated marginals) is not appropriate when working with nonadditively regenerative marginal distributions.

Figure A9.1. Plots of Normally Random Variates Before and After Transformation



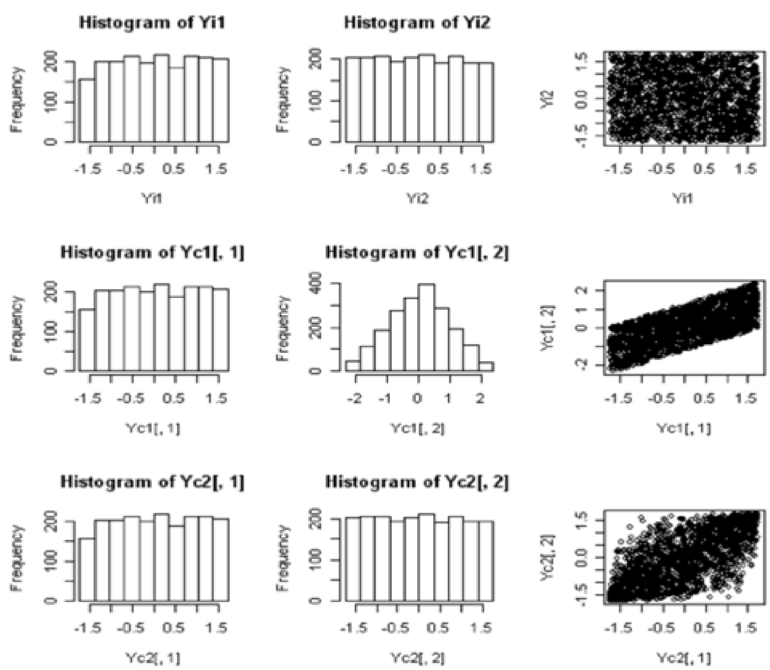
A.9.1.2 Linear Combinations of Nonregenerative Distributions

The top three panels in Figure A9.2 present histograms and a joint scatter plot from a 2,000 by 2 bivariate pseudo-sample Y_1 generated as two independent *uniform* $-\sqrt{3}, \sqrt{3}$ distributions with mean 0 and variance 1. The histograms and scatter plot of the marginal distributions indicate that the pseudo-samples appear to be uniformly and independently distributed over the $-\sqrt{3}, \sqrt{3}$ interval.

Assume that a correlated bivariate uniform distribution is desired with correlation 0.7. Because the uniform distribution is not additively regenerative, generating correlated variates using the Cholesky decomposition weighted-average procedure destroys the original marginal distributions. The middle three panels in Figure A9.2 demonstrate this result. With a bivariate distribution, the Cholesky decomposition transformation leaves the first marginal unchanged. However, the second variate is reconstructed as a linear combination of both the original marginal samples. The second histogram in the middle set of panels clearly shows that the resulting variate is not uniformly distributed although the correlation between the two transformed random variates is 0.7. The scatter plot of the joint observations is presented in the third panel of Figure A9.2.

The results of applying the Iman-Conover process to the uniform marginal samples are presented in the third panel of plots in Figure A9.2.[17]

Figure A-2. Results of Generating Correlated Uniform Random Variates



[17] As we indicate above, the Iman-Conover process can easily be implemented in Excel or other programming environments. Following is R code that can be used to compute the reordered correlated pseudo-sample. The user calls the function with the Y_I and SIGMA matrices. The function returns the correlated Y_C sample matrix.

```
ImanConover=function(yi,sigma) {
yc=yi
ydim=dim(yi)          # record the dimension of the YI matrix
zi=matrix(rnorm(ydim[1]*ydim[2]),ydim[1],ydim[2])   # populate the normal(0,1) ZI matrix
zc=(zi %*% (solve(chol(cov(zi)))) %*% (chol(sigma))  # create the correlated ZC matrix
for (j in 1:ncols) {
 ys=sort(yi[,j])
 yc[,j]=ys[rank(zc[,j])]              # create the correlated YC matrix
 }
yc
 }
```

Because the Iman-Conover process merely involves reordering the original marginal pseudo-sample, the process has clearly not affected the histograms of the marginal distributions. The Pearson correlation of the transformed variates for this example is about 0.695. The third plot in panel three is a scatter plot of the joint distribution after the reordering process.

The Iman-Conover process can easily be used to generate correlated random variables over a wide range of possible functional forms for the marginal distributions in an economic policy simulation model.

Appendix A9.2: Consumer/Producer surplus changes under various levels of Animal ID system adoption and demand Changes

Table A9.2.1. Producer and Consumer Surplus Changes from 30% Adoption of a Full Animal Identification/Tracing Program.

