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PERCEPTIONS OF RETINAL IMAGING TECHNOLOGY FOR IDENTIFYING LIVESTOCK EXHIBITS

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Abstract – This paper will outline the results of an online survey about the perceptions of Indiana 4-H Youth Educators on the use of retinal imaging for the purpose of identifying 4-H livestock projects. Indiana has begun a three year implementation period of retinal imaging and doing away with nose printing as the method of permanent livestock identification. The perceptions relate to the benefits and disadvantages of utilizing retinal imaging technology and the reasons why a particular educator decided to purchase or not purchase the equipment during the first year of the implementation.
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Index terms – retinal imaging, technology perceptions, innovation diffusion

I. INTRODUCTION

The primary purpose of this study was to evaluate the general attitudes of county extension educators and 4-H volunteers regarding the retinal imaging process as a means of identifying and verifying the identity of 4-H animal projects. Participants in this study included county Extension educators who had or had not purchased retinal imaging equipment in 2005. The second objective of the study was to identify the perceived strengths and weaknesses of the retinal imaging process of county extension educators.

Retinal imaging technology has been used for the purpose of identifying humans since the 1970's. In recent years this technology has been adapted for the use of individually identifying livestock such as cattle, goats and sheep, on the basis of the vein pattern located on the retina of the eye. The manufacturer has coupled the retinal image with the global positioning satellite system, (GPS), to verify the location of the animal at the time of image collection [1]. Each eye has a unique retinal pattern that is present and remains unchanged from birth. In 2005, the Indiana 4-H Youth Development began implementing retinal imaging as an alternative method of permanent identification for enrolling livestock animals into its program [2]. The implementation period is three years, 2005-2007, making retinal imaging the mandatory method for enrolling livestock that will be exhibited at the Indiana State Fair. The animals must be enrolled at the county level, and therefore utilize adult volunteers to identify each animal. From 1985 through 2006, counties collected nose prints of these exhibition animals to provide a source of permanent identification rather than relying on eartags that could be lost, or moved from animal to animal [3].

Beginning in 1985, nose printing was utilized as a low cost method of permanent identification for 4-H livestock exhibits. The downside of this method of permanent identification is that it took a trained eye to be able to confirm a match between enrollment and verification prints, and the quality of prints across the state was not consistent [4]. Many times volunteers are utilized in collecting the prints. The individual that owns the animal is asked to make a judgment call about the quality of the image. However, these individuals are not trained in analyzing nose prints and many times approve prints that are smeared or unclear. The inconsistent quality of nose prints across the state made it necessary to look at other options of identification. Blomeke conducted a study in 2004, investigating retinal imaging as an alternative method of identifying 4-H beef and sheep projects.

During the initial retinal imaging study, researchers were given casual feedback from Extension educators, adult volunteers, and 4-H members. However, this feedback was only observed in passing and no data was recorded. One example of peoples' reaction to retinal imaging was the reluctance of some 4-H members to allow their animals to be imaged for fear of harming the animal. In counties where more than one weigh-in occurred, participation increased at the second weigh-in, after participants had the opportunity to observe the retinal imaging equipment at the first weigh-in and see that it was safe for use in their animals [4].

The reaction of Extension educators across the state was mixed. It seemed many of the educators involved in the initial study were excited about using the retinal imaging equipment. One concern expressed by educators who did not participate in the study was that the equipment was too expensive. In 2005, twenty-five of the ninety-two Indiana counties used retinal imaging as a method to identify at least one species of 4-H livestock projects.

Indiana was the first state in the U.S. to use retinal imaging as a means of permanent identification of 4-H livestock projects. Other states have shown interest, but the technology and process are still gaining acceptance for this application. [4] found retinal imaging be a superior form of livestock identification compared to nose printing, although no data has been collected about how people feel about the retinal imaging process and how well the process might work when administered by county Extension educators and volunteers. This research seeks to determine the attitudes and perceptions about the utilizing the retinal imaging technology from three different populations, and to identify the perceived strengths and weaknesses of the retinal imaging process.

