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By Brittany Anita Simmons

Entitled An Evaluation of Electronic Identification in 4-H Beef, Sheep and Swine

For the degree of Master of Science

Is approved by the final examining committee:

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AN EVALUATION OF ELECTRONIC IDENTIFICATION IN 4-H BEEF, SHEEP AND SWINE

A Thesis

Submitted to the Faculty

of

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by

Brittany Anita Simmons

In Partial Fulfillment of the

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of

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DEDICATION

To my parents, Gary and Pat, I could not have survived this process without you. Thank you for your undying love and support. I have been blessed to have you there for late night calls for your wise advice and reminders of God's plan. I love you both with all of my heart.

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ABSTRACT

Simmons, Brittany Anita. M.S., Purdue University, May, 2009. An Evaluation of Electronic Identification in 4-H Beef, Sheep and Swine. Major Professor: Dr. Clinton P. Rusk.

The purpose of this study was to evaluate electronic identification, in the form of an ear tag, in 4-H beef, sheep and swine. The objectives of this study were to determine the retention rate, as well as the readability of the ear tags over various lengths of time. The researcher placed electronic identification (EID) ear tags in 4-H animals at time of county livestock enrollment. A total of 428 beef, 457 sheep and 885 swine were tagged at individual county enrollment days. During weigh-in at the county fair, a total of 302 beef, 360 sheep and 829 swine were evaluated to determine the readability of their EID ear tags. An electronic wand, called a LightningROD, was used to read the EID tags of animals that were to be exhibited at the county fair. The time lapse between ear tagging the livestock and reading the ear tag at the county fair, varied from two days to six months based on animal specie and the participating county.

The results showed that 98.4% of beef cattle retained their electronic ear tags, 96.3% of sheep retained their ear tags and swine had a 99.1% retention rate. The results also showed that out of the 1,463 animal tags that were still intact within the ear, only one tag was unable to be read by the wand. With the high retention rates and the high readability of the EID tags among all three species, researchers concluded that the EID ear tag is a reliable form of temporary identification in 4-H beef, sheep and swine projects.

CHAPTER 1. INTRODUCTION

The ultimate goal of the United States Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS) is to "protect American agriculture" (United States Department of Agriculture-Animal and Plant Health Inspection Service [USDA-APHIS], 2009c). APHIS "improves the agricultural productivity and competitiveness and contributes to the national economy and the public health" (USDA-APHIS, 2009c). In order to protect the well-being of the U.S. people, the health of the U.S. livestock, as well as the economic well-being of those industries, "we must be able to quickly and effectively trace an animal disease to its source" (USDA-APHIS, 2009a). The USDA/APHIS organization is interested in finding out if electronic identification (EID) ear tags will assist in a quicker traceback time if a situation should arise.

If and when a disease outbreak should occur, animal health officials need to know the following information:

Which animals are involved in a disease outbreak?

Where the infected animals are currently located?

What other animals might have been exposed to the disease? (USDA-APHIS, 2009a).

A concern with the traceability system is the retention rate of the EID tags. This study evaluated the retention rate and readability rate of EID ear tags.

This study consisted of tagging 4-H beef, sheep and swine in the following Indiana counties: Hancock, Johnson, Lake, Madison, Monroe, Putnam, Steuben and Whitley. All animals from each respective specie in the represented county were tagged at 4-H enrollment. The tags were then read at county fair weigh-in, in order to collect the data needed.

1.1. Statement of the Problem

The traceback time using traditional ear tags is nearly impossible to capture. It is very difficult to retrieve the animal's location, as well as the animals that have been in contact with the infected animal. With the use of EID tags, some officials believe the time required to trace an animal back to its place of origin (traceback time) will decrease to approximately 48 hours (University of Tennessee, 2004). Electronic identification ear tags have the potential to not only reduce traceback time and improve efficiency, but they can also keep individual animal's history from birth to death.

This study determined the retention rate of EID ear tags, as well as their readability rate in enrolled 4-H beef, sheep and swine. This study was a collaborative effort between Purdue University and the USDA/APHIS. Purdue University was responsible for the data collection and data analysis. The USDA/APHIS provided a grant to cover all costs of the project including travel, supplies and equipment.

1.2. Purpose and Objectives

The purpose of this study was to evaluate electronic identification, in the form of an ear tag, in 4-H beef, sheep and swine.

The objectives of this study were to:

1. Determine the retention rate of EID ear tags in beef, sheep and swine.
2. Determine the readability rate of EID ear tags, over various lengths of time.

1.3. Assumptions

The researcher made the following assumptions through the duration of this study:

- The Extension Educators in the participating counties ordered the correct number sequence for the 2008 year ear tags.
- Volunteers helping tag the livestock had previous tagging experience.
- Educators, volunteers or livestock owners would contact the researcher if the EID tag was lost or damaged. This information was provided to the exhibitors on a handout at county enrollment.

1.4. Limitations

A few limitations existed within this study. Participation was only open to the 92 Indiana counties. County participation was strictly on a voluntary basis. Another limitation was that the number of the animals enrolled in each county was different. This allowed for various amounts of data to be collected within each county. Some counties had more than one enrollment date. This created issues for the researcher being able to attend all of the taggings in that particular county.

Another limitation was that different volunteers tagged the animals in each county. There were also multiple people tagging in a few counties, which could have resulted in different retention rates based on the experience of the volunteer taggers. The last limitation was that some 4-H livestock exhibitors enrolled more livestock than they planned to exhibit at the county fair. This lead to more animals being tagged than returned to the fair to have their tags read, resulting in less data being collected.

1.5. Definition of Terms

4-H- A youth serving organization that develops youth from grades K-12 by enabling them to reach their full potential through: learning by doing, learning life

skills (leadership, citizenship, communication and decision-making), setting goals, learning responsibility and gaining self-confidence that can be applied over a lifetime. 4-H also develops youth ethics and teaches youth to accept wins and losses gracefully in competitive situations (Washington State University, n.d.). In Indiana, 4-H is part of the Purdue University Cooperative Extension Service (CES) and it is funded by county, state, and federal tax dollars. At the local level, leadership is provided by the 4-H Youth Educator(s) (Indiana 4-H, n.d).

County Enrollment- For this study, any 4-H member who has signed up to possibly exhibit an animal(s) at the county or state level. A member may enroll more animals than they plan to exhibit (Howell, 2006).

County Fair- For the purpose of this study, a county fair is an annual event, held in each of Indiana's 92 counties, which provides an opportunity for 4-H members to compete and showcase their 4-H project(s) and exhibit(s).

County Weigh-In- For purposes of this study, a county weigh-in is the arrival of livestock brought to the county fair by the 4-H member, to be weighed before county exhibition.

Electronic Identification (EID) – Is synonymous with radio frequency identification (RFID), which is accomplished through the use of a transponder and a reader. A transponder or "microchip" is attached to the animal using an ear tag, bolus or implant. The reader emits energy in the form of radio waves. The transponder absorbs energy from waves and transmits a signal containing the unique number. The reader receives the transponder signal and displays a unique identifier in the form of a number (Department of Agriculture and Rural Development, 2007).

