Perceptions of Retinal Imaging Technology for Verifying the Identity of 4-H Ruminant Animals

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Abstract
The purpose of the study reported here was to determine the perceptions of 4-H members and volunteers regarding the retinal imaging process as an innovative method to verify the identity of 4-H animals. Participants were surveyed to determine the perceived strengths and weaknesses of the retinal imaging process and to determine whether participants consider retinal imaging to be beneficial to the Indiana 4-H program. Retinal imaging was perceived to be an accurate and efficient method of livestock identification by both 4-H members and adult volunteers. Volunteers determined that their ability to capture a retinal image requires skill and practice.

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Introduction

An affordable, convenient, and permanent form of identification is needed for 4-H livestock projects. Some livestock shows require exhibitors to submit blood or hair samples from their

animals several months prior to the show. These samples are then used to conduct DNA matching with blood or hair samples collected at the show. Although DNA provides a permanent form of biological identification, DNA matching is expensive and does not allow for "real time" verification of animals at 4-H livestock exhibitions.

Blomeke (2004) reported several advantages of using retinal imaging to verify the identity of 4-H livestock projects. The process is completely non-invasive and does not harm the animal in any way. The retinal image is consistently clearer than a nose print. In a comparison exercise, retinal images proved to be easier to match than nose prints. As a result of Blomeke's study, a mandate was issued requiring retinal images of 4-H ruminant animals entered at the Indiana State Fair.

Indiana was the first state to use retinal imaging to verify the identity of 4-H livestock projects. Other states have shown interest, but the technology and process are still gaining acceptance for animal verification. Although retinal imaging proved itself superior to nose printing as a form of livestock identification (Rusk, Blomeke, Balschweid, Elliott, & Baker, 2006), no data were collected to determine public acceptance of the process.

The study reported here was conducted to evaluate volunteer leaders' and 4-H livestock members' perceptions of the retinal imaging process and the equipment used to collect retinal images. The specific objectives of this study were to:

1. Determine respondents' perceptions of the retinal imaging process as a means of verifying animal identity.

2. Determine the perceived strengths and weaknesses of the retinal imaging process so they can be altered, corrected, and/or shared between counties and states.

3. Determine whether participants consider retinal imaging beneficial to the Indiana 4-H Program.

Methodology

Six hundred ninety-one 4-H livestock members (who were at least 14 years old and previously had an animal retinal imaged) and 88 adult volunteers (who used the retinal imaging equipment to scan 4-H animals) were surveyed to determine their perceptions of the benefits and challenges of the retinal imaging process. Names of participants were provided by Extension educators in 17 Indiana counties that had used retinal imaging to identify their 4-H animal projects. Researchers followed Dillman's (2000) recommendations for mail survey research, which were proven to be effective methods of gathering responses from dispersed populations.

Pilot tests were conducted to ensure the validity of the survey instruments. The pilot test of the 4-H survey occurred at a Junior Leader lock-in. The volunteer survey was pilot tested at a livestock leader training. Discussions following the pilot tests resulted in an "undecided" category being added to the Likert-type scale on both survey instruments, resulting in a five-point scale.

Volunteer and 4-H member populations were asked to respond to multiple questions using a five-point Likert-type scale. Each population was also asked several open-ended questions that varied according to their involvement in the retinal imaging process. The total length and design of the surveys were taken into consideration because the number of questions and length of the survey can affect response rate (Gay & Airasian, 2003).

Volunteers were asked how the retinal scanning process was conducted, how the Optireader[TM] device performed, and what problems, if any, were encountered with the equipment during the enrollment process. Volunteers were also asked if they encountered any resistance from 4-H families while they were scanning their livestock.

Four-H members were asked basic demographic questions, including gender, the year they were born, and the number of years they have been enrolled in 4-H livestock projects. Youth were also asked about their initial reaction to retinal scanning, how efficiently the equipment was used, and if retinal imaging would be beneficial to the 4-H program.

Quantitative data were analyzed using the Statistical Package for the Social Sciences (SPSS 12.0 for Windows) and Statistical Analysis Software (SAS). A Fisher's chi-square test was used to compare means.

Results

4-H Volunteers

Responses were received from 51 adult volunteers (40 male and 11 female), which yielded a response rate of 58%. The majority of respondents (58.8%) were over 40 years-old, while the remaining participants were 21 to 40 years-old. Seventy-one percent of the participants had at least some post high school education. Volunteers' responses regarding the efficiency of the retinal

imaging process and their ability to collect and verify retinal images are shown in Table 1.