B. Program Organization

Extension programs, such as 4-H and Youth Development, receive funds from the federal, state and county governments [5]. Each Indiana county has at least one Extension educator employed by Purdue University. In addition to the work done by the Extension educator, volunteer assistance is vital to the success of the 4-H Youth Development program in every county. These volunteers often sit on committees that make decisions concerning the 4-H Youth Development programs, and provide the manpower necessary to make the various programs run. A team of specialists at Purdue University helps develop policies and procedures and administers the 4-H Youth Development program. Counties are given the freedom to run the county program as the educator and county volunteers see fit, as long as all rules and guidelines mandated by the state are met [6],[5]..

Extension educators often serve as change agents for communities by making Land Grant University research accessible to local citizens [6]. The Smith-Lever Act of 1914 challenged Extension Educators to diffuse research information from their state university to local citizens and encouraged the application of this research.

C. Diffusion of Innovation

The theory of "diffusion of innovations" outlined in [6] served as the theoretical framework for this study. Diffusion research has been fundamental since the early days of Extension programs. Diffusion is defined in [6] as "the process by which an innovation is communicated through certain channels over time among the members of a social system. It is a special type of communication, in that the messages are concerned with new ideas" . Diffusion is related to the work of Extension educators, as they work to disseminate knowledge and research findings in an effort to improve people's quality of life [5].

The four main elements necessary for diffusion are: the innovation itself, communication channels, time, and the social system [6]. All of these elements play a role in how a new idea or type of technology is accepted into an organization or society. Extension Educators often play important roles in introducing an innovation through various communication channels.

An innovation is defined as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" [6]. Innovations are often introduced to individuals or units of adoption by a change agent, someone who may try to sway the innovation-decision process in the direction deemed desirable by the change agency [6]. Change agents do not always try to speed up the diffusion of an innovation; if the change agent does not deem the innovation to be advantageous to the population he or she may try to slow the diffusion process.

Once an innovation has been introduced to a population, news of the innovation is spread through various communication channels. There is a variety of communication channels that may influence the innovation-decision process of an individual. Mass media such as news print, radio, television, and flyers are effective ways for change agents to reach a large audience. Personal interaction with sales people has been found to have a considerable influence on the innovation-decision process. The most influential communication channel is often interaction with peers and neighbors who have already started using the innovation [6], [7].

The most influential diffusion study in agriculture to date began in the 1930s with a study of hybrid corn. In [7] the rate at which farmers integrated hybrid seed corn into their farming operations was studied. The behavior of the farmers was also observed. Ryan chose hybrid seed corn to study how social relationships of farmers influenced their economic decisions [6].

The Cooperative Extension Service has played an important role in the diffusion of innovations since its inception [6], [5]. The Smith-Lever Act of 1914, which essentially established the modern Cooperative Extension Service (CES) at Land Grant Universities, states the following mission for CES:

> "… to aid in diffusing among the people of the United States useful and practical information on subjects relating to agriculture and home economics, and to encourage the application of the same… (Seevers 1997, p. 7)"

Through the years, Extension educators have diffused the research conducted at Land Grant Universities to the people in the communities they serve. Many times the goal was to introduce mechanical or technological innovations to the home or farm. Often times, Extension educators take on the role of "change agent." A change agent is someone who attempts to influence people while they are making the decision to adopt or not adopt an innovation [6]. Extension educators learn of an innovation from the research done at the state university and either introduces it to the community or hold off, depending on their idea of the benefit the innovation will provide. Change agents lean on the support of opinion leaders, who are influential members of the community and often respected by other members of the community.

D. Characteristics of an Innovation

The characteristics that individuals perceive an innovation to possess have an effect on how quickly the innovation will be diffused [8],[6]. Both [8] and [6] outline the following characteristics that help influence an

individual's innovation-decision process: relative advantage, compatibility, complexity, trialability and observability.

The innovation-decision process can be divided into five major stages (Rogers 2003). Communication channels, such as the social system and mass media, influence each of these stages.