Extension Educator- “Professional employees of the State Extension service of the land-grant institutions and the Extension Service-USDA, may include county staff (agents, program assistants, EFNEP educators) district staff (agents, directors, program specialists) and state staff (administrators, program specialists)” (Seevers, Graham, Gamon & Conklin, 1997, p. 245). The structure of this system may vary from state to state.

International Standardization Organization (ISO) – Has developed standards for EID transponders. The first three numbers in the government number identify the animal’s country of origin. With these transponder standards, it allows EID tags from various countries to be read by a wand and to be visually identified (ID INFO, 2006).

Livestock- Any domestic or domesticated animal including bovine, ovine, porcine, caprine and equine raised for the production or consumption of food (Food and Agriculture Organization of the United Nations World Health Organization, 2001).

Livestock Member- For the purposes of this study, any 4-H member enrolled in beef, sheep and swine projects.

RFID- “Any electronic identification system comprised of a reader/scanner/interrogator and a transponder that can read or write data content using a specified radio frequency” (ID INFO, 2006).

Traceback Time- The time it takes to trace an animal back to its place of origin (University of Tennessee, 2004).

Transponder- A microchip embedded within the ear tag that has a code for a unique identification number. The transponder can be activated by an electronic signal emitted from a reader (Trenkle, 2006).

Volunteer- “Unpaid individuals who offer their time, talents and services to the organization,” (Seevers et al., 1997, p. 251).

CHAPTER 2. REVIEW OF LITERATURE

2.1. Introduction

"Livestock identification is the first step in a traceability system for meat and meat products," (United States Department of Agriculture [USDA], 2008a). Over the years numerous methods have been used for the identification of livestock among farmers and the food production industry. In the 1800s and 1900s, identification consisted of hot branding and ear notches that were used as a theft deterrent and for purposes of record keeping (USDA, 2008a). "In the 1960s statutory regulations required identification methods be in effect in place to trace diseased animals during outbreaks and eradication programs," (USDA, 2008a).

There are numerous ways to identify livestock with each method containing its own pros and cons. Ear tags (metal and plastic), back tags, branding (freeze and hot), paint branding, tattoos, ear notches, electronic identification, neck chains, nose printing and retinal imaging are the main identification methods used (National Institute for Animal Agriculture [NIAA], 2003; Neary & Yager, 2002). Any method that can be altered in any way is considered to be a temporary form of identification, such as ear notches. An ear notch can simply be added to the animals ear to change the animals identification. If a method can not be altered in any way, it is considered to be a form of permanent identification, such as retinal imaging. Retinal imaging focuses on the pattern of the veins in the eye, making it impossible to alter the identification of the animal.

2.2. Identification of Methods

Ear tags are a common form of identification and are used in all species. These tags can come in two forms, metal and plastic. Metal tags are easy to remove, but difficult to alter. Although metal tags can have an easy application process, they require the reader to be inches away in order to see the numbers on the tag (NIAA, 2003).

Plastic tags are another form of ear tag that can be purchased pre-numbered or blank so the producer can label the tags (Neary & Yager, 2002). These tags also come in a variety of colors and sizes, which can be selected according to the producer's needs. Ear tags are placed on the animal by piercing the ear in-between the second and third cartilage (Neary & Yager, 2002). Ear tags are typically inexpensive and usually easy to read from a distance.

Back tags are most commonly used in swine and cattle. These tags are intended for short-term use and usually retained from a few days to a week. The tags are easily applied with glue and the animal rarely needs to be restrained. The tags are easy to remove, inexpensive, difficult to alter and can be read from several feet away (Disney, Green, Forsythe, Wiemers, & Weber, 2001).

Brands have good tamper resistance and can be read from several yards away. Branding requires training and skill to perfect. Freeze branding is typically used on horses and cattle. This technique uses copper irons, submerged in liquid nitrogen or dry ice and alcohol, then placed on the animal's skin. The cold irons kill the cells that produce color pigment in the hair follicles, but the hair still continues to grow. The application time varies from animal to animal based on age and the color of the animal's hide. The lighter the color and the older the animal the greater the application time (Neary & Yager, 2002).

Tattooing is a form of permanent identification that can be applied to most species. It has good tamper resistance, but requires a person to be inches away in order to read the tattoo. A person must have some training or skill in order to apply the tattoo in the animal's ear (NIAA, 2003). A tattoo is applied into the ear using ink and a number/lettered die made-up of sharp, needlelike projections that

are secured on the application pliers (Neary & Yager, 2002). After the needles pierce the ear, ink is applied over the piercings and the tattoo should be visible within a few days.

Ear notching is commonly used in the swine industry as a means of temporary identification. Ear notching has a low tamper resistance, and an individual can be several few feet away and still read the notches. In order to properly apply ear notches, a person must be trained or skilled in the process, which requires knowledge of the proper numbering sequence in the ear, such as the litter number and pig number. Ear notching consists of removing a V-shaped portion of the pig's ear matching the pigs litter number and its individual number (Neary & Yager, 2002). Pigs should be notched at 1-3 days-of-age (Brady, n.d.).

There are various systems in the ear notching process, but all are quite simplistic once the process is known. The ear notches in the pig's right ear designate the pig's litter number. The ear notches in the pig's left ear designate the individual pig number (National Pork Board, n.d.). For younger pigs (under 25 pounds), the notch should be about ¼ inch deep. For larger pigs, the notch should be ½ inch deep. There should also be at least ¼ of an inch left between each notch (Brady, n.d.). The right ear has five values designated for notches, these numbers are 1, 3, 81, 9 and 27. All of these notches except 81 can be used twice in order to accumulate the litter number. The left ear has three areas on the ear where the notch can be placed. The numeric values for these locations are 1, 3 and 9. As with the litter number, the individual notches can be used more than once in order to accumulate the desired individual pig number (Brady, n.d.).

Neck chains are most commonly used in the dairy cattle industry. These chains are typically made of plastic with a numbered tag attached to the chain. The chains are short enough so they do not slip over the animal's head, but long enough to allow the animal to grow normally. The neck chains are a temporary form of identification and lack tamper resistance. Neck chains can be seen fairly

well, but they are difficult to see when the animal is in a large group (Neary & Yager, 2002).

Paint branding is a temporary form of identification, that is usually coupled with a permanent form of identification. This procedure uses numbered irons, similar to those used in freeze branding and hot branding. The iron is first dipped in paint or sprayed with paint and then applied to the back of the animal. Paint branding is often associated with animals at sales to indicate their lot number. It is also used to identify mothers and their offspring with the same corresponding numbers (Neary & Yager, 2002).

Electronic identification includes ear tags, microchips and electronic collars (Neary & Yager, 2002), which can be beneficial in many ways. Electronic identification automates data capture, which in return reduces time and expense. Secondly, EID increases accuracy by eliminating human error. The decrease in human error is accomplished by electronically transferring the numbers stored on the reader to the computer. This would eliminate the possibility of an individual writing the numbers down incorrectly since the reader accumulates the numbers electronically. Third, an electronic identification (EID) tag can provide the entire history of an animal. The tag can provide recent health treatments, age and even genetics with a supplementing software package (Allflex, 2006).