Table 1.
The Perceived Ability of Indiana 4-H Volunteers to Use Retinal Imaging
Equipment and Match Retinal Scans and Nose Prints

Statement	N	Mean	St. Dev.	Frequency of Responses				
				1	2	3	4	5
Weigh-in and identification was run in an efficient manner	51	3.9	1.0	1	4	8	22	16
I was able to capture sufficient retinal images with relative ease on the majority of the animals that I scanned	51	3.7	1.1	3	5	10	21	12
I can match retinal scans to identify animals	49	3.7	1.2	4	1	12	16	14
I can match nose prints to identify animals	49	2.9	1.3	9	10	12	14	4
I was sufficiently trained to use the retinal scanning equipment	51	3.8	1.1	2	5	10	17	17
Note: Scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Undecided, 4 = Agree, and 5 = Strongly Agree								

Volunteers' perceptions of the benefits of using the retinal imaging equipment were categorized according to common themes, and the results are presented in Table 2.

Table 2.
4-H Volunteers' Perceptions of the Benefits of Retinal Imaging Technology (n = 51)

Category	Response	Percentage*
Accuracy of identification	19	37.3
Easier/more efficient method to identify animals	19	37.3
Reduces subjectivity and human error	14	27.5
Digital/technology advancement	8	15.7
Cleaner than nose printing		713.7
No answer	3	5.9
*Percentage = frequency / n Note: percentages total more than 100% because some responses fit into more than one category		

Thirty-seven percent of the respondents perceived that retinal imaging is more accurate than nose printing. Responses in this category included the following.

- "It's computerized and more accurate than a nose print."

- "The images are so much easier to read and compare!"

- "The greatest benefit of this technology is the ability for clear images to be collected."

Thirty-seven percent of the respondents also said retinal imaging was an easier and more efficient method to identify animals. One person said, "Retinal imaging takes the guess work out of identifying lambs and goats."

Volunteers' perceptions of the greatest challenge of using the retinal imaging equipment were categorized according to common themes and the results are listed in Table 3.

Table 3.
4-H Volunteers' Perceptions of the Challenges of Using Retinal Imaging
Technology (n = 51)

Category	Response	Percentage*
Technology	20	39.2
Human Error	19	37.3

Difficulty with animals' behavior	16	31.4
Environmental conditions	7	13.7
Other challenges	2	3.9
*Percentage = frequency / n Note: percentages total more than 100% because some responses fit into more than one category		

Thirty-nine percent of respondents cited concerns with the technology as a disadvantage of the retinal imaging equipment. Many of the concerns related to image capture time.

Thirty-seven percent of respondents identified human error as a disadvantage of using the retinal imaging equipment. One volunteer said, "The greatest challenge with this technology is taking the time to practice ahead of time to become proficient. However, taking time to practice helps when you are under the pressure of 4-H members and parents."

Thirty-one percent of respondents listed difficult behavior of animals as a challenge to using the equipment. One respondent said, "Getting the animal to remain quiet enough to obtain the image was a challenge. The same problem exists with nose printing and leads to less accurate results than those obtained through retinal scanning." Environmental challenges to using the equipment centered on issues with sunlight, glare, and humidity forming on the lens of the camera.

Over two-thirds of the respondents (68.6%) indicated they did not face any opposition from 4-H families during the enrollment process. Responses included the following.

- "They thought it went fairly smooth and were interested in the new process."

- "Everyone was very cooperative."

- "Most were eager to learn how it worked."

4-H Members

Responses were received from 250 4-H livestock members, which yielded a response rate of 36%. Respondents ranged in age from 13 to 19 years-of-age. Fifty-three percent were female, and 47% were male. Eighty-five percent had been enrolled in 4-H livestock projects for 5 to 10 years.

4-H members responded to statements about the efficiency of their county animal enrollment process, their confidence in using retinal images and nose prints to identify animals, and how beneficial retinal scanning will be to the Indiana 4-H program. Results of these responses are reported in Table 4.

Table 4.
4-H Members' Perceptions of Using Nose Prints and Retinal Images to Identify Livestock Projects

Statement	N	Mean	St. Dev.	Frequency of Responses				
				1	2	3	4	5
The county weigh-in and identification was run in an efficient manner.	247	3.7	1.2	12	38	23	112	68
I was informed of the retinal scanning procedure before the county weigh-in.	248	4.2	1.2	16	18	8	68	138
I feel confident that animals can be verified by matching retinal scans.	249	4.3	1.0	4	11	34	67	133
I feel confident that animals can be verified by matching nose prints.	249	3.5	1.0	9	35	75	88	42
Using retinal scanning to positively identify animals will be beneficial to the 4-H program.	249	4.1	1.1	11	10	35	91	102
Note: Scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Undecided, 4 = Agree, and 5 = Strongly Agree								

4-H livestock members identified several issues associated with using the retinal imaging equipment. Responses were grouped in five general categories and are reported in Table 5.

