Genetic evaluation of horn fly abundance using subjective assessment and imaging tools

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Introduction

- Horn Fly
  - Obligate Blood Feeder
  - 20-38 blood meals per day
  - 1.5 mg
- Current Methods of Control
- Effect on Cattle
  - Stress
  - Production Traits
  - Avoidance Behavior
  - Disease

Over a billion dollars

of economic loss in the United States annually

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Introduction

- Genetic basis for horn fly abundance
  - Variations within and across breeds
  - Heritabilities of Horn Fly resistance traits
    - 10 to 80%
  - Mosquitos (human)
  - Ticks (cattle)

Major bottlenecks

- Quantifying horn fly abundance under pasture settings
- Identification of appropriate horn fly resistance and tolerance related phenotype(s)
  - Reasonable genetic basis
  - Easy and cost effective to collect
  - Appropriate technologies for their collection and analysis
- No reliable estimates for the onset of economic injury threshold (EIT) due to HF abundance
  - A threshold of 200 flies per side of an animal is often used
  - Variation in the onset threshold across animals
- No knowledge about the decay in performance after the onset threshold
  - Ability of the animal to be productive and withstand increased HF abundance after onset of injury

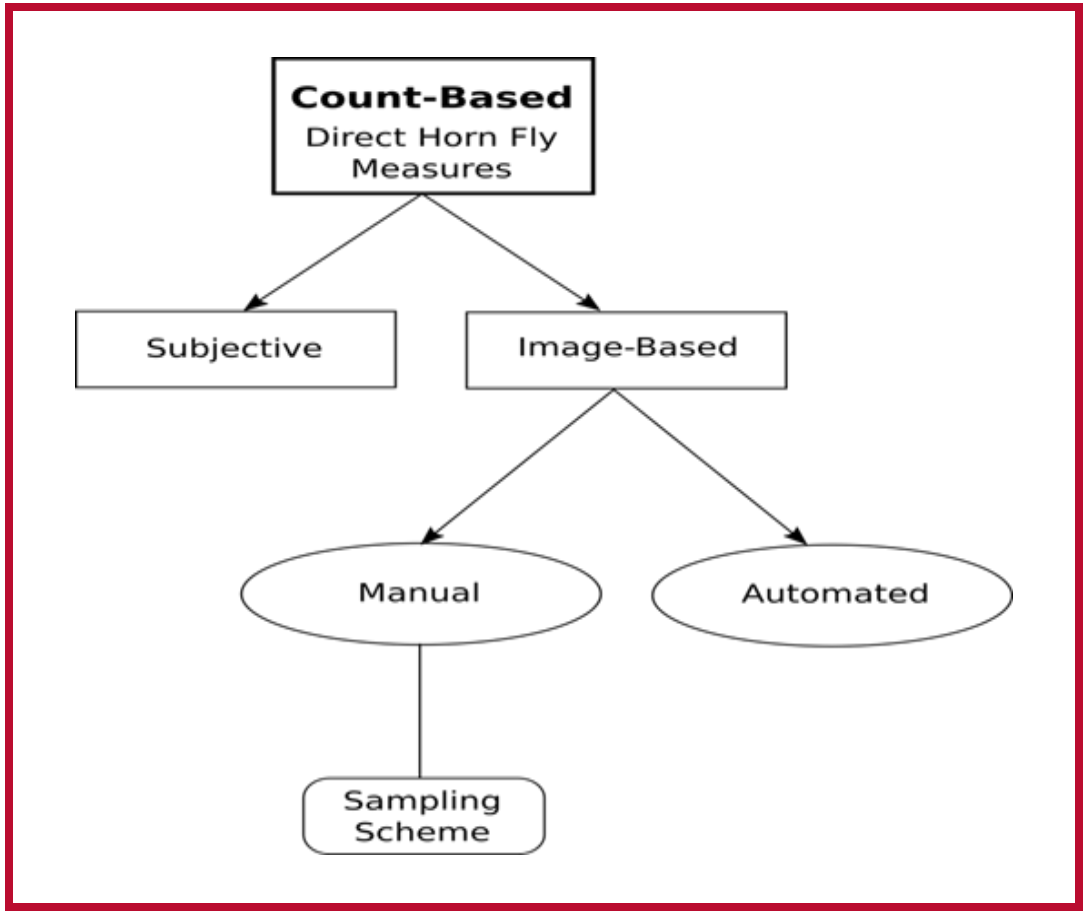
Objectives

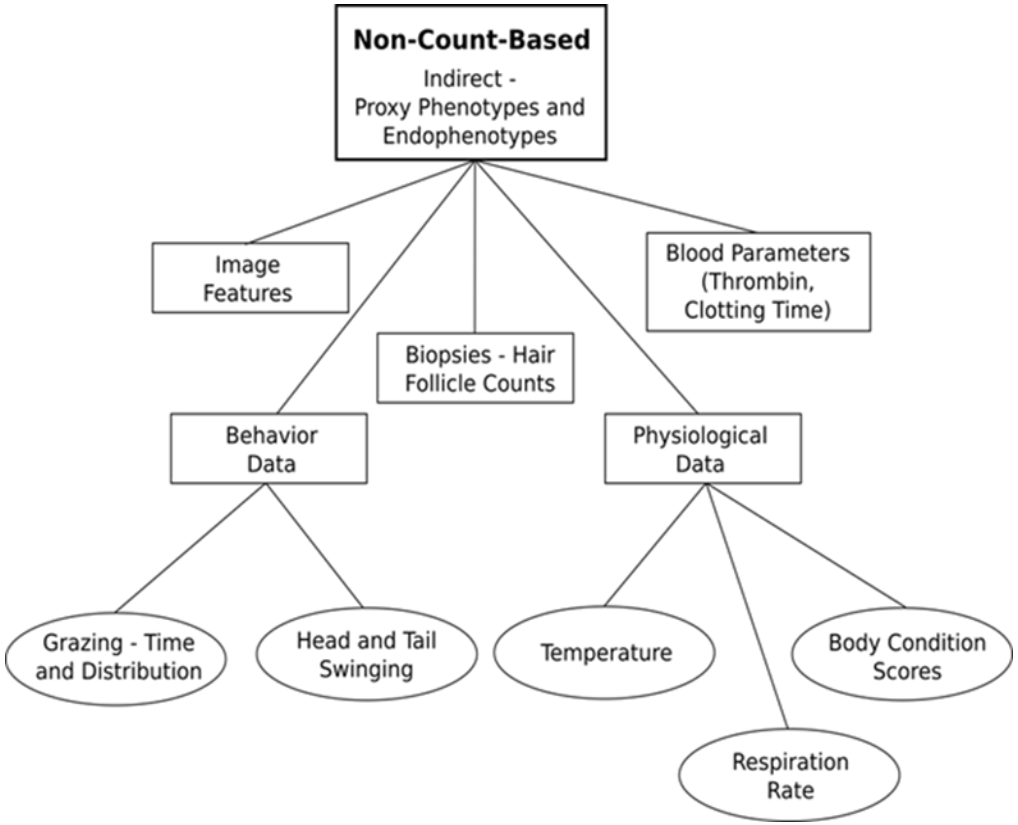
Quantify abundance of horn flies on beef cattle under pasture settings

Assess subjective and image-based methods of estimating fly abundance

Evaluate the genetic parameters associated with fly abundance on beef cattle

Assessment of Horn Fly Abundance





Data Collection

- Data collected on 928 beef cattle housed on 2 UGA farms
  - Eatonton Beef Research Unit (Eatonton, GA)
  - Northwest Georgia Research and Education Center (Calhoun, GA)

- Fly count
  - Animals enrolled during summer of 2019 and 2022
    - No Fly control used
    - Counts taken twice each year
  - Subjective Evaluation
  - Digital Images

- The pedigree consisted of 1305 animals

Image-based Counts

- Two image counts were derived
  - **Image_All**
    - Box placed from wither to hook and chest floor to udder
    - Counted all flies in box
  - **Image_Region**
    - Box subdivided into grid
    - Separated in density regions (Low, Med, High)
    - Percentage of grid squares counted in each density region (5%, 10%, 20%)