Nose printing is a form of permanent identification that is commonly used in the exhibition of beef, sheep and goats. Nose printing is very similar to finger printing, in that each nose print is unique to each individual animal. Each nose print has its own pattern of dots and lines. A nose print is gathered by thoroughly wiping the animal's nose, then applying ink to the nose. An index card is then placed against the animal's nose, in order to get an ink transfer. Nose printing problems result from: too much moisture on the animals nose, too much ink applied to the nose and untimely movement of the animal (Neary & Yager, 2002). Nose printing requires a fingerprint specialist to match the prints.

Retinal imaging is a relatively new method of permanent identification for beef, sheep and goats that is tamper resistant and can be read from a few inches

to several feet away (NIAA, 2003). This process takes a digital image of the retinal vascular pattern of the animal (Blomeke, 2004). “The uniqueness of each animal’s retinal vascular pattern is present from birth and does not change during the animal’s life,” (Marchant, 2002, p. 17). The retinal imaging camera is connected to a global positioning satellite (GPS), which stamps the retinal image of each animal with the date, time and location; thus making retinal imaging tamper resistant (NIAA, 2003; Marchant, 2002).

2.3. Reasons for Identification

With “recent animal health and food borne illness scares in all parts of the world” (Kellom, Paterson, Clark, & Duffrey, 2006), animal and source verification are becoming a necessity to keep our food supply and the people who eat it safe (Kellom et al., 2006). With radio frequency identification (RFID), researchers will be better able to trace the entire life cycle of an animal from birth to slaughter, thus decreasing the effects of disease in our food supply.

There are numerous reasons an animal should have proper identification. At the Indiana State Fair, the recommendations for animals being exhibited are as followed:

> Acceptable methods vary by species, but may include an ear tag, legible tattoo, standard ear notch, individual brand or breed registration number. Swine can have a standard ear notch. Cattle may have an official ear tag, a tattoo, an individual brand or a registration number. Sheep and goats can have an official Scrapie ear tag, Scrapie tattoo, or breed registration tattoos. Horses can have a lip tattoo, individual brand, description of markings with a name or a registration number, if accompanied by the

animal's registration paper, (Board of Animal Health, 2008).

The need for animal identification has become imperative for both public and animal health (Marchant, 2002). For public health, the emergence of diseases in humans is caused by "contaminated food products, and cases of harmful chemical residues in food highlight the need for systems which enable secure traceability of animals and animal products" (Marchant, 2002, p. 3). The public has an increasing need for information about the safety of the food they are eating. "To improve public health and increase consumer confidence in food safety, there is a need for farm to retail information systems that enable the traceability of animals and meat products throughout the food chain," (Marchant, 2002, p. 4).

There are also reasons why identification is needed for the protection of animal health. In order to properly control a disease outbreak, it is necessary to trace the infected animal back to its place of origin. "Many livestock identification systems have traditionally been provided through eradication programs, such as those in the United States for brucellosis, tuberculosis and pseudorabies," (Marchant, 2002).

Brucellosis Disease in Cattle

In 1934, a brucellosis eradication program was put into effect at a national level to eliminate brucellosis from the United States. Brucellosis is a bacterial disease in cattle that causes a decrease in milk production, infertility, weight loss, loss of young and lameness (United States Department of Agriculture [USDA], 2008b). "The disease is contagious and can, though rarely, affect humans. There is no known treatment for brucellosis, and depopulation of infected and exposed animals is the only effective means of disease containment and eradication," (USDA, 2008b).

"Tattoos have played a critical role in the national brucellosis eradication program by providing the means of identification for cattle vaccinated against brucellosis," (Marsh, 2004). When the animal is vaccinated, a tattoo is applied to

the ear. “The tattoo identifies the animal as an ‘official vaccinate,” (United States Department of Agriculture-Animal and Plant Health Inspection Service [USDA-APHIS], n.d.). The number on the tattoo identifies the year the animal was vaccinated.

Scrapie Disease in Sheep

“Scrapie is a fatal, degenerative disease affecting the central nervous system of sheep and goats,” (United States Department of Agriculture-Animal and Plant Health Inspection Service [USDA-APHIS], 2009b). Scrapie disease can be found in all parts of the world. “The disease was eradicated from Australia and New Zealand after outbreaks in 1952 and 1954. In the United States, the disease was first diagnosed in Michigan in 1947,” (Hartwig, 2000). Scrapie enters the animal’s body orally and is spread from animal to animal in flocks. Scrapie begins to affect the nervous system at 2 to 3 years after contraction. Infected animals show behavioral changes, tremors, lose weight, itch, and react abnormally to noise and movement (Hartwig, 2000).

The purpose of the mandatory National Scrapie Eradication Program is “to allow diseased and exposed animals to be traced back to their flock/herd of origin so the spread of Scrapie can be prevented,” (Greiner, 2002). This individual identification for each animal came in the form of a tag, from the USDA, which had a unique producer identification number printed on the tag (Greiner, 2002). If an animal tested positive for Scrapie disease, the animal could then be traced back to its place of origin.

Pseudorabies Disease in Swine

The United States Department of Agriculture started a national pseudorabies (PRV) eradication program in 1989. “PRV is an infection disease of swine caused by porcine herpesvirus,” (Southeastern Cooperative Wildlife Disease Study [SCWDS], 2004). The transmission of this disease is spread by aerosol or reproductive transmission. Once infected, swine carry the disease for their entire life and once infected, the population remains infected (SCWDS,

2004). “PRV rarely causes morbidity in adult swine, but frequently causes abortion in pregnant sows and death of neonatal piglets,” (SCWDS, 2004).

“The U.S. pork industry’s commitment to mandatory identification was lead by the pseudorabies eradication program, which created a system for identifying premises with infected animals,” (National Pork Producers Council, 2009, p. 4). During the pseudorabies eradication program, swine were identified by a premises identification number on an ear tag, which was unique to each farm (Marsh, 2004).

“Producers understood the importance of eradicating the disease from the national herd. They took action by registering for premises identification, another invaluable tool in this program. Today’s National Animal Identification System is founded on premises identification, in part, because this was so successful in the past,” (Pork Checkoff, n.d.).

2.4. Radio Frequency Identification (RFID)

Radio frequency identification (RFID) is being used more frequently as a form of livestock identification. USDA defines radio frequency identification as:

> a automated system that uniquely identifies each animal and will make it possible to: identify the origin of each animal; trace the path of each animal from location to location; trace each animal exposed to disease; eradicate or control an animal health threat; retrieve information within hours of an outbreak and implement intervention strategies; improve consumer confidence; and provide assurance to buyers regarding the animal’s life history, (USDA, 2008a, p. 1).

Radio frequency identification of livestock can be accomplished in three forms: ear tags, injectable transponders and rumen boluses (Walker, 2006). The most common form of RFID in livestock is the low frequency ear tag. These ear tags contain a microchip within the plastic confines of the tag that emit a radio frequency. The RFID tags require a special tag reader (called a scanner) which, is an identification device that uses a radio frequency electromagnetic field to stimulate and create a coordinated data response from a transponder (Walker, 2006). The microchip is activated by an electronic signal from a reader that decodes the received data, stores the number in its the memory and transfers the number to another storage system (Trenkle, 2006).

