PRODUCER LEVEL COST ANALYSIS OF THE U.S. NATIONAL ANIMAL IDENTIFICATION SYSTEM

by

CHRISTOPHER RAPHAEL CROSBY

B.S., Brigham Young University, 2004

A THESIS

Submitted in partial fulfillment of the requirements
for the degree

MASTER OF SCIENCE

Department of Agriculture Economics

College of Agriculture

KANSAS STATE UNIVERSITY

Manhattan, Kansas

2008

Approved by:

Major Professor
Dr. Kevin C. Dhuyvetter

Abstract

A Microsoft Excel based budget was developed to find the cost of becoming National Animal Identification Systems (NAIS) compliant in the U.S for beef cow-calf producers. This budget was turned into a stochastic budget by using different distributions for five key variables. From these distributions 10,000 observations were simulated using Latin Hypercube sampling.

From the comprehensive budget, a second, more simple budget was constructed for obtaining NAIS cost. This Microsoft Excel based model gives beef cow-calf producers an estimate and a prediction interval associated with the estimated cost of adopting a cattle ID system that is compliant with the National Animal Identification Systems quickly and conveniently, requiring only six inputs. Both the comprehensive and the quick budget are available online. An Ordinary Least Squares regression was estimated using the simulated observations to find marginal effects associated with key variables.

The driving factor of total cost per head was eID tag price for operations that tag and eID tag price and chute costs for non-tagging operations. For producers with five or less animals, it was cheaper to hire third parties to tag animals. From the sample data generated, smaller operations pay significantly more than larger operations on a per head basis, as the minimum cost was $2.08 for the larger operations and the maximum cost to small operations was $17.56. The estimated overall average cost per head for the cow/calf industry was $6.26, with a standard deviation of $4.12. Costs were on a per breeding female basis. The Excel spreadsheet budget and model can be downloaded at http://www.agmanager.info/ for producers who wish to estimate NAIS costs specific to their operations.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGMENTS

I would like to thank Dr. Kevin Dhuyvetter for his help with this study. He has taken time to teach me analytical skills, and has furthered my knowledge of spreadsheets and how to use them correctly. The NAIS budgets in this study come from a project that we worked together on and represents his time, opinions, and ideas. This project would not have been possible without his assistance.

I would like to thank Dr. Ted Schreoder and Dr. Jason Bergtold for their help with the statistics, stochastic modeling, and SAS. There knowledge is vast in this area of econometrics and they willingly took time to impart their knowledge. They were always willing to help regardless of what they were doing.

Finally, I would like to thank my family for the support offered through my college years and my wife who had to endure many nights ‘single’ while I was trying to complete my thesis.

CHAPTER 1 — INTRODUCTION

1.1 History of Animal Identification

Animal identification is not a new concept in the livestock industry, references to animal identification can be traced back 3,800 years. Alexandra the Great's horse had the image of an ox branded on its breast and croup, the ancient Romans would brand the names of the owner and breeder on their chariot racing horses, and seventh century China would ear mark or brand their postal service horses to identify their animals (Blancou, 2001).

In 1716, King Friedrich Wilhelm I instituted the first recorded national animal identification program by requiring all imported animals to be branded and the owner to have a dated document specifying the owner's name and origin of the animal. Shortly thereafter, the first known government mandated disease eradication program was instituted by the Council of the King of France. They mandated that any animal infected with rinderpest was to be branded with the letter M on a horn and then slaughtered immediately (Blancou, 2001).

Animal identification in the United States is as old as the country itself; however, it was not until the 1940's that the first U.S. government sponsored animal identification program was introduced to help eradicate brucellosis in cattle (Breiner, 2006; USDA, 2005). With the advent and acceptance of plastic ear tags, producers began in mass to individually identify animals on a herd level without government participation.

Ear tags are currently the most common individual cattle identification method in the U.S. (Disney et al., 2001). The use of the plastic ear tag has enabled production records to be kept, cows and calves to be identified, and culling decisions made easier. Hence, from producers adopting plastic ear tags, government and private sponsored animal identification programs have been instituted to manage disease and insure the quality of beef (WLIC, 2008a; Buskirk, 2006; Parish, 2006).

1.2 National Animal Identification System

In 2002, the National Institute for Animal Agriculture organized a steering committee, organized from leaders in the animal industry, to create the first standard animal ID plan for all U.S. producers (USDA, 2005). The following year, this group developed the U.S. Animal Identification Plan (USAIP), and after the first recorded case of Bovine Spongiform Encephalopathy (BSE) in the U.S. in 2003, the Secretary of Agriculture announced that it would hasten the implementation of the National Animal Identification System (NAIS), which is based on the concepts found in the USAIP.

The initial drafts of NAIS called for a mandatory program; however, the current draft calls for a strictly voluntary program (USDA, 2005; USDA 2007h). This voluntary program has four main goals: (i) respond rapidly (within 48 hours) to a disease outbreak, (ii) support ongoing eradication programs, (iii) protect U.S. exports, and (iv) protect U.S. market confidence (Breiner, 2006; Gray, 2004). The purpose of this program is perhaps best described as a system “designed for rapid tracing of animals during an outbreak situation, limiting the scope and expense of the outbreak, and allows the Animal Plant and Health and Inspection Services (APHIS) and its partners to minimize the impact on domestic and foreign markets” (USDA, 2005, pg. 5).

In June of 2004, NAIS reached a significant milestone by signing cooperative agreements with the state and tribal governments and, as a result, in 2005 premises registration was operational and available to all producers in every state and two territories. By 2006, cooperative agreements between NAIS and private/state animal tracking databases had been established, becoming operational in 2007 (WLIC, 2008b).

Veterinary Services, a program administered by APHIS, a division of the United States Department of Agriculture (USDA) oversees the NAIS program in conjunction with state and tribal governments.

1.3 Components of the NAIS

NAIS is comprised of three main components: premises registration, animal identification (AID), and animal tracking. While each component is necessary for NAIS to fulfill the purpose of its creation, producers may choose which components they will participate in due to the voluntary nature of the program, and are not required to participate in all three (USDA, 2007h).

1.3.1 Premises Registration

The premises registration process is administered at the state/tribe level. Thus, the required information on registration forms and the specifics of the registration process vary between states. However, the main purpose of the registration is to have the producer register their contact information along with the physical address and animal type(s) of their operation. This information allows the government to quickly notify the relevant producers in the event of a disease outbreak. Therefore, registration is important as the

USDA needs to be capable of timely disease notifications to producers in a localized geographical region to minimize possible negative impacts to their production. Proponents of a national ID program argue that this prevents the disease outbreak from reaching epidemic proportions (USDA, 2008d).

After the premises has been registered, the producer will receive a premises identification number (PIN) which is a seven digit alphanumeric number, and refers to the geographical area of the premises; hence, PINs are transferable to other people if the operation is sold or ownership transferred. Each PIN is associated with all animal identification numbers (AIN) on the premises thus creating a system in which animals can be traced. Producers who have more than one species on a premises will only need one PIN; however, multiple PINs may be obtained if a producer wishes to do so. Factors that would warrant multiple PINs include: different locations of permanent livestock structures, areas that are densely populated, animal movement between locations, geographic separation, and proximity to other livestock and operations (USDA, 2007h).

Premises registration is the keystone of the NAIS because it gives the USDA a starting point in the event a disease event happens; therefore, when an event occurs the U.S. government will spend days instead of weeks determining where a NAIS compliant animal has been and where the producers are located that need to be contacted. The goal is that the government should be able to accomplish these tasks within 48 hours when the whole NAIS system is running. At the very least, having a premises registered would allow the USDA to notify/quarantine/vaccinate the geographic areas where there is a problem, thus stopping the spread of the disease and protecting the export markets of non-affected producers (USDA, 2007h; USDA, 2008c).

1.3.2 Animal Identification

The second component in NAIS is animal identification. Animal identification can be done in a variety of ways as long as the device used has the AIN recorded electronically and/or visually on the device. The guidelines NAIS publishes for AID in the U.S. is technology neutral; however, different animal industries have adopted different types of NAIS compliant AID technologies—with most being electronic based (USDA, 2007h). For example, a horse owner may use a transponder that is injected into the neck, a cattle producer may use an ear tag that has a transponder inside the female button, and a swine producer may use an ear tag that has a bar code etched into it. These are all examples of NAIS compliant AIN devices used in the animal industry.

1.3.2.1 Animal Identification Number

Cattle producers who participate in NAIS will need to assign their animals a unique AIN by tagging them with an eID that is NAIS compliant. These tags can be purchased through many livestock supply stores and are readily available. The U.S. issues International Standards Organization (ISO) compliant AINs; therefore, the AINs start with 840, which is the U.S. country code. Following the country code are 12 numbers with a space between each group of three, which represents the unique animal number assigned to the device. The exception to this standard is the inclusion of all other official numbering systems (Bangs program, TB program, etc.) to ensure database compatibility with government programs currently operating. These official numbers will be grandfathered in and can be entered into approved databases.

When an AIN is submitted to an approved database, it will be associated with the owner's premises ID, thus allowing the traceback system to be functional. In the event that the animal is sold, it is vitally important that the buyer of the animal (and the premises of transaction if different from the sellers premises) does not remove or replace the AIN tag. Rather, the buyer should read and submit the AIN to an approved database of the producers choice, thus keeping the line of traceability unbroken (USDA, 2007h).

1.3.2.2 eID Tags

For cattle, the AIN tag is an electronic transponder that is encased in a two-piece (button) ear tag that can have a conventional (visual) tag attached onto the female portion of the button for management purposes. The mode in which the AIN is recorded is usually electronically; however, the eID tag should have the AIN imprinted on it so the AIN can be read visually. The eID tag is placed between the two cartilage ribs of the animal's left ear unless the ear is missing, then it may go into the right ear which is usually reserved for calf vaccination tattoos (Buskirk, 2006). Water and metal tend to attenuate the signal sent from the eID; therefore, it is important not to place the tag too close to the animal's head or have readers too close to metal objects as the readers may have trouble reading the eID tag consistently.

Information about the animal is not required by NAIS; therefore, the only information contained in the transponder is the AIN. The transponder inside the eID tags uses the radio frequency produced by the reader to "power up" and sends the AIN to the reader (Electro-Com, 2007). To be NAIS compliant, the tag must be a one-time use tag with the printing on the tag not easily changed or erased; the AIN and U.S. shield printed on the tag must be readable from 30 inches; and the tags must have a 99% retention rate (USDA, 2006a).

For animals that lose their eID tags or lose the functionality of their eID tag, producers are to replace the eID tag before the animal leaves the premises, and if possible, link the new AIN to the old AIN. In some cases, a new eID tag with the old AIN can replace the lost or malfunctioning eID tag; doing so when possible will help keep records linked to the correct information in the databases. Where these options are not possible, the producer at a minimum should make a record that the animal was re-identified (USDA, 2007h).

1.4 Animal Tracking

When the premises is registered and the animals identified using eID tags, the producer can proceed with the animal tracking component of NAIS. This component requires that any animal leaving or entering the premises have this movement information entered into a database along with the corresponding premises ID. This information allows the USDA to know where the animal has been, and other animals it has been in contact with, in the event the animal is suspected of carrying a disease.

To facilitate animal tracking at the speed of commerce, an electronic system can be employed to read and accumulate AINs after which they are recorded into a database. These systems are not necessary for producers who sell through an auction medium or for producers who do not bring large number of non-auction cattle onto their premises. For producers who introduce a small number of cattle onto their premises, they can read the AID number visually and then upload the information to the correct database.

1.4.1 Readers

Devices that emit a radio frequency (transceiver) and read eID tags electronically are conventionally called readers because they are able to energize the eID and decode or read the AIN sent from the eID tag back to the reader (Blasi et al, 2003). If readers are ISO compliant, they will read both half and full duplex eID tags. This information is then sent to a data accumulator where it will be stored until the memory is dumped into a database. Occasionally, a reader will not be ISO complaint in which case they might only read the eID tags they were designed for.

RFID readers can be classified into two categories: panel and wand. Panel readers are typically stationary and are used for high volume areas such as working alleys and auction yards as restraining is not necessary to employ these types of readers. They are more costly to purchase than wand readers and require a permanent location and shelter from the elements.

Wand readers are typically used because of their mobility, durability, and cost; however, the trade off is wand readers are not capable of reading eIDs at distances that panel readers are capable of. Therefore, the animal must be restrained before a wand reader can read the eID. These devices have a lower initial investment than panel systems, but they are not able to process the volumes of cattle that panel systems can, because wand readers can only read one restrained animal at a time. Both types of readers will usually interface with the data accumulator via a cord or wireless technology.

1.4.2 Data Accumulators

Data accumulators are any device that accumulates information sent by the reader(s). Scale heads, PDAs, laptop and desktop computers are all examples of accumulators currently being used. Some wand readers have memory capabilities and thus act as a data accumulator as well as a reader. The system requirements of accumulators are user/software dependent. Producers who wish to upload the AINs to an external database must choose an accumulator with the capabilities of connecting to the internet. Likewise, producers who wish to analyze the information collected "in house" must have a platform and software capable of doing so.

1.4.3 Animal Tracking Databases

The movement of animals and the records of premises are kept on private and state/tribal owned Animal Tracking Databases (ATD) with the information contained in the databases controlled by the private and state/tribal entity. The cost of the ATD service is company dependant; therefore, the cost of data storage can vary dramatically depending on the options and services of the database provider.

In order to be certified as an ATD, the company maintaining the database needs to (i) demonstrate that they maintain the data elements in accordance with NAIS specifications, (ii) sign an agreement with APHIS, and (iii) the database must be fully compliant and capable of providing information when requested (USDA, 2007h). As of May 9, 2008, 17 database companies met the first requirement. Out of the 17, 11 met the second requirement, and only five met all three requirements (USDA, 2008b). These systems are also required to be online 98% of the time to ensure rapid response to data inquiries.

The federal government maintains a portal that allows USDA officials to communicate with the ATDs when investigating an animal disease event. This portal system is under the control of the federal government and is called the Animal Trace Processing System (ATPS). The ATPS is available for state and federal use, but will only be used under the following circumstances: there is an indication of or confirmed foreign animal disease, an animal disease emergency as directed by the Secretary of Agriculture, or when there is a need to trace an animal involved with a program disease (USDA, 2007h; USDA, 2008a). Because the ATPS is a portal and not a database, it does not store any information; rather, it provides access to data held in private and state/tribal ATDs.

When the ATPS is used to access a database, only the PIN, AIN, date of the movement, and the type of movement (moved to another premises, bought, etc.) will be requested by the ATPS. With this information, the federal government will then decide on the action that should be taken (USDA, 2008a).

1.5 National Animal Identification System Adoption Reluctance

Adoption of NAIS has been slow as many people and organizations are actively opposing it (FTCLDF, 2008; Recipe for America, 2008). Reasons for this opposition are varied; some stemming from valid concerns while others come from misinformation and propaganda. The biggest concern of opponents to NAIS is the cost to implement the program (FTCLDF, 2008). While other social issues are also presented by opponents to NAIS, they are not discussed here.

Many producers recognize that the industry has functioned without NAIS for centuries in the U.S. and, therefore, they assume that NAIS is not needed and would add more expense for the producer (FTCLDF, 2008). While cynics might see it this way, there is no way of knowing what the welfare issues are because the cost and benefits of such a system are not yet known. While the current system of branding and ear tagging has worked quite well in the past, it has not been without cost. Before knowing if an alternative system might be better, one would have to know the costs and benefits of both systems. Only then could one decide whether the current system should be replaced by comparing which system has the lowest cost to society while keeping benefits in mind.

The next concern stemming from the cost of NAIS is the fact that economies of size/scale will make it more expensive for the small operator to comply. According to anti-NAIS activists, implementation of NAIS will stop small farm production (FTCLDF, 2008; LAC, 2007; Recipe for America, 2008). While it is likely that economies of size exist, it is strictly a gray matter exercise to discuss the cessation of small farm production stemming from an unknown cost differential. Before this legitimate concern can be substantiated, cost differences must be known, or at least estimated with a high degree of confidence.

The last concern that most anti-NAIS groups comment on is the cost per head. These sites routinely use misinformation unknowingly or, perhaps, purposely by stating a cost for implementing NAIS. Some sites report that it would cost as much as $37 per head to implement NAIS (FTCLDF, 2008); however, this is usually based on emotions and not a true cost analysis. For example, the RFID cost spreadsheet developed by Dhuyvetter and Blasi (2003) has been used inappropriately in some cases to substantiate claims. While this tool helps producers estimate the cost of implementing a RFID system that includes buying all the components needed for herd management, the estimated costs can be manipulated by using extreme values (e.g., high tag costs and one animal).

1.6 Objective

Voluntary participation in NAIS is strongly encouraged by the U.S. government, with Wisconsin making premises registration mandatory and Michigan requiring all cattle to be eID tagged when they leave the premises (Buskirk, 2006; Michigan RFID Education Task Force, 2008; WLIC, 2008a). However, even with encouragement from the federal and state governments to participate, producers do not have a tool that will allow them to calculate the economic costs of participation, allowing them to determine how the cost might impact their bottom line. Participation in NAIS will continue to be stagnant until producers can determine the benefits and costs of NAIS adoption for their individual operations. This study will only look at the cost side of NAIS as a first step; however, benefits are just as important and should be looked at in a future study.

The purpose of this study will be to identify NAIS adoption costs and provide two unique tools that producers can use to explore the costs of becoming NAIS compliant, thus alleviating misconceptions and helping producers make better informed decisions. This will be accomplished with the development of a Microsoft Excel worksheet that has two economic costing tools and will be made available at http://www.agmanager.info.

The first tool will be a Microsoft Excel spreadsheet that will allow NAIS adoption costs to be identified and will also allow producers to enter operation-level data to calculate the economic costs of NAIS compliance unique to their operations.

The second tool will also be in the form of an Excel spreadsheet, but will only require a few operation-level inputs that will be incorporated into a budget similar to the comprehensive budget. The difference between the two models is it will calculate or hold constant other important variables based on user inputs to find an estimate of NAIS compliant costs.

1.7 Overview

Chapter 2 reviews cost analyses, estimates from previous studies, and producer opinions. These studies range from a RFID cost worksheet to a foreign government study; each study provides a unique perspective on the complexity and costs of adopting a NAIS. After previous literature has been reviewed, the methods, and assumptions used to create the Excel based tools will be reviewed in Chapter 3. Chapter 4 will examine the formulation of the stochastic budget and the Ordinary Least Squares regression. Chapter 5 will discuss the empirical results of the budget, the regression, and will compare both Excel based tools. This study will conclude with Chapter 6, which will have concluding remarks and suggestions for future study.

.

CHAPTER 2 — REVIEW OF RELEVANT ARTICLES

2.1 Introduction

The purpose of this review was to ascertain what should and should not be included in an economic NAIS costing tool for individual producers. Published tools, studies, cost analyses, and producer groups are all valuable sources of information that are included in this review.

In 2007, the USDA awarded a NAIS study to Kansas State University to do a benefit-cost analysis of a voluntary NAIS for the U.S. livestock industry. Prior to this time, a government sanctioned estimate has not been completed and there is only one known study (Mus, 2006), and one known costing tool (Dhuyvetter and Blasi, 2003) devoted to RFID cost estimation for the U.S. livestock industry. Australia, who has a National Livestock Identification Scheme (NLIS) program similar to NAIS, had a cost analysis of their AID system published in 2004 (Alliance Consulting and Management, 2004) and is reviewed in this chapter. These three sources are reviewed first.

To supplement the relevant but small amount of information, Country of Origin Labeling (COOL) studies are also reviewed. COOL has been a topic of interest for the academic community, and as a result, there have been several attempts to identify and quantify the costs of COOL. These estimates vary considerably (Vansickle et al., 2003), and great care must be exercised when reviewing these studies as COOL legislation specifically does not allow a traceback system (Umberger, 2004). Consequently, COOL studies omit some relevant costs for a NAIS. However, COOL does require the recording of where animals were born, raised and processed; therefore, even though NAIS and COOL are not the same, the implications, considerations, and costs to cow/calf producers are comparable. Because of this, several COOL cost studies dealing with producer costs are reviewed next.

The final source of information reviewed came from producer groups. The producer groups reviewed are not in favor of a NLIS or NAIS system; as a result, their specific cost estimates appeared to be considerably overstated and thus will not be directly analyzed in this study. This is unfortunate because these groups represent producers that have the knowledge and understanding of the critical parts needed in a cost analysis. However, to capitalize on this knowledge, their letters and cost analyses are reviewed to see what costs producers feel should be considered in a NAIS cost analysis.

2.2 Kansas State University NAIS Study

In 2007, the USDA APHIS appointed Kansas State University to lead a study on the benefits and costs of a voluntary NAIS for the animal industry, which included experts from four universities. However, currently their report has not been published and has been temporarily sequestered by the USDA, and thus will not be reviewed. It is mentioned here to inform readers that this study should be forth coming.

2.3 RFID Costs–Dhuyvetter and Blasi

In 2003, Blasi et al. published "A Guide for Electronic Identification of Cattle". For this primer, Dhuyvetter and Blasi (2003) developed a Microsoft Excel spreadsheet tool to help producers identify what the approximate cost of adopting RFID technology would be based on their inputs. While their tool has been cited often (Mus, 2006; Resende-Filho and Buhr, 2006; Ishmael, 2003; RFID Journal, 2005), it has been misused on multiple occasions (Anti-NAIS; Pakko, 2007; Smith, 2006) to show the public the outlandish costs of a NAIS program in the U.S. This tool was developed to provide producers a means to estimate their operation-specific cost of an improved herd management eID system that was RFID based (Dhuyvetter and Blasi, 2003).