1. *Knowledge* is when an individual learns about an innovation and begins to understand how it functions.
2. *Persuasion* is the stage in which a person forms an opinion about the innovation.
3. *Decision* is when an individual has obtained enough information to choose whether or not to adopt the innovation.
4. *Implementation* is when a new idea is put into practice.
5. *Confirmation* is when an individual has begun using an innovation and seeks reinforcement for their decision. During this stage, an individual will decide whether or not to continue using the innovation depending on the information gathered from the use of the innovation.

II. METHODOLOGY

For this study questions asked of Extension educators were focused on how they came to the decision to use the retinal imaging process. They were the gatekeepers and decided if the county would purchase the equipment and use the process. The researchers were interested in how they came to the decision and if they made the decision on their own. Educators were asked who they consulted before making the decision of whether or not to purchase the equipment, such as livestock committees. Educators were also asked what they feel is the greatest advantage or disadvantage of the retinal imaging process.

The Extension educator questionnaire asked for demographic characteristics in addition to whether or not they purchased the retinal imaging equipment for use in 2005; which determined the specific questions they would answer later in the survey. For those educators who purchased the retinal imaging equipment, additional questions asked why they purchased the equipment, which species were enrolled using the retinal imaging process, and how volunteers were selected to use the equipment. Educators who had not purchased the equipment were asked why they didn't purchase the equipment, what they would like to know about the equipment before purchasing it, and how they plan to meet the state mandate requiring retinal images for all 4-H beef cattle, goats and sheep being exhibited at the 2007 Indiana State Fair. Educators were also asked if they consulted any boards or groups before making the decision to purchase the equipment and why they approached or didn't approach these groups. Open-ended questions asked what the educators perceived as advantages and disadvantages of the equipment.

A. Demographics

The respondent of this survey are all employed by the Purdue Extension Service and work in the field of 4-H Youth Development. Demographics such as gender, age, and whether or not the county of employment had purchased the retinal imaging equipment for 2005 was collected. The survey respondents consisted of 76 individuals, 46 women and 30 men, and the majority age range of these individuals was 41-50 years old (39.5 percent of respondents). The percentage of respondents indicating their county of employment had purchased the retinal imaging equipment for use in 2005 was 48.7 percent (37 of 76 counties).

B. Survey Results

Respondents completed separate questions based on whether or not their county of employment had purchased the retinal imaging equipment. Participants were asked why they chose to purchase the retinal imaging equipment and given a list of choices, including an "other" option. Table 4 shows the frequency of responses to this question. The percentages do not add up to 100 percent, because educators were able to select more than one answer.

TABLE 1
RESPONSES FROM EDUCATORS AS TO WHY THEY PURCHASED RETINAL IMAGING EQUIPMENT (n = 37)

Response	Frequency	Percentage
Other reasons	32	86.5
We have had problems with nose prints in the past and wanted to see if retinal imaging would be an improvement	30	81.1
This is the direction Purdue Cooperative Extension will be going in the future	13	35.1
We wanted to get the equipment while it was being offered at a reduced price	13	35.1
I like to try new things	11	29.7
I felt this would improve my county's 4-H livestock program	11	29.7

Eighty-six percent (32 of 37) of respondents indicated there were "other reasons" they purchased the retinal imaging equipment besides the reasons listed in the survey. Seven respondents actually listed "other reasons", including: "Wanted to test the system and see how it works."; "The 4-H volunteers were in favor of the purchase."; "The State was requiring this procedure by 2007."; "After being a pilot [county] for beef [imaging] in 2004, we saw there could be benefits to using the equipment."; "More accurate information."; "We purchased [the equipment] in 2006 without the discount because we will need it in 2007 and wanted to start early."

Respondents who had not purchased the retinal imaging equipment were asked why they had not made the purchase. Table 2 shows the frequency of responses to this question. Again, the percentages do not add up to 100

percent because educators were able to select more than one answer to this question.