Surplus Measure	Short Run	Long Run	Cumulative	Cumulative Present Value	Cumulative Percent Of Total
	million dollars				
Producer Surplus					
Retail Beef	-9.91	-0.12	-134.03	-112.66	-0.038%
Wholesale Beef	-35.51	-0.62	-210.97	-178.39	-0.107%
Slaughter Cattle	-139.42	-1.73	-489.86	-423.79	-0.214%
Feeder Cattle	-143.55	-3.39	-478.26	-417.24	-0.264%
Total Beef Producer Surplus	-332.15	-5.84	-1,304.29	-1,115.00	-0.243%
Retail Pork	14.59	-0.05	36.65	33.06	0.028%
Wholesale Pork	3.28	-0.23	6.26	5.98	0.010%
Slaughter Hog	1.52	-0.47	-1.51	-0.47	-0.001%
Total Pork Producer Surplus	19.49	-0.75	41.00	38.63	0.016%
Retail Domestic Lamb	1.19	-0.01	1.18	1.25	0.032%
Wholesale Lamb	0.17	-0.01	-0.80	-0.56	-0.034%
Slaughter Lamb	-0.42	-0.06	-3.00	-2.40	-0.153%
Feeder Lamb	-2.67	-0.08	-9.80	-8.49	-0.485%
Total Lamb Producer Surplus	-1.73	-0.16	-12.25	-10.12	-0.112%
Retail Poultry	41.95	0.01	92.28	83.63	0.045%
Wholesale Poultry	30.18	-0.01	71.04	64.47	0.037%
Total Poultry Producer Surplus	72.05	0.00	161.94	146.66	0.041%
Total Meat Producer Surplus	-243.94	-6.80	-1,109.90	-947.86	-0.119%
Consumer Surplus					
Retail Beef	-136.70	-0.55	-409.41	-360.75	-0.112%
Retail Pork	3.33	-0.23	9.90	8.87	0.004%
Retail Domestic Lamb	-2.86	-0.02	-9.27	-8.13	-0.175%
Retail Imported Lamb	3.80	0.02	10.83	9.61	0.107%
Retail Poultry	-0.46	0.04	18.61	15.49	0.004%
Total Meat Consumer Surplus	-129.46	-0.76	-378.70	-336.18	-0.027%

Table A9.2.2. Producer and Consumer Surplus Changes from 50% Adoption of a Full Animal Identification/Tracing Program.

Surplus Measure	Short Run	Long Run	Cumulative	Cumulative Present Value	Cumulative Percent Of Total
	million dollars				
Producer Surplus					
Retail Beef	-19.00	-0.21	-242.15	-205.58	-0.069%
Wholesale Beef	-64.02	-1.09	-383.90	-326.55	-0.196%
Slaughter Cattle	-245.81	-3.04	-858.36	-745.70	-0.376%
Feeder Cattle	-253.96	-5.97	-843.38	-736.59	-0.466%
Total Beef Producer Surplus	-588.54	-10.28	-2,303.37	-1,967.53	-0.428%
Retail Pork	25.44	-0.08	63.81	57.33	0.048%
Wholesale Pork	5.71	-0.39	11.10	10.54	0.017%
Slaughter Hog	2.69	-0.80	-2.31	-0.53	-0.001%
Total Pork Producer Surplus	33.92	-1.27	72.10	67.63	0.028%
Retail Domestic Lamb	1.98	-0.01	2.01	2.10	0.053%
Wholesale Lamb	0.29	-0.02	-1.34	-0.93	-0.057%
Slaughter Lamb	-0.70	-0.09	-5.00	-4.01	-0.256%
Feeder Lamb	-4.45	-0.14	-16.31	-14.05	-0.809%
Total Lamb Producer Surplus	-2.85	-0.26	-20.40	-16.84	-0.187%
Retail Poultry	73.02	0.01	159.98	145.24	0.079%
Wholesale Poultry	52.30	-0.02	123.58	112.07	0.064%
Total Poultry Producer Surplus	125.39	-0.01	282.19	256.42	0.071%
Total Meat Producer Surplus	-434.81	-11.92	-1,968.97	-1,677.80	-0.212%
Consumer Surplus					
Retail Beef	-240.60	-0.97	-717.43	-636.20	-0.197%
Retail Pork	5.89	-0.39	17.47	15.79	0.008%
Retail Domestic Lamb	-4.76	-0.03	-15.42	-13.55	-0.292%
Retail Imported Lamb	6.36	0.03	18.12	16.13	0.180%
Retail Poultry	-1.10	0.07	31.55	26.15	0.006%
Total Meat Consumer Surplus	-227.89	-1.33	-658.96	-586.86	-0.048%

Table A9.2.3. Producer and Consumer Surplus Changes from 70% Adoption of a Full Animal Identification/Tracing Program.

Surplus Measure	Short Run	Long Run	Cumulative	Cumulative Present Value	Cumulative Percent Of Total
	million dollars				
Producer Surplus					
Retail Beef	-35.39	-0.34	-408.54	-346.87	-0.117%
Wholesale Beef	-105.18	-1.71	-630.50	-534.45	-0.326%
Slaughter Cattle	-396.21	-4.77	-1,373.30	-1,181.33	-0.603%
Feeder Cattle	-398.55	-9.70	-1,308.38	-1,159.81	-0.733%
Total Beef Producer Surplus	-940.97	-16.47	-3,702.95	-3,149.67	-0.691%
Retail Pork	39.44	-0.12	99.31	89.22	0.075%
Wholesale Pork	9.01	-0.56	18.33	17.21	0.028%
Slaughter Hog	4.34	-1.16	-1.87	0.57	0.001%
Total Pork Producer Surplus	53.18	-1.84	115.28	107.89	0.044%
Retail Domestic Lamb	2.83	-0.01	2.93	3.09	0.077%
Wholesale Lamb	0.41	-0.03	-1.86	-1.30	-0.080%
Slaughter Lamb	-0.97	-0.13	-7.00	-5.62	-0.357%
Feeder Lamb	-6.22	-0.20	-22.84	-19.68	-1.136%
Total Lamb Producer Surplus	-3.96	-0.37	-28.50	-23.41	-0.261%
Retail Poultry	112.90	0.02	245.51	223.17	0.121%
Wholesale Poultry	80.87	-0.03	190.52	174.04	0.098%
Total Poultry Producer Surplus	194.69	-0.01	438.73	398.11	0.110%
Total Meat Producer Surplus	-706.45	-18.81	-3,157.19	-2,704.56	-0.342%
Consumer Surplus					
Retail Beef	-384.34	-1.52	-1,146.63	-1,015.54	-0.313%
Retail Pork	9.72	-0.56	28.88	26.24	0.013%
Retail Domestic Lamb	-6.67	-0.05	-21.56	-18.96	-0.411%
Retail Imported Lamb	8.98	0.04	25.73	22.80	0.255%
Retail Poultry	-1.62	0.10	48.67	41.06	0.010%
Total Meat Consumer Surplus	-365.15	-2.04	-1,056.77	-936.05	-0.076%