This spreadsheet tool requires the user to provide eight critical pieces of information: interest rate, eID cost, reader cost, accumulator cost, software costs, other costs (subscription, labor and internet outlays), useful life, salvage value and the percentage of the component cost that should be applied to the ID system.

The interest rate, investment life, initial investment, and salvage value are used to determine the annualized costs of the management system. The annualized cost is used instead of using a straight line, double declining, or accelerated depreciation methods to determine the cost of depreciation because the authors were interested in estimating economic depreciation as opposed to depreciation for tax purposes. The authors assumed that the entire component cost would be allocated incrementally over the useful life much like the straight-line depreciation method does; however, unlike straight-line depreciation, an interest rate was applied to the balance of the asset's remaining value to reflect the opportunity cost. Simply stated, if a producer required a loan to purchase the components, then the annualized costs would represent the components cost plus the interest outlay, or if the producer paid cash for the components, then it represents the opportunity costs associated with the purchase.

The eID tag cost is the single, most expensive annual cost in an eID system, and the authors split this into two categories: cows and calves. This distinction is necessary because the one-time costs of cow eID tags should be annualized over multiple periods, while calf tags should be annualized over a single period. Intuitively, this distinction is necessary because the life of the investment should match the periods the investment is being annualized over so the cost is not over or under stated.

The reader, accumulator, and software components are imperative to the producer who wants to improve their ID system as well as any producer who implements eID technology and introduces large amounts of purchased cattle to the premises. The reader transmits the unique AID number to the computer where software records and displays the information from the tag and any producer database-stored information tied to the tag number.

While ISO eID tags are required to have the AIN imprinted on the back of the button, not using the reader and computer to collect the data would be timely, tedious, and prone to error on large batches of animals.

The Other Costs category captures the cost of implementing and managing the eID tag system. The labor cost should reflect the cost of tagging and retagging animals on the premises along with the labor cost of reading, recording, and managing the electronic files. The software cost reflects the cost to the producer to purchase software that is compatible with the reader and accumulator so it can communicate with the data being sent to the computer by the reader. The internet cost reflects the cost of the internet for subscription and reporting services.

The useful life and salvage value are necessary to determine the annualized cost of a component. While the useful life of a component may sometimes be a guesstimate by the producer, without it annualizing costs would be impossible. The estimated salvage value is also important as the annualized cost would be inflated if a salvage value existed and was not accounted for.

The last producer input Dhuyvetter and Blasi included, that many people may overlook, is the component cost percent ascribed to an eID tag system. A good example of a component not being used for just one purpose would be a computer. Producers who need to buy a computer (to implement an eID tag system) may be tempted to allocate all of the costs to the eID tag system; however, in reality, the producer may use the computer for finances, their spouse may use it to check email and their kids may use it to do homework assignments. Clearly, the computer is not solely being used for an eID tag system in this example. Therefore, the percentage of the cost ascribed to an eID system should match the percentage of time it is used for that purpose. Doing otherwise would inflate the component cost and would not represent the true cost of the eID tag system.

Dhuyvetter and Blasi (2003) developed a powerful costing tool that is cited often. This model captures all of the large costs associated with eID and is in a format that is easy to use for producers and researchers alike. However, this model does not cover some of the smaller costs incurred when a NAIS is implemented; therefore, this study will use this model as a starting point and add to it to cover all NAIS costs, which will give a more complete cost estimate.

2.4 Traceability System Approaches and Cost Analysis for the Beef Industry

In his study, Mus (2006) assumed that an electronic transponder in the form of a passive RFID ear tag, an electronic reader, data accumulator, and software would be needed to institute a NAIS in the USA. Using this equipment, the RFID ear tag's unique AID number would be transmitted to an ATD. These data could be accessed at any stage to read and update the animal's information. His model, which mirrored Dhuyvetter and Blasi (2003), broke the cash outlay into two segments: operational cost and investments. This was done so that investment costs such as readers, computers, and software could be broken out of the total cost and analyzed separately.

For producers, the eID and conventional combination tag was assumed to average \$2.94 per tag, which was based on a single data point from www.cattlestore.com. The eID reader's life was assumed to last three years and the data accumulator and software costs were taken from Dhuyvetter and Blasi (2003) spreadsheet without any adjustment. A five percent discount rate was used to find the annualized costs. It was assumed that animals that were sold followed a generic selling pattern that flowed from the producer to the sale yard, then to backgrounders who sold the animals to feedlots, and from feedlots to the slaughter plant. It was assumed that all tags were placed at the premises of birth and no replacements tags were accounted for.

With the above assumptions and costs, the cost per head was found for varying herd size categories. When the cost per size group was graphed, it was evident that economies of size existed and the graph established a geometrically decaying line. For the 20 head group it would cost approximately \$70.00 per head while it would only cost approximately

$3.54 for the 2,500 head group. The cost differential between the groups was driven by the ability of the larger groups to spread out fixed costs over a larger group. Variable costs did not change on a per head basis.

For producers who backgrounded their cattle on a different premises, it was assumed that 100 percent tag retention occurred and the only costs were those of the eID reading components. The biggest difference between cow-calf producers and background operators was that a panel reader was assigned to backgrounding operations in lieu of a handheld reader. These results indicated that economies of size still existed. The 2,000 head group would cost an average of $6.85 per head and the 50,000 head group on average cost $2.00 per head. The largest portion of these costs came from subscription fees ($1.79) and labor ($3.84 and $0.15).

Mus (2006) showed some of the different components needed for a complete NAIS study and reveals the complexity of modeling the NAIS cost for cow/calf producers; it also shows how to incorporate these components into a deterministic model. However, some of the input costs were inadequately estimated and some assumptions were not realistic and were made for simplicity.

2.5 Cost Analysis of NLIS Compliance for Beef Producers

The Australian government commissioned Alliance Consulting and Management to do a cost study for their NLIS. Australia (with their NLIS) is the most notable country to date that has pushed forward with a NAIS type of system. This cost analysis was published in 2004 and was done under the assumption of a mandatory AID system for Australian beef producers (Alliance, 2004).

Ear tags are known for having less than perfect retention rates (Felsman, 1993; Ringwall, 2003). The NLIS study recognized this fact and thus included the average cost of a RFID ear tag plus a one percent loss rate per year. While this rate would be far too low for conventional tags (Felsman, 1993; Ringwall, 2003), the technology in use for NLIS is eID ear tags which have been shown to have better retention rates than conventional tags (Watson, 2002, Williams, 2006). Therefore, this rate was used in the cost estimates, as it was the retention rate for eID ear tags as mandated by the Australian government.

This study also accounted for the cost of a tag applicator. The NLIS study reported a $100 range for two-piece tag applicators. The driver of this large range was the complexity and the specialization of the ear tag applicator. Any two-piece, universal tag applicator will work; however, if used improperly, they can crush the electronics in the button. To ensure this does not happen, more specialized tag applicators exist that will prevent this from happening. The NLIS study used the lowest ear tag applicator cost which was the universal applicator. The reason for this decision was not stated.

The labor for attaching the ear tag was based on two people earning $150 per day with an assumed ear tag application rate of 600 calves per day. The costs of sorting, catching, and corral depreciation was not accounted for. The report justified this decision by pointing out that these things would be required for other husbandry practices (vaccinating, branding, shipping, etc.) and a producer would ear tag an animal at the same time as these practices.

The next major cost the NLIS study addressed was the cost of eID readers and the record keeping activities associated with eID tags. The NLIS study assumed that producers would use wand readers to read eID ear tags. The wand reader was depreciated over five years to calculate an annual cost.

The cost of recording the movements of animals to a database was not included in the NLIS cost analysis. The labor costs associated with reading and recording animal movement was based on a single person, earning $150 per day and recording 600 animals a day. The costs of the electronic equipment needed to transfer the information from the wand reader to a database was not included and this was justified by assuming that producers would not buy a computer or internet access for the specific purpose of NLIS compliance. However, the report is clear that access to a computer and a modem would be required to record animal movements.

Animal injury and weight loss associated with ear tag application and eID tag reading were not included in the analysis. This decision was defended by suggesting that the weight loss associated with tag application was gut fill and would be regained immediately once the animal was turned back onto feed and water. The report also defended not including animal injury and dark cutter costs by assuming these were due to other husbandry practices and not an AID system.

The analysis did not give total costs for Australian producers; rather, it gave sample operations and found the costs for these operations. The final costs for the NLIS system had a range of $0.03 to $2.56 per head of cattle owned or $0.07 to $5.77 per head sold.

Like Mus (2006), this study is an example of the thoroughness required for a deterministic NAIS cost model along with some of the important variables needed to be included. This report was lacking on documentation and some of the assumptions were not justified to the reader; furthermore, the presentation of the cost analysis is scenario based and is therefore difficult for a cow/calf producer to determine what their cost may be.

2.6 COOL Estimates

As mentioned, COOL is not NAIS; however, many of the cost components of COOL apply to NAIS, specifically, the cost of preserving cattle's individual identity (Umberger, 2004). Three widely used cost analyses for COOL are from Davis (2003), Sparks Companies Inc. (2003), and Vansickle et al. (2003).

Davis had the highest estimate at a cost of 1.3 billion dollars to the cow/calf sector (Smith, 2003). To determine this cost, Davis (2003) estimated that it would cost $10 per head for a permanent ID, 40 hours a year to record location and date of birth, 10 hours a year recording sales information at $8.50 per hour, and a $200 travel auditing charge. The total cost Davis (2003) reported came to $2,725 for an operation with 100 cows, 15 bulls, 15 heifers, and 85 calves. Based on these values it would cost an average of $13.30 per head (Wagner, 2004).

Sparks Companies Inc. (2003) estimated the cost of COOL between that of Davis (2003) and Vansickle et al (2003). Sparks broke the cattle industry into two sectors: Feedlot and Cow/Calf Rancher—Backgrounder. The Feedlot sector will be considered along with the Cow/Calf Rancher—Backgrounder section because it is pertinent to any producer who introduces animals onto their premises from outside sources.

Sparks Companies Inc. (2003) assumed that eID tags or chips would need to be placed in individual animals in order for a COOL system to work, and the main cost components would be the eID technology, labor which consisted of clerical activities and the readers with the necessary computer hardware and software. For animals coming onto the premises it was assumed that the major cost components would be reading and replacing lost eID technology, reading and/or writing to that animal's record, and training of personnel.

Sparks Companies Inc. (2003) assumed that for Cow/Calf Rancher—Backgrounders the eID would be placed in the animal at the premises of birth or at the first premises of transaction, and the animal would be sold multiple times. It was also assumed that the auction markets, backgrounders, buying agents, etc. would have the necessary components to read and record the transaction of the animal. Their final estimate for the cost of tracking animals from the original producer to the packing plant was $4.88 per head.

Vansickle et al. (2003) had the lowest estimate of the three groups. While this paper did not break the different species groups out and discuss each separately, it did provide some useful insights. Vansickle et al. (2003) pointed out that the labor rate used in any analysis should come from the Bureau of Labor Statistics. This addressed an issue stemming from reports using $25 per hour for secretarial labor that Vansickle et al. (2003) felt excessive. The paper also pointed out that the total number of labor hours used to maintain records should not exceed 12 hours per year, which was a USDA estimate, and they did not allow for any new recording system as they argued that it was not necessary for a COOL type of program. With these arguments, they felt that at the very most, a COOL program would cost the cow/calf sector $69,757,116. While this is an estimate for a COOL program, this would be the minimum amount the U.S. could expect a NAIS system to cost because only labor was accounted for and no other eID component.

The COOL cost estimates presented are valuable to this study because they show the components needed for a COOL program in the U.S., many of which would be required to institute the NAIS program. The cost estimates also give a lower bound so the NAIS budget can be checked and calibrated if needed.

2.7 Producer Groups

A letter by the Australian Beef Association (ABA) (2005) to the Australian government and a letter by Liberty Ark Coalition (LAC) to Kansas State University (LAC, 2007) are now reviewed. While these author's conclusions are based more on opinions and emotions than on economics, it does provide a unique perspective to what the Australian and American beef industries see as needed components in a NAIS cost estimate.

The ABA points out that extra handling of cattle would cause more stress, which would lead to a higher shrinkage, and the extra handling practices needing to be employed would raise the injury rate of handlers and to the cattle themselves. ABA listed in detail the costs that should be included: electronic tags and the cost of replacement tags, readers, labor for tagging and replacing of lost tags, shrink to cattle, and a charge that auction yards would charge for the equipment needed to read and tag cattle without eID tags.

They presented their cost analysis along with these components, but they are not reviewed in this study as the objectivity of their analysis was questionable; however, the points that the ABA make are legitimate concerns that should be addressed in a NAIS cost analysis.

Many of the concerns voiced by the LAC were valid and indeed should be addressed in any NAIS analysis. The cost of internet services, ATD(s), eID tags, labor needed to handle animals an additional time, shrinkage due to the extra handling of the animals, secretary labor needed for filing reports, and a computer needed to accumulate data and send the reports were among their top concerns. They also noted that economies of size would exist and this would prove to benefit large producers at the expense of small producers.

The last concern by LAC was the opportunity for the government to charge for premises registration. According to NAIS, "Because premises registration is carried out by individual States/Tribes, each may choose to keep premises registration free or not in their respective areas, based on local needs. To date, all States/Tribes are registering premises at no charge" (USDA, 2007h, pg. 20). This statement indicates that in the future government entities may charge for premises registration; therefore, an analysis should be flexible enough to include these costs if they do occur.

CHAPTER 3 — BUDGET METHODS

3.1 Introduction

In order to estimate the economic costs of NAIS, a budget was developed based on information found through research and communication with producers. Producers will be able to replace this information when they download the budget; however, this information will be used as a starting point, and will enable an average cost of NAIS compliance of the average producer to be reported in this study.

Before the budget process was started, several key assumptions were made. It was assumed that an eID tag system utilizing RFID technology would be used on individual animals to implement the AID system, and cow/calf producers were defined for this study as all producers who breed cattle for the express purpose of raising and selling a calf crop. A budget was developed for two categories of producers: producers who currently tag their cattle and producers who do not. In order for a beef operation to be considered a tagging operation, the producer had to tag their animals with a plastic, panel (conventional) ear tag. The tagging information for beef producers is found in the National Animal Health Monitoring System (NAHMS) report titled, "*Part 1: Reference of 1997 Beef Cow-Calf Management Practices*" (USDA, 1997a). The methods hereafter discussed will apply to both categories of producers unless stated otherwise.

This chapter is organized into five main sections: costs associated with ear tagging; eID component and reading costs; eID labor, chute, and other costs; premises registration cost; and a summary of costs. This chapter will explain the methods used to derive the NAIS budget.

3.2 Tagging Costs

This section includes the information needed to derive a point estimate of the number of eID tags initially placed. With this information, the total initial outlay for eID tags is determined. The following discusses how eID tag outlays were calculated.

3.2.1 Operation Distributions

Different sizes of operations within the budget are grouped so economies of size would be evident if it exists. This is also done to report costs for operations at different sizes. For the downloadable version of the budget, only one size is available because producers input their specific data into the budget (i.e., operation size is an input).

To examine costs by operation size, the United States Department of Agriculture's (USDA) National Agriculture Statistics Service (NASS) size groups are used as breakpoints for this study. To find the average number of breeding stock per size grouping, the NASS database was queried and the beef cattle inventory for January 2007 (USDA, 2007a) and July 2007 (USDA, 2007b) were obtained, along with the 2007 percent of cattle by size of operation (USDA, 2007c) and the number of operations per size group operating in 2007 (USDA, 2007d). The average number of cattle for each operation size group is calculated as

$$\frac{\left(Inventory_{Jan} + Inventory_{July}\right) \cdot PCattle_S}{2} \tag{3.1}$$

where,

Inventory	=	U.S. beef cattle inventory;
Jan	=	January;
July	=	July;
PCattle	=	Proportion of total U.S. beef cattle per operation size;
S	=	Size index.

To find the number of breeding bulls located on a premises, the NAHMS Beef report (USDA, 1997a) was used, which showed a national average estimate of one bull for every 25.3 cows. Dividing the number of cows per operation by 25.3 provides an estimate of the number of bulls for each operation. With this information, the total breeding herd (cows and bulls) were calculated for each size group. With this information, the total number of eID tags placed could be estimated. For a producer who uses the downloadable version of this budget, they will replace this information with their own.

3.2.2 eID Tags Placed

To calculate the total cost of eID tags, which is the objective in this section, the total number of animals tagged in a year needed to be ascertained. To do this, the two categories (producers tagging and producers not tagging) were assigned a calving rate of 94.3% and a cull rate of 11.0%. These rates made for the best reconciliation between slaughter reports and a calculated number of calves and culls slaughtered (USDA, 2007f).

When twinning is taken into account, the calving rate translated into a pregnancy rate of 93.3%. It should be noted that according to the NAHMS Beef report (USDA, 1997a), pregnancy rate is approximately 92.6% and the cull rate is 11.9%. This indicates that the calving and cull rates used in this analysis were not out of line, the difference being small enough to be explained by differing years or the survey sample.

To calculate the number of eID tags placed, different assumptions were used for the differing categories. For the operators who currently tag, eID tags placed is calculated as

$$P_i^T = \left(\frac{(Cows_i \cdot PregRate) - PD - AOD}{(1 - eIDLossRate)} \right) + AOD \qquad (3.2)$$

where,

P	=	Number of eID tags purchased;
T	=	Tagging operations;
i	=	Operation size index;
$Cows$	=	Number of mother cows on operation;
$PregRate$	=	Proportion of pregnant females on the operation;
PD	=	Parturition deaths, head;
AOD	=	All other calf deaths, head;
$eIDLossRate$	=	Proportion of eID tags lost.

It is assumed that all parturition related deaths were not tagged, while calves dying after parturition are eID tagged but not retagged. The USDA (2006b) published these death percentage rates. It is assumed that operations that currently tag would incur a tag loss and these previously tagged animals would need to be retagged prior to being shipped to buyers. For operations that do not currently tag, it is assumed that cattle are not tagged until shipped to the auction yard where they are tagged for a fee. This fee will be discussed in further detail later in this chapter. Thus, operations that currently tag their cattle will end up purchasing slightly more tags due to tagging calves that die prior to weaning and cattle that lose their eID tags that need to be retagged.

The tag loss rate applied is 2.5%. While this loss rate is higher than governmental standards allows, research has found tag loss rates ranging from less than 1% to 5% for eID ear tags (Walker, 2006; Watson, 2002; Williams, 2006; Evans, Davy and Ward, 2005). For this study, the median value of 2.5% is used. Producers who use the downloadable version of the budget can adjust these rates to match the environment in which they run their cattle. Table 3.1 shows input variables (italicized) and calculated values related to tag costs that are required for the downloadable spreadsheet.

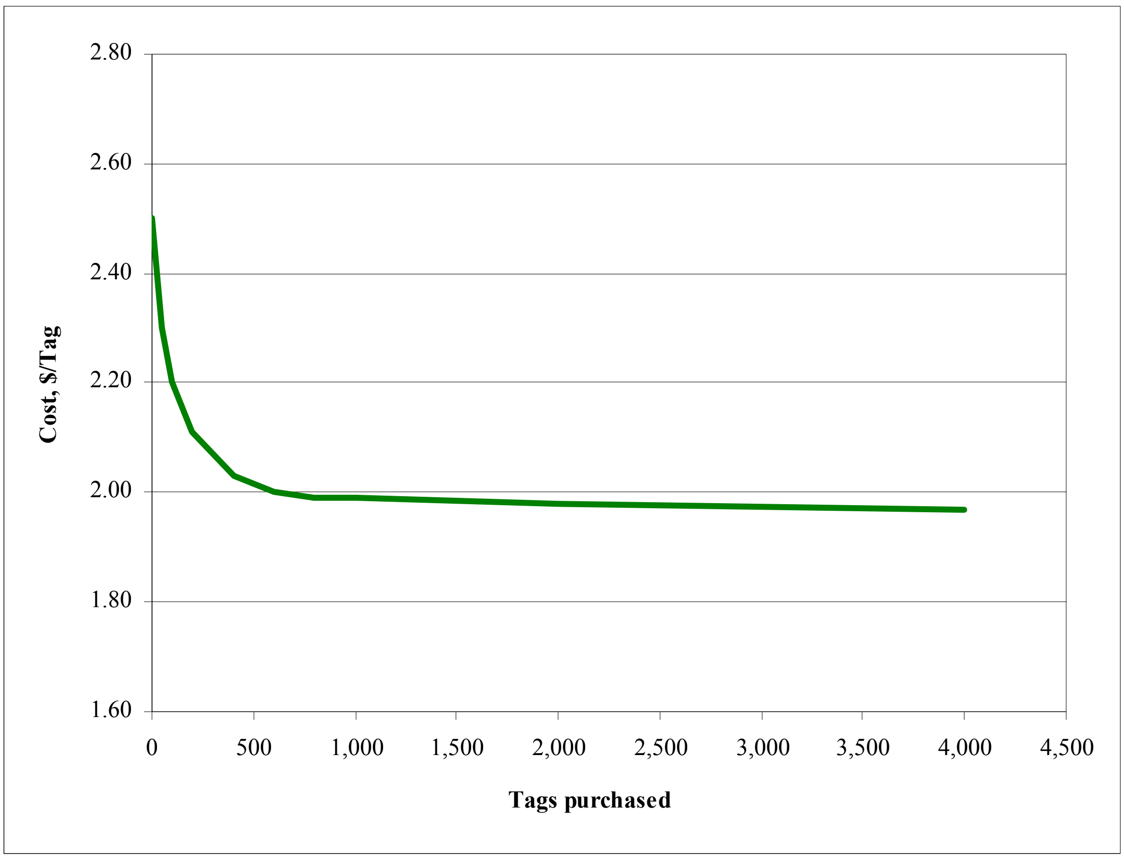
Table 3.1 Line Items Used to Calculate the Number of eID Tags Purchased

Tag=1, No tag=0, All Others	*1*
Average number of breeding females, head	*45.0*
Breeding bulls in herd, head	*2.0*
Calving rate, %	*93.00*
Calf death before tagged, %	*1.43*
Calf death after being tagged, %	*4.42*
Replacement heifers, % retained	*15.10*
Replacement animals, head	6.8
Cow disappearance, %	*4.10*
Cow cull rate, %	*11.00*
Bull cull rate, %	*25.00*
Cows culled, head	5.0
Bulls culled, head	0.5
Total animals sold, head	38.1
Total calves born - alive before being tagged, head	41.3
Total calves dead after being tagged, head	1.8
Total calves available for sale, head	39.4
Number of calves to retag, head	1.0
Total cows and bulls re-tagged/tagged, head	1.2
Tag loss rate, %	*2.50*
Total Tags Purchased	**43.0**
eID tag cost, $/unit	*2.50*
eID Tag Cost, Total $	**115.00**

3.2.3 eID Tags and Applicator Cost

To find the cost of two-piece, eID tags the internet was searched and 12 web sites were located that offered eID cattle tags. These businesses were located in the lower 48 states of the United States, and the prices ranged from $1.95 to $3.00, with the average cost being $2.25 per tag. It is assumed that volume discounts would exist when eID purchase are made. Therefore, the two costs, $2.50 and $1.95 were assumed to represent the cost to operations that bought 1 tag and 10,000 tags, respectively. These data were then used to fit a logarithmic line through the points to find a continuous cost function. The $3.00 endpoint was not used because it was considered as an outlier. Figure 3.1 shows the relationship between the quantity of tags purchased and tag price that was assumed for this study.