TABLE 2
RESPONSE OF EDUCATORS AS TO WHY THEY DID NOT PURCHASE RETINAL IMAGING EQUIPMENT IN 2005 (n = 42)

Response	Frequency	Percentage
Lack of funds	32	76.2
Other reasons	29	69.1
Wanted to see how it worked for others before purchasing it for my county	21	50.0
Did not know enough about the technology	12	28.6
Lack of support from families involved in livestock projects	7	16.7
Livestock committees did not approve the purchase	6	14.3
Skeptical of Purdue giving us new things to learn	3	7.1

Sixty-nine percent (29 of 42) of respondents indicated there were "other reasons" they did not purchase the retinal imaging equipment besides the reasons listed in the survey. The reasons included: low livestock enrollment, funding not approved, lack of information/skeptical of the process, concerns with the manufacturing company, and other reasons. Several responses fit into more than one category. Table 3 shows the frequency of responses given by Educators for not purchasing the retinal imaging equipment.

TABLE 3
REASONS, OTHER THAN THOSE LISTED ON THE SURVEY, FOR NOT PURCHASING THE RETINAL IMAGING EQUIPMENT (n = 30)

Category	Frequency	Percentage
Funding not approved	14	46.7
Low livestock enrollment	13	43.3
Lack of information/skeptical of the process	9	30.0
Concerns with the manufacturing company	3	10.0
Other reasons	2	6.7

C. Perceived Benefits of Retinal Imaging

Although not all of the educators completing this survey had purchased the equipment, even those that had not purchased it at this time were able to see some of the benefits of using the technology. Table 4 shows the frequency of responses given about the perceived benefits of using retinal imaging to individually identify livestock enrolled in the Indiana 4-H Program.

TABLE 4
EDUCATORS' PERCEPTIONS OF THE BENEFITS OF RETINAL IMAGING (n = 69)

Category	Frequency	Percentage
Improved accuracy and better quality of identification	45	65.2
No more nose prints to handle	17	24.6
It will reduce cheating	5	7.3
None/no response	14	20.3

Sixty-five percent (45 of 69) of the respondents indicated that retinal imaging provides greater accuracy and a higher quality identification system. Responses included: "All scans are the same."; "We understand that it will eliminate any question of the right animal being shown and sold."; "More efficient, more accurate."; "Easier to read than nose prints."; "Fool proof identification at the state level."; "Once our livestock volunteers are educated on the technology, they can easily check all animals at fair check-in to assure honesty of 4-H families."; "Hopefully this will improve the quality of the identification procedure."

Twenty-four percent (17 of 49) of the respondents said it will be a benefit to no longer handle nose prints. Responses included: "Leaving out-dated nose print process behind."; "Reduce the ability to get away with things as can sometimes happen with nose printing (hard to read, etc.)"; "Use of electronic transfer of images and less likely to lose prints. No need to wipe noses."; "Nose prints for the most part were useless."; "Ease in transferring data, less of a hassle than nose print cards, better quality than nose prints."

Five respondents indicated that retinal imaging will reduce cheating. Responses included: "Reduce the number of animals that are switched."; "Fewer avenues for cheating."; "Decreases the opportunity for switching animals (cheating)."; "Deters cheating at junior shows."

Twenty percent (14 of 69) of the respondents did not provide a response to this question, or indicated there were no benefits to using this equipment. Responses included: "No Response."; "I don't currently see any benefit."; " For us at the county level, there are essentially none. While I don't argue that the technology is an improvement over nose printing, I feel the majority of the benefit goes to the state-level, not the county, even though the cost of this technology comes from the county level."; "I see very little benefit. It DOES take away the nose printing, but it is a very steep price to pay."

D. Perceived Disadvantages

Educators were also asked about the disadvantages of the retinal imaging process. Answers varied and several responses fit into more than one category. Responses were broken down into seven categories which include: cost, the amount of time required to learn how to use the equipment and obtain a scan, technology and maintenance, volunteer training and understanding, manufacturer concerns, questioning how long the process will be viable, and no response. Table 5 illustrates the

frequency of responses of disadvantages of retinal imaging provided on the survey.