Table A9.2.4. Producer and Consumer Surplus Changes from 50% Adoption of a Premises Registration Program.

Surplus Measure	Short Run	Long Run	Cumulative	Cumulative Present Value	Cumulative Percent Of Total
	million dollars				
Producer Surplus					
Retail Beef	2.22	0.01	6.28	5.61	0.002%
Wholesale Beef	0.29	0.00	1.12	0.97	0.001%
Slaughter Cattle	-0.40	0.00	-0.28	-0.24	0.000%
Feeder Cattle	-0.40	-0.03	-0.40	-0.34	0.000%
Total Beef Producer Surplus	1.58	-0.03	6.17	5.39	0.001%
Retail Pork	0.71	0.00	1.61	1.47	0.001%
Wholesale Pork	0.15	-0.02	0.17	0.18	0.000%
Slaughter Hog	0.05	-0.03	-0.28	-0.19	0.000%
Total Pork Producer Surplus	0.92	-0.05	1.45	1.41	0.001%
Retail Domestic Lamb	0.18	0.00	0.14	0.16	0.004%
Wholesale Lamb	0.03	0.00	-0.17	-0.12	-0.007%
Slaughter Lamb	-0.10	-0.01	-0.61	-0.50	-0.032%
Feeder Lamb	-0.46	-0.01	-1.72	-1.49	-0.085%
Total Lamb Producer Surplus	-0.34	-0.03	-2.35	-1.93	-0.021%
Retail Poultry	2.10	0.00	4.49	4.06	0.002%
Wholesale Poultry	1.55	0.00	3.38	3.08	0.002%
Total Poultry Producer Surplus	3.70	0.00	7.90	7.19	0.002%
Total Meat Producer Surplus	5.55	-0.11	12.97	11.91	0.001%
Consumer Surplus					
Retail Beef	-1.34	0.01	-1.91	-1.82	-0.001%
Retail Pork	0.10	-0.02	0.19	0.18	0.000%
Retail Domestic Lamb	-0.51	-0.01	-1.71	-1.50	-0.032%
Retail Imported Lamb	0.62	0.00	1.86	1.64	0.018%
Retail Poultry	-0.08	0.00	0.68	0.56	0.000%
Total Meat Consumer Surplus	-1.15	0.00	-0.83	-0.87	0.000%

Table A9.2.5. Producer and Consumer Surplus Changes from 50% Adoption of a Bookend Animal Identification Program.

Surplus Measure	Short Run	Long Run	Cumulative	Cumulative Present Value	Cumulative Percent Of Total
	million dollars				
Producer Surplus					
Retail Beef	-19.99	-0.18	-205.37	-172.81	-0.058%
Wholesale Beef	-52.22	-0.84	-301.62	-252.85	-0.152%
Slaughter Cattle	-195.84	-2.24	-678.74	-590.99	-0.297%
Feeder Cattle	-186.17	-5.00	-622.94	-545.99	-0.345%
Total Beef Producer Surplus	-458.30	-8.24	-1,785.11	-1,525.54	-0.334%
Retail Pork	19.86	-0.01	51.79	46.35	0.039%
Wholesale Pork	4.97	-0.09	13.32	12.04	0.019%
Slaughter Hog	3.16	-0.18	6.58	6.21	0.010%
Total Pork Producer Surplus	27.78	-0.28	72.07	65.44	0.027%
Retail Domestic Lamb	1.21	-0.01	1.31	1.37	0.034%
Wholesale Lamb	0.18	-0.01	-0.75	-0.54	-0.033%
Slaughter Lamb	-0.41	-0.05	-2.90	-2.34	-0.149%
Feeder Lamb	-2.56	-0.08	-9.44	-8.11	-0.465%
Total Lamb Producer Surplus	-1.59	-0.15	-11.66	-9.63	-0.107%
Retail Poultry	64.22	0.01	126.70	115.24	0.063%
Wholesale Poultry	35.84	0.01	86.62	78.42	0.044%
Total Poultry Producer Surplus	100.56	0.02	213.67	193.17	0.054%
Total Meat Producer Surplus	-335.18	-8.67	-1,512.80	-1,286.46	-0.164%
Consumer Surplus					
Retail Beef	-190.12	-0.76	-563.57	-499.46	-0.154%
Retail Pork	7.01	-0.07	23.46	20.52	0.010%
Retail Domestic Lamb	-2.76	-0.02	-8.97	-7.90	-0.169%
Retail Imported Lamb	3.81	0.02	10.81	9.56	0.107%
Retail Poultry	2.68	0.06	32.94	27.77	0.007%
Total Meat Consumer Surplus	-174.73	-0.77	-500.73	-443.70	-0.036%

Table A9.2.6. Producer and Consumer Surplus Changes from 50% Adoption of a Full Animal Identification/Tracing Program.