Figure 3.1 eID Tag Costs by Volume



As this study focused on the additional cost of implementing an eID based NAIS program, the cost of tag applicators is the difference between conventional tag applicators (one-piece and two-piece) and eID tag applicators. While many conventional, two-piece applicators will work with eID tags, it is possible that conventional applicators will damage the eID button during application of the ear tag. To account for conventional and eID applicators being used, the marginal applicator cost is calculated as

$$\frac{\sum Applicator_{Conv} + Applicator_{eID}}{N} - \frac{\sum Applicator_{Conv}}{N_{Conv}} \tag{3.3}$$

where,

Applicator	=	Ear tag applicator cost;
eID	=	Index for eID tags;
Conv	=	Index for conventional tags;
N_{conv}	=	Number of conventional taggers;
N	=	Number of total taggers.

The internet was searched and the costs of conventional two-piece applicators and eID only applicators were averaged together. This average came to $30.72 per applicator. The cost for conventional ear tag applicators (one and two-piece) averaged $18.88. The difference between these two averages ($11.84) is used to show the additional cost associated with eID. It is assumed that the average life span of an applicator is four years and the number of applicators increased as the operation size increased. Producers will be able to change the life span and number of tag applicators in the downloadable version as seen in table 3.2 (user inputs are italicized).

Table 3.2 Applicator Cost Inputs from Budget

Tag Applicator Costs	
Cost of eID tagger, $/unit	*30.72*
Cost of current ear tagger, $/unit	*18.90*
eID tag applicator cost, marginal $/unit	11.84
Number of tag applicators	*1*
Years of eID tag applicator	*4.0*
Annual Cost of Tag Applicator, total $	**3.55**

3.2.4 Labor and Chute Costs

Producers who become NAIS compliant have an additional time outlay when they attach the extra tag into a calf's ear. Because producers that currently tag have already absorbed the initial time outlay and tagging costs of the conventional tagging program, only the extra time to tag an animal is considered, which is assumed to take 30 seconds to insert the second tag. The labor rate used for this study is $9.80 per hour (USDA, 2007e; Dept. of Labor, 2007b). Labor for tagging does not apply to operations that do not tag their cattle.

To account for the marginal costs when applying eID tags to post weaning animals, setup time, tagging time, number of employees, and chute charges were considered for operations that tagged at birth, but only for animals that lost their tags. For operations that do not tag, only chute charges were assessed to every animal sold.

Published articles from North Dakota State University showed that it took 66 seconds to work an animal in a squeeze chute (Ringwall, 2005a; Ringwall, 2005b). Therefore, the total labor cost is calculated as

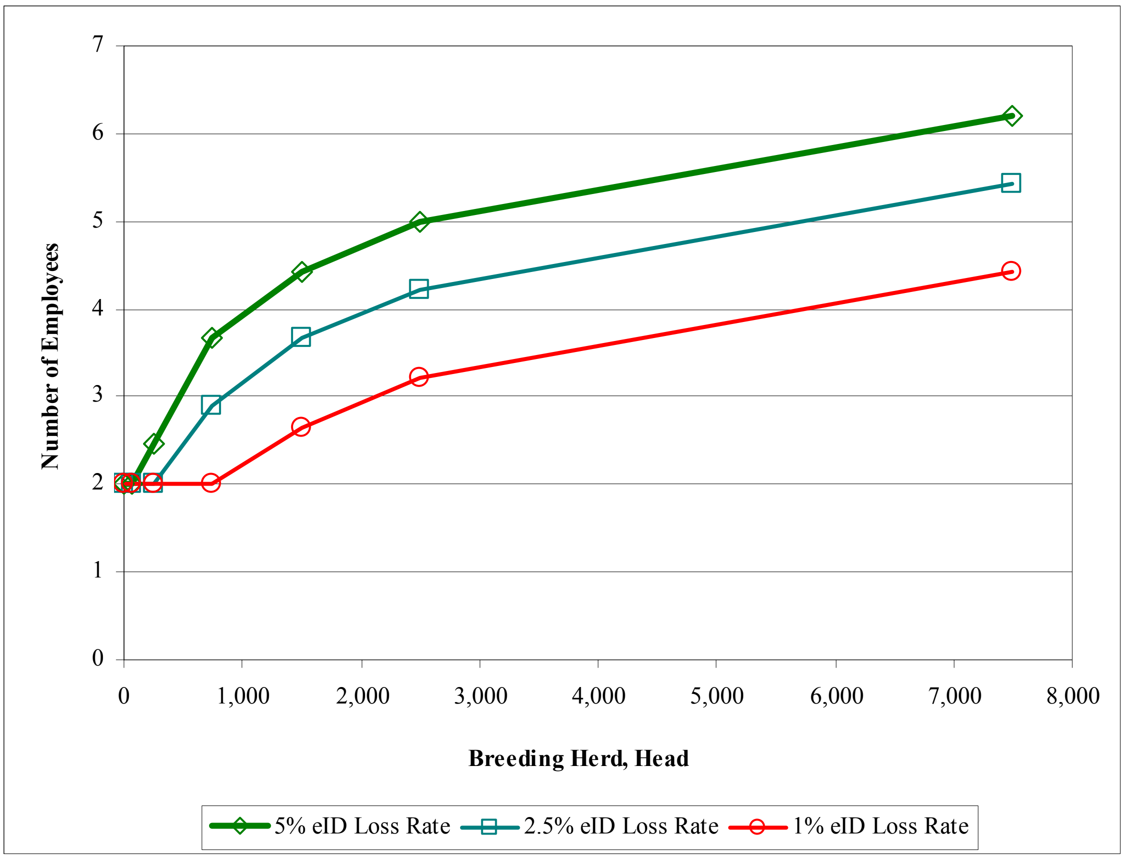
$$Labor = \left[\left(S + WorkTime \cdot Tagged\right)/60\right] \cdot L \cdot W \quad (3.4)$$

where,

Labor	=	Cost of labor, $;
S	=	Set up time, minutes;
WorkTime	=	Time required to tag animal, minutes per animal;
Tagged	=	Number of animals tagged;
L	=	Number of employees working animals;
W	=	Wage of employees, $/hour.

This analysis assumed a 15-minute set up time. The number of employees used was estimated and is a function of animals being tagged, which was estimated from producer opinion. The work force size ranged from two laborers for the smallest size operations to six laborers for the largest operations. Figure 3.2 shows the relationship between operation size and labor requirements at differing eID loss rates. Regardless of the operation size, it is assumed that it would take a minimum of two people to retag animals. This assumption was made because it takes at least one person to bring animals to the chute, and one person to operate the chute. Producers will be able to change the labor price, amount, and setup time in the downloadable budget.

Figure 3.2 Labor Needs for Retagging Animals With Lost eID Tags



To calculate the chute cost associated with tagging animals, producers who tag were charged $1.00 per head. This reflects feedlot industry rates that ranges from $0.75 to

1.50 (Boyles, Frobose and Roe, 2002; Ringwall, 2005a). For producers who do not tag, it is assumed that the auction yard would charge producers for a tagging service. Based on survey results from Kansas auction yards (Bolte, 2008) and Livestock Marketing Association (LMA) data regarding size distribution of auction markets (LMA, 2008) it was estimated that the average chute and labor cost would be $2.54 per head. This cost did not include the cost of an eID tag. Producers who use the downloadable budget can change chute costs.

Table 3.3 shows an example of how labor and chute costs are organized in the downloadable version of the budget (user inputs are italicized).

Table 3.3 Chute and Labor Costs

Costs Associated with Working Cattle	
Labor and Chute Costs	
Setup time required for retag, hours	*0.25*
Time spent working one animal, seconds	*66.00*
Hours required to re-tag / sort	0.29
Number of employees, employees	*1.0*
Labor Cost to Retag, Total $	**3.00**
Cost of tagging service, $/head	*2.54*
Chute charge, $/head	*1.00*
Total Chute Cost, $	**2.29**

3.2.5 Injury Costs

Working animals inevitably leads to injury both to humans and to animals. To account for the extra costs associated with working animals longer or an extra time, estimates of human and animal injury costs were calculated and applied to the final NAIS implementation cost.

To calculate human injury, an average of two different methods was used. The first method used average incidence rates from three studies for farm operation accidents (U.S. Dept. of Labor, 2007a; Myers, 2001; NIOSH, 2004) and multiplied the average number of incidents by the average medical costs of 2001-2002 and 2002-2003 adjusted for inflation (National Safety Council, 2006; U.S. Dept. of Labor, 2008). This is multiplied by the time spent working an animal for NAIS reasons to get the marginal cost of human injury associated with working animals longer/more. The second method was much more direct and simply assumed that accident costs represent 10% of the laborer cost dedicated to tagging/retagging cattle.

To estimate the marginal animal injury cost of eID tagging, the number of cattle (beef and dairy) workings per year was estimated. Dairy cattle workings were assigned a 10% weight as they are more used to machines, alleys, and people than beef cows. After the total number of cattle workings was calculated, the cost of lame animals, which came to $104,427,000, was divided by the number of cattle workings to find the marginal animal injury cost of working cattle (USDA, 2006b). It is a strong assumption to assume all lamed animals were caused by working them; however, it was the only estimate found. This number, now on a per head basis, is then applied to the number of animals needing replacement tags.

3.2.6 Shrink

Shrink can be a large cost to producers. To correctly capture the shrink costs in the budget, research and communication with animal scientists and producers took place. Many publications have shown the effects of shrink related to time off feed (Barnes, Smith and Lalman, 2007; Gill et al; Ishmael, 2002; Krieg, 2007; Richardson, 2005; Self and Gay, 1972). The complexity of the beef industry and the published information available is such that it was impossible to find an estimate of average marginal shrink induced by tagging animals.

To calculate shrink costs for operations that tag, a two-pound shrink is assumed for every weaned animal that is retagged before being shipped. While the literature generally suggests that total shrink is more than this, the literature is also clear that most of this shrink is gut fill. For those operations retagging their animals, feed and water loss can be replaced as soon as animal are turned back into their pen or pasture. However, what is not replaced is the loss of the animals weight gain for that day. While operation dependent, most will try to have an average daily gain between one and three pounds for the weaned animals. This study used an average of 2.00 pounds for calves and 2.75 pounds for cull cattle.

To calculate a shrink cost for operations that do not tag, water and feed loss were considered because they affect the sellable weight. It is assumed that the animal would not have an opportunity to eat or drink after they were tagged at the sale yard, or if they have the opportunity, the animal would not take it, before they were sold. This is assumed as an upset animal will not usually eat or drink. To account for this sellable weight being lost, a more traditional approach is used. From a published article by Richardson (2005), it is reported that a shrink rate of 0.5% (2.6 lbs) is observed with 30 minutes of sorting animals. This rate is used in this study because it was felt that most of the feed and water shrink would have occurred shipping the animal to the auction yard; therefore, a higher rate would not be appropriate as it would over inflate the shrink costs.

The total amount of shrink for both weaned and cull animals were then multiplied by the group's respective average selling price to find the cost of shrink. This number is then multiplied by 25% to reflect the amount that should be attributed to tagging animals. This value represents expert opinion from animal scientists and veterinarians.

Producers will be able to change shrink percentage, animal weight, price of animal, and the amount ascribed to NAIS in the downloadable version of the budget.

3.3 eID Components and Reading Costs

The eID components and reading costs used in the budget are a function of animals read, electronic readers (panel or wand), data accumulator, software, database charges, and fixed costs. The following will discuss each of these components individually.

3.3.1 Purchased or Transferred Animals

To capture the cost of eID tag reading in the budget, the average number of animals brought onto a premises was estimated using the NAHMS Beef report (USDA, 1997a) which reported the average percentage of buying premises for 1996. Using this information the average number of animals purchased per buying premises is assumed to equal the number of replacements needed to maintain herd size equilibrium. This is calculated as

$$R_i = \left(CullRate + CowRate\right) \cdot Herd \tag{3.5}$$

where,

R	=	Replacements purchased;
i	=	Operation size index;
CullRate	=	Proportion of mother cows culled;
CowRate	=	Proportion of mother cows that disappear;

Herd = Number of breeding animals.

Bolte (2008) revealed that Kansas auction yards would install reading panels in their facilities as a service to members, and it is assumed the study is a representative sample for all auction yards in the U.S. With this information, it was decided that the number of animal eIDs needing to be read by a buying operation would be equal to the number of animals not purchased through the auction yard because the auction yard would provide this service. A study by Schmitz, Moss, and Schmitz (2003) estimated that 72.2% of all cattle are sold through local and video auctions. Contained in that same report is 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 reflect the percentage of animals sold through an auction medium.

The average percentage of animals sold through an auction is applied uniformly to the number of cattle purchased by operation size to find the number of cattle purchased through the auction. After this number is calculated, it is subtracted from the total number of animals brought on a buying premises to find the total number of eID tags needing to be read.

It has been reported that panel readers can miss up to 2.8% of all RFID tags (Reinholz et al,). To capture this and the extra time needed to ensure a 100% read rate when using handheld readers, the total number of animals read is multiplied by 2.8% to estimate the number of misreads an operation would experience. This is then added to the total number of tags needing to be read to get total reads per year.

Producers can change the percentages of animals purchased through an auction and the misread percentage in the downloadable version of the NAIS budget.

3.3.2 Electronic Reader

For the purpose of this budget, it is assumed a producer had three options to read the AIN from an eID tag: custom hire, wand reader, or a panel system. Visually reading the AIN on the eID tag is not considered because of the substantial amount of time involved which would cost the producer more in the long run than if the producer employed one of the three options previously mentioned.

The system used to read eID tags is based on the number of animals read. If the cost of the eID components divided by the total number of reads is greater than a custom read charge, the operator will hire someone to read the eID tags. If the cost is less than a custom read charge, the operator will own the equipment needed to perform the task.

3.3.2.1 Wand and Panel Readers

eID reading costs depend largely on the cost of the reader. For the budget, it was decided to base this cost on work done by Bass et al. (2007). The eID wand readers are annualized over three years and had an initial outlay of $1,091. eID readers in this price category are able to capture and temporarily store data until downloaded into a computer. While this type of reader is more expensive than those that do not store eID data, some producers already own desktop computers and likely would not want, or be able to move them to the 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 different types of data accumulators (i.e., computers). Panel reader costs were also based on Bass et al. (2007), and were annualized over four years and had an initial outlay of $3,580. Panel systems also incurred a $500 installment outlay at the beginning of the panel reader's life which is annualized over a ten-year period. For operations that employed panel readers, a $500 per year maintenance charge is also assessed.

Producers can change reader costs, maintenance costs, and the number of years in service in the downloadable version of the NAIS budget.

3.3.3 Custom Reading

It is assumed that producers whose reading cost is greater than a custom read charge would not buy the eID reading components, but rather would hire it done. Therefore, the budget applies a custom read rate to the operations that fall into this category. Because research did not reveal any custom rates for reading eID tags, a custom read charge is estimated.

To get an estimate of what this rate may be, 10 states with 15 unique brand inspection fees were analyzed. Some of these schedules included an hourly charge for employee labor. In these instances, $9.80 per hour is used (U.S. Dept. of Labor, 2007b). Other schedules included mileage, and in these cases it is assumed a 50 mile round trip at the government recommended reimbursement rate of $0.485 per mile (GSA, 2007). These 15 individual rates were applied to groups of cattle from three head to 20,000 head. This was done for each of the 10 states and 15 brand inspection rates. The average associated with the different herd size is used to determine the custom read cost. Table 3.4 shows the custom read schedule and the breakpoints used.

Table 3.4 Custom Read Schedule

Head	3	5	10	15	20	25	50	100	500	1,000	5,000
Cost, $/head	4.55	3.09	1.99	1.62	1.44	1.33	1.11	1.00	0.91	0.90	0.89

Producers will be able to modify the custom read schedule in the downloadable budget if they so desire.

3.3.4 Data Accumulator and Software

The data accumulator cost included in the budget is $692, which represented the average cost for laptop computers from six internet websites. This cost is annualized over four years and had a $0 salvage value as it was assumed that the technology would be obsolete by the end of the four years. According to the 1997 NAHMS beef report (USDA 1997a), some operations already own computers and thus, would not need to purchase one. To adjust the average cost of the accumulators applied to the NAIS implementation cost a weighted average cost per operation size is calculated as

$$Cost = (1 - \%Owned) \cdot ComputerCost \tag{3.6}$$

where,

Cost	=	Weighted cost;
%Owned	=	Proportion of computers owned by cow/calf operations;
ComputerCost	=	Cost of laptop, $.

Many different software packages are available that would satisfy the software requirement of an eID tag system. The value ($400) used for this report represents 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 AINs and to write the necessary documents.

Producers can change accumulator costs, software costs, the number of years in service, and salvage value in the downloadable version of the NAIS budget.

3.3.5 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, 2007g, pg. 4). As of May 2008, there were 17 approved ATDs or Compliant ATDs that were participating in the NAIS program that meet the minimum requirements outlined in the Integration of Animal Tracking Databases with the NAIS and have a signed cooperative agreement with USDA Animal Plant Health Inspection Service (USDA, 2008e).

Bass et al. (2007) attempted to contact multiple ATD providers to find the cost per head they charged so an average cost could be ascertained and incorporated into the budget. Not surprisingly, this information was not readily given out; and the information that was expressed is not specific enough for this study. To find a more accurate estimate, Kevin Kirk from Michigan’s Department of Agriculture was contacted by Bass et al. (2007). Mr. Kirk, who oversees the Michigan State ATD, was able to provide the total data storage cost for Michigan producers. From this, the per-head charge for Michigan producers was estimated to be $0.085 and is used as a point estimate for this study.

3.3.6 Other/Fixed Charges

The time needed to submit the AIN to an ATD and the internet fee is considered next. To determine clerical costs, the time submitting a batch of AINs and the number of batches submitted needed to be estimated. The Wisconsin working group for pork found that it took 15 minutes to submit a batch (WPA, 2006). It is assumed that a minimum of four batches (one hour of clerical labor) would be assigned to the smallest producer group, and a total number of 16 batches (four hours of clerical labor) would be assigned to the largest group. Clerical labor is then multiplied by the average secretary wage of $14.60 per hour to find the total clerical cost (U.S. Dept. of Labor, 2007b).

It is assumed that in order to be able to achieve a "48 hour traceback system" producers would need to submit their batches of AIDs via an internet access point. In calculating this cost, a $50 per month access charge is assumed for 12 months. However, because some operations already had a computer, it is assumed they also had internet access so a weighted cost of internet was applied towards the final NAIS cost. It is realized that this assumption is less than perfect; however, the information for a more accurate assumption is not available.

Producers can change these costs in the downloadable version of the NAIS budget.

3.4 eID Labor, Chute, and Miscellaneous Costs

It is assumed that all beef operations that purchase cattle will run them through chutes to vaccinate, de-worm, or perform some other basic husbandry practice. Therefore, the total number of animals that needed their eID tags read is multiplied by 20 seconds to find the marginal time of reading the eID tags. The total time is multiplied by $9.80 per hour (USDA, 2007e; U.S. Dept. of Labor, 2007b) and the total number of employees to find the total cost of eID labor. The number of employees needed to work the cattle is broken into two groups: the eID reading employee and other employees. The other employee group had differing amounts of people based on operation size.

The full chute charge is reduced to 25% because of the assumption that producers will already be working their animals when they read the eID tags. The 25% chute charge is applied because animals spend approximately 25% more time in the chute to have their tags read.

Animal and human injury costs are added according to the amount of extra time the animal is in the chute, and shrink is not added to any cattle being read because it is assumed that that purchased animals will be used for breeding purposes.

3.5 Premises Charge

Currently there are not any premises registration fees as many states are trying to make the process as economical as possible. Presently, APHIS reports that 32.1% of all operations with over $1,000 income have been registered (USDA, 2008e).