The official RFID tag issued by the United States Department of Agriculture contains two sets of numbers printed on the tag itself. The first is a fifteen digit government number that is unique to a particular animal and will link that animal to the USDA data base (Trenkle, 2006). The second set of numbers is usually three to five digits in length, and identifies a particular animal in a specific county or on a farm.

Injectable transponders or microchips are most commonly used in horses, llamas and alpacas (Animal Plant Health Inspection Service [APHIS], 2007). These microchips contain a miniature radio frequency transponder and antenna. Injectable transponders are implanted under the skin of the animal, usually near the neck, between the shoulder blades or near the base of the ear (Neary and Yager, 2002).

The rumen bolus is a ceramic capsule that contains an electronic transponder and thus, provides another form of RFID. This capsule is administered orally and remains in the reticulum of cattle, sheep, goats and deer (Huber, 2004).

There are many benefits to using RFID technology within the livestock industry. First, it is a more reliable and effective form of livestock identification, than more traditional systems such as branding and ear notching. Radio frequency identification also supports computerized and automated recording to

manage a large number of livestock in a manner that is cost effective and efficient. Also, the RFID tag gives off a low frequency signal that is not affected by moisture or tissue (USDA, 2008a). Radio frequency identification allows fewer individuals to maintain record on large livestock operations, eliminates the time required to record the animal's information and decreases the possibility of human error in recording this information (Cox, Petersen & Mathis, 2004).

2.5. Related Studies

Rusk (2002) tested the effectiveness of electronic ear tags in 4-H sheep and swine. During this study, five Indiana counties tagged 625 sheep and 508 swine.

The results for the sheep found no missing tags in Lawrence County, allowing for a 100% readability rate for the ear tags. Adams County had a 98% readability rate with one missing ear tag. Hendricks County also had one missing ear tag which yielded a readability rate of 99%. Knox County had a 96% readability rate in sheep with 2 tags missing and two tags unreadable. White County had a 90% readability rating with 18 failed tags. The White county tags were placed in the ear upside down, which made it more efficient for the individual working with the sheep. This placement of the tags; however, seemed to be less successful than the placement in the other participating counties. Of the 18 failed tags in White County, 10 were removed due to swelling of the ear that was caused by too close of tag placement in relation to the animal's head. Four tags were pulled apart, two others were pulled out of the ear, but were still intact. Two additional tags were unable to produce a signal. The total average retention rate for sheep was 96%, but the EID tags had greater than a 98% retention rate when the electronic portion of the tag was placed inside the ear of lambs (Rusk, 2002).

The tags in the Knox County hogs produced a 67% readability rate. Two hundred forty-two of the 362 hogs had a readable tag when returning to the

county fair. One hundred five hogs had missing tags and 15 tags did not produce an electronic signal. In this study, the tags were put in with the number part of the tag facing outward on the backside of the ear. Unfortunately, this placement allows an easier access for other hogs to tear and chew on the tag (Rusk, 2002).

During this study (Rusk, 2002), the use of EID tags increased the efficiency and speed of weighing and checking-in animals at the county fair. The use of EID tags also reduced human error, since the tag reader accumulated the numbers electronically.

A second study conducted by Cox, Petersen and Mathis in 2004, over 150 commercial crossbred cows and calves were tagged with both an RFID tag and a visual tag. During the nine months the cattle had their tags, there was no malfunction or loss of RFID tags. Three percent of the visual tags were lost during this same time span.

The National Animal Identification System (NAIS) implemented a pilot project in the Southwest including: Arizona, California, Oregon and Texas. More than 31,000 livestock were tagged with RFID tags: 27,179 in California, 3,634 in Arizona and 546 in Oregon (National Animal Identification System [NAIS, 2007]). “One producer, with 6,000 tagged animals, reported a retention rate of nearly 100 percent, compared with a 96-98 percent rate for visual tags. Another producer, with 206 tagged steers, reported a retention rate of 98 percent,” (NAIS, 2007).

The fourth study, conducted at the University of Wisconsin-Madison in 2005, evaluated electronic ear tags and the corresponding readers. Two hundred three breeding ewes were tagged with one of five types of electronic ear tags. Of the 203 ewes tagged, a total of 20 ewes (9.9%) had tags that were lost, removed or not readable. Of these 20 tags, 14 were lost, 5 were removed and 1 was not readable. All of the EID tags were dipped in disinfectant solution before being placed in the animal’s ear. Even with this precautionary measure, 15 ewes still had an occurrence of sore/infected ears (Thomas et al., 2005).

A second trial performed in this same study, observed EID tags in state fair market lambs that were tagged in May. Two hundred seventy-one market

lambs were examined and 52 lambs (19.2%) lost their ear tags (Thomas et al., 2005). One of the conclusions from this trial with EID tags was “it appeared that environmental and management factors that differ between farms are more important in determining electronic tag loss and retention than breed of lamb, sex of lamb, weight of lamb at the time of application, or the individual person inserting the tag,” (Thomas et al., 2005).

2.6. International Studies

A study conducted in New Zealand in 1998 by Stärk, Morris, and Pfeiffer consisted of four trials comparing electronic and visual identification in pigs. The first trial was conducted on a commercial swine herd of 244 sows. Two types of ear tags were used: a traditional visual ear tag and an EID tag.

A traditional ear tag was placed in the sow’s right ear and an EID tag was applied to her left ear. The results were as follows: four EID tags and nine visual tags were lost during the trial (111-518 days). Only two sows lost both of their tags during the trial. One EID tag stopped transmitting after seven days in the ear (Stärk et al., 1998).

In 1990, a Canadian study placed EID tags and implants in 432 piglets at different commercial farms. Three hundred thirty-four piglets were implanted in the front or the back of their ear. Ninety-eight additional piglets were tagged with EID ear tags. At the end of the trial, 79% of the implants were still intact and readable, while 81% of the EID tags were in place and readable (Robinson, 1995, p. 208).

A study conducted in Ireland in 2000 compared two different brands of EID ear tags; Allflex and Nedap. In the study, 511 cattle were tagged with Allflex EID tags and 510 cattle were tagged with Nedap EID tags. Within 28 days of the start of the study, 6 of the 511 Allflex ear tags were not able to be read and 19 of the 510 Nedap tags were unable to be read. Of these 19 Nedap ear tags, 11 of the tags had an issue with the connection between the male and female

components of the tag. Seven months into the study, there were two additional Allflex tags lost and 5 more losses of Nedap tags. The final results showed that eight out of 511 cattle lost their Allflex tags and 23 out of 510 cattle lost their Nedap tags (Fallon, Rogers and Earley, 2002).

2.7. Summary

Four-H livestock projects in Indiana are required to have some form of identification. All Indiana counties are required to tag their enrolled 4-H market livestock with a county ear tag. Although the current county tags are sufficient, RFID tags provide potential benefits to the counties and the industry. The RFID tags have the potential to decrease human error and increase efficiency at the county level. At the industry level, RFID tags can be used to help veterinary professionals track disease and identify the premises of contraction in a timely manner.

