

# **An Evaluation of Retinal Imaging Technology for 4-H Beef and Sheep Identification**



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# Overview

- Background Information
- Research Questions
- Equipment and Methods
- Results
- Recommendations

# Retinal Vascular Pattern

- The central artery and vein make up the trunk.
- Unique branching pattern provides identifying information.
- Permanent and tamper proof.



# RVP con't...

## Retinal Vascular Patterns

- Recognized as unique to individuals in 1936 by Dr. Carlton Simon
- Further research in 1978 supported the uniqueness of RVP in identical twins
- U.S. Navy has used retinal imaging technology for over 30 years as a secure access measure

# Optibrand system...

- Hand held computer
- Camera wand
- Battery pack
- Software Suite



# Nose prints



- Ridge patterns individually identify animals
- Prints read by an Indiana State Police fingerprint specialist
- 5 consecutive points must match between enrollment and verification prints

# Identification Requirements for Indiana 4-H Market Animals

- **Beef**
  - Nose print
  - 5 digit county tag
    - By April 1 for steers and May 15<sup>th</sup> for registered and commercial heifers
- **Sheep**
  - Nose print
  - 5 digit county tag (for market and commercial ewes)
  - Breeder's tag or tattoo (for registered ewes)
    - By May 15<sup>th</sup>

# Research Motivations

- Want to look at an alternative method of identification due to:
  - Lack of consistency of nose print quality
  - Want a real-time verification

Example case: Iowa State Fair 2002 –  
Grand Champion Steer “Pickles”

# Research Questions

- 1) Is retinal imaging a consistently more reliable form of permanent identification than nose printing?
- 2) What are the false match and false non-match rates of visual verification of retinal images?
- 3) Are there differences in false match and false non-match rates between beef and sheep?

# OptiReader™ Device

- OptiReader™ device can be used as a universal data collection instrument, that allows all forms of animal ID to be collected with a single piece of equipment.
  - Scan RFIDs or barcodes.
  - Capture photos of ear tags.
  - Collect and store all types of production and process verification data.
  - For this study, we only used the retinal imaging capabilities.

# Information Collected...

- 4-H Member(s) enrolling the animal
- Visual Tag Number
- County Name
- Breed
- Time to collect nose print
- Time to collect retinal image

# Software Suite

- Reader Configuration
  - Choose 1 or 2 eye session and species
- Image Management Tools
  - View images and additional information, edit additional information, create jpeg images
- Data Exporter
  - Export data to another database program such as Microsoft Excel or Microsoft Access

# Reader Configuration

The screenshot displays the 'Reader Configuration Utility - Version 2.8' application. The interface is divided into several sections:

- General Info:** Includes fields for 'Preparation date\*' (Thu Feb 05 10:02:32 EST 2004), 'GPS update interval (minutes)\*' (400), 'Species\*' (bovine), 'Session type\*' (two eye), and 'Session comment\*' (Default Session).
- Navigation:** A menu bar at the top includes 'File', 'Owner', 'Session', 'Screens', and 'Help'. A secondary menu bar below it includes 'Reader Configuration', 'Tools', 'Settings', and 'Help'.
- Configuration List:** A list box on the right shows 'Tag Number', 'County', 'Image(s)', and 'Owner's name'. The 'Image(s)' entry is selected and highlighted.
- Preview:** A window titled 'Preview - Lot of item' displays a grayscale image of a cow's face.
- Operations:** A vertical column of buttons on the far right includes 'new', 'edit', 'remove', 'replay', and 'replay all'.

(\*) Denotes required field

# Image Management Tools

File Name = 0f04c04e05f00001092101000189.blob  
Device ID =f04c04e05f0  
Carcass Barcode = 00278145  
Reader Comment = LORENA  
Session Comment =Default Session  
Firmware =480  
Date of image = 08/09/2004  
Time of image = 19:23:20  
Latitude = 40.443395  
Longitude = -104.691458  
Time to acquire image = 825  
User Tunables = JV:7, GV:235, GNum:300, Sens:0  
Image forced = N  
Rejected Images = 0  
[Photo: Photo1](#)



# Subjects

- Imaged beef or sheep projects in 8 Indiana Counties
  - Attended 4-H animal enrollment days to image retinas
  - Nose prints taken by county beef or sheep committee members
  - Tagging completed by county committee members

# Enrollment Procedure

- 4-H member and parent sign an informed consent form
- Animal placed in a chute
- Restrain head
- OptiReader™ Device is placed in close proximity to the eye (< 1 inch)
- Targeting activated
- Capture images of Right and Left Eyes
- Store for comparison