Surplus Measure	Short Run	Long Run	Cumulative	Cumulative Present Value	Cumulative Percent Of Total
	million dollars				
Producer Surplus					
Retail Beef	-19.00	-0.21	-242.15	-205.58	-0.069%
Wholesale Beef	-64.02	-1.09	-383.90	-326.55	-0.196%
Slaughter Cattle	-245.81	-3.04	-858.36	-745.70	-0.376%
Feeder Cattle	-253.96	-5.97	-843.38	-736.59	-0.466%
Total Beef Producer Surplus	-588.54	-10.28	-2,303.37	-1,967.53	-0.428%
Retail Pork	25.44	-0.08	63.81	57.33	0.048%
Wholesale Pork	5.71	-0.39	11.10	10.54	0.017%
Slaughter Hog	2.69	-0.80	-2.31	-0.53	-0.001%
Total Pork Producer Surplus	33.92	-1.27	72.10	67.63	0.028%
Retail Domestic Lamb	1.98	-0.01	2.01	2.10	0.053%
Wholesale Lamb	0.29	-0.02	-1.34	-0.93	-0.057%
Slaughter Lamb	-0.70	-0.09	-5.00	-4.01	-0.256%
Feeder Lamb	-4.45	-0.14	-16.31	-14.05	-0.809%
Total Lamb Producer Surplus	-2.85	-0.26	-20.40	-16.84	-0.187%
Retail Poultry	73.02	0.01	159.98	145.24	0.079%
Wholesale Poultry	52.30	-0.02	123.58	112.07	0.064%
Total Poultry Producer Surplus	125.39	-0.01	282.19	256.42	0.071%
Total Meat Producer Surplus	-434.81	-11.92	-1,968.97	-1,677.80	-0.212%
Consumer Surplus					
Retail Beef	-240.60	-0.97	-717.43	-636.20	-0.197%
Retail Pork	5.89	-0.39	17.47	15.79	0.008%
Retail Domestic Lamb	-4.76	-0.03	-15.42	-13.55	-0.292%
Retail Imported Lamb	6.36	0.03	18.12	16.13	0.180%
Retail Poultry	-1.10	0.07	31.55	26.15	0.006%
Total Meat Consumer Surplus	-227.89	-1.33	-658.96	-586.86	-0.048%

Table A9.2.7. Producer and Consumer Surplus Changes from 30% Adoption of a Full Animal Identification/Tracing Program with a 7.92% Export Beef Demand Increase.

Surplus Measure	Short Run	Long Run	Cumulative	Cumulative Present Value	Cumulative Percent Of Total
	million dollars				
Producer Surplus					
Retail Beef	-30.20	2.93	-1.52	-17.31	-0.006%
Wholesale Beef	-68.74	12.24	30.92	0.03	0.000%
Slaughter Cattle	5.06	63.78	1,351.71	1,036.81	0.521%
Feeder Cattle	-45.69	39.45	734.71	549.05	0.348%
Total Beef Producer Surplus	-138.21	118.54	2,086.42	1,549.37	0.334%
Retail Pork	23.34	-0.34	34.11	32.91	0.027%
Wholesale Pork	5.80	-0.41	3.06	4.23	0.007%
Slaughter Hog	3.24	-0.58	-3.32	-1.45	-0.002%
Total Pork Producer Surplus	32.65	-1.34	34.33	35.80	0.015%
Retail Domestic Lamb	1.29	-0.01	1.20	1.26	0.032%
Wholesale Lamb	0.19	-0.01	-0.77	-0.54	-0.033%
Slaughter Lamb	-0.41	-0.06	-3.02	-2.43	-0.155%
Feeder Lamb	-2.67	-0.09	-9.87	-8.49	-0.486%
Total Lamb Producer Surplus	-1.62	-0.16	-12.29	-10.05	-0.112%
Retail Poultry	63.97	-0.09	99.25	92.60	0.051%
Wholesale Poultry	46.19	-0.12	74.36	69.73	0.040%
Total Poultry Producer Surplus	109.26	-0.21	175.31	164.63	0.046%
Total Meat Producer Surplus	3.81	116.86	2,324.13	1,759.07	0.220%
Consumer Surplus					
Retail Beef	-235.72	11.45	-287.45	-295.96	-0.089%
Retail Pork	6.99	-0.78	0.91	2.81	0.001%
Retail Domestic Lamb	-2.88	-0.02	-9.29	-8.15	-0.176%
Retail Imported Lamb	4.02	0.01	10.86	9.69	0.109%
Retail Poultry	0.73	-0.61	2.60	3.80	0.001%
Total Meat Consumer Surplus	-225.47	10.01	-274.69	-285.83	-0.023%

Table A9.2.8. Producer and Consumer Surplus Changes from 50% Adoption of a Full Animal Identification/Tracing Program with a 14.14% Export Beef Demand Increase.