CHAPTER 3. METHODS OF RESEARCH

3.1. Introduction

The purpose of this study was to evaluate electronic identification, in the form of an ear tag, in 4-H beef, sheep and swine. The objectives of this study were to determine the retention rate, as well as the readability of the ear tags over various lengths of time. A total of 428 beef, 457 sheep and 885 swine were tagged during individual county enrollment days in 8 counties in Indiana. At county fair weigh-in, a total of 302 beef, 360 sheep and 829 swine had their EID tags read electronically. The time lapse between ear tagging the livestock and reading their tags at the county fair weigh-in, varied from two days to six months based on animal specie and the participating county.

This study was a collaborative effort between Purdue University and the United States Department of Agriculture (USDA)/Animal and Plant Health Inspection Service (APHIS). Purdue University was responsible for the data collection and data analysis. The USDA/APHIS provided the monetary grant to cover all costs of the project including travel, supplies and equipment.

3.2. Participants

In each of Indiana's 92 counties, 4-H Youth Development Educators were e-mailed the details and purpose of the study. Participating counties were given an incentive of free EID ear tags. The Educators asked their beef, sheep, and swine superintendents if they were interested in participating in this study. Educators wishing to participate provided their county's date and time for beef,

sheep, and swine enrollment; the number of beef, sheep, and swine to be enrolled; and the date and time of weigh-in for each specie at the county fair. The State 4-H Livestock Extension Specialist chose the participating counties with the higher number of beef, sheep and swine enrolled. The State 4-H Livestock Specialist budgeted 500 beef ear tags, 500 sheep ear tags and 1000 swine ear tags for this study. These numbers allowed a large number of animals to be evaluated for tag retention rate and tag readability. The researcher and Educators were able to hand-out information about the research project to youth and their families at the enrollment site. The researcher was also able to answer questions about the study not only at the enrollment site, but also at the county fair. The investigator chose the following Indiana counties, their respective 4-H Youth Development Educators and the participating livestock specie to participate in this research study:

- Hancock County - Sarah Burke - Sheep
- Johnson County - Sara Wagler and Ashley Schultz - Beef
- Lake County - Jennifer Govan - Swine
- Madison County - Gary Simmons - Sheep
- Madison County - Gary Simmons - Swine
- Monroe County - Jeff Holland - Swine
- Putnam County - Lauralee Baugh - Beef
- Steuben County - Neasa Kalme - Swine
- Whitley County - David Addison - Beef

3.3. Research Approval

Laboratory Animal Training Association

The Laboratory Animal Training Association (LATA) required the researcher to complete a training comprised of information on the humane care and use of lab animals as regulated by the federal government. The researcher

successfully completed this online training module with laboratory swine on February 27, 2008.

Purdue Animal Care and Use Committee

Prior to collecting data, the Purdue Animal Care and Use Committee requires approval of projects intending to teach or conduct research on vertebrate animals. The protocol for this research was submitted on February 11, 2008 and final approval was granted on February 11, 2008. The approved protocol number for this research is PACUC No. SMI-325.

Human Subjects Committee

All research, at Purdue University, that involves human participants requires approval from the committee on the Use of Human Research Subjects. During this process, the researcher is required to submit a copy of the survey, including questions, directions and procedures. The Review Board either accepts or makes suggestions regarding surveys, in order to protect the rights of human subjects. A Research Exemption Request was submitted to the committee on the Use of Human Research Subjects on July 11, 2008 and final approval for this research was granted on July 22, 2008. A Research Exemption was requested due to the fact that the participants completing the survey were anonymous and all over the age of 18. The Human Subjects approval number for the research study is REF #0807007054.

3.4. Instruments and Measures

The EID tags used in this research project were shipped from Digital Angel Corporation. Upon arrival, the researcher separated the tags and tag buttons and placed them into groups of 25. The researcher labeled the buttons of the sheep and swine tags, with a permanent marker. The button of the ear tag contained the USDA number and was labeled with the corresponding county

number on the front of the tag, based on numerical sequence. The cattle tags had both the county number and the USDA number listed on the front of the tag, so they did not require additional labeling.

The bags containing the EID tags with the lowest tag numbers for each county were numbered starting with one. The bags containing the back parts of the tags were numbered the same way. This prevented any mix-up of the tags, for research purposes.

After the tags were individually numbered, all of the tags were individually read by the researcher using an Allflex Compact Series Reader. This battery powered, hand-held device electronically read the microchip embedded in the tag without storing it in memory. This allowed the researcher to verify that the ear tag was readable before the tag was placed in the animal's ear and to ensure that the USDA number marked on the ear tag matched the number read by the device.

The researcher attended enrollment days for the following counties: Hancock and Madison County-sheep, Johnson, Putnam and Whitley Counties-beef and Lake, Madison, Monroe and Steuben Counties- swine. During the county enrollment day, beef and sheep were tagged and retinal imaged as required for animals participating at the state fair. Swine were tagged and their ear notches recorded on state 4-H swine enrollment forms. As an extra precaution, sheep and swine tags were dipped in Nolvasan solution, a sanitizing disinfectant used to prevent possible infection around the tagging site of the animal's ear.

Prior to returning to the county fair to read swine ear tags, an Excel spread sheet was created for each county participating in the study. The Excel sheet contained the county tag number; the USDA tag number; the number read by the electronic wand; the name of the 4-H member; the premises ID number where the animals lived and if possible; the breed, gender, and ear notch for each animal.

3.5. Data Collection

The data were collected at the county fair weigh-in held during the summer. Each county's data collection was based on the county's species and the process used for enrollment. At each county, the researcher brought a laptop computer loaded with Plexis Wedge-KeyInjector Version 2.3, an electronic wand and the Bluetooth wireless connection. Each animal's EID tag was read by the Wireless LCD-LightningROD, an electronic scanner purchased from I.D.ology. The scanner saved all of the tag numbers (that were read) in its memory. These numbers were then transferred to a laptop using a Bluetooth wireless device and the KeyInjector software. The software allowed all of the information stored in the memory portion of the LightningROD device to be transferred into the previously developed Excel spreadsheet.

The results for each county are as follows:

- Hancock County – 317 sheep were tagged on enrollment day - 241 sheep tags were read at the county fair - 4 tags had been ripped out, 10 tags were lost, 3 tags were ruined during tagging, but all tags were readable.
- Johnson County – 149 beef cattle were tagged on enrollment day -105 beef tags were read at the county fair - 1 tag had been ripped out, 1 tag was lost, 1 tag was replaced due to the ear breaking down, but all tags were readable.
- Lake County – 110 hogs were tagged on enrollment day - 90 swine tags were read at the county fair - 0 tags were lost - all tags were readable.
- Madison County – 140 sheep were tagged on enrollment day - 119 sheep tags were read at the county fair - 1 tag had been ripped out and 1 tag was unable to be read by the scanner.
- Madison County – 423 hogs were tagged at the beginning of the county fair - 3 tags were bent which caused them to pull

apart, 1 tag was ruined during tagging, 1 tag was broken during tagging, but all tags were readable.