Theoretically, premises registrations will last for the life of the operation. While the premises registration is currently a free service, time, mileage, and any printing to register premises are not. To capture these costs, it is assumed that a producer would spend $25 worth of time, money, and supplies to register his/her premises. A 100-year time horizon was assumed, and a renewal fee of $10 every three years was assessed to the operation. This $10 would cover the cost of any fees, paperwork, and time that may be required at a future date. This brought the annualized premises cost to $5 per year.

3.6 Final Breakdown

All costs in the budget were annualized at a rate 7.75%. For operations that bought tags, calf tags had an investment period of nine months to reflect the amount of time that the producer owned the ear tags. To account for cow tags, every operation that tags with eID tags buys eID tagged replacements animals (their own or someone else's). By doing this, the eID cost is transferred to the cull animals without eID tags. The cows also have the cost of their tags annualized to reflect the opportunity cost the producer incurs using eID tags.

Finally, each cost item for both groups (those who tag, and those who do not) is summed to get the individual groups final cost and can be conceptually seen

$$\begin{aligned} C = f\,(&y, T, TagCost, ApplicatorCost, Labor, Shrink, ReadCosts, \\ &ChuteCosts, InjuryCosts, PremisesCost, InterestCost) \end{aligned} \tag{3.7}$$

where,

C	=	Cost function;
y	=	Animals sold, head;
T	=	Type of operation;
TagCost	=	Total outlay for tag purchases, \$;
ApplicatorCost	=	Marginal cost of eID tagging applicators, \$;
Labor	=	Total Labor costs, \$;
Shrink	=	Total Shrink costs, \$;
ReadCosts	=	Total Reading costs, \$;
ChuteCosts	=	Total Chute costs, \$;
InjuryCosts	=	Total Injury costs of both employees and animals, \$;
PremisesCost	=	Premises fee, \$;
InterestCost	=	Opportunity cost on eID investment, \$.

Table 3.5 shows the layout of the summary of cost section in the budget for the categories discussed in this chapter. The estimated costs shown in table 3.5 is for a 45 head

operation that currently tag their animals. Table 3.6 shows the completed budget (in spreadsheet form with user inputs italicized) that is available on http://www.agmanager.info/.

Table 3.5 Breakdown of Costs ($)

Tags and Tagging Cost	**$133.45**
eID Tag	116.33
Applicator	3.55
Labor	6.62
Chute	2.27
Shrink	3.82
Injury	0.78
Reading Costs	**$15.15**
eID Capital	8.05
Labor/Chute	6.17
Shrink/Injury	0.93
Premise Registration	**$5.03**
Opportunity Costs on breeding stocks eID	**$9.14**
TOTAL	**$162.69**

Table 3.6 Completed NAIS Budget as Appears in the Spreadsheet

Categories:	
Tag=1, No tag=0, All Others	*1*
Average number of breeding females, head	*45.0*
Breeding bulls in herd, head	*2.0*
Calving rate, %	*93.00*
Calf death before tagged, %	*1.43*
Calf death after being tagged, %	*4.42*
Replacement heifers, % retained	*15.10*
Replacement animals, head	6.8
Cow disappearance, %	*4.10*
Cow cull rate, %	*11.00*
Bull cull rate, %	*25.00*
Cows culled, head	5.0
Bulls culled, head	0.5
Total animals sold, head	38.1
Total calves born - alive before being tagged, head	41.3
Total calves dead after being tagged, head	1.8
Total calves available for sale, head	39.4
Number of calves to retag, head	1.0
Total cows and bulls re-tagged/tagged, head	1.2
Tag loss rate, %	*2.5*
eID tag cost, $/unit	*2.50*
Total Tags Purchased	**43.0**
eID Tag Cost, Total $	**115.00**
Tag Applicator Costs	
Cost of eID tagger, $/unit	*30.72*
Cost of current ear tagger, $/unit	*18.88*
eID tag applicator cost, marginal $/unit	11.84
Number of tag applicators	*1*
Years of eID tag applicator	*4.0*
Annual Cost of Tag Applicator, Total $	**3.55**
eID Tag Labor Cost	
Labor rate, $/hour	*9.80*
Additional time to tag second time, seconds	*30.0*
Cost of tagging animal twice (2X), $/head	0.08
Cost of Tagging 2X, Total $	**3.56**
Costs Associated with Working Cattle	
Labor and Chute Costs	
Setup time required for retag, hours	*0.25*
Time spent working one animal, seconds	*66.00*

Table 3.6 Continued

Hours required to re-tag / sort	0.31
Number of employees	*1.0*
Labor Cost to Retag, Total $	**3.00**
Cost of tagging service, $/head	*2.54*
Chute charge, $/head	*1.00*
Total Chute Cost, $	**2.29**
Cattle Shrink Costs	
Shrink from working calves, %	*0.38*
Average calf weight, lbs/calf	*524*
Pounds lost/calf	2.00
Total weight lost, lbs	2.00
Average calf price, $/lb	*1.21*
Percent of price to assign to shrink, %/head	*25.00*
Shrink % from working cows, %/head	*0.20*
Average cull weight, lbs/cull	*1,274*
Pounds lost/cull	2.55
Total weight lost, lbs	3.00
Average cull price, $/lb	*0.48*
Percent of price to assign to shrink	*25.00*
Total Shrink Cost, $	**0.96**
Miscellaneous Costs	
Weighted injury cost, $/year	*646.01*
Human Injury, % of labor cost	*10*
Human injury, $	0.43
Animal injury, $/head	*0.16*
Animal injury, $	0.34
Meat damage, $/head	*0.00*
Total meat damage, $	0.00
Total Miscellaneous Cost, $	**0.77**
Total Working Costs, $	**7.00**

Component Cost Calculator	
Electronic Reader	
Description	Hand
Cost of panel reader, $/unit	*3,583*
Cost of handheld reader, $/unit	*1,092*
Useful life, years	*3*
Salvage value, %	*0.0*
Annual cost, $	422.00
Percent allocated to NAIS	*100*

Table 3.6 Continued

NAIS cost, total $	422
NAIS cost, $/read	227.96
Handheld = 0, Panel reader = 1	0
Installation costs for panel reader, $	*500*
Useful life of installation, years	*10*
Salvage value, %	*0.0*
Annual cost, $	0.00
Percent allocated to NAIS	*100*
NAIS cost, $	0
NAIS cost, $/read	0.00
Total Cost of Electronic Reader, $	**422.00**
Total Cost of Electronic Reader, $/read	**227.96**
Data Accumulator	
Description	Computer
Initial cost, $	*692*
Useful life, years	*4*
Salvage value, %	*0*
Annual cost, $	208.00
Percent to NAIS	*100*
NAIS cost, $	**208.00**
NAIS cost, $/read	**112.28**
Software	
Description	Software
Initial cost, $	*400*
Useful life, years	*4*
Salvage value, $	*0*
Annual cost, $	120.00
Percent allocated to NAIS	*100*
NAIS cost, $	**120.00**
NAIS cost, $/read	**64.90**
Approved Storage Database	
Description	Storage
Fixed annual cost, $	*0*
Cost per head, $/head	*0.08*
Annual cost, $/head	0.09
Annual cost, $	0.17
Percent allocated to NAIS	*100*
NAIS cost, $	**0.17**

Table 3.6 Continued

NAIS cost, $/read	**0.09**
Other/Fixed Costs	
Description	Labor
Office labor, hours	*1*
Office labor rate, $/hour	*14.60*
Annual cost, $	15.45
Percent allocated to NAIS	*100*
NAIS cost, $	15.45
NAIS cost, $/read	8.35
Description	Internet
Annual cost, $	*600*
Annual cost, $	635
Percent to NAIS	*100*
NAIS cost, $	635
NAIS cost, $/read	343.10
Description, panel reader maintenance	Maintenance
Maintenance cost for panel reader, $/year	*500*
Annual cost, $	0.00
Percent allocated to NAIS	*100*
NAIS cost, $	0.00
NAIS cost, $/read	0.00
Total Other Costs, $	**650.00**
Total Other Costs, $/read	**351.45**
Total Annualized Reader Costs	**1,400.00**
Total Annualized Reader Costs,$/read	**756.69**
Annualized Component Cost Summary	
Electronic reader, $	421.82
Data accumulator, $	207.77
Software, $	120.10
Database, $	0.17
Other, $	650.32
Total Component Cost	**1,400.00**
Animals Bought and Number of Reads	
Average number of cattle bought, head	*6.0*
% Animals sold through auction	*70.0*
Average non-cattle bought, head	1.8
Animals moved to new premise-not sold, head	*0.0*
Number of times read	*0*

Table 3.6 Continued

Total reads of non-sold animals	0.0
Non-auction cattle reads	1.8
Misread percentage	*2.8*
Total animals misread, head	0.1
Number of times read	*1*
Total Reads	**1.9**
Costs Associated with Reading Tags	
Labor and Chute Costs	
Total setup time, minutes	*30.00*
Read time per animal, seconds	*20.00*
Time required to read RFID tags, hours	0.51
Non-reader employees	*1.0*
Total Labor Costs, $	**10.58**
Chute cost, $/head	1.00
Adjustment to chute cost, %/head	*25.00*
Total Chute Costs, $	**0.49**
Cattle Shrink Costs	
Shrink % from reading cattle	*0.00*
Average weight/head, lbs	*1,100*
Weight lost/head, lbs	0.00
Total weight lost, lbs	0.00
Average price, $/lb	*0.00*
Percent of price to assign to shrink	*0.00*
Total Shrink Cost, $	**0.00**
Miscellaneous Costs	
Human injury, $	0.66
Animal injury, $	0.09
Damage to meat, $	0.00
Total Miscellaneous Cost, $	**0.75**
Total Operating Costs of Reading, $	**12.00**
Total Operating Costs, $/Read	**6.39**
Work and read: Yes=1, no =0	*0*
Weighted crew labor cost, $	0.68
Weighted total chute cost, $	0.49
Weighted shrink/injury cost, $	0.93
Total Operating Cost of Reading, $	**12.00**
Total Operating Cost, $/Read	**6.54**
Total Cost of Reading, $	**1,412.00**
Total Cost, $/Read	**763.23**
RFID System is:	**Outsourced**

Table 3.6 Continued

RFID capital cost per read, $	4.35
Labor/chute costs per read, $	3.34
Shrink/injury cost per read, $	0.50
Total RFID Cost per Read, $	**8.19**
Total RFID Cost per Operation, $	**15.00**
Premises Cost	
Premises cost, total $	*1.94*
Registration renewal cost, $	*3.09*
Annual Cost of Premises Registration, $	**5.03**
Final Cost Breakdown	
Interest rate on RFID investment	*7.75*
Interest rate on operating costs	*7.75*
Months calf tag purchased	*9*
Interest on tags for cows and bulls, $	**9.33**
Total costs, $	**161.43**
Total costs, $/head sold	**4.24**
Total Annual Cost, $/operation	**161.00**
Total Annual Cost, $/head sold	**4.24**
Total Annual Cost, $/inventory	**3.59**

CHAPTER 4 – STOCHASTIC MODELING

4.1 Introduction

Two of the objectives of this study was to use an Ordinary Least Square (OLS) regression to find coefficients that when multiplied with producer level information would provide an estimated cost along with a prediction interval of implementing NAIS. To estimate an OLS regression, multiple observations are needed; unfortunately, NAIS costs for operations utilizing an eID system were not available. To overcome this obstacle, observations were simulated by converting the budget into a stochastic model. These simulated observations provide information about the distribution of NAIS compliance costs and were used for the OLS regression. NAIS Costs can be estimated in a budget framework, but this study chose to use a regression analysis.

The purpose of this chapter is to discuss turning the budget into a stochastic model. The stochastic modeling framework includes the sampling method employed, decision variables and associated distributions simulated, the distribution from which the random variables would be pulled from, and the empirical regression to be estimated. The following sections present and discuss each of these components of the stochastic model.

4.2 Sampling

The sampling method used in an analysis can affect the variance of the sample statistics. Therefore, a careful consideration of the sampling method being employed was warranted. This analysis considered two different types of sampling methods: Monte Carlo and Latin Hypercube sampling (LHS). These two methods rely on computer iterations to obtain the sample, and if correctly executed, the sample is statistically distributed in a way that an inference of the population can be made.

4.2.1 Monte Carlo vs. Latin Hypercube Sampling

Monte Carlo or random sampling selects input values by choosing a random value from a chosen distribution *N* number of times. This method is effective in replicating the population variances when the sampling size is large, but for small *N* this method fails to converge to the true population variance. The main cause of this failure is a reliance on randomly picking values; therefore, when *N* is small, the probability of observing a low probability event is low (Wittwer, 2004b; Ramuski, 2008). Despite this limitation, Monte Carlo sampling is the traditional sampling method for stochastic modeling, and is considered a standard to which all other sampling methods are compared (Wittwer, 2004a).

Latin Hypercube sampling uses less computing power than Monte Carlo sampling and is able to converge to the true population variance with smaller *N* (Xu et al. 2005; Olsson, Sandberg, and Dahlblom, 2003). The sampling efficiency arises because LHS selects random variable input values more systematically, allowing low probability events to be sampled (Ramuski, 2008). This is accomplished by stratifying each k^{th} input distribution into *N* (i.e., *N*=500) strata so that each stratum has an equal marginal probability (McKay, Beckman, and Conover, 2000). For each iteration, input values are randomly drawn from a random k^{th} distribution's strata, and then randomly paired with randomly selected input values from the other input distributions to form a draw for the N^{th} iteration (McKay, Beckman, and Conover, 2000). This ensures that small value input variables are not always being grouped with other small value input variables from other distributions (Ramuski, 2008). This property makes LHS more efficient than Monte Carlo because it assures that the entire range in the set of *k* distributions is being fully sampled. For a proof of this technique, the reader is referred to McKay, Beckman, and Conover, (2000) pg 59-61.

For the purpose of this study, LHS will be employed as the sampling method because of its ability to be more efficient when simulating observations.

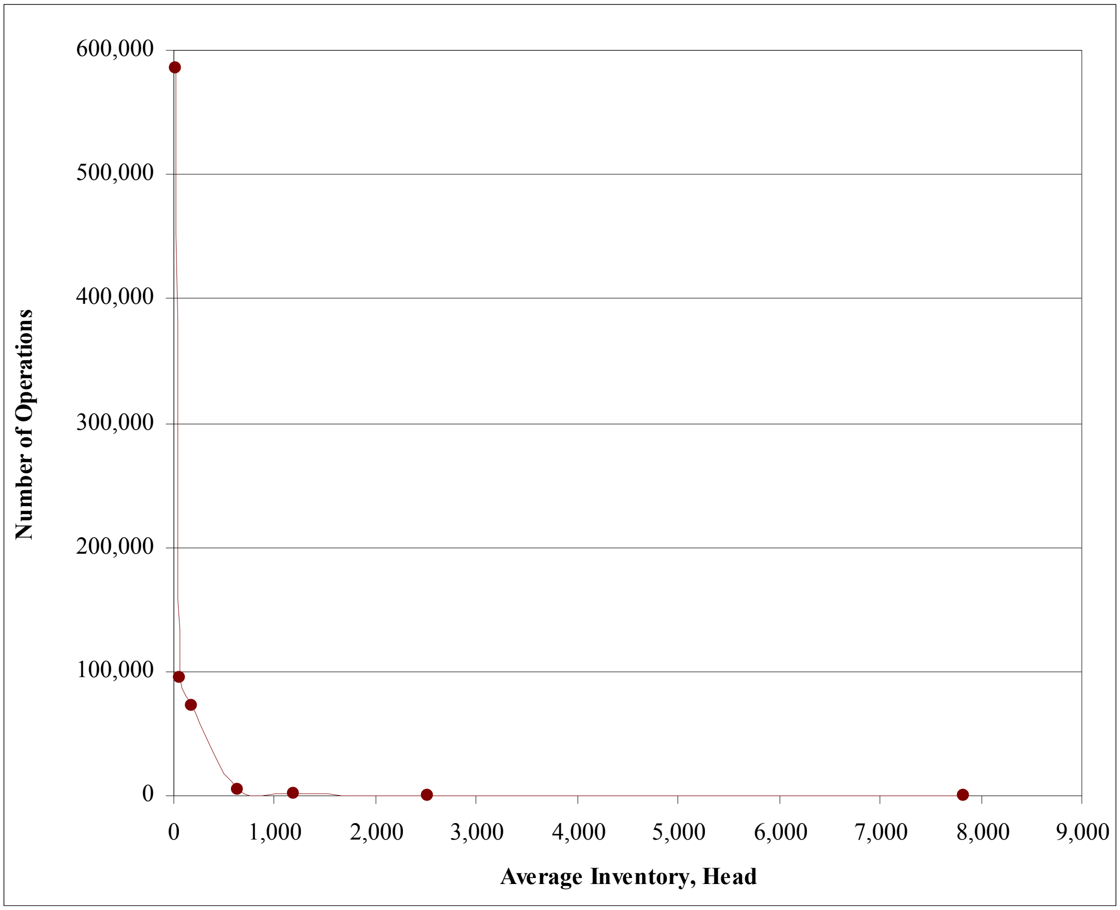
4.3 Input Variable Distributions

Inferences about a population using probability distributions are quite common; however, the distribution selected must reflect that of the population in order to be certain the inferences are relevant (Wackerly, Mendenhall, and Scheaffer, 2002). Histograms, means, standard deviations, and other statistics were compiled and compared to find the probability distributions that matched known sample distributions the closest. Once probability distributions were ascertained for all the needed input variables, appropriate probability density functions (a "theoretical model for distribution frequency of a population measurement" (Wackerly, Mendenhall, and Scheaffer, 2002 pg. 155)) were used for simulation of stochastic input values.

4.3.1 Operation Size Distribution

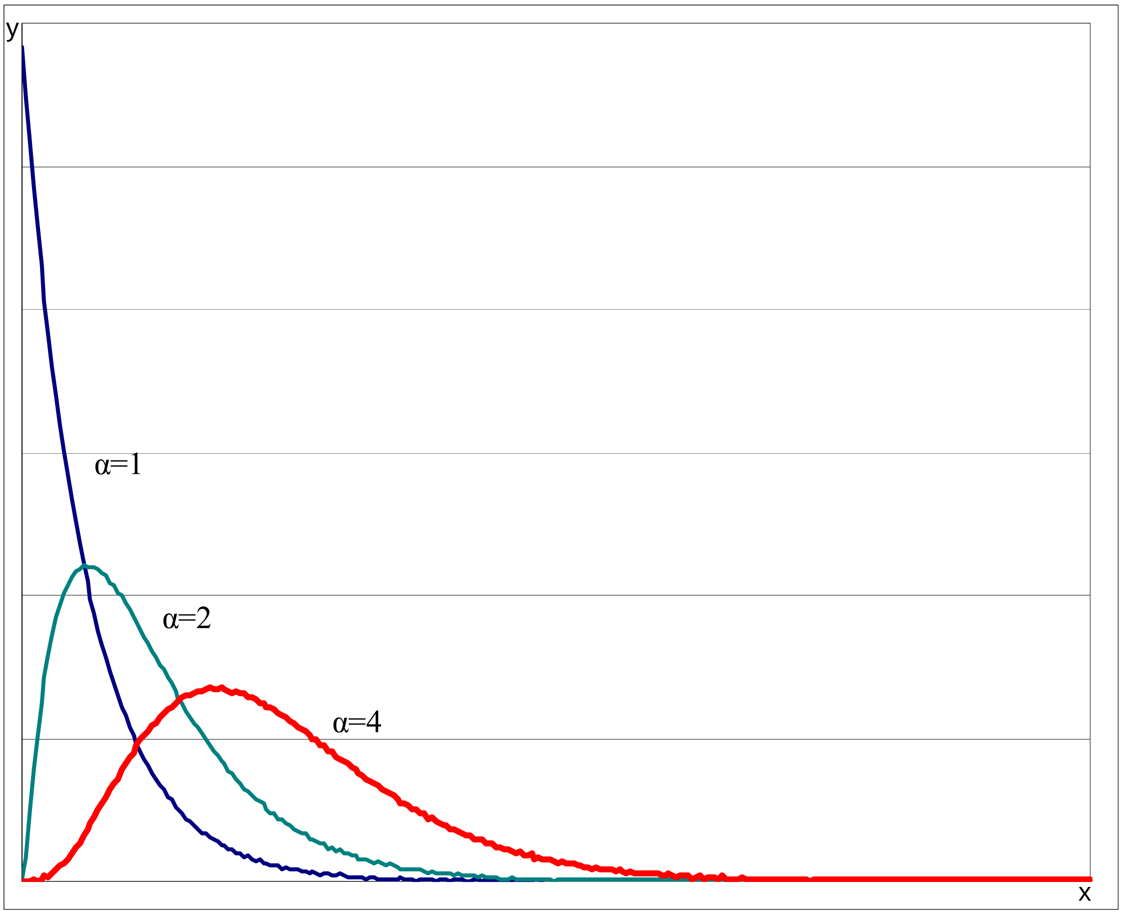
The sample distribution for operation size should have a non-negative domain and be skewed to the right to match the distribution seen in figure 4.1. This figure shows a histogram of U.S. cow/calf operations grouped by breakpoint averages that can be obtained through NASS reports.

Figure 4.1 Number of Operations by Average Inventory



The gamma distribution was chosen to replicate the operation size distribution because gamma distributions are non-negative, skewed distributions with most of the area near the origin of the distribution (Wackerly, Mendenhall, and Scheaffer, 2002). Chi-square and exponential distributions are part of the family of gamma distributions. The gamma distribution has two input parameters, β and α. The β parameter is referred to as the scale parameter and calibrates the distribution by multiplying the gamma-distributed random variable by β. The α parameter is referred to as the shape parameter because the value assigned to α determines the shape or thickness of the tails of the distribution as seen in figure 4.2.