Surplus Measure	Short Run	Long Run	Cumulative	Cumulative Present Value	Cumulative Percent Of Total
	million dollars				
<u>Producer Surplus</u>					
Retail Beef	-56.41	5.23	-10.36	-38.50	-0.012%
Wholesale Beef	-123.58	21.88	54.32	0.12	0.001%
Slaughter Cattle	11.83	114.15	2,433.58	1,859.36	0.931%
Feeder Cattle	-79.52	70.62	1,325.44	990.92	0.626%
Total Beef Producer Surplus	-245.90	212.12	3,762.88	2,811.65	0.598%
Retail Pork	41.02	-0.60	59.08	57.48	0.047%
Wholesale Pork	10.24	-0.71	5.36	7.50	0.012%
Slaughter Hog	5.79	-1.00	-5.54	-2.32	-0.004%
Total Pork Producer Surplus	57.41	-2.33	60.85	62.75	0.025%
Retail Domestic Lamb	2.17	-0.01	2.02	2.13	0.053%
Wholesale Lamb	0.31	-0.02	-1.29	-0.92	-0.056%
Slaughter Lamb	-0.69	-0.09	-5.04	-4.07	-0.259%
Feeder Lamb	-4.45	-0.14	-16.43	-14.17	-0.811%
Total Lamb Producer Surplus	-2.68	-0.27	-20.47	-16.74	-0.186%
Retail Poultry	112.46	-0.17	173.48	161.91	0.088%
Wholesale Poultry	80.92	-0.21	129.64	122.19	0.070%
Total Poultry Producer Surplus	192.30	-0.39	307.75	287.38	0.081%
<u>Total Meat Producer Surplus</u>	4.87	209.20	4,185.69	3,151.34	0.395%
<u>Consumer Surplus</u>					
Retail Beef	-417.47	20.45	-503.34	-518.74	-0.157%
Retail Pork	12.45	-1.38	1.78	5.17	0.002%
Retail Domestic Lamb	-4.80	-0.04	-15.49	-13.59	-0.294%
Retail Imported Lamb	6.77	0.01	18.29	16.22	0.182%
Retail Poultry	1.04	-1.09	3.07	5.67	0.001%
Total Meat Consumer Surplus	-399.53	17.90	-483.51	-502.26	-0.040%

Table A9.2.9. Producer and Consumer Surplus Changes from 70% Adoption of a Full Animal Identification/Tracing Program with a 22.95% Export Beef Demand Increase.

Surplus Measure	Short Run	Long Run	Cumulative	Cumulative Present Value	Cumulative Percent Of Total
	million dollars				
Producer Surplus					
Retail Beef	-97.64	8.49	-38.12	-77.89	-0.025%
Wholesale Beef	-203.37	35.60	85.73	0.00	0.003%
Slaughter Cattle	20.52	185.95	3,981.41	3,050.59	1.516%
Feeder Cattle	-118.11	114.85	2,199.96	1,653.58	1.035%
Total Beef Producer Surplus	-391.73	345.35	6,157.61	4,605.85	0.974%
Retail Pork	64.97	-0.96	93.07	90.04	0.074%
Wholesale Pork	16.35	-1.08	8.91	12.33	0.019%
Slaughter Hog	9.32	-1.49	-6.98	-2.37	-0.004%
Total Pork Producer Surplus	91.06	-3.53	97.66	100.29	0.041%
Retail Domestic Lamb	3.12	-0.02	2.93	3.07	0.077%
Wholesale Lamb	0.44	-0.03	-1.81	-1.29	-0.078%
Slaughter Lamb	-0.97	-0.13	-7.06	-5.71	-0.362%
Feeder Lamb	-6.22	-0.20	-22.97	-19.84	-1.140%
Total Lamb Producer Surplus	-3.66	-0.38	-28.47	-23.32	-0.260%
Retail Poultry	176.85	-0.27	269.25	253.43	0.138%
Wholesale Poultry	127.59	-0.34	201.14	190.73	0.108%
Total Poultry Producer Surplus	303.22	-0.63	474.72	450.05	0.125%
Total Meat Producer Surplus	0.13	340.96	6,839.39	5,137.32	0.645%
Consumer Surplus					
Retail Beef	-672.63	33.23	-797.74	-828.12	-0.251%
Retail Pork	20.49	-2.16	4.10	9.36	0.005%
Retail Domestic Lamb	-6.75	-0.06	-21.77	-19.06	-0.413%
Retail Imported Lamb	9.71	0.02	26.04	23.21	0.258%
Retail Poultry	1.74	-1.78	2.59	7.03	0.002%
Total Meat Consumer Surplus	-640.86	29.16	-769.58	-800.44	-0.063%

Table A9.2.10. Producer and Consumer Surplus Changes from 90% Adoption of a Full Animal Identification/Tracing Program with a 34.13% Export Beef Demand Increase.