- Monroe County – 243 hogs were tagged on enrollment day - 219 swine tags were read at the county fair - 3 hogs had lost their EID tag, 1 tag had been ripped out, 1 tag was ruined during tagging, but all of the tags were readable.
- Putnam County – 124 beef cattle were tagged on enrollment day - 91 beef tags were read at the county fair - 1 steer had its ear tag ripped out, but all tags were readable.
- Steuben County – 109 hogs were tagged on enrollment day - 97 swine tags were read at the county fair - 1 pig lost its tag, but all tags were readable.
- Whitley County – 155 beef cattle were tagged on enrollment day - 106 beef tags were read at the county fair - 1 steer had its ear tag ripped out, but all tags were readable.

The researcher brought a lap top computer to each county fair weigh-in that contained each county's Excel spreadsheet on the desktop. Before data collection began, the researcher made sure the Bluetooth connector was properly inserted into the USB port of the lap top and that there was proper Bluetooth communication between the computer and the electronic wand. This resulted in a blue light appearing on the wand itself.

In most cases, the EID scanning in each county was completed by the researcher while animals were confined in the scale. While the animal was being weighed, the wand was waved approximately 6 inches over the animal's ear. In Madison County, the collection of swine data was handled differently. Madison County hogs were tagged during weigh-in at the county fair so, reading of the ear tags could not take place the same day, without achieving inaccurate results. In this case, the hogs were scanned two days after tagging, which was the day of the county fair swine show. The scanning of the ear tags took place when the

hogs exited the show ring through a gated corral. The researcher was able to lean over the paneled corral and wave the wand over the exiting hog's ear. The wand would vibrate and buzz when the tag was scanned successfully.

After each individual animal was scanned, the USDA number was stored in the memory of the wand. After all of the enrolled animals were scanned, the USDA numbers were downloaded from the LightningROD onto the Excel sheet using the Key Injector software. The Excel sheet was then available to the county for their use and information.

3.6. Data Analysis

The quantative data were entered and analyzed in Statistical Package for the Social Sciences, SPSS 16.0 for Windows, 2007. Descriptive statistics used to analyze the data included: means, percentages and standard deviations. The statistical information collected was used to summarize, arrange and interpret the data. The researcher acquired statistical assistance from the Purdue University Department of Statistics.

Since independent t-tests were used to analyze data, the alpha for each table had to be reconfigured. There were multiple t-tests ran on each table, making the chance of error higher. The alpha was determined by taking the standard alpha (.05) and dividing it by the number of tests performed.

The Excel spread sheet, used for data collection, helped organize the data collected from the counties. The spread sheet had columns for listing: the county name, specie, county tag number, RFID tag number, government tag number, exhibitor name, premises ID and whether the ear tag was retained or not. The data were coded using the following system: if the RFID tag column (indicating whether or not the tag was retained) was blank and there were no comments made (retag, lost, etc.) then the retained column was left blank, which told the researcher that the animal did not return to the county fair and thus, no data were available. If the RFID column was filled and there were no comments made, then the retained column would read 1. This told the researcher that the tag was

retained and readable. If the RFID tag column was blank and there were comments made, the retained column read 0. This number told the researcher that the EID tag was not retained.

CHAPTER 4. RESULTS

4.1. EID Ear Tags as a Form of Dependable Identification

In order to properly evaluate the electronic identification process, 1,770 4-H animals were tagged on nine county enrollment days. When the livestock returned to be exhibited at the county fair, the tags were read by an electronic wand. The total number of tags used in each county was figured, including mistags and broken tags. The mistags and broken tags were then subtracted to give the researcher the total number of animals tagged in each specie, in each county. The animals that returned to the county fair were read with an electronic wand. This number was totaled in each county before the tags that were unreadable, lost or torn-out were subtracted.

Table 4.1 is a summary of the total number of EID tags used in each county, the number of animals tagged in those counties and the number of animals returning to the county fair weigh-in. This table also indicates the number of EID tags unable to be read by the electronic wand, the number of tags lost or torn-out, the total percentage of tags that were not retained and the total percentage of readable tags.

Table 4.1 Summary of EID Ear Tag Study

County	Specie	Total # Tags Used[1]	# of Animals Tagged[2]	# of Animals Returning to County Fair[3]	# of Tags Not Readable[4]	# of Tags Lost[5]	# of Tags Torn-Out[6]	Other[7]	% of Tags Not Retained	% of Tags Retained
Johnson	Beef	149	149	105	0	1	1	1	2.9%	97.1%
Putnam	Beef	124	124	91	0	0	1	0	1.1%	98.9%
Whitley	Beef	156	155	106	0	0	1	0	0.9%	99.1%
Hancock	Sheep	327	317	241	0	10	4	0	5.8%	94.2%
Madison 1	Sheep	160	140	119	1	0	1	0	1.7%	98.3%
Lake	Swine	110	110	90	0	0	0	0	0%	100%
Madison 2	Swine	427	423	423	0	0	0	3	0.7%	99.3%
Monroe	Swine	245	243	219	0	3	1	0	1.8%	98.2%
Steuben	Swine	110	109	97	0	1	0	0	1%	99%

[1] The number of tags placed in the animal's ear and also lost due to mistaggings, broken ear tags and other situations.
[2] The total number of animals that were tagged.
[3] The total number of animals returning to the county fair to have their ear tags read.
[4] The tags that could not be read by the wand, but were still intact in the animal's ear.
[5] Lost tags consisted of no tag being present in the ear, but the ear was not visibly torn.
[6] Torn-out tags were the tags that were ripped from the ear, with the ear being visibly torn.
[7] "Other" consisted of tags bent, causing the tag to fall apart (3), or a tag the owner asked to be removed because it was damaging the animal's ear (1).

Table 4.2 shows the number of animals from each specie that returned to the county fair to participate in the exhibition and have their tags read. The total of 1,491 was 84.2% of the animals tagged during county enrollment days.

Table 4.2 Total Number of Animals Present at County Fair Weigh-In

Specie	N
Beef	302
Sheep	360
Swine	829
Total	1,491

4.2. Retention Rate Comparison Between Species

The retention rate comparison between species was calculated by conducting an independent sample t-test that compared specie to specie based on the retention rate of the EID tag within that specie. Table 4.3 shows the comparison of retention rates between beef, sheep and swine. The t-test compares sheep and swine, returned a value of .000 which indicated there was a significant difference between the retention rates of sheep and swine. The other two tests performed between beef and sheep, and between beef and swine returned values of .041 and .336, indicating there was not a significant difference between the retention rates. The three t-tests on the tables below were based on an alpha of .016. This alpha was calculated by taking the standard alpha (.05) and dividing it by the number of tests performed (3).

Table 4.3 Comparison of Retention Rates Between Species

Species	N	Mean[1]	St. Dev.	T-test (p-value)
Beef vs.	302	.98	.128	
Sheep	360	.96	.206	.041
Beef vs.	302	.98	.128	
Swine	829	.99	.098	.336
Sheep vs.	360	.96	.206	
Swine	829	.99	.098	.000*

Note. P < .016 *Signifies statistical significance
[1] Mean is the decimal equivalent of the percent tags retained. Variable was coded 0 = not retained, 1 = retained.