Figure 4.2 Gamma Probability Distribution with Differing α's and β=1



The α and β parameters that matched the operation size distribution the closest had α (the shape parameter) equal to 0.21528 and β (the scale parameter) equal to 1500. The shape and scale parameters were determined by setting the distribution median equal to 41.4 head, which resulted in having a 10,500 head operation being sampled. The gamma distribution was unconstrained in any way. The distribution and sampling method used resulted in a median operation size of 41.4, a mode of 1.0, and a standard deviation of

695.9. Because gamma distributions are continuous and the number of cattle on an operation takes integer values, input values simulated from the gamma distributed random variable for operation size were rounded to the nearest whole number. A continuous distribution was used in lieu of a discrete distribution (cows only come in halves when in the freezer) because a discrete distribution function could not be found that would replicate the desired shape and scale. However, given the large sample, the use of a continuous distribution should not affect the accuracy.

4.3.2 Pregnancy Rate Distribution

Biological factors have been shown to follow a normal (sometimes referred to as Gaussian) probability distribution when the sample size is large (Moore, 2003). In order to have a probability distribution function return a normally distributed random variable the population mean and standard deviation are needed. While population means and standard deviations are rarely known, the sample mean and standard deviation have shown to be unbiased estimators and thus can be used for these parameters (Berry and Lindgren, 1996; Wackerly, Mendenhall, and Scheaffer, 2002).

The 1997 NAHMS beef report (USDA, 1997a) reported an average pregnancy rate of 92.6% with a standard error of 0.6% for the 2,713 operations sampled. Standard error (SE) is the standard deviation of the sample statistic and is calculated as

$$SE = \frac{S}{\sqrt{N}}. \tag{4.1}$$

Rearranging this equation the standard deviation of pregnancy rate of the sampled operations was calculated as

$$S = SE \cdot \sqrt{N}, \tag{4.2}$$

where SE is the standard error, S is the standard deviation, and N is the number of observations.

This standard deviation calculation equaled 0.3125. This standard deviation caused the pregnancy rate to range from -0.48% to 216%. This range of values is far too great (not to mention physically impossible) for this study, and suggests that calving rate may not be normally distributed, or NAHMS calculates their standard error differently than shown in equation 4.1.

To assure that pregnancy rates drawn during the simulation can realistically occur for any operation, this study will use a truncated normal distribution with a mean of 92.6%, standard deviation of 0.3125 and arbitrarily truncated the distribution between 80% and 100%.

4.3.3 eID Loss Distribution

Three probability distributions were considered to replicate the eID loss rate: (i) normal, (ii) exponential, and (iii) uniform. The normal distribution was considered, assuming that ear tag loss rate is a function of biological factors. As already mentioned, biological factors are often normally distributed. Alternatively, the loss of an ear tag could be considered a product failure or product life issue, which can be modeled using the exponential distribution (see Wackerly, Mendenhall, and Scheaffer, 2002).

Because ear tag loss is a function of biological factors, product failure issues, and management practices, the uniform distribution was considered and chosen to represent the eID tag loss rate. A uniform probability distribution function is bounded between zero and one and gives each possible outcome an equal probability of occurring (Wackerly, Mendenhall and Scheaffer, 2002; Moore, 2003). By using a uniform distribution in this way, it is implicitly assumed that eID loss rate is randomly distributed, but the distribution is unknown. The uniform probability function ranged from 0.1% to 5% to reflect different loss rates reported in previous research (Walker, 2006; Watson, 2002; Williams, 2006; Evans, Davy and Ward, 2005).

4.3.4 Tagging Distribution

To determine which operations tagged their animals during the simulation process, a discrete probability distribution with the random variable taking a value of zero or one (success or failure) was needed. Thus, a Bernoulli distribution (trial) was used.

A Bernoulli distribution function measures the probability of success with each trial containing a population of a zero or one (Berry and Lindgren, 1996). The Bernoulli distribution function requires only one parameter, the probability (*p*) parameter, which is equal to the probability of a success. The random variable returned from the probability distribution is either zero (failure) or one (success). Accordingly, for this study, the *p* parameter was set equal to the probability of an operation tagging their animals (success), which was shown in Chapter 3 to be 52.6%.

4.3.5 Heifer Purchase Distribution

Operations that wish to have a static herd size must replace cows that are culled or die throughout the course of the year. Operators have two options to replace these animals. The operator may choose heifer calves from their herd as replacements for their cowherd, or they may buy bred or open heifers for herd replacements. A Bernoulli distribution was used to identify operations that purchase replacement heifers because of properties that have previously been discussed.

The probability that an operation would buy outside replacement heifers was an aggregate of two numbers reported in the 1997 NAHMS Beef report (USDA, 1997b). This survey reported that 7.9% of all operations bought weaned, open, beef heifers, and an additional 4.1% of operations bought bred heifers. These two numbers were aggregated to find the percentage of operations that brought heifers onto their operation (12%). It was assumed that if an operator bought replacement heifers all required replacement heifers were bought.

4.4 Software Simulation Platform

Statistical simulations can be done by multiple statistical software programs (e.g., add-ins for Microsoft Office Excel) and can be programmed by those with knowledge of statistics and appropriate programming platforms (e.g., MATLAB). This analysis used @Risk version 4.5 to simulate the observations. The software @Risk 4.5 is a Microsoft Office Excel add-in that comes with options such as statistical output, different sampling techniques, and the capability of sampling multiple distributions when running simulations (Palisade Corporation, 2002). This modeling platform was chosen over other simulation platforms because of its ability to integrate with Microsoft Office Excel and its ability to sample distributions using the LHS method.

4.5 Regression Model

Regression analysis is used when the relationship between a dependant variable and independent variable(s) want to be examined. For example, if output (Y) is a function of several independent variables (X_i) (i.e., $Y=f(X_1, X_2, X_3)$), a correctly specified regression analysis will calculate the marginal impact of each individual variable on output and show the statistical significance of each variable. For instance, an estimated parameter value of 1.5 associated with the *TagPrice* variable would mean the price of an eID tag contributes 1.5 times the eID price to the overall cost per head (given the dependent variable (Y) is cost per head).

OLS is an estimation technique for the linear regression. An OLS regression mathematically minimizes the sum of the squared errors (Maddala, 2001). That is, OLS estimates the regression $Y_i = \alpha + \beta X_i + e_i$ such that it minimizes

$$TotalError = \sum (Y_i - \alpha - \beta X_i).$$

OLS regression will be used in this analysis. The following sections will discuss the data, the functional form, and the model specifications.

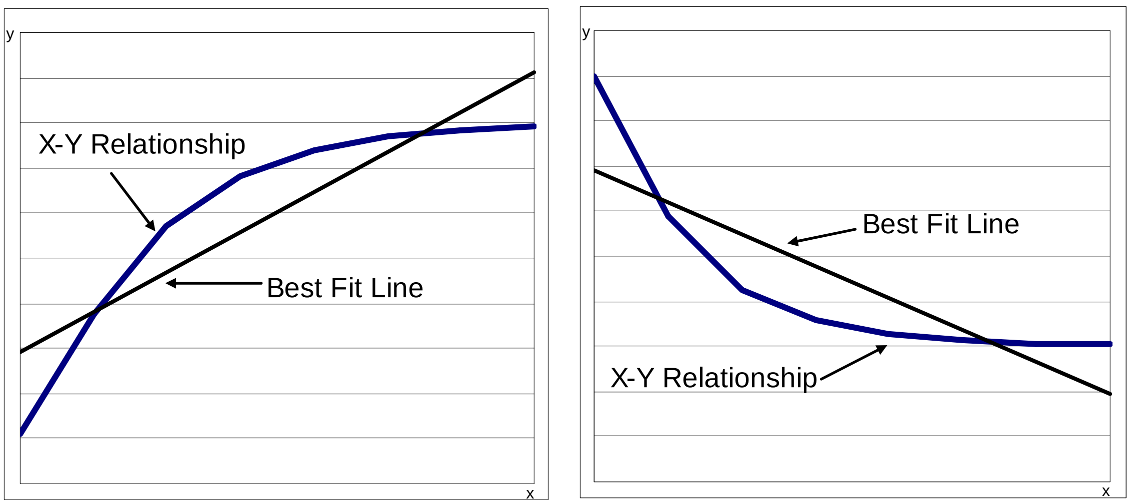
4.5.1 Data

The data used for the OLS regression were generated from the stochastic budget during the simulation process. The total cost and the cost per head were calculated for the i^{th} operation after the stochastic variables had been inputted in to a stochastic budget during the i^{th} iteration. The budget input variables, cost per head, and the total cost for the i^{th} operation were then outputted so they could be used in the OLS regression.

4.5.2 Functional Form

Figure 4.3 shows regression results of assuming the independent variables are linearly associated with the dependant variable when the actual relationship is non-linear. While the best-fit line in figure 4.3 minimizes the sum of the squared error for the assumed model, only two points are correctly modeled for the entire dataset.

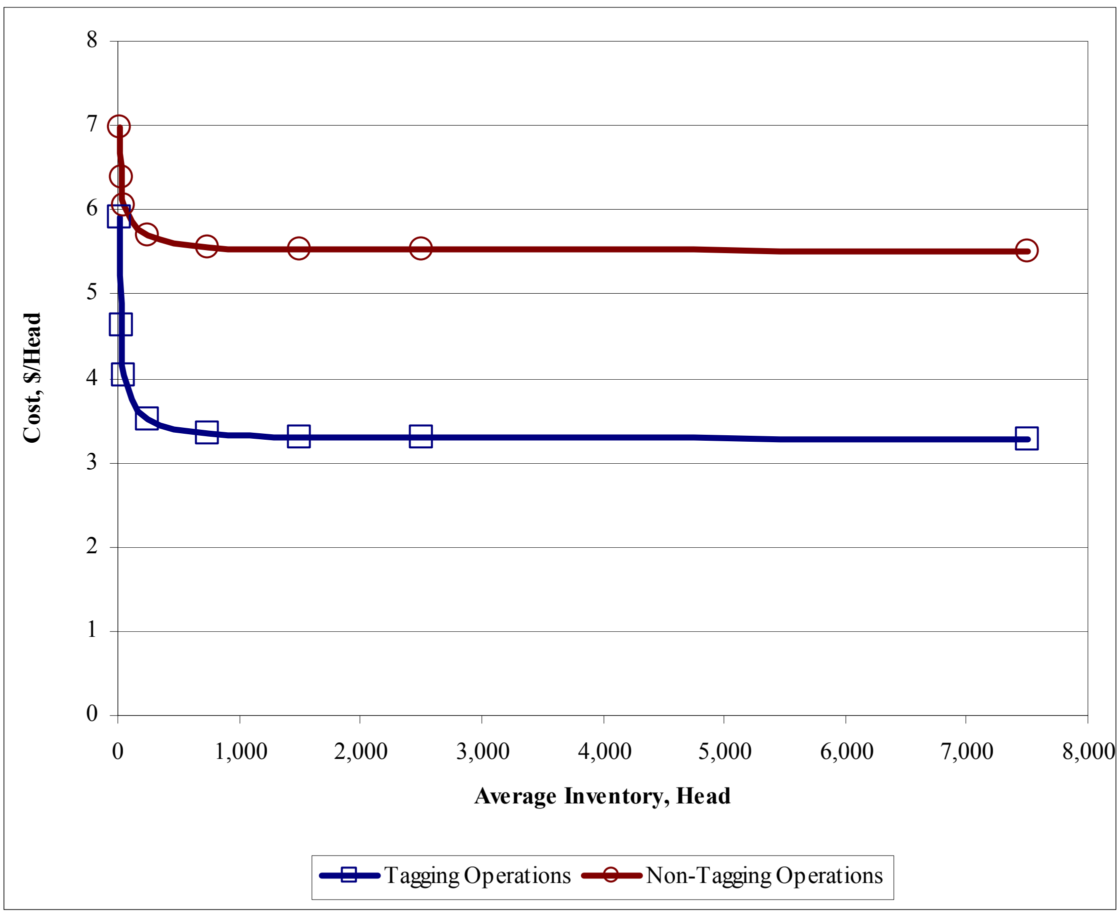
Figure 4.3 Relationship between X-Y and Best-Fit Line



To use an OLS regression with data exhibiting this type of non-linear relationship, the independent variable can be transformed so a better relationship exists between the independent and dependant variables (Larsen, 2008).

The type of transformation the independent variables needs to undergo determines the functional form of the OLS regression. Figure 4.4 shows the relationship between the cost per head and number of head for the two types of cow/calf operations. These cost curves are clearly decreasing at a decreasing rate. The semi-log and reciprocal functional forms are often used to transform the type of non-linear relationships figure 4.4 depicts into a linear relationship (Maddala, 2001; Larsen, 2008). To choose between these two forms, the rate at which the curve decreases must be analyzed (Larsen, 2008). For curves that flatten slowly the semi-log functional form works best; however, for curves that flatten rather quickly the reciprocal function works best (Larsen, 2008). As figure 4.4 shows, the cost curves flatten quickly and decrease much slower after about the 250 head inventory mark. Therefore, a reciprocal functional form for the operation size variable was used for the OLS regression.

Figure 4.4 Cost Per Head Curves for Cow/Calf Operations



This non-linear relationship was expected for two reasons: (i) as herd size increases, fixed costs are spread over more animals, and (ii) volume discounts for purchased tags. Economies of size was built into the budget; as a result, the fixed and variable costs per head decrease as herd size increases. These factors contribute to the non-linearity between the dependent and size variables.

4.5.3 Empirical OLS Specification

The conceptual relationship between costs and the stochastic model is a function of the number of animals needing to be tagged, the eID price, the amount of labor needed to perform the necessary tasks, assessed fees for auction services and premises registration, and opportunity cost on the capital spent performing these activities. Labor and capital outlays were a function of animal inventory and thus were not stochastically changing; therefore, they were not included in the empirical specification. Equation (4.4) shows the conceptual model to estimate

$$C = f\,(Animals, TagPrice, Labor, Capital, Fees, Oportunity\ cost). \qquad (4.4)$$

Using this information and appropriate nonlinear transformations (discussed previously), the empirical OLS regression was specified as

$$\begin{aligned} CPH_i &= b_0 + b_1 OneOver + b_2 Tag + b_3 NoTagSize \cdot OneOver + b_4 HP \\ &\quad + b_5 TagPrice + b_6 PregRate + b_7 eIDLossRate \cdot Tag \end{aligned} \qquad (4.5)$$

where,

CPH	=	NAIS cost, \$/head;
i	=	Index for i^{th} operation;
OneOver	=	1/size of operation;
Tag	=	Dummy variable for tagging operations;
NoTagSize	=	Slope dummy variable for non-tagging operations;
HP	=	Dummy variable for heifer purchasing operations;
TagPrice	=	Price of eID tags, \$/tag;
eIDLossRate	=	Proportion of eID tags lost;
PregRate	=	Proportion of pregnant cows.

The transformed variable for herd size, 1/*N,* was included in the model because the number of tags bought, labor inputs, and other inputs were a function of herd size. Figure 4.4 shows the cost curves for tagging and non-tagging operations. As can be seen in this figure, the intercept and slope are different for the two different types of operations. Accordingly, the *Tag* dummy variable was included to shift the intercept of non-tagging operations and the *NoTagSize* dummy variable was included to adjust the slope for non-tagging operations. The *HP* and *eIDLossRate* variables were included in the model because they were stochastic variables that directly influenced the total cost. The *eIDLossRate* variable was multiplied by the *Tag* dummy variable because the loss rate of eID tags does not apply to operations that do not tag. *TagPrice* was included because it is the single, most expensive input in the budget (see table 5.7 in Chapter 5) for tagging operations and a significant change in price will affect total cost dramatically. *PregRate* was included because it directly affects the number of animals to tag.

CHAPTER 5 – RESULTS

5.1 Introduction

The purpose of this chapter is to review the results of the simulation and the constructed budget. The simulation results are reviewed first, the OLS regression results are discussed next, and the NAIS budget results are discussed last. Following this discussion, the results from the NAIS budget and model will be compared.

For the producer who wishes to find their specific NAIS cost of compliance, the NAIS budget can be download at http://www.agmanager.info.

5.2 Simulation Results

The Latin Hypercube simulation ran for 10,000 iterations, and each iteration sampled five distributions from the stochastic budget during the simulation process. Table 5.1 shows summary statistics for the output variables from the simulation.

The following section shows the histograms of the simulated distributions used in the stochastic budget.

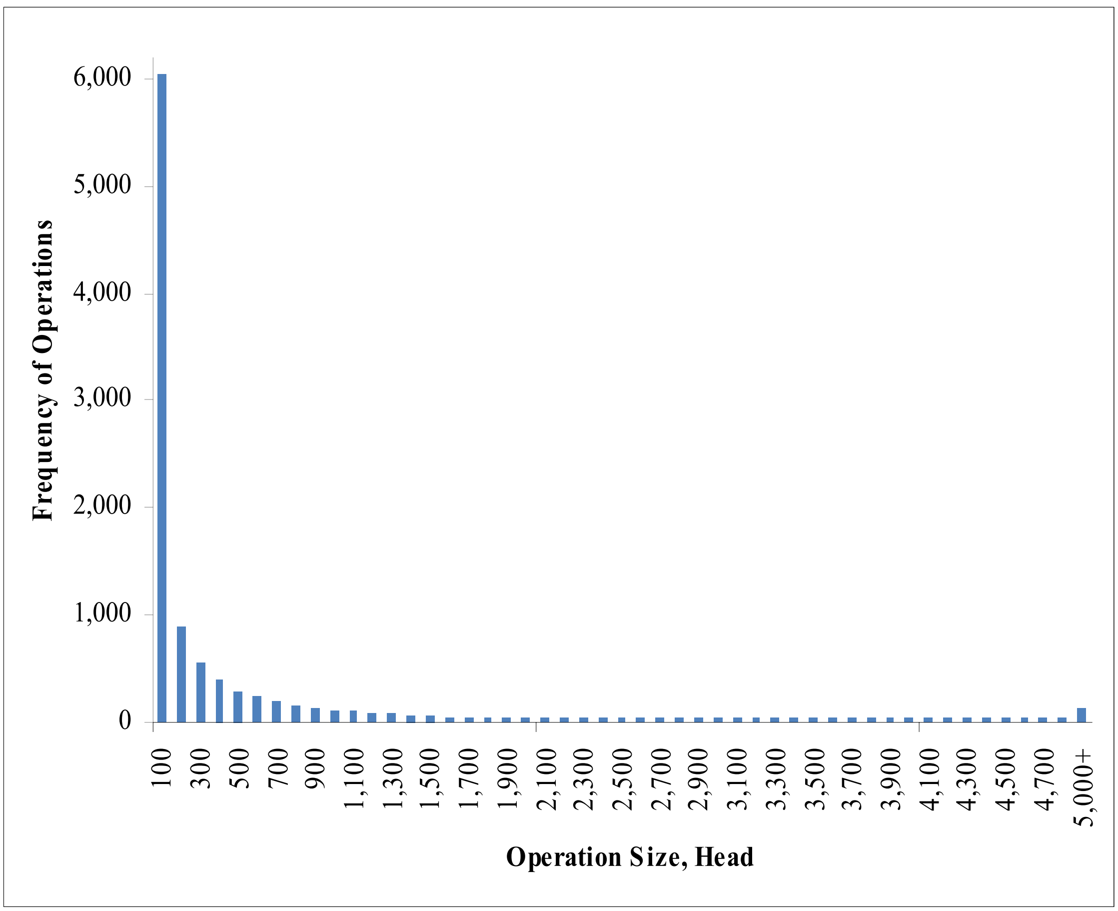
Table 5.1 Summary Statistics of Simulated Variables and Resulting Costs

Input Name	Mean	Minimum	Maximum	Std Dev
Operation Size, head	324.00	1.00	10,511.00	696.00
Tag, %	52.60	0.00	100.00	49.90
Preg Rate, %	92.60	80.00	100.00	31.20
eID Loss Rate, %	2.50	0.00	5.00	14.00
HP	0.12	0.00	1.00	32.50
TagPrice, $/tag	2.28	1.95	2.50	0.20
Total Cost, $	1,171.00	16.00	49,493.00	2,624.00

5.2.1 Gamma Distribution

The *OperationSize* random variable is gamma distributed; accordingly, as figure 5.1 demonstrates, the first size group (<100 head) has the most operations. The distribution steeply decreased to the second category, and from the second category on, the histogram is decreasing in a geometrically decaying fashion. This is generally consistent with NASS statistics of the cow/calf industry.

Figure 5.1 Histogram of Operation Sizes Used in the Stochastic Budget



Unfortunately, this distribution is too heavy in the tail to represent the cow/calf industry perfectly based on NASS statistics. However, this specification was the closest specification that gave both the range and variability needed to replicate operation sizes in the beef industry.