TABLE 5
EDUCATORS' PERCEPTIONS OF THE DISADVANTAGES OF RETINAL IMAGING (n = 69)

Category	Frequency	Percentage
Cost	28	40.6
Amount of time required to learn how to use the equipment and obtain a scan	25	36.2
Technology and maintenance	18	26.1
Volunteer training and understanding	11	15.9
Manufacturer concerns	5	7.3
Questioning how long the process will be viable	3	4.4
No response	5	7.3

Forty percent (28 of 69) of the respondents indicated that cost is one of the major disadvantages of this equipment. Responses included: "How much will it cost to update the equipment? Another challenge will be paying for the images scanned each year."; "New technology brings uncertainty. It is an effective yet very expensive means of policing cheaters ... a cost none of us wish we had to pay."; "Cost. It is very expensive for a county that has less than 10 kids go to the State Fair in these species."; "Upkeep could be expensive once the warranty is expired."; "How much will it cost to repair equipment and how long will it last. (Just like a computer, eventually the technology gets better.)"

Thirty-six percent (25 of 69) of the respondents expressed a concern about the time required to learn how to use the equipment and obtain scans during enrollment. Responses included: "…the time needed by volunteers to acquire competency in its use. Until then, it will be a significant inconvenience."; "The challenge that presents itself is the willingness of volunteers to practice a significant amount to become quick at collecting images. Time should not be the main focus, but rather collecting quality images."; "…will take a process that currently takes us 6-8 hours and stretch it into a multi-day process unless we eliminate all those who are not going to State Fair."; "Right now, we do not have enough people trained to use the scanner. We are working to create some training opportunities for volunteers in our county. Also, when we used it, it took a lot longer than the nose prints. This goes back to needing to practice more before the event and making sure all variables (lighting, space, etc.) are addressed before the weigh-in."; "Learning to use it properly and getting a good scan; keeping volunteers trained."

Twenty-six percent (18 of 69) of respondents expressed concern about maintenance of the technology. Responses included, "Breakdown of parts."; "Nose prints are a hard copy and can be photocopied. The card, equipment, etc. either work or they don't work and other than equipment from other counties, there is no backup."; "So far, the 4-H families have been pretty accepting of it; there are a few, however, that question the ability to store and retrieve the retinal images."; "Need for repairs on equipment from time to time."; "I have concern over the use of this equipment in extremely hot or cold conditions."; "GPS lock, there are some times GPS has black outs."

Fifteen percent (11 of 69) of the respondents said that one disadvantage of the retinal imaging process was the training and understanding of the equipment that is required. Responses included: "Intelligent people are required to administer the equipment."; "Not having enough trained people, not enough trainings offered, lack of understanding of the process."; "Limited amount of technicians. Malfunction of technology."

Five respondents expressed concerns about the company that manufactures the equipment and charges a fee for every image that is uploaded into the system. Responses included: "Once they have all of the counties on board, look for the per animal cost to go up to $1.50 or greater per animal. I just love their business plan."; "Indiana is the only current state participating in this technology. There is only one company that does not have loyalty to continue supporting Purdue."; "The fact there is no market competition. The fact that there is no long-term contract with the manufacturer that fixes the pricing schedule. The fact that the manufacturer could fail, leaving (potentially) 92 counties with valueless equipment."; "One vendor."; "We're now subservient to this one company as to whatever they want to charge. We don't know what the cost is in fixing the equipment . . . too many "ifs" that aren't discussed."

Three respondents questioned how long the technology and process would be viable before something else takes its place. Responses included: "What happens in three years when something new comes along?"; "The fact that technology will be changing rapidly, we may not be able to keep up or have to continually update for a period of time…"; "Rapid changes in technology that might possibly make the equipment, etc. obsolete in a short time."

Five respondents did not respond to this question. Two responses were not able to be categorized. They included: "Change is not easy in a small county."; "If a person wants to cheat, then that person will find a way. I have already been told by several other people that beef people know how to put a contact in a cow's eye to have it scanned, then move it to another cow's eye to have the exact same scan. I think this is a large investment to try to stop a handful from cheating."