4.3. Retention Rate Comparison of Species Between Counties

The EID ear tag retention rate comparison of species between counties were calculated by conducting an independent sample t-test, comparing counties within the same specie. Tables 4.4, 4.5 and 4.6 show the retention rate comparison among counties where beef, sheep and swine were represented. The alpha for this set of tests was .005 or higher. This was calculated by dividing the standard alpha (.05) by the number of tests ran (10). There did not prove to be a difference in the retention rate of EID ear tags between counties for beef, sheep or swine.

Table 4.4 Comparison of Retention Rates of EID Ear Tags Between Counties for Beef

Counties	N	Mean	St. Dev.	T-test (p-value)
Johnson vs.	105	.97	.167	
Putnam	91	.99	.105	.388
Johnson vs.	105	.97	.167	
Whitley	106	.99	.097	.310
Putnam vs.	91	.99	.105	
Whitley	106	.99	.097	.914

Note. P < .005 *Signifies statistical significance

Table 4.5 Retention Rate of EID Ear Tags Between Counties for Sheep

Counties	N	Mean	St. Dev.	T-test (p-value)
Hancock vs.	241	.94	.234	
Madison	119	.98	.129	.074

Note. P < .005 *Signifies statistical significance

Table 4.6 Comparison of Retention Rates of EID Ear Tags Between Counties for Swine

Counties	N	Mean	St. Dev.	T-test (p-value)
Lake vs.	90	1.00	.000	
Madison	423	.99	.084	.424
Lake vs.	90	1.00	.000	
Steuben	97	.99	.102	.337
Lake vs.	90	1.00	.000	
Monroe	219	.98	.134	.198
Madison vs.	423	.99	.084	
Monroe	219	.98	.134	.197
Madison vs.	423	.99	.084	
Steuben	97	.99	.102	.744
Monroe vs.	219	.98	.134	
Steuben	97	.99	.102	.603

Note. P < .005 *Signifies statistical significance

CHAPTER 5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary

The purpose of this study was to evaluate the use and efficiency of electronic identification (EID) ear tags. The research collected will prove useful in establishing the effectiveness and efficiency of EID ear tags in livestock.

The objectives of this study were to:

1. Determine the retention rate of EID ear tags in beef, sheep and swine.
2. Determine the readability rate of EID ear tags, over various lengths of time.

In each of Indiana's 92 counties, 4-H Youth Development Educators were e-mailed the details and purpose of the study. Participating counties were given an incentive of free EID ear tags. The Educators then asked their beef, sheep and swine superintendents if they were interested in participating in this study. Educators wishing to participate provided their county's date and time for beef, sheep and swine enrollment, the number of beef, sheep and swine to be enrolled and the date and time of weigh-in for each specie at the county fair. The State 4-H Livestock Specialist chose the participating counties with the higher number of beef, sheep and swine enrolled.

The ear tagging of beef cattle took place in 2008 between February 9 and March 8. Sheep ear tagging took place on May 9 and 10, while swine tagging took place from May 4 through July 19. Electronic ear tags read at county fairs from July 13 to August 4. At each county, the EID tag readings were stored on the LightningROD until they were transferred to a laptop computer. The readings

were then downloaded to an Excel spread sheet after all the animals' tags had been read. The sheet was then presented to the county for further use.

A total of 1,491 livestock (302 beef cattle, 360 sheep and 829 swine) returned to county fairs to have their EID tags read. In addition to these animals, 15 lost their EID tag, 9 animals had their EID torn-out, 1 tag was removed and 3 tags were bent while in the animal's ear. Of the 1,491 EID ear tags that were read at county fair weigh-ins, only 1 was unreadable by the LightningROD.

5.2. Conclusions and Recommendations

The first objective of this study was to determine the retention rate of EID ear tags in 4-H beef, sheep and swine. The average retention rate of the ear tags in beef was 98.4%, sheep was 96.3% and swine was 99.1%. By comparison, a study by Rusk in 2002 tested the effectiveness of electronic ear tags in 4-H sheep and swine. The results from this study yielded a 67% retention rate in hogs and a 98% retention rate in sheep, when the electronic portion of the tag was placed inside the ear correctly.

A t-test indicated there was a significant difference found when comparing the retention rates between sheep and swine in this study. The average retention rate for sheep was 96.3%, while the average retention rate for swine was 99.1%. Although, both retention rates are high, there is a statistical difference.

The second objective of this study was to determine the readability rate of EID ear tags in 4-H beef, sheep and swine. The readability rate of the EID tags was determined by the number of tags that were able to be read by the wand, while still in the animal's ear at the time of weigh-in. During the reading process, a total of 1,463 EID tags were read, this excludes the tags that were lost, torn-out or otherwise not in the animal's ear. Of the 1,463 tags that were read by the wand, only one of the electronic identification ear tags was unable to be read by the wand.

It can be concluded that that the EID tags have a high retention rate, high readability rate, as well as being similarly retained and readable among species.

The results of the current study imply that the EID ear tag technology is suitable for use in Indiana 4-H beef, sheep and swine projects.

Based on the findings and observations made in the study, a few recommendations can be made. The first recommendation is that the sheep and swine ear tags be formatted in the same way as the beef ear tags. The beef ear tags contained both the government number and the county number on the front part of the ear tag. The researcher found that having both numbers present on the front part of the tag was beneficial for three reasons. First, it made the government number more visible and easy to visually match the number on the LCD screen of the reader. Secondly, it created less preparation for the researcher and less confusion for the individual arranging the tags prior to tagging. Finally, having both tag numbers created an accurate and smooth weigh-in process for the 4-H member and the Extension Educator.

The researcher would also recommend a larger county number be printed on the sheep ear tag. The small print made it difficult to see the number from a distance and made it more difficult for the 4-H member to identify their animal, which was the purpose of the county number in this study.

Another recommendation the researcher suggests is an EID study involving other livestock species. Boer goats were mistakenly tagged in two counties participating in the research. The researcher collected the data from one county by using the same process as the other species. The researcher scanned the goats as they were held in the scales. Of the 17 goats that returned to the county fair weigh-in, all EID tags were retained and all of the tags were readable by the wand. These results imply that EID ear tag technology may be suitable for other livestock species as well.

If the USDA decides to make EID tags a mandatory method of identification for 4-H beef, sheep and swine, the researcher recommends that the tags be supplemented with retinal imaging of beef, goats and sheep. The biometric security coupled with the digital technology would decrease the chance

of an individual trying to forge an animal's identity, as well as help prevent a possible disease outbreak.

For future studies, the researcher highly recommends selecting counties with only one enrollment day per specie. This would allow all of the livestock in participating counties to be ear tagged by the same individual. One livestock individual tagging all of the animals in the study would eliminate many of the limitations that numerous individual taggers present. The researcher found that many of the counties had their volunteers going to numerous individual farms to tag their livestock. When the researcher arrived for enrollment night, large groups of livestock were already tagged. The benefit of having one tagger would be the consistency of all the tags being placed in the animal's ear by one individual. The researcher also recommends that this individual have previous tagging experience, in order to ensure that the tags are properly placed in the animal's ear.

5.3. Observations

There were numerous observations made by the researcher during the course of this study. When the animals were tagged at enrollment, many individuals (Educators, volunteers, parents and 4-H members) were very curious about the new tags being used. A paper was handed-out with information regarding the EID tags, which opened up the communication lines for questions to the researcher.