# Preparation for Verification

- Printed a certificate for each enrolled animal.  
Certificate contained:
  - 4-H member's name
  - County/County tag number
  - Species/Breed of animal
  - Images of left and right eyes
  - GPS coordinates of enrollment
  - Date of enrollment
  - Blank space for notes
    - Such as information pertaining to a retag

# Verification...

- Attended each county's fair
  - Re-imaged all animals previously enrolled
  - Conduct a one eye session
    - Took multiple images at different angles if necessary

**Boone County had 3 beef animals that had lost ear tags. Conducted 2 eye session for the 3 animals to confirm identity.**

# Numbers...

County	Enrolled	Re-Image	Visually Verified	Percent Verified
Boone	70	45	45	100
Elkhart	163	84	74	88.10
Fountain	88	66	66	100
Huntington	78	57	52	91.23
Porter	92	65	62	95.38
Adams	29	24	24	100
Hancock	101	67	67	100
Jasper	90	66	66	100
Totals:	491	474	456	96.20

# Verification rates...

- 94.32 % of the beef cattle re-imaged were verified on site.
  - The images not verified on site have been submitted to Optibrand for computer and professional technician verification
- 100 % of the sheep that were re-imaged were verified on site.

# ANOVA results:

- Conducted One Way ANOVA test and the results indicated:
  - Mean time collecting **nose print**  $\neq$  mean time collecting **retinal image**
  - Mean time to collect information from **cattle**  $\neq$  mean time to collect information from **sheep**
  - Mean time to collect information in a **location**  $\neq$  time collect information in another **location**

# Location and Method Effects

Dependent Variable: Time

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Location	80147.28	7	11449.61	8.08	< .001
Method	119227.90	1	119227.90	84.18	< .001
Location * Method	94618.48	7	13516.93	9.54	< .001

# Method and Species Effects

## Tests of Between-Subjects Effects

Dependent Variable: Time					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Method	152519.55	1	152519.55	100.40	<.001
Species	13074.89	1	13074.89	8.61	<.001
Method * Species	27908.53	1	27908.53	18.37	<.001

# Visual Verification Exercise

- Matching exercises given to Extension Educators and adult 4-H volunteers on the Purdue campus in June
  - Asked to determine if each presented pair of images were a match, non-match, or if they were unsure
  - 4 sets of 10 images (10 beef retina, 10 beef nose prints, 10 sheep retina, and 10 sheep nose prints)

# Results of Visual Verification

Species Method	Percentage Correct	Percentage Unsure Answers
Beef nose print	68.94	8.42
Beef retina	98.64	0.27
Sheep nose print	79.47	5.26
Sheep retina	84.86	0.00

# Mean Score of participant response

		Match	Non-Match	Unsure Match	Unsure Non-Match
Beef	Nose Print	2.63	4.26	0.66	0.18
	Retina	4.97	4.89	0.00	0.03
Sheep	Nose print	3.68	4.26	0.29	0.24
	Retina	3.62	4.86	0.00	0.00

# Percentage breakdown of participant response

Correct Response	True Match			True Non-Match				
	Match	Non-Match	Unsure	Match	Non-Match	Unsure		
Participant Response	Beef	Nose print	52.6	43.2	13.2	11.1	85.3	3.7
		Retina	99.5	0.50	0.00	1.6	97.8	0.5
Participant Response	Sheep	Nose print	73.7	20.5	5.8	10.0	85.3	4.7
		Retina	72.4	27.6	0.00	2.7	97.3	0.00

# Breakdown of answers...

## Descriptive Statistics

	N	Min	Max	Mean	Std. Dev
Match Correct	150	0	5	3.72	1.30
Non-Match Correct	150	1	5	4.57	.79
Unsure (match)	150	0	3	.24	.60
Unsure (non-match)	150	0	2	.11	.38

# False Match and False Non-Match Rates

	Method	N	%False Match	% False Non-Match
Beef	Nose print	348	6.03	18.69
	Retina	369	0.81	0.27
Sheep	Nose print	360	5.28	10.83
	Retina	370	1.35	13.78

# Summary of Results...

- It takes longer to take a retinal image than to take a nose print.
- The accuracy of matching retinal images is higher than the accuracy of matching nose prints.
  - Untrained individuals can be utilized over hiring professionals.

# Recommendations...

- The retinal imaging system would work well for 4-H beef and sheep project enrollments
- Need additional software to create certificates
- Replaceable cables
- Modify the unit to reduce the cost
- Counties collect images and send files to State 4-H office for storage

# Further Research

- Expand visual verification exercises
  - Larger set of retinal images
  - Include goats
- Conduct a large scale comparison of visual verification versus electronic verification

# Questions?