III. CONCLUSIONS

Demographic information obtained from the Youth Educator population was limited to a few categories. Education and race were not considered, as this population is fairly homogeneous for educational background and ethnicity. All educator positions require a Masters Degree and all but two of the Educators were Caucasian. The typical respondent to the Youth Educator survey was a female between the ages of 41-50 who had not purchased and used the retinal scanning equipment in 2005. Sheep

and goats were the most common species that were retinal scanned. All respondents had access to a computer and possessed at least some computer skills, as all responses to the Educator survey were submitted online through an Internet website. This is consistent survey of Educators' perceived computer skills, where over 98 percent of the respondents indicated they could utilize the Internet [9]. Of those educators who did not purchase the equipment, the majority said they did not have the funds to purchase the equipment or they wanted to see how the system worked for other counties before they used it. Of the educators who purchased the retinal scanning equipment, the majority did so because of previous problems with nose printing, and the fact that they were ready for an alternative system to identify livestock.

A. Implications

Attitudes about the retinal imaging equipment and process were mostly positive. Although responses ranged from extremely positive to very negative, many respondents balanced the positive and negative aspects of retinal imaging. The affirmative attitudes towards the retinal imaging equipment were based on the ability to positively identify animals with retinal scans. Negative attitudes centered on the training required for volunteers to properly use the equipment and the increase in time needed to acquire a retinal image compared to the time it takes to obtain a nose print. In the original retinal imaging study, [4] noted that it does take longer to obtain a retinal image than a nose print, but the quality of the retinal image is consistently higher and easier for an untrained person to match images and verify the identity of an animal.

When Educators who purchased the retinal scanning equipment were asked why they did so, the majority indicated they had experienced problems with nose printing in the past and were looking for an improved method to verify the identity of livestock projects. Educators who did not purchase the retinal imaging equipment said they did not have the funds to purchase the equipment. Only twenty-eight percent of non-purchasers said that a lack of knowledge about the equipment kept them from purchasing the retinal scanner. When considering whether or not Educators feel that retinal imaging is a viable method to verify the identity of livestock projects, the responses imply that Educators are confident in the ability of the technology to identify livestock by retinal images. This is also supported by the response of Educators who approached county groups to gather support for purchasing the equipment. Arguments against the purchase focused on cost, while the acknowledgement of retinal imaging as a better identification system was the most common reason given in favor of purchasing the equipment.

Based on individual responses, the Educators who had used the retinal imaging equipment felt that it was beneficial to the Indiana 4-H Youth Development program. Some Educators who had not purchased the equipment indicated they felt it would be beneficial, but other reasons had prevented them from purchasing the equipment. The Educators who were strongly opposed to utilizing the equipment did not feel as though it would be a good use of funds, or were not fully educated about the process and the science behind the procedure.

B. Limitations and Recommendations

The first limitation of this study is the population does not lend itself to be a true innovation-diffusion study. According to [6] age, race, education levels, and income are significant factors to classify innovators. The race, education levels and income are similar for this particular population. In this study, the age and gender of Educators could be the reason just under half of them purchased the retinal scanning equipment. People in the age range of the majority of respondents to this survey (41-50 years old) tend to fall in the "late majority" innovator category. When asked why Educators had not purchased the equipment, the frequency of the response "Wanted to see how retinal imaging worked for others before purchasing it for my county" implies that these Educators are going to rely on second-hand knowledge of the innovation. This is consistent with the findings in [7] that later adopters depend on word-of-mouth knowledge to obtain information about the innovation rather than first-hand knowledge.

The second limitation of this study is the perceptions were collected after the first year of implementation of retinal imaging into counties. At this point in time, the use of the equipment is voluntary and could be contributing to resistant attitudes of using high tech methods of identification. It is recommended that additional research of perceptions of retinal imaging technology be completed after the methodology becomes mandatory and choice is no longer an option. The perceptions of collecting retinal images may change as the educators work with the technology on a yearly basis

A third limitation of this study is approximately half of the educators responding to the survey have not experienced using the technology. Therefore the perception of the technology is more based on opinion and secondhand knowledge of the technology than individual experience. A comparative study after the full implementation of retinal imaging technology would be useful in determining the perception of the technology after its implementation.

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V. VITA

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