The researcher noticed that questions regarding the EID technology were not asked by families, volunteers and visitors until the county fair weigh-in. When the researcher was at the Madison County Fair, the swine tags were read while the hogs were leaving the show ring. In-between classes, the researcher was asked numerous questions about the technology and the study itself by 4-H families as well as non-4-H visitors watching the show. Many of the individuals asking questions thought the researcher was harming the animal in some way until it was explained to them what the wand and study truly entailed.

The researcher found it necessary to use the proper needle in the ear taggers when inserting the EID tags. If the needle being used was not long enough, then the needle would break through the side of the tag button, which prevented instillation of the tag from occurring. The researcher also found that EID tags were thicker than normal tags, so some of the ear taggers did not have a large enough opening to accommodate EID tags. The researcher recommends the use of Destron Fearing's Universal Duflex Eartag Applicator to apply EID tags. The researcher used these taggers during the study and found that the taggers complimented the EID tags.

The LightningROD was very effective at reading the EID tags from an approximate distance of six inches away from the tag. The researcher also found it convenient to read the EID tags while the animals were confined in the scale at county weigh-in. This made it convenient for the researcher and time effective for the county, thus assuring a smooth process.

When the researcher returned to county fairs to read the EID tags, numerous counties were pleased with and impressed by the technology and the tags. The individuals at the reading sites were very impressed by the speed of the LightningROD tag reader, the retention rate of the tags and the capabilities this tag offers. Several counties expressed interest in using the EID tags again next year.

When the researcher returned to the county fairs to read EID tags, she passed out a voluntary survey (Appendix E) to Educators, volunteers, and parents involved in the EID study. When this survey was distributed in Hancock County, numerous volunteers completed the survey as a group, writing down the same comments on all of the forms. This made some of the surveys void in terms of comments and thoughts. The researcher then formulated a chart of concerns and compliments based on the valid surveys returned.

Table 5.1 Survey Results

Compliments	Concerns
Easy to scan and easy to tag	The beef tags were too big
Numbers were very easy to read	High cost
Moved the process along quickly	Too many tags were lost
Unable to read visually, but can be easily read with a scanner	Tags did not fit into the tagging pliers
It is nice to have the number go directly to the computer	

The researcher also observed a common misconception about the research. Since the swine tags in Madison County were being read by the wand as hogs exited the show ring, the researcher was asked numerous questions about the study by individuals watching the show. A majority of the questions were asked by the general public not involved in 4-H. All of the questions were geared toward the function of the wand. Originally, many individuals thought the wand was a shocking device used to speed-up movement of the hogs. After a quick explanation of the study, many individuals were excited and curious to learn about the technology.

The researcher found that positive outcomes out-weight the expense of the tags. The EID tags were easily and quickly read by the wand. Human error was virtually eliminated based on the communication from the wand to the KeyInjector, which allowed the EID numbers to be inserted into the spread sheet without an individual taking time to write down the individual tag numbers.

One county in the study had numerous animals lose their EID tag. These losses could be due to the type of fencing material used to confine the animals,

or how the animal was handled, since a majority of the animals with lost or ripped tags lived on the same farm.

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APPENDICES

Appendix A. Informational Letter for 4-H Beef Members

February 2008

Dear 4-Her,

The new tag placed in your animal's ear today is a Radio Frequency Identification (RFID). This is simply an ordinary tag with an electronic implant within the top part of the tag. There are two individual numbers located on the tag; government and county. The first number is the fifteen digit government id that is unique to your animal. (This number is not found on any other animal in the United States.) The second number is the county number which is similar to the number on the tags in the past.

We are currently conducting research on the tag concerning efficiency and duration. I will be coming back during weigh-in at the fair, to scan the tag with a wand, which will then enter the information into a computer. This allows no need to reenter the numbers and this in turn, will save time. We are also watching how long the tag lasts in the ear.

Both of these items are critical to our research. Please let me know if your animal's tag is lost, damaged or if you simply have any questions. Thank you for your time and understanding.

SEE YOU AT THE FAIR!

Brittany Simmons
YDAE Graduate Student
(765) 494-0553
basimmon@purdue.edu

Appendix B. Informational Letter for 4-H Sheep Members

May 2008

Dear 4-Her,

The new tag placed in your animal's ear today is a Radio Frequency Identification (RFID). This is simply an ordinary tag with an electronic implant within the top part of the tag. There are two individual numbers located on the tag; government and county. The first number is the fifteen digit government id that is unique to your animal. (This number is not found on any other animal in the United States.) The second number is the county number which is similar to the number on the tags in the past.

We are currently conducting research on the tag concerning efficiency and duration. I will be coming back during weigh-in at the fair, to scan the tag with a wand, which will then enter the information into a computer. This allows no need to reenter the numbers and this in turn, will save time. We are also watching how long the tag lasts in the ear.

Both of these items are critical to our research. Please let me know if your animal's tag is lost, damaged or if you simply have any questions. Thank you for your time and understanding.

SEE YOU AT THE FAIR!

Brittany Simmons
YDAE Graduate Student
(765) 494-0553
basimmon@purdue.edu

Appendix C. Informational Letter for 4-H Swine Members

May 2008

Dear 4-Her,

The new tag placed in your animal's ear today is a Radio Frequency Identification (RFID). This is simply an ordinary tag with an electronic implant within the top part of the tag. There are two individual numbers located on the tag; government and county. The first number is the fifteen digit government id that is unique to your animal. (This number is not found on any other animal in the United States.) The second number is the county number which is similar to the number on the tags in the past.

We are currently conducting research on the tag concerning efficiency and duration. I will be coming back during weigh-in at the fair, to scan the tag with a wand, which will then enter the information into a computer. This allows no need to reenter the numbers and this in turn, will save time. We are also watching how long the tag lasts in the ear.

Both of these items are critical to our research. Please let me know if your animal's tag is lost, damaged or if you simply have any questions. Thank you for your time and understanding.

SEE YOU AT THE FAIR!

Brittany Simmons
YDAE Graduate Student
(765) 494-0553
basimmon@purdue.edu

Appendix D. Example of Excel Spread Sheet Used for Data Collection

County Name	Specie	County #	RFID Reading	Government #	Exhibitor (L,F)	Premise ID	Retained? (1 = yes, 0 = no)

1. IF Column E blank AND Column O blank THEN Column P blank
2. IF Column O blank AND Column E not blank THEN Column P = 1
3. IF Column O not blank AND Column E blank THEN Column P = 0

Appendix E. Volunteer Survey

If possible, I would appreciate it if you would complete the survey below with regards to the electronic tag research. Participation is voluntary and participants must be 18 years old. Thank you in advance for your time and effort.

What was your connection with the electronic ear tag process? (Circle one)

Educator/Volunteer Parent

What worked well in using the electronic tags and process?

What did you dislike about the electronic tags and process?

What would you change about the tags or the process?

What benefits did you see from using this new technology?

What obstacles do you foresee with this technology?

Did the process run as smoothly as with normal tags?

Did the electronic ear tag(s) come out of your animal(s) during the summer? If yes, how many of the electronic tags came out and when did they come out?