5.2.2 Bernoulli Distributions

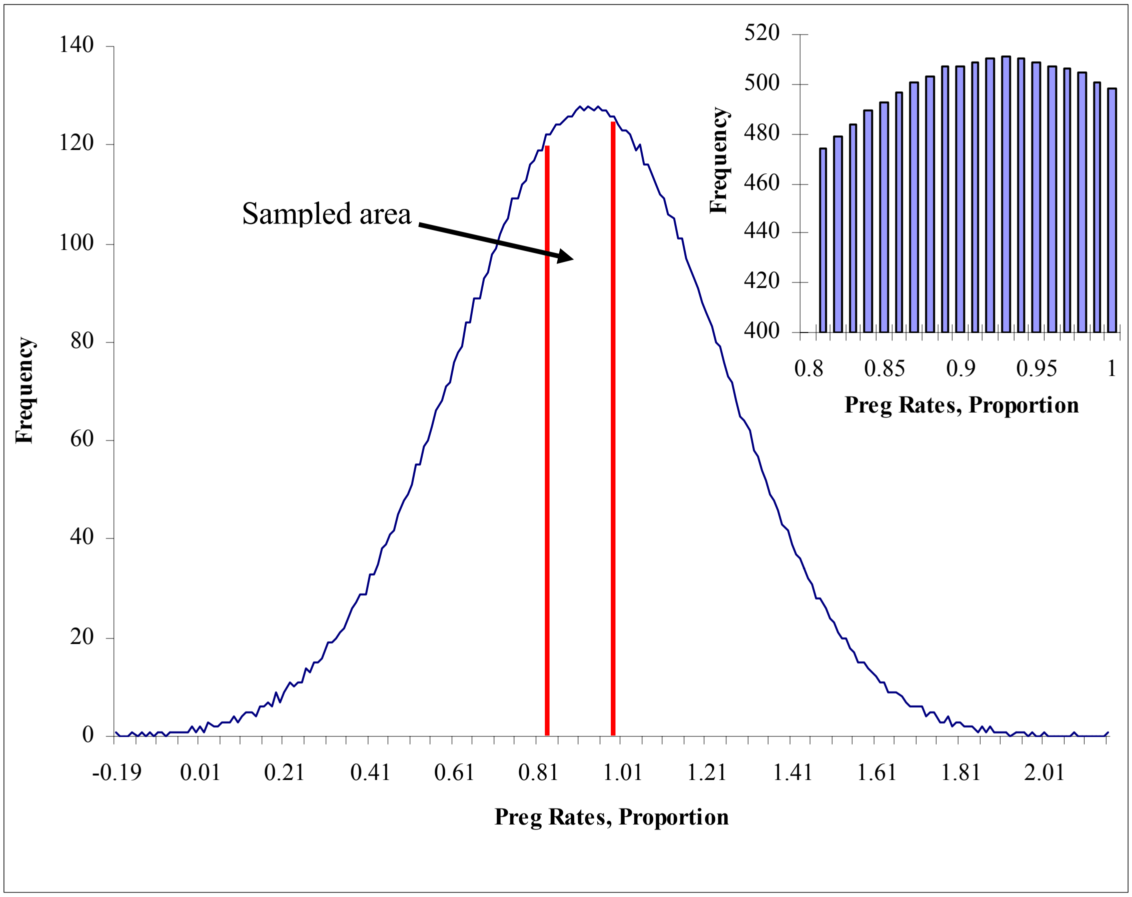
The *Tag* and *HP* random variables are Bernoulli distributed. Bernoulli distributions have an expected value of *Y* that equals the probability of *Tag* or *HP* taking a value of 1. Accordingly, tagging operations had a probability of 52.6%, which indicates that out of 10,000 operations 5,260 operations that tag should have been drawn during the sampling process. The empirical results show that 5,262 operations were drawn during the simulation.

The heifer purchased distribution had a 12% probability of an operation buying replacement heifers. Therefore, an expected 1,200 operations sampled that buy replacement heifers should be drawn in the sampling process. Empirically, the number of operations that purchased heifers during the simulation was 1,200, which indicates that the sample statistic converged to the specified parameter.

5.2.3 Normal Distribution

The *PregRate* random variable is normally distributed. A normal distribution should be symmetrical and peak around the mean. Figure 5.2 shows the unconstrained normal distribution and the inset shows the histogram of the pregnancy rates used in the stochastic budget. The shape of the inset histogram does not look like the traditional bell curve associated with normal distributions because the distribution was truncated at 80% and 100%. Therefore, it is slightly skewed because the mean was 92.6% indicating that the distance from the mean to the left side of the distribution (80%) is not equivalent to the distance from the mean to the right side of the truncated distribution (100%). Figure 5.2 shows this relationship.

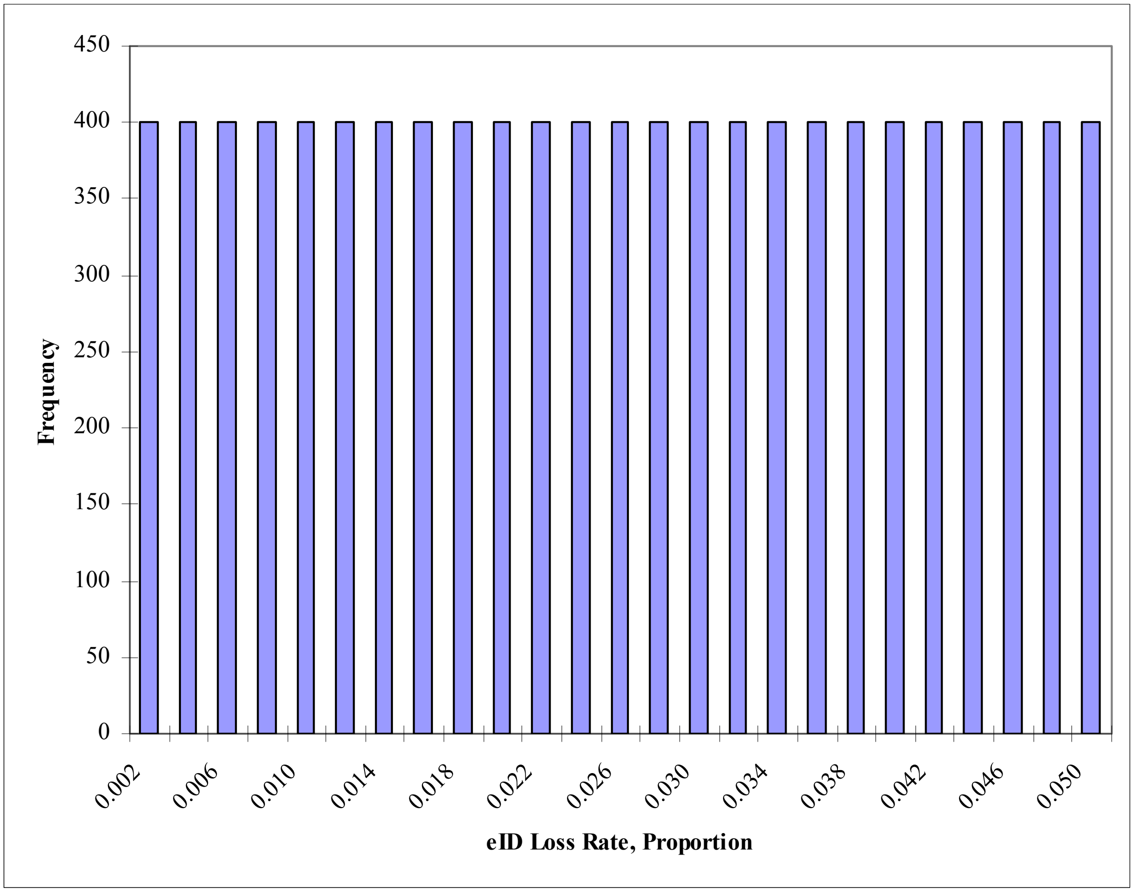
Figure 5.2 Histogram of Pregnancy Rates Used in the Stochastic Budget



5.2.4 Uniform Distribution

The eID loss rate is uniformly distributed and figure 5.3 shows a histogram of the random variable *eIDLossRate* sampled during the simulation process.

Figure 5.3 Histogram of eID Loss Rates Used in the Stochastic Budget



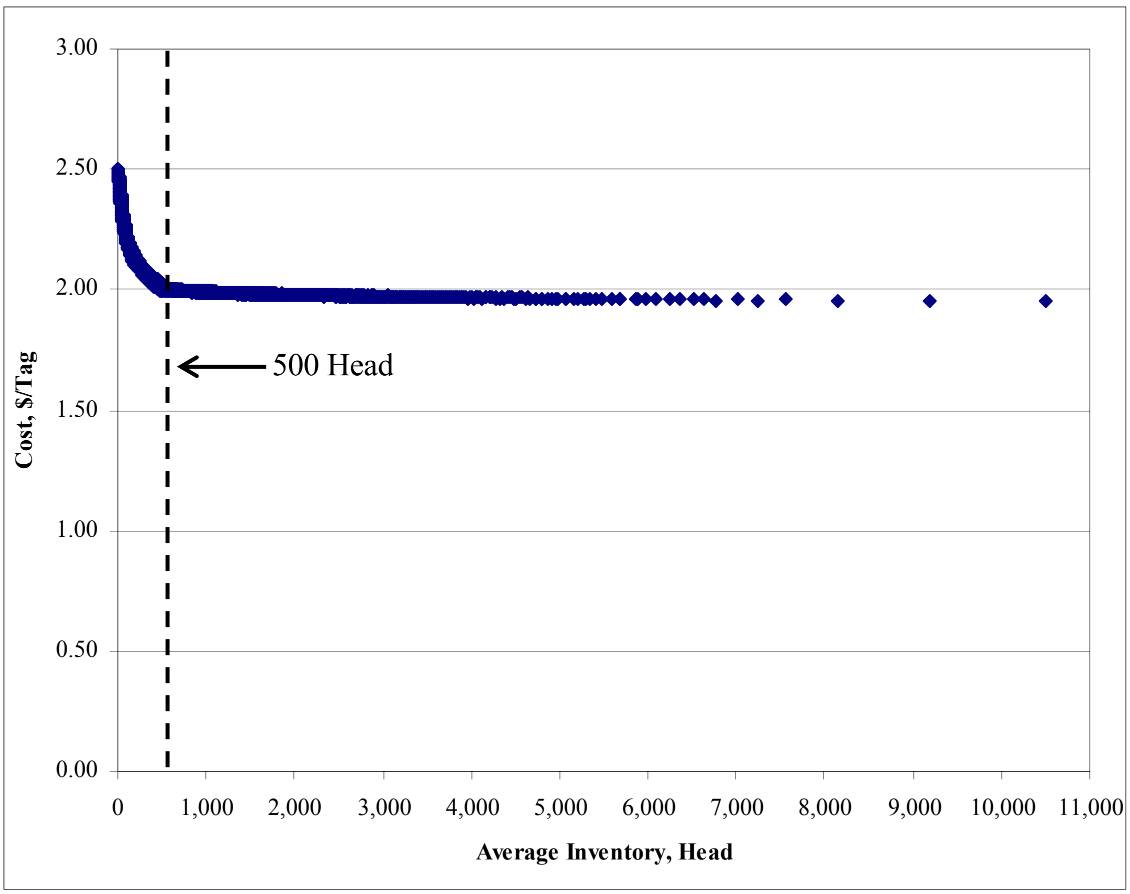
5.2.5 Tag Price

Tag price is not a stochastic variable, but is a function of operation size and was an output variable in the simulation. An output variable is a value that is associated with the i^{th} iteration for the i^{th} producer during the simulation.

Tag prices were expected to range from \$2.50 to \$1.95, and as the herd size increased, tag prices were expected to decrease at a decreasing rate. This expectation comes from assuming that discounts would be given for bulk purchases and the budget was constructed accordingly (see Chapter 3). To ascertain that the function was behaving as hypothesized, the statistics from the simulation were compared with the tag-price expectation.

Figure 5.4 shows a scatter plot of tag prices from the simulation. Tag prices demonstrate a “L” shape that may be observed when tag price diminishes with volume purchases due to volume discounts. Empirically, tag prices ranged from $2.50 to $1.95, and the slope decreases at a decreasing rate as the cost per tag decreases rapidly until 500 head, at which point the curve flattens out.

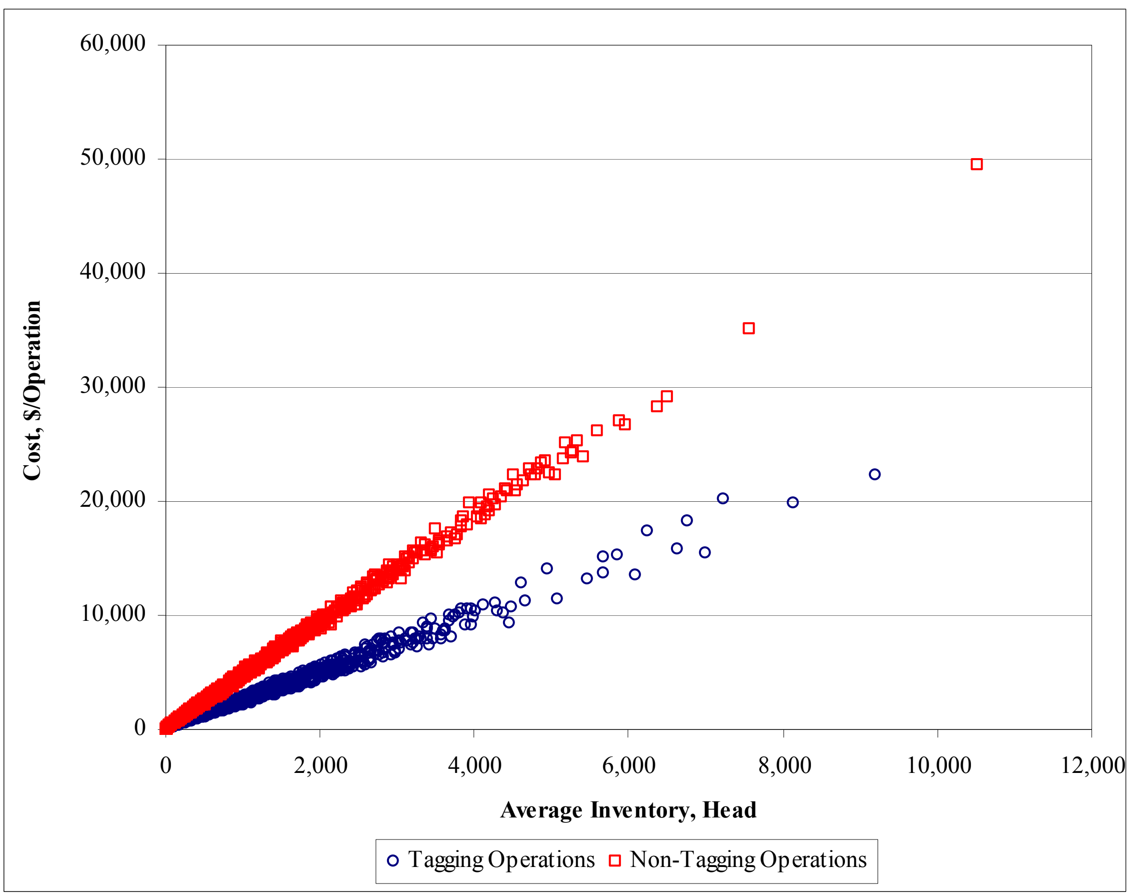
Figure 5.4 Scatter Plot of Tag Prices Used in the Stochastic Budget



5.2.6 Total Cost

Total cost was a function of many deterministic and stochastic variables in the stochastic budget and was an output variable during the simulation. The scatter plot of total cost was examined to look for errors in the stochastic budget that may appear as outliers when graphed. The scatter plot should show two different slopes for the two different types of operations and be relatively linear. Figure 5.5 shows a scatter plot of total cost for the operations drawn during the sampling process. The scatter plot does not reveal any inconsistencies or outliers, and operations that do not currently tag incur a greater cost, which is evident by the different slopes of the two categories.

Figure 5.5 Scatter Plot of Total Cost from Sample Operations



5.3 OLS Regression

Equation 4.5 was estimated using OLS regression with SAS version 9.1.3. A regression analysis provides a convenient way of looking at marginal effects as the resulting coefficients are the marginal effects of the independent variables. While the constructed NAIS budget could be modified to accomplish these objectives, the regression analysis was used so a prediction interval could be estimated.

SAS provides parameter estimates and t-statistics along with the fit statistics that offer a way of determining the efficacy of the model. These statistics and estimates will be discussed in this section. The first group of statistics reviewed is the Analysis of Variance. Following this discussion, the parameter estimates and their implications will be reviewed.

5.3.1 Fit Statistics

The Analysis of Variance for the model is reported in table 5.2. The model had an adjusted R^2 of 0.9989, which is interpreted as 99.89% of the variation in the dependent variables is explained by the variation in the independent variables. The Root Mean Square Error (RMSE) indicates the average error of the model is $0.13 per head, and the F-test, which tests the probability of all variables in the model being statistically zero indicates that collectively, the variables are different than zero at the α=0.01 level (Moore, 2003).

Table 5.2 Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	169,882.0	24,269.0	1,350,219	<.0001
Error	9,992	179.597	0.018		
Corrected Total	9,999	170,062.0			
Root MSE		0.134			
Dependent Mean		6.256			
Coefficient Variation		2.143			
R-Square		0.9989			
Adjusted R-Square		0.9989			

5.3.2 Parameter Estimates and Implications

The estimated parameter coefficients are shown in table 5.3. All variables were significantly different from zero at the α =0.01 level. This is not surprising because random error did not occur in the stochastic budget and the parameters were known.

The *OneOver* variable was positively correlated with cost per head; however, because this variable was transformed so a relationship would exist with the dependant variable, caution should be used when looking at the marginal affect. As herd size increases, the variable *OneOver* decreases. Therefore, as *OneOver* decreases (herd size increases) the cost per head decreases; thus, demonstrating a positive correlation between *OneOver* and cost per head. This relationship is expected because the budget was constructed so that as operations increased in size, producers are able to spread fixed costs over more output and they have more buying power, hence cost per head decrease.

The dummy variable *Tag* is an intercept shifter for operations that tag their cattle and is negative. This is consistent with expectations because operations that tag cattle in the stochastic budget have a lower cost than operations that do not tag when the operation size is larger than five head.

Table 5.3 Parameter Estimates

Variable	Parameter Estimate	Standard Error	t Value	Pr>|t|
Intercept	-0.255	0.045	-5.72	0.198
OneOver	14.183	0.006	2,324.96	<.0001
Tag	-2.396	0.005	-527.70	<.0001
NoTagSize	-8.442	0.007	-1,143.40	<.0001
HP	0.072	0.004	17.49	<.0001
TagPrice	0.772	0.009	87.42	<.0001
PregRate	3.629	0.043	84.53	<.0001
eIDLossRate	11.401	0.128	89.23	<.0001

The dummy variable *NoTagSize* is a slope adjustment variable for operations that do not tag. As figure 4.4 in Chapter 4 shows, as operation size increases the slope of cost per head for non-tagging operations becomes flatter; thus, this variable should be negatively correlated. The empirical results confirm this relationship.

The variable *HP* is positive indicating that when a producer purchases replacement heifers, the cost per head goes up by $0.072. This is consistent with expectations because reading costs are incurred in the stochastic budget when an animal is brought onto a new premises, thus increasing costs.

The variable *TagPrice* is positively correlated with cost per head, which is consistent with expectations. However, the magnitude of the parameter estimate is not consistent with expectations. The coefficient for *TagPrice* is 0.772, which indicates that as eID tag prices increase $1, the cost per head increases $0.772. This magnitude is biased, as a $1 increase should increase cost per head by at least $1.00. However, it is surmised that because tag price was strictly a function of operation size, the operation size variable is catching some of the tag price effects. Different model specifications and functional forms were tried to correct this coefficient to no avail.

The variable *PregRate* is positively correlated with cost per head. This is intuitive as the number of animals needing to be tagged is directly influenced by the number of cows that calve. Therefore, for every 1% increase in pregnancy rate, cost per head increases $0.036.

The variable *eIDLossRate* only affects tagging operations, as non-tagging operations do not incur a tag loss rate. *eIDLossRate* is positive, and implies that as the loss rate increases 1% the cost per head increases $0.11.

5.4 Model Evaluation

With the budget constructed and the parameters estimated for the regression model, the results can be reviewed and compared. The discussion will start by reviewing results from the budget. Following this discussion, the results from the budget and the model will be evaluated together to ascertain how well the regression model predicts the estimated costs calculated by the stochastic budget.

5.4.1 Budget

An advantage of deterministic models like the NAIS budget developed is they can be tailored to fit individual situations and management styles. The following results show the total costs of NAIS compliance for several operation sizes with inputs at national averages. For the producer who wishes to estimate their specific NAIS compliance cost, the budget can be downloaded at http://www. agmanager.info.

Table 5.4 shows the total cost per operation by size of operation. As expected, total cost for non-tagging operations exceed those of tagging operations.

Table 5.4 Total NAIS Cost of Compliance by Average Operation Size and Type

Operation Size, Head	20	75	250	750	1,500	3,500	5,000
Tagging Operations	72	220	665	1,880	3,717	8,587	12,233
Non-Tagging Operations	106	373	1,199	3,509	6,991	16,246	23,178

Table 5.5 lists the cost categories of the budget and the percentage each cost category attributes to the total cost. The most expensive input for operations who tag is the eID tag; however, this is not the case for the non-tagging operations. eID tags and chute costs are equally expensive; in fact, when non-tagging operations get larger than 230 head, the chute costs become the most expensive input. This occurs because the volume discounts on eID tags make cash outlays for eID tags decrease on a per head basis.

Table 5.5 Percent of NAIS Cost Attributed to Cost Categories by Operation Type and Size

Operation Size, Head	20		750		5,000	
	Tag	No-Tag	Tag	No-Tag	Tag	No-Tag
RFID Tag	67.8	40.6	80.9	38.0	81.5	37.7
Applicator	5.5	0.0	1.2	0.0	0.3	0.0
Labor	9.7	0.0	4.6	0.0	5.2	0.0
Chute	1.4	40.4	2.0	45.7	2.1	46.1
Shrink	2.3	11.5	3.3	13.0	3.4	13.1
Injury	0.9	2.8	0.6	2.9	0.7	2.9
Reading Costs	0.0	0.0	0.5	0.3	0.2	0.1
Premises Registration	6.9	4.7	0.3	0.1	0.0	0.0
Interest on cow tags	5.5	0.0	6.6	0.0	6.6	0.0
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0

Table 5.6 is a cost matrix for tagging operations with cost of eID tag on the vertical axis and the operation size on the horizontal axis. This matrix was calculated using the budget with all inputs held constant except eID tag costs which incremented by $0.25, and shows how cost per head increases as eID price increases.