Surplus Measure	Short Run	Long Run	Cumulative	Cumulative Present Value	Cumulative Percent Of Total
	million dollars				
Producer Surplus					
Retail Beef	-152.99	12.64	-63.64	-119.91	-0.040%
Wholesale Beef	-304.27	53.05	137.92	0.10	0.005%
Slaughter Cattle	52.38	277.81	6,008.17	4,620.69	2.267%
Feeder Cattle	-156.02	171.75	3,343.75	2,548.64	1.576%
Total Beef Producer Surplus	-550.50	515.97	9,356.81	6,972.44	1.491%
Retail Pork	93.73	-1.41	132.20	129.03	0.105%
Wholesale Pork	23.79	-1.52	13.07	18.23	0.029%
Slaughter Hog	13.78	-2.03	-8.09	-2.03	-0.003%
Total Pork Producer Surplus	132.09	-4.96	140.17	146.62	0.059%
Retail Domestic Lamb	4.28	-0.02	4.01	4.19	0.105%
Wholesale Lamb	0.59	-0.04	-2.45	-1.73	-0.106%
Slaughter Lamb	-1.30	-0.18	-9.54	-7.70	-0.489%
Feeder Lamb	-8.38	-0.27	-30.98	-26.75	-1.542%
Total Lamb Producer Surplus	-4.86	-0.51	-38.35	-31.43	-0.350%
Retail Poultry	254.64	-0.41	384.13	362.24	0.197%
Wholesale Poultry	183.07	-0.50	286.19	270.96	0.154%
Total Poultry Producer Surplus	437.48	-0.93	671.78	644.10	0.178%
Total Meat Producer Surplus	16.98	509.76	10,371.26	7,771.57	0.973%
Consumer Surplus					
Retail Beef	-978.47	49.47	-1,115.11	-1,179.58	-0.359%
Retail Pork	30.41	-3.11	7.55	14.68	0.007%
Retail Domestic Lamb	-9.12	-0.08	-29.34	-25.72	-0.558%
Retail Imported Lamb	13.22	0.02	35.39	31.56	0.350%
Retail Poultry	2.70	-2.66	1.23	7.55	0.002%
Total Meat Consumer Surplus	-931.59	43.51	-1,081.19	-1,110.45	-0.089%

Table A9.2.11. Producer and Consumer Surplus Changes from 30% Adoption of a Full Animal Identification/Tracing Program with a 0.24% Domestic Beef Demand Increase.

Surplus Measure	Short Run	Long Run	Cumulative	Cumulative Present Value	Cumulative Percent Of Total
	million dollars				
Producer Surplus					
Retail Beef	159.83	42.03	1,087.40	879.42	0.296%
Wholesale Beef	6.44	32.41	429.18	321.71	0.194%
Slaughter Cattle	-88.76	35.17	279.12	173.08	0.087%
Feeder Cattle	-110.18	20.40	43.21	0.25	0.000%
Total Beef Producer Surplus	-26.33	130.56	1,826.45	1,351.20	0.290%
Retail Pork	26.11	0.02	64.67	58.29	0.049%
Wholesale Pork	6.57	-0.18	14.46	13.44	0.021%
Slaughter Hog	3.76	-0.44	3.90	4.45	0.007%
Total Pork Producer Surplus	36.81	-0.61	84.14	76.84	0.031%
Retail Domestic Lamb	1.31	-0.01	1.44	1.46	0.037%
Wholesale Lamb	0.19	-0.01	-0.74	-0.52	-0.032%
Slaughter Lamb	-0.42	-0.06	-2.97	-2.40	-0.153%
Feeder Lamb	-2.67	-0.08	-9.79	-8.48	-0.484%
Total Lamb Producer Surplus	-1.60	-0.16	-11.98	-9.84	-0.110%
Retail Poultry	70.77	0.03	148.47	135.65	0.074%
Wholesale Poultry	51.17	0.02	115.56	105.71	0.060%
Total Poultry Producer Surplus	122.46	0.05	265.21	241.69	0.067%
Total Meat Producer Surplus	130.96	130.02	2,171.18	1,665.84	0.208%
Consumer Surplus					
Retail Beef	-18.30	165.56	1,226.25	889.04	0.275%
Retail Pork	8.25	-0.10	23.05	21.01	0.010%
Retail Domestic Lamb	-2.88	-0.02	-9.23	-8.13	-0.175%
Retail Imported Lamb	4.04	0.02	11.24	10.02	0.113%
Retail Poultry	1.17	0.21	35.25	29.46	0.007%
Total Meat Consumer Surplus	-5.66	165.65	1,305.55	945.88	0.078%

Table A9.2.12. Producer and Consumer Surplus Changes from 50% Adoption of a Full Animal Identification/Tracing Program with a 0.43% Domestic Beef Demand Increase.

Surplus Measure	Short Run	Long Run	Cumulative	Cumulative Present Value	Cumulative Percent Of Total
	million dollars				
Producer Surplus					
Retail Beef	279.48	74.19	1,911.99	1,541.71	0.519%
Wholesale Beef	10.54	57.22	753.83	563.08	0.340%
Slaughter Cattle	-156.52	62.09	495.30	305.53	0.153%
Feeder Cattle	-194.86	36.00	82.52	0.28	0.000%
Total Beef Producer Surplus	-49.65	230.48	3,214.25	2,380.94	0.509%
Retail Pork	45.77	0.05	113.69	102.36	0.085%
Wholesale Pork	11.48	-0.31	25.50	23.71	0.038%
Slaughter Hog	6.63	-0.75	7.18	8.07	0.013%
Total Pork Producer Surplus	64.71	-1.03	148.21	135.51	0.055%
Retail Domestic Lamb	2.21	-0.01	2.45	2.48	0.062%
Wholesale Lamb	0.31	-0.02	-1.24	-0.88	-0.053%
Slaughter Lamb	-0.69	-0.09	-4.97	-4.01	-0.255%
Feeder Lamb	-4.44	-0.14	-16.30	-14.12	-0.808%
Total Lamb Producer Surplus	-2.64	-0.26	-19.88	-16.36	-0.182%
Retail Poultry	123.63	0.06	259.81	237.56	0.129%
Wholesale Poultry	89.45	0.03	202.34	184.93	0.106%
Total Poultry Producer Surplus	214.64	0.09	464.69	422.48	0.118%
Total Meat Producer Surplus	227.14	229.58	3,823.71	2,931.10	0.366%
Consumer Surplus					
Retail Beef	-32.68	292.21	2,165.64	1,567.45	0.484%
Retail Pork	14.53	-0.16	41.07	37.15	0.018%
Retail Domestic Lamb	-4.81	-0.03	-15.40	-13.56	-0.292%
Retail Imported Lamb	6.78	0.03	18.96	16.88	0.189%
Retail Poultry	1.79	0.37	60.76	50.75	0.012%
Total Meat Consumer Surplus	-11.36	292.37	2,300.85	1,667.26	0.137%