Table 5.
4-H Livestock Members' Perceptions of Challenges Associated with the Retinal Scanning Process (n = 250)

Response	Frequency	Percentage*
No problems observed	119	47.6
Length of time necessary to obtain an image	47	18.8
Animal behavior made capturing an image difficult	44	17.6
Human error	32	12.8
Difficult to capture image for various reasons	20	8.0
*Percentage = frequency / n Note: percentages total more than 100% because some responses fit into more than one category		

Nineteen percent of the respondents identified the length of time needed to capture an image as the main challenge with the process. Eighteen percent felt the behavior of the animal was a problem in obtaining images. One person said, "It was difficult to get a good scan if the animal wasn't held still."

Thirteen percent of the 4-H members identified human error on the part of the person collecting images as the biggest challenge of the system. One 4-H member said, "There may have been some lack of experience on the part of the people operating the retinal scanner." Seventy-four percent (185 of 250) of respondents agreed that retinal images should be the required form of animal identification for 4-H animals entered at the State Fair.

Conclusions

The first objective of the study reported here was to determine respondents' perceptions of the retinal imaging process as a means of verifying animal identity. Volunteers confirmed that retinal imaging is an accurate and easy way to identify animals; however, they indicated that obtaining images can be difficult and a legitimate cause of frustration.

When asked about their initial reaction to retinal imaging being used at their county enrollment, over 60% of the 4-H respondents indicated they were positive about the new technology. Respondents were curious about the technological advancement and excited because it could alleviate the possibility of 4-H members purchasing animals just prior to the fair and pretending they had owned the animals prior to the enrollment deadline. Four-H members felt confident that retinal imaging could positively identify their animals.

The second objective of the study was to determine the perceived strengths and weaknesses of the retinal imaging process. Volunteers cited the clarity of the images and the ease of comparing images as the greatest strengths of the retinal imaging system. Volunteers also mentioned the reduction in both human error and subjectivity with retinal imaging, because the machine determines if an image is acceptable. A majority of 4-H members who were able to see both nose prints and retinal images at enrollment said that retinal images provide a more clear and accurate image to verify animal identity.

Many respondents indicated the machine was slow to lock on to an image, even if a clear image was present on the screen of the hand-held computer. It is the researchers' observation that experience using the retinal imaging technology decreases the time it takes to obtain a useable retinal image. Volunteers determined that their ability to capture a retinal image requires skill and practice. Although Blomeke (2004) reported that the ability to capture a retinal image does not need to be re-learned year after year, practice is essential when a user does not have adequate experience using the machine.

The third objective was to determine whether participants consider retinal imaging beneficial to the Indiana 4-H Program. Despite some frustration with using the retinal imaging equipment, volunteers felt that retinal imaging is an accurate identification system. Over half of the respondents said their perception of the retinal imaging equipment was positive after using it to identify 4-H animals. Four-H members "agreed" to the statement "Using retinal scanning to positively identify animals will be beneficial to the 4-H program," with an average response of 4.1 on a five-point scale.

In summary, volunteers were confident in the accuracy and efficiency of retinal imaging, but found the time required to learn how to use the equipment to be the greatest challenge. Volunteers and 4-H members indicated that retinal imaging is beneficial to the 4-H program. Based on these findings, the researcher accepts both of the null hypotheses:

H_{01}: Adult volunteers view retinal imaging as a viable means to verify 4-H animal identity.

H_{02}: 4-H livestock members view retinal imaging as a viable means to verify 4-H animal identity.

Implications

Extension educators across the country are in need of an affordable, convenient, and permanent identification method to verify the identity of 4-H livestock projects (Rusk et al., 2006). Retinal imaging provides a non-invasive technique to identify animals and allow for the "real time" verification of these same animals at livestock expositions. The findings from the study reported here will be invaluable to Extension educators and Extension boards who are considering retinal imaging as a possible method to verify the identity of 4-H animals in their state or county.

In addition to providing a viable method to verify the identity of 4-H animals, retinal imaging provides an opportunity to educate 4-H members about science and technology in a way that allows them to see direct applications to agriculture. As volunteers become more proficient at collecting images and 4-H members understand the science behind the technology, their perceptions may change. Frustrations at using new technology may disappear as volunteers become more comfortable with the process and the equipment.

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