Table 5.6 Costs per Head for Tagging Operations at Varying eID Prices by Herd Size

		Average Herd Size, Head						
		20	75	250	750	1,500	3,500	5,000
Price of eID Tag	$1.25	2.32	1.81	1.71	1.68	1.67	1.66	1.66
	$1.50	2.60	2.08	1.98	1.95	1.94	1.94	1.94
	$1.75	2.87	2.36	2.26	2.23	2.22	2.21	2.21
	$2.00	3.15	2.63	2.53	2.50	2.49	2.49	2.49
	$2.25	3.42	2.91	2.81	2.78	2.77	2.76	2.76
	$2.50	3.70	3.18	3.08	3.05	3.04	3.03	3.03
	$2.75	3.97	3.46	3.36	3.33	3.32	3.31	3.31
	$3.00	4.25	3.73	3.63	3.60	3.59	3.58	3.58

To determine the effect of eID loss rates on total cost and eID tag costs, a cost matrix was calculated (Table 5.7) that has eID tag costs on the vertical axis and an eID loss rate on the horizontal axis. This matrix was calculated using the budget and held all variables constant except the eID loss rates and eID tag prices. As this table shows, at a $2.00 eID tag price, cost per head increases $0.56 cents per head as eID loss rate increases from 0% to 5%.

Table 5.7 Effects of eID Price and eID Loss Rates on Cost Per Head

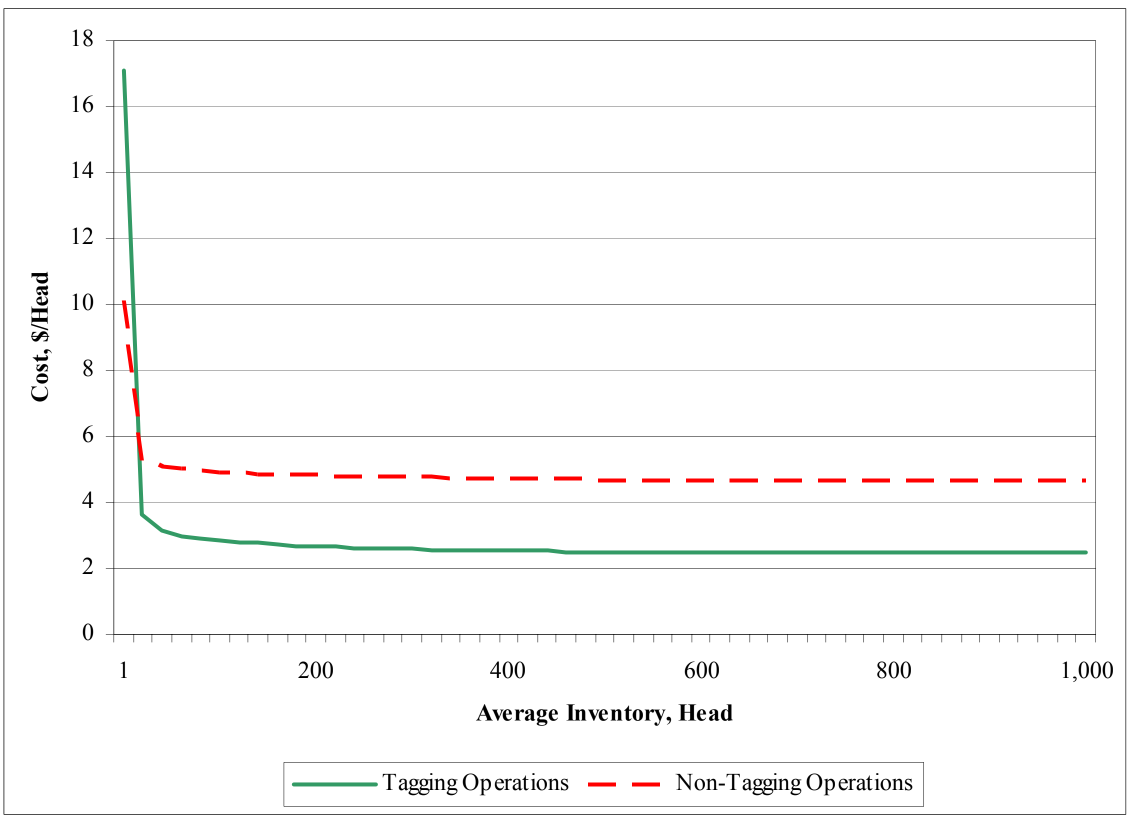
		eID Loss Rate					
		0%	1%	2%	3%	4%	5%
Price of eID Tag	1.25	1.47	1.56	1.65	1.75	1.85	1.95
	1.50	1.73	1.83	1.93	2.03	2.14	2.24
	1.75	1.99	2.10	2.20	2.31	2.42	2.53
	2.00	2.26	2.36	2.47	2.59	2.71	2.82
	2.25	2.52	2.63	2.75	2.87	2.99	3.11
	2.50	2.78	2.90	3.02	3.15	3.27	3.40
	2.75	3.05	3.17	3.30	3.43	3.56	3.69
	3.00	3.31	3.44	3.57	3.71	3.84	3.98

A 500 head, tagging operation with all other variables held at the means.

While larger operations pay more on an operation basis, on a cost per head basis the smaller operations pay more. Figure 5.6 shows the relationship between operation size and cost per head. For producers who currently tag, cost per head decreases in a geometric decaying fashion with the smaller operations paying the most. The reason smaller operations pay more per head is fixed costs are not spread out over as many animals, and labor productivity increases as herd size increases.

For producers who do not tag, the cost per head decreases slower as operation size grows compared to tagging operations. This occurs because producers who do not tag only received volume discount on the eID tag, and were charged a constant price for custom ear tagging at the auction yard. Operations with fewer then five head have higher costs than non-tagging operations due to the capital investments and labor outlays tagging producers incur to become NAIS compliant.

Figure 5.6 NAIS Compliance Cost Per Head by Operation Type and Size



The diseconomies of size is large for operations with less than 20 head. For instance, for an operation that tags and only has one cow, the cost of NAIS compliance is $17.10 per head. This cost steeply decreases with each additional animal added to the herd. These results support a previous tool developed by Dhuyvetter and Blasi (2003), which demonstrated that operations with small herd sizes had high eID implementation costs.

5.4.2 Reading Components

Opponents of NAIS often suggest that the cost of NAIS compliance is prohibitively expensive for small operations. NAIS opponents conclude this by assuming that reading components must be purchased by small operations to become NAIS compliant (LAC, 2007). This study does not make this assumption; rather, this study assumes that the economic profit available from reading eID tags will entice businesses to enter into the eID tag reading market. Thus, small operations will utilize custom reading services because this will cost less than reading the eID tags themselves.

For early adopters this assumption does not hold because people have not had time to react to this signal. Regardless, it is assumed that producers will not buy eID reading components until they can perform the electronic eID reading themselves at an equivalent or lower cost than a custom reading rate.

Table 5.9 shows a cost-read matrix with computer (data accumulator) price on the vertical axis and eID handheld reader price on the horizontal axis. This matrix indicates how many animals need to be read before an operator will purchase reading components at given prices and the reading schedule used in the budget; this schedule is a function of reads and thus varies by the number of animals read. Internet costs were assumed to be incurred if a computer had to be bought; however, if a producer had a computer (cost=$0), it was assumed that the producer had an internet connection as well. Office labor was not included in the matrix calculation so the effects of computer costs and handheld costs could be evaluated. For the eID reading component costs assumed in the budget (approximately $700 for a computer and $1,100 for a reader), approximately 880 animals would have to be read annually before a producer would buy eID reading components.

Table 5.8 Number of Animals Read Before eID System is Purchased at Varying Costs

	eID Handheld Reader Cost, $									
Computer Cost, $	0	400	600	800	1,000	1,200	1,400	1,600	1,800	2,000
0	1	176	271	356	446	541	631	721	811	901
400	280	455	550	640	730	820	910	1000	1100	1190
500	315	490	585	675	765	855	945	1045	1135	1225
600	350	530	620	710	800	890	980	1080	1170	1265
700	380	565	655	745	835	925	1025	1115	1205	1300
800	415	600	690	780	870	960	1060	1150	1240	1335
900	450	635	725	815	905	995	1095	1185	1280	1370
1,000	485	670	760	850	940	1040	1130	1220	1315	1405
1,100	525	705	795	885	975	1075	1165	1255	1350	1440

5.4.3 Prediction Model

The purpose of this study is to provide a point estimate of NAIS costs which was accomplished by constructing a budget and estimating a regression model. The budget provides the user with enough input options to pinpoint NAIS compliance cost, tailored to their operation; however, the regression model is more general requiring fewer inputs. Accordingly, the model is simpler and requires less time, but potentially is less accurate because it does not give the precise cost incurred by becoming NAIS compliant. Rather, it returns an average cost estimate of becoming NAIS compliant conditional upon several key variables. Therefore, the cost estimate returned from the model may not equal the producers cost estimate returned from the budget (which is assumed to be more accurate). Hence, an interval containing the point estimate needed to be ascertained. Confidence intervals and prediction intervals were considered for this purpose.

5.4.3.1 Interval Estimation

Confidence intervals provide an upper and lower bound of the cost estimate at the mean response. This interval provides a range that contains the cost estimate *p* percent of the time. The interval range increases as the probability (*P*) of capturing the true cost estimate increases; accordingly, the range for 90% probability is smaller than the range for 99% probability. Confidence intervals are calculated as (Moore, 2003)

$$b \pm t_c \cdot s \tag{5.6}$$

where,
b = Estimated statistic;
t_c = Critical value from a t-distribution;
s = Standard deviation of sample.

While confidence intervals provide the range of estimate values at the mean response (Moore, 2003), this study is interested in the interval range at an individual response.

Prediction intervals compensate for the increased variability of individual responses by increasing the range of the interval; thus, they are more appropriate for this study. With the increased variability accounted for, the prediction interval should contain the budget point estimate *p* percent of the time. Prediction intervals are calculated as (Greene, 1993; Griffiths, Hill, and Judge, 1993)

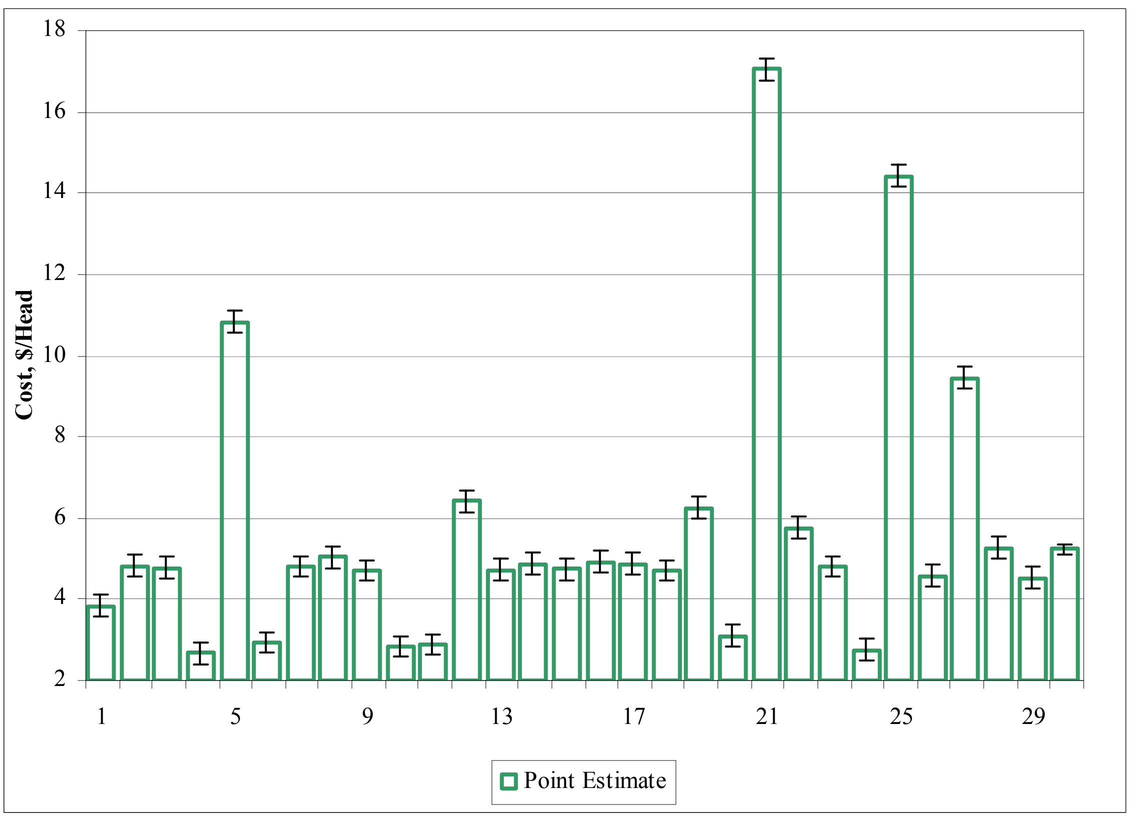
$$b \pm t_c \cdot \sqrt{s^2\left(1 + x^{0\prime}(X'X)^{-1}x^0\right)} \tag{5.7}$$

where,

b = Estimated statistic;
t_c = Critical value from a t-distribution;
$\sqrt{(\cdot)}$ = Standard deviation of the variables.

Therefore, to calculate a prediction interval, the Mean Square Error (MSE) (s^2) and the X'X matrix need to be estimated, and the t_c value decided upon (Greene, 1993). The MSE value is contained in the OLS regression output located in the Analysis of Variance section, and the $(X'X)^{-1}$ matrix is outputted by SAS. A significance level of 95% was used in this analysis; therefore, t_c equaled 1.96. Figure 5.7 shows the resulting prediction interval for the first 30 operations from the sample.

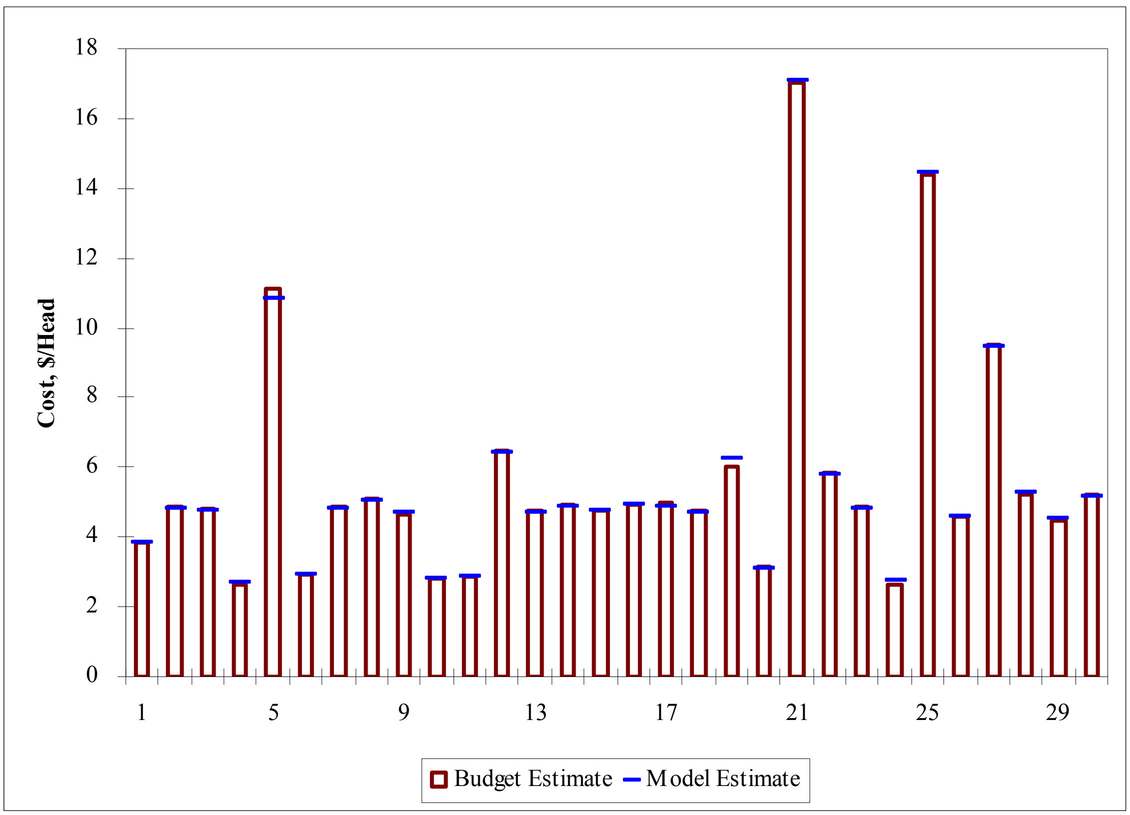
Figure 5.7 Point Estimate and Prediction Interval for Estimated Cost per Head



5.4.4 Budget-Model Comparison

The regression model had a relatively high adjusted R^2 value and a small RMSE, which indicates that the model mirrors the budget well. Figure 5.8 shows the model estimates and the budget estimates of the first 30 operations in the sample. As the high R^2 suggests, the model estimates compare closely to the NAIS costs estimated from the NAIS budget.

Figure 5.8 Budget Estimates Verses Model Estimates



The total error between the NAIS budget cost estimates and the model cost estimates is referred to as total operation error. However, to make a meaningful comparison the residuals were standardized according to

$$P_i = \left(\frac{Residual_i}{Prediction_i} \right) \tag{5.9}$$

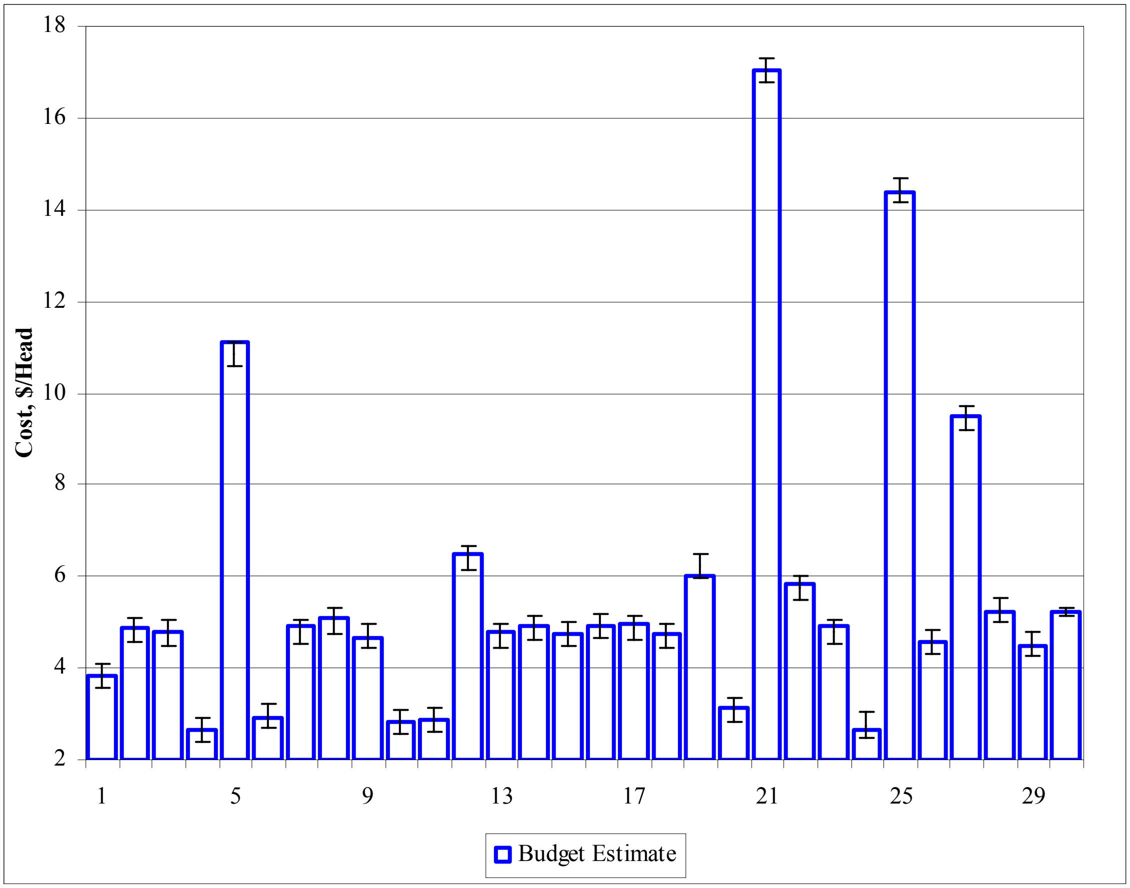
where,

i	=	Index for i^{th} operation;
Residual	=	Prediction error, \$/head;
Prediction	=	Predicted cost per head, \$.

The maximum percentage that any operation was off was 10%, and 86.2% of the 10,000 simulated operations had a 3% error or less, and 96.5% of operations had a 5% error or less.

Figure 5.9 shows how the interval estimation correlates to the actual cost per head from the budget. The interval estimation contains 95% of the estimated costs produced from the budget within its bounds. To keep the scale of the figure readable, only the first 30 operations drawn from the simulation were graphed.

Figure 5.9 Budget Estimated Bound by Interval Estimation



CHAPTER 6 – CONCLUSION

Forms of animal identification have been around for centuries. The U.S. has had a government animal identification system since the 1940's to help eradicate diseases. With cost of disease management rising and the successful implementation of foreign government tracking systems, the U.S. has proposed the National Animal Identification System (NAIS) to help manage both disease and costs associated with disease. The NAIS proposed by the government has caused debates from proponents and opponents on the producer cost of becoming compliant. To date, NAIS is 100% voluntary with some organizations pushing for mandatory participation and other organizations pushing for dismissal, yet a comprehensive and reliable tool to help estimate the cost of a NAIS to the individual producer is not available.