Table A9.2.13. Producer and Consumer Surplus Changes from 70% Adoption of a Full Animal Identification/Tracing Program with a 0.67% Domestic Beef Demand Increase.

Surplus Measure	Short Run	Long Run	Cumulative	Cumulative Present Value	Cumulative Percent Of Total
	million dollars				
Producer Surplus					
Retail Beef	435.74	117.62	3,002.55	2,425.91	0.813%
Wholesale Beef	12.95	90.76	1,174.01	869.84	0.525%
Slaughter Cattle	-254.26	98.50	774.75	467.24	0.239%
Feeder Cattle	-306.89	56.79	139.24	2.93	0.002%
Total Beef Producer Surplus	-95.12	365.27	5,079.13	3,722.43	0.797%
Retail Pork	72.03	0.09	178.92	161.23	0.134%
Wholesale Pork	18.12	-0.44	41.22	38.24	0.061%
Slaughter Hog	10.54	-1.09	13.13	14.33	0.023%
Total Pork Producer Surplus	102.34	-1.46	237.68	216.00	0.087%
Retail Domestic Lamb	3.16	-0.01	3.62	3.63	0.091%
Wholesale Lamb	0.44	-0.03	-1.74	-1.21	-0.073%
Slaughter Lamb	-0.96	-0.13	-6.94	-5.61	-0.357%
Feeder Lamb	-6.21	-0.20	-22.89	-19.73	-1.136%
Total Lamb Producer Surplus	-3.60	-0.37	-27.59	-22.75	-0.253%
Retail Poultry	193.79	0.09	407.94	371.49	0.202%
Wholesale Poultry	139.65	0.05	317.04	288.96	0.165%
Total Poultry Producer Surplus	335.59	0.14	729.25	660.50	0.183%
Total Meat Producer Surplus	339.25	364.07	6,015.21	4,590.61	0.574%
Consumer Surplus					
Retail Beef	-58.00	463.28	3,412.97	2,466.01	0.758%
Retail Pork	23.35	-0.20	66.80	60.30	0.029%
Retail Domestic Lamb	-6.75	-0.05	-21.58	-19.01	-0.411%
Retail Imported Lamb	9.72	0.04	27.26	24.20	0.269%
Retail Poultry	2.81	0.57	95.13	79.52	0.019%
Total Meat Consumer Surplus	-26.98	463.55	3,628.72	2,618.28	0.216%

Table A9.2.14. Producer and Consumer Surplus Changes from 90% Adoption of a Full Animal Identification/Tracing Program with a 0.96% Domestic Beef Demand Increase.

Surplus Measure	Short Run	Long Run	Cumulative	Cumulative Present Value	Cumulative Percent Of Total
	million dollars				
Producer Surplus					
Retail Beef	616.55	167.83	4,250.25	3,429.40	1.148%
Wholesale Beef	15.95	129.52	1,661.31	1,235.50	0.746%
Slaughter Cattle	-369.21	140.54	1,102.82	667.72	0.335%
Feeder Cattle	-440.14	80.88	197.89	0.06	0.000%
Total Beef Producer Surplus	-150.22	521.09	7,226.74	5,284.86	1.126%
Retail Pork	102.79	0.15	255.37	229.25	0.191%
Wholesale Pork	25.92	-0.57	60.01	55.54	0.088%
Slaughter Hog	15.14	-1.44	20.56	21.72	0.035%
Total Pork Producer Surplus	146.34	-1.90	343.24	312.25	0.125%
Retail Domestic Lamb	4.32	-0.02	4.99	4.98	0.125%
Wholesale Lamb	0.59	-0.04	-2.38	-1.64	-0.100%
Slaughter Lamb	-1.30	-0.18	-9.37	-7.56	-0.482%
Feeder Lamb	-8.37	-0.27	-30.83	-26.58	-1.537%
Total Lamb Producer Surplus	-4.80	-0.50	-37.10	-30.46	-0.340%
Retail Poultry	275.25	0.13	577.44	526.37	0.287%
Wholesale Poultry	197.59	0.07	450.60	410.42	0.234%
Total Poultry Producer Surplus	475.87	0.20	1,034.46	938.56	0.259%
Total Meat Producer Surplus	469.28	519.52	8,564.25	6,516.81	0.811%
Consumer Surplus					
Retail Beef	-86.04	661.04	4,863.54	3,504.80	1.074%
Retail Pork	33.96	-0.22	97.99	88.16	0.042%
Retail Domestic Lamb	-9.12	-0.06	-29.12	-25.61	-0.556%
Retail Imported Lamb	13.25	0.05	37.00	32.88	0.365%
Retail Poultry	4.08	0.81	135.43	113.67	0.027%
Total Meat Consumer Surplus	-40.43	661.44	5,160.86	3,732.09	0.308%

Table A9.2.15. Producer and Consumer Surplus Changes in the Absence of an Animal Identification/Tracing Program and a 10% Permanent Loss of Beef Export Markets.