Research in the area of NAIS cost has been sparse and only one known tool has been developed for producer use. A benefit-cost analysis for the U.S. livestock industry was submitted to APHIS in 2008 by Kansas State University; however, a comprehensive NAIS costing tool for individual U.S. cow/calf producers that provides producers a way to determine their costs has not been published. This study provides producers two tools to estimate these costs in the form of a Microsoft Excel worksheet that is downloadable at http://www.agmanager.info.

Published studies from other countries, producer input and knowledge, and relevant information from COOL studies were used to build a complete budget that producers can use to determine the cost of becoming NAIS compliant.

NAIS rules are not final so assumptions had to be made in order to construct the NAIS budget. It was assumed that NAIS would remain voluntary, that for profit third parties would perform tasks that producers were unable to do economically (yet still desire to be NAIS compliant), volume discounts would be given to producers who buy eID tags in bulk, and economies of scale would be exhibited as operation size increased. These assumptions were made to construct the NAIS budget.

Both cash and opportunity costs are considered in this study, with cash outlays being charged 7.75% to account for opportunity costs; accordingly, the tools from this study are economic costing tools. Therefore, the point estimate returned from these tools includes both cash and non-cash costs. Non-cash costs like depreciation, opportunity costs, and shrink, do not require a cash outlay; but non-cash costs do reduce producer's net worth directly by reducing assets and revenues.

The budget was turned into a stochastic model to produce data observations for a regression analysis. This was accomplished by utilizing five distributions within the budget. A gamma distribution was used for operation size, a Bernoulli distribution was used to identify tagging operations and operations that buy heifers, a truncated normal distribution was used for pregnancy rates, and a uniform distribution was used for eID loss rates that operations might experience. The distribution specifications were matched to known sample distribution as close as the available information allowed, and where this information was not available, assumptions were made using economic theory. With the distributions specified, Latin Hypercube sampling was employed for the sampling technique and 10,000 draws produced the sample needed to perform the regression analysis.

The regression analysis used OLS to estimate the regression, and with the estimated coefficients, a model was constructed to give producers a second way of estimating NAIS cost of compliance. This model only requires six inputs by the producer. A prediction interval was also estimated so that the prediction interval contained 95% of the NAIS compliance cost estimates that producers would get if they used the budget instead of the model.

Becoming NAIS compliant does not mean eID reading components (computer and reader) need to be purchased; on the contrary, this analysis found that reading components would rarely be purchased for NAIS compliance alone. Based on the assumptions in the budget, only operations reading approximately 880 animals annually could justify buying all of the components. However, if a producer already owned a computer and had an internet subscription, they would only need to read 446 animals to justify buying the reader. Regardless, small operations could never economically justify buying reading components to become NAIS compliant.

It was found that the average cost for becoming NAIS compliant was \$6.26 per head for the cow/calf industry, which ranged from \$17.56 to \$2.08, and had a standard deviation of \$4.12. However, because the true operation size distribution is not known, this estimate is only accurate if the gamma distribution used in the sampling process matches the population distribution.

Diseconomies of scale were greatest between one and 20 head, after which, a large increase in operation size was required to realize any economically significant reductions in costs per head. Operations with more than 250 cows have costs that are relatively constant and little economies of size is gained after this point.

This study adds to the research by providing an in-depth analysis of NAIS compliance cost to individual producers and gives producers two tools, which will help producers determine their NAIS compliance costs. Both tools are available in a Microsoft Office Excel spreadsheet that can be downloaded from http://www.agmanager.info.

Further research is needed on the benefits of NAIS compliance to the individual producer, as this study does not address this area of interest. The potential for benefits related to NAIS implementation are considerable assuming management reacts to information in a beneficial manner. However, information needed by the individual producer to realize these advantages is not known.

REFERENCES

Alliance Consulting and Management. *Cost Analysis of NLIS Compliance for Beef Producers.* May, 2004. Accessed May, 2008, available at http://www.mla.com.au/NR/rdonlyres/09C04839-42A0-424F-B108-BC96AA0349D6/0/CostAnalysisofNLIScomplianceforbeefproducersMay2004.pdf

Anti-NAIS. *National Animal Identification System (NAIS).* Presentation presented at http://www.slideshare.net/appaloosas/anti-nais/.

Australian Beef Association (ABA). 2005. *Submission to the Queensland Government Relating to the National Livestock Identification System Regulatory Impact Study.* Toowoomba, January.

Bass, P.D., K.E., Belk, M.B. Bowling, T.G. Field, S.H. Geleta, S.B. LeValley, J.M. Meisinger, R.G.L. Murphy, D.L. Pendell, J.A. Scanga, G.C. Smith, J.N. Sofos, J.D. Tatum, W.R. Wailes. 2007. *Assessing The Impact Of The National Animal Identification System (NAIS) With Regard To Beef, Pork And Lamb Harvesting And Rendering Facilities In The US*. Final Report submitted to USDA APHIS on September 25.

Barnes, K, S. Smith, and D. Lalman. 2007. *Managing Shrink and Weighting Conditions in Beef Cattle*. Oklahoma Cooperative Extension Service. F-3257.

Berry, D and B. Lindgren. 1996. *Statistics: Theory and Methods.*2nd Ed. Belmont: Wadsworth Publishing Company.

Blancou, J. 2001. *A history of the traceability of animals and animal products.* Rev. sci. tech. off. Int. Epiz. 20(2):420-425.

Blasi, D., K. Dhuyvetter, M. Spire, M. Epp, and B. Barnhardt. 2003. *A Guide for Electronic Identification of Cattle.* KSU Agr. Exper. Sta. & Coop. Ext. Serv.

Bolte, K., 2008. *Electronic Animal Identification Systems at Livestock Auction Markets: Adoption Rates, Costs, Opportunities, and Perceptions (Summary).* Working Paper, Dept. of Agr. Econ., Kansas State University.

Boyles, S., Frobose. D., and Roe, B. 2002. *Ownership Options for Feeding Cattle*. The Ohio State University Animal Science AS-15-02.

Breiner, S. 2006. *2006 National Cow-Calf Survey—Producer reaction and response to the National Animal Identification System.* Presentation, Dept. of Animal Science, Kansas State University.

Buskirk, D. 2006. *Radio Frequency Identification Ear Tag Application and Management.* Dept. of Ani. Sci. E-2967, University of Michigan.

Davis, E.E. 2003. Country of origin labeling. Available on the World Wide Web: http://livestock-marketing.tamu.edu/COOL.html.

Dhuyvetter, K. and D. Blasi. 2003. *RFID Costs.XLS*. Accessed June 2008, available at www.agmanager.com.

Disney W.T., J.W. Green, K.W. Forsythe, J.F. Wiemers, and S. Weber. 2001. *Benefit-cost analysis of animal identification for disease prevention and control.* Rev. sci. tech. Off. Int. Epiz. 20(2): 385-405.

Evans, J., Davy, J., and Ward T. 2005. *An Introduction to Electronic Animal Identification Systems and Comparison of Technologies*. Cooperative Extension. University of California.

Electro-Com. 2007. *LF 134 kHz vs. HF 13.56 MHz for Livestock Identification.* White Paper. Mt. Waverly VIC.

Farm-To-Consumer Legal Defense Fund (FTCLDF). 2008. *Reasons to Stop the NAIS.* Accessed August 20, 2008, available at www.ftcldf.org/nais.html.

Felsman, R. 1993. *Beef Cattle Identification.* University of Arkansas at Pine Bluff Cooperative Extension Program. No. FSA3002-3M-5-00R. Accessed September 2008, available at http://www.uaex.edu/Other_Areas/publications/PDF/UAPB/FSA-3002.pdf.

Gill, D, K. Barnes, K. Lusby, and D. Peel. dated. *Ranchers Guide to Custom Cattle Feeding.* Beef Cattle Handbook. BCH-8040.

Gray, C. 2004. *The National Animal Identification System: Basics, Blueprint, Timelines, and Processes.* WEMC FS #1-04.

Greene, W. 1993. *Economic Analysis.* 2nd ed. Englewood Cliffs: Prentice Hall.

Griffiths, W., R. Hill, and G. Judge. 1993. *Learning and Practicing Econometrics*. New York: John Wiley and Sons, Inc.

GSA. 2007. *Privately Owned Vehicle (POV) Mileage Reimbursement Rates*. Accessed December, 2007, available at http://www.gsa.gov/Portal/gsa/ep/contentView.do?contentId=9646&contentType=GSA_BASIC.

Ishmael, W. 2002. *Time is Weight*. Beef Magazine. Accessed October, 2007, available at http://beefmagazine.com/mag/beef_time_weight/.

Ishmael, W. 2003. *Bigger is Cheaper*. Beef Magazine. Accessed September 2008, available at http://beefmagazine.com/mag/beef_bigger_cheaper/.

Krieg, K. 2007. *Shrink*. Alaska Livestock Series. Feb. LPM-00744.

Larsen, P. 2008. *Transforming Variables.* Dept. of Statistics. St111, University of Southern Denmark. Accessed September 29, available at http://statmaster.sdu.dk/courses/st111/module06/index.html.

Liberty Ark Coalition (LAC). 2007. *Cost-benefit Analysis of the National Animal Identification System (NAIS).*

LMA. 2008. Personal communication. March.

Maddala, G. 2001. *Introduction to Econometrics.* West Sussex: John Wiley & Sons.

McKay, M.D., R.J. Beckman and W.J. Conover. 2000. *A Comparison of Three Methods for Selecting Values of Input Variables in the Analysis of Output From a Computer Code. Technometrics*, 2000(42):55 - 62.

Michigan RFID Education Task Force. 2008. *Home Page*. Accessed September 2008, available at http://www.michigananimalid.com/.

Microsoft. 2008. *Microsoft. Office Professional 2007*. Accessed May 2008, available at http://office.microsoft.com/en-us/products/FX101211561033.aspx.

Moore. D. 2003. *The Basic Practice of Statistics.* 3rd ed. New York: W.H. Freeman and company.

Mus, M. 2006. Traceability System Approaches and Cost Analysis for the Beef Industry. MS Thesis, Washington State University, August.

Myers, J. 2001. *Injuries Among Farm Workers in the United States, 1995*. Cincinnati, OH: National Institute for Occupational Safety and Health (NIOSH), Publication: 2001-153, May.

National Institute for Occupational Safety and Health (NIOSH). 2004. *Work-Related Injury Statistics Query System*. Atlanta, GA. Accessed January 2008, available at http://www2a.cdc.gov/risqs/default.asp.

National Safety Council (NSC). 2006. *Injury Facts*. Available at http://www.nsc.org/injuryfacts/.

Olsson A., Sandberg, G., Dahlblom O. 2003. *On Latin Hypercube Sampling for Structual Reliability Analysis.* Structural Safety. 25(22):47-68.

Pakko, M. 2007. *Barnyard Boon or Bust.* The Regional Economist. January: 11-12. Accessed September 2008, available at www.stls.frb.org/publications/re/2007/a/pdf/nais.pdf.

Palisade Corporation. 2002. @Risk: Advanced Risk Analysis for Spreadsheets, Version 4.5. Newfield, NY: Palisade Corporation.

Parish, J. 2006. *Breed Association Sponsored COmmerical Marketing Programs.* Cattle Business in Mississippi, November/December. Accessed September 22, 2008, available at http://msucares.com/livestock/beef/mca_novdec2006.pdf.

Ramuski. 2008. *Latin Hypercube Sampling: Quicker Monte Carlo Simulations*. Accessed September 9, 2008, available at http://expertvoices.nsdl.org/cornell-cs322/2008/04/28/latin-hypercube-sampling-quicker-monte-carlo-simulations/.

Recipe for America. 2008. *Animal Ag: National Animal ID System.* Accessed August 20, 2008, available at www.Recipeforamerica.org/page.php?id=3&mode=print.

Reinholz, A., D. Vaselaar, G. Owen, D. Freeman, J. Glower, K. Ringwall, M. Riesinger, and G. McCarthy. Undated. *Learning from Animal Identification with UHG RFID Technology*. North Dakota State University. CNSE. Available at http://autoidlabs.mit.edu/cs/convocation/2006_05_01_LasVegas/presentations%5CMcCarthy.pdf.

Resende-Filho, M. and B. Bhur. 2006. *Economic Evidence of Willingness to Pay for the National Animal Identification System in the U.S.* Paper presented at the International Association of Agricultural Economists Conference, Gold Coast, Australia, 12-18 August.

RFID Journal. 2005. *Can RFID Protect the Beef Supply?* Accessed September 2008, available at http://www.rfidjournal.com/article/view/722/1/1.

Richardson, C. 2005. *Reducing Cattle Shrink.* Ministry of Agriculture, Food and Rurual Affairs. September; AGDEX 425/20.

Ringwall, K. 2003. BeefTalk: *Tagin and Tracking Cows is not as Simple as it Sounds.* North Dakota State University Agr. Exp. Sta..

Ringwall, K. 2005a. *BeefTalk: Overhead Costs Loom Big in Working Cattle on Range*. North Dakota State University Agr. Exp. Sta., January.

Ringwall, K. 2005b. BeefTalk: *Tagging Cattle Challenges Time Management Concept.* North Dakota State University Agr. Exp. Sta., January.

Self, H.L. and N. Gay. 1972. *Shrink During Shipment of Feeder Cattle*. Journal of Animal Science. 35:489.

Schmitz T., C. Moss, and A. Schmitz. 2003. *Marketing Channels Compete for U.S. Stocker Cattle*. Journal of Agribusiness. 21(2):131-148.

Smith, P. 2006. *Community Commentary: NAIS could prove costly, unsafe and illegal.* Wallowa County Chieftain. March 30th. Accessed September 2008, available at http://www.wallowacountychieftain.info/main.asp?SectionID=6&SubSectionID=6&ArticleID=9754&TM=19778.85.

Smith, R. 2003. *COOL start-up costs put at $9 billion; AMS issues listening dates, locations.* April. Accessed August 16, 2008, Available at www.oznet.ksu.edu/ANSI/COOL/feedstuffs/Feedstuffso8.htm.

Sparks Companies Inc. 2003. *COOL Cost Assessment: Prepared by the Sparks/CBW Consortium*. April.

Umberger, W. 2004. *The National Animal Identification System and Country-of-Origin Labeling: How Are They Related?* Animal Identification. WEMC FS#4-04.

U.S. Department of Agriculture. 1997a. *Part I: Reference of 1997 Beef Cow-Calf Management Practices*. USDA:APHIS:VS, CEAH, National Animal Health Monitoring System. Fort Collins, CO.

U.S. Department of Agriculture. 1997b. *Part II: Reference of 1997 Beef Cow-Calf Management Practices*. USDA:APHIS:VS, CEAH, National Animal Health Monitoring System. Fort Collins, CO.

U.S. Department of Agriculture. 2005. *National Animal Identification System (NAIS)—A State-Federal-Industry Cooperative Effort.* APHIS, Washington DC, April.

U.S. Department of Agriculture. 2006a. *National Animal Identification System (NAIS)—Administration of Identification Devices with the Animal Identification number*. APHIS, Washington DC, February.

U.S. Department of Agriculture. 2006b. *Cattle and Calf Death Loss*. USDA-NASS. Washington DC, May.

U.S. Department of Agriculture. 2007a. *U.S. & All States Data-Cattle & Calves Cattle Inventory-January 1*. USDA-NASS. Washington D.C. Accessed February 2008, available at http://www.nass.usda.gov/QuickStats/Create_Federal_All.jsp.

U.S. Department of Agriculture. 2007b. *U.S. & All States Data-Cattle & Calves Cattle Inventory-July 1*. USDA-NASS. Washington D.C. Accessed February 2008, available at http://www.nass.usda.gov/QuickStats/Create_Federal_All.jsp.

U.S. Department of Agriculture. 2007c. *U.S. & All States Data-Cattle & Calves Cattle Operations-Percents*. USDA-NASS. Washington D.C. Accessed February 2008, available at http://www.nass.usda.gov/QuickStats/Create_Federal_All.jsp.

U.S. Department of Agriculture. 2007d. *U.S. & All States Data-Cattle & Calves Cattle Operations-Numbers*. USDA-NASS. Washington D.C. Accessed February 2008, available at http://www.nass.usda.gov/QuickStats/Create_Federal_All.jsp.

U.S. Department of Agriculture. 2007e. *Farm Labor*. USDA-NASS. Washington DC, August. Accessed October 2007, available at http://usda.mannlib.cornell.edu/usda/current/FarmLabo/FarmLabo-08-17-2007.pdf.

U.S. Department of Agriculture. 2007f. *Livestock Slaughter*. USDA-NASS. Washington D.C., January. Accessed February 2008, available at http://usda.mannlib.cornell.edu/usda/nass/LiveSlau//2000s/2008/LiveSlau-01-25-2008.pdf.

U.S. Department of Agriculture. 2007g. *A Business Plan to Advance Animal Disease Traceability*. USDA-APHIS. Washington D.C., December.

U.S. Department of Agriculture. 2007h. *National Animal Identification System (NAIS)—A User Guide and Additional Information Resources.* APHIS, Washington DC, December.

U.S. Department of Agriculture. 2008a. *Animal Tracking.* APHIS, Washington DC, May. Accessed August 19, 2008, available at http://animalid.aphis.usda.gov/nais/animal_track/content/wp_c_index.shtml.

U.S. Department of Agriculture. 2008b. *National Animal Identification System: Participating Animal Tracking Databases (ATDs) Status Report.* APHIS, Washington DC, May.

U.S. Department of Agriculture. 2008c. *Why Get a PIN.* APHIS, Washington DC, May. Accessed August 19, 2008, available at http://animalid.aphis.usda.gov/nais/premise_id/content/wp_c_why_register.shtml.

U.S. Department of Agriculture. 2008d. *Top Reasons to Participate in NAIS.* APHIS, Washington DC, May. Accessed September 19, 2008, available at http://animalid.aphis.usda.gov/nais/about/top_reasons.shtml.

U.S. Department of Agriculture. 2008e. *National Animal Identification System Participating Animal Tracking Databases (ATDs) Status Report*. USDA-APHIS. Washington D.C., May. Accessed June, 2008 available at http://animalid.aphis.usda.gov/nais/nais/naislibrary/documents/guidelines/NAIS_ATDs_for_web.pdf.

U.S. Department of Labor, Bureau of Labor Statistics (BLS). 2007a. *Incidence Rate and Number of Nonfatal Occupational Injuries by Selected Industrie*s, 2006.Washington D.C., October.

U.S. Department of Labor, Bureau of Labor Statistics (BLS). 2007b. *May 2007 National Occupational Employment and Wage Estimates*: United States. Washington D.C., May. Accessed November 2007, Available at http://www.bls.gov/oes/current/oes_nat.htm#b43-0000.

U.S. Department of Labor, Bureau of Labor Statistics 2008. *Consumer Price Index – All Urban Consumers.* Washington D.C., 2008.

Vansickle, J.R. McEowen, C.R. Taylor, N. Harl, and J. Conner. 2003. *Country of Origin Labeling: A Legal and Economic Analysis.* Paper No. PBTC 03-5, International Agricultural Trade and Policy Center, University of Florida, Gainesville, May.

Wackerly, D., W. Mendenhall, and R. Scheaffer. 2002. *Mathematical Statistics with Applications.* 6th ed. Pacific Grove: Duxbury.

Wagner, S. 2004. *Cattle raisers Examine Country-of-Origin Labeling Law.* March. Accessed August 16, 2008, at www.thecattlemanmagazine.com/issues/2003/0503/origin.asp.

Walker, J. 2006. *Radio Frequency Identification for Beef Cattle*. Extension Extra. ExEx2051, South Dakota State University.

Watson, K. 2002. Jumping into EID. Quality Beef Connection, June. Accessed October 2007, available at http://ucce.ucdavis.edu/files/filelibrary/1524/24481.pdf.

Williams, S. 2006. *Extension Assists Producers with Preparations for National Animal Identification*. Impact. University of Idaho Extension. Accessed October 2007, available at http://www.uiweb.uidaho.edu/extension/impacts/Pdf_06/2-06swilliams-identification.pdf.

Wisconsin Livestock Identification Consortium (WLIC). 2008a. *Welcome.* Wisconsin, August. Accessed August 19th, 2008, available at www.wiid.org/index/php.

Wisconsin Livestock Identification Consortium (WLIC). 2008b. *National Efforts.* Wisconsin, August. Accessed August 19th, 2008, available at www.wiid.org/printable.php?action=effortnew.

Wisconsin Pork Association (WPA). 2006. *Wisconsin Pork Association Final Report Animal ID Project—Phase II*. Accessed February 2008, available at http://www.wiid.org/resource/1179496787_WPA_Final_Report_Phase_II.pdf.

Wittwer, J.W. 2004a. *Monte Carlo Simulation Basics.* Accessed August 2008, available at http://vertex42.com/ExcelArticles/mc/MonteCarloSimulation.html.

Wittwer, J.W. 2004b. *Monte Carlo Simulation in Excel: A Practical Guide.* Accessed August 2008, available at http://vertex42.com/ExcelArticles/mc/MonteCarloSimulation.html.

Xu, Chonggang, H. He, Y. Hu, C. Yuanman, L. Xiuzhen, R. Bu. 2005. *Latin Hypercube sampling and Geostatisitcal Modeling of Spatial Uncertainty in a Spatially Explicit Forest Landscape Model Simulation.* Ecological Modeling. 185(2005): 255-269.