Surplus Measure	Short Run	Long Run	Cumulative	Cumulative Present Value	Cumulative Percent Of Total
	million dollars				
Producer Surplus					
Retail Beef	81.15	5.65	149.22	127.93	0.044%
Wholesale Beef	137.13	17.23	206.45	178.55	0.109%
Slaughter Cattle	-224.97	-49.52	-2,143.71	-1,741.23	-0.886%
Feeder Cattle	-107.97	-53.86	-1,517.87	-1,191.51	-0.757%
Total Beef Producer Surplus	-110.71	-80.59	-3,222.91	-2,561.19	-0.560%
Retail Pork	-8.96	0.20	-4.57	-5.96	-0.005%
Wholesale Pork	-3.06	0.13	-0.41	-1.13	-0.002%
Slaughter Hog	-1.91	0.13	0.52	-0.14	0.000%
Total Pork Producer Surplus	-14.25	0.47	-4.76	-7.40	-0.003%
Retail Domestic Lamb	-0.13	0.00	-0.10	-0.11	-0.003%
Wholesale Lamb	-0.01	0.00	0.00	-0.01	0.000%
Slaughter Lamb	-0.01	0.00	0.01	0.00	0.000%
Feeder Lamb	0.00	0.00	0.02	0.01	0.001%
Total Lamb Producer Surplus	-0.16	0.00	-0.08	-0.10	-0.001%
Retail Poultry	-33.70	0.08	-34.14	-33.36	-0.018%
Wholesale Poultry	-18.85	0.13	-13.56	-15.10	-0.008%
Total Poultry Producer Surplus	-52.98	0.22	-49.66	-49.82	-0.014%
Total Meat Producer Surplus	-182.00	-79.93	-3,290.08	-2,645.07	-0.336%
Consumer Surplus					
Retail Beef	127.74	-15.13	-95.66	-31.46	-0.010%
Retail Pork	-4.16	0.68	5.79	3.07	0.001%
Retail Domestic Lamb	0.03	0.00	0.09	0.07	0.002%
Retail Imported Lamb	-0.24	0.01	-0.13	-0.16	-0.002%
Retail Poultry	-1.31	0.82	16.69	11.54	0.003%
Total Meat Consumer Surplus	644.49	1,406.45	13,798.58	10,410.01	0.839%

Table A9.2.16. Producer and Consumer Surplus Changes in the Absence of an Animal Identification/Tracing Program and a 25% Permanent Loss of Beef Export Markets.

Surplus Measure	Short Run	Long Run	Cumulative	Cumulative Present Value	Cumulative Percent Of Total
	million dollars				
Producer Surplus					
Retail Beef	202.60	14.12	361.48	312.37	0.107%
Wholesale Beef	342.05	42.93	496.71	435.20	0.269%
Slaughter Cattle	-562.08	-123.66	-5,350.27	-4,344.00	-2.239%
Feeder Cattle	-269.85	-134.15	-3,710.58	-2,954.39	-1.895%
Total Beef Producer Surplus	-277.28	-200.91	-8,045.22	-6,391.45	-1.407%
Retail Pork	-22.41	0.49	-11.42	-14.89	-0.013%
Wholesale Pork	-7.65	0.31	-1.03	-2.83	-0.004%
Slaughter Hog	-4.77	0.33	1.29	-0.36	-0.001%
Total Pork Producer Surplus	-35.63	1.17	-11.88	-18.37	-0.008%
Retail Domestic Lamb	-0.33	0.00	-0.25	-0.27	-0.007%
Wholesale Lamb	-0.04	0.00	-0.01	-0.02	-0.001%
Slaughter Lamb	-0.01	0.00	0.02	0.01	0.001%
Feeder Lamb	-0.01	0.00	0.04	0.02	0.001%
Total Lamb Producer Surplus	-0.40	0.01	-0.20	-0.25	-0.003%
Retail Poultry	-84.24	0.19	-85.26	-83.36	-0.046%
Wholesale Poultry	-47.13	0.34	-33.90	-37.74	-0.021%
Total Poultry Producer Surplus	-132.45	0.55	-124.14	-124.43	-0.035%
Total Meat Producer Surplus	-455.09	-199.20	-8,212.58	-6,601.83	-0.843%
Consumer Surplus					
Retail Beef	319.68	-37.82	-229.16	-74.61	-0.023%
Retail Pork	-10.40	1.70	14.46	7.68	0.004%
Retail Domestic Lamb	0.08	0.01	0.22	0.18	0.004%
Retail Imported Lamb	-0.61	0.02	-0.32	-0.40	-0.004%
Retail Poultry	-3.29	2.05	41.73	28.84	0.007%
Total Meat Consumer Surplus	302.99	-34.02	-172.92	-44.58	-0.004%