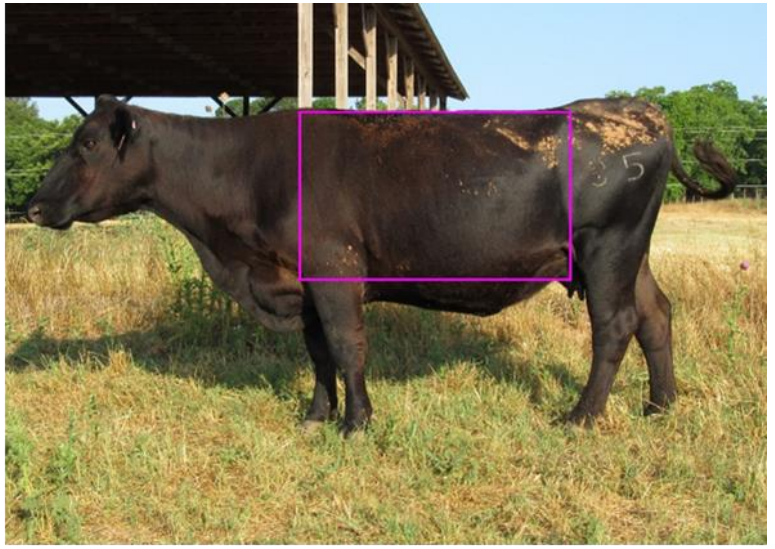


Figure 1: Box used for counting horn flies

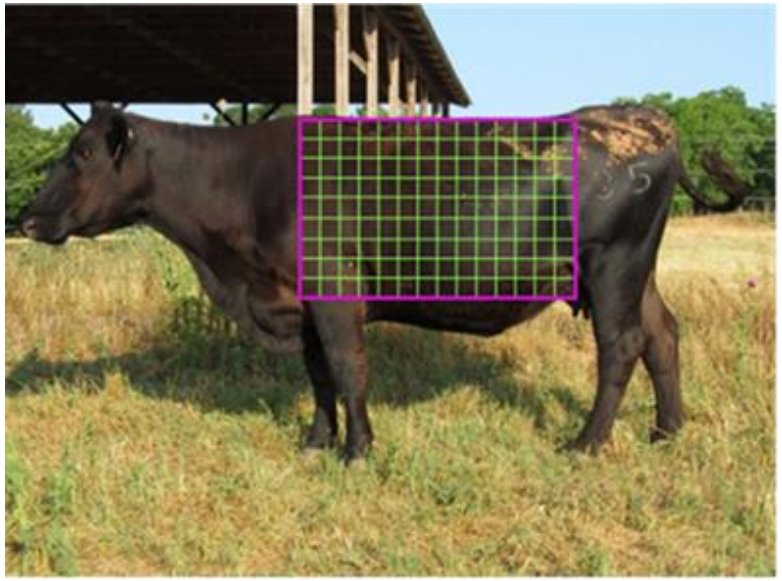


Figure 2: Grid used in the sampling schemes for counting horn flies

Data Editing

- Average of the subjective evaluations were used
- The records of an animal were removed
  - Difference between evaluators is > 500 flies
  - Difference between subjective and image-based assessments is > 500 flies
- Horn fly abundance traits were discretized into classes based on the quartiles of their distributions

Data Analysis: Models

- Linear and threshold mixed Models

$$\boldsymbol{y} = \boldsymbol{X\beta} + \boldsymbol{Zu} + \boldsymbol{Wp} + \boldsymbol{e}$$

where $\boldsymbol{y} = (\boldsymbol{y}_1, \boldsymbol{y}_2, \boldsymbol{y}_3)'$ is the vector of fly counts using the subjective and image-based assessment (linear model) for the liabilities for the different fly abundance classes (threshold model). The systematic effects included the year, farm, month, pregnancy status, and age of the animal. $\boldsymbol{u}$ and $\boldsymbol{p}$ are the additive and permanent effects

- Whole image-based count (Image_All) was available only on 184 animals
  - Missing records were imputed

- Full Bayesian Analysis was used to implement both models

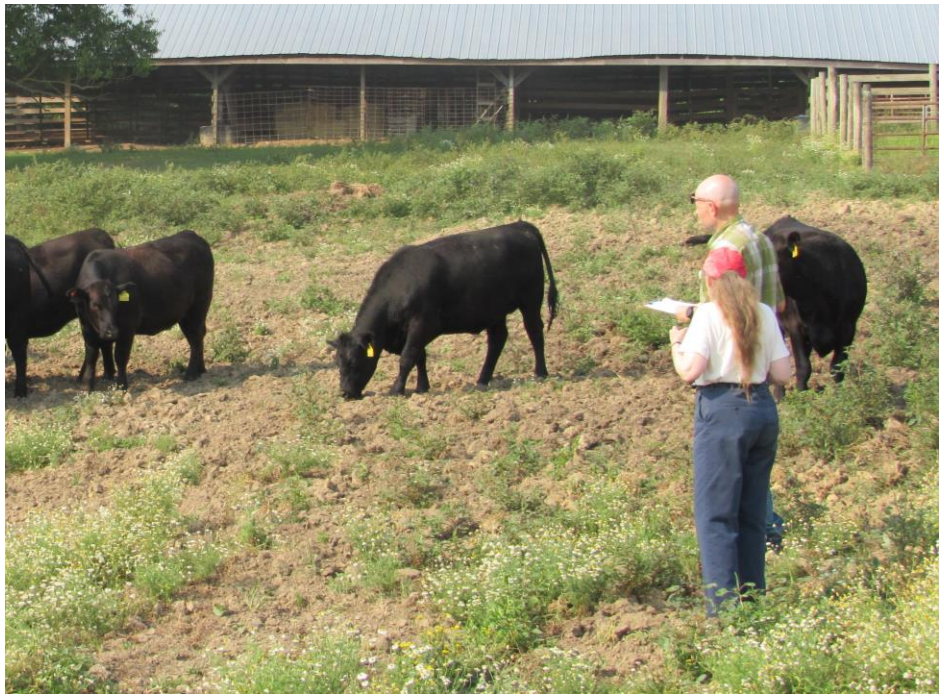
Fly Count Summary

Farm	# of Animals	Mean	Min	Max	Standard Deviation
Average Subjective Counts					
Calhoun	918	394	50	1800	199
Eatonton	762	339	50	1217	146
Image_Region					
Calhoun	816	296	0	2169	298
Eatonton	610	193	0	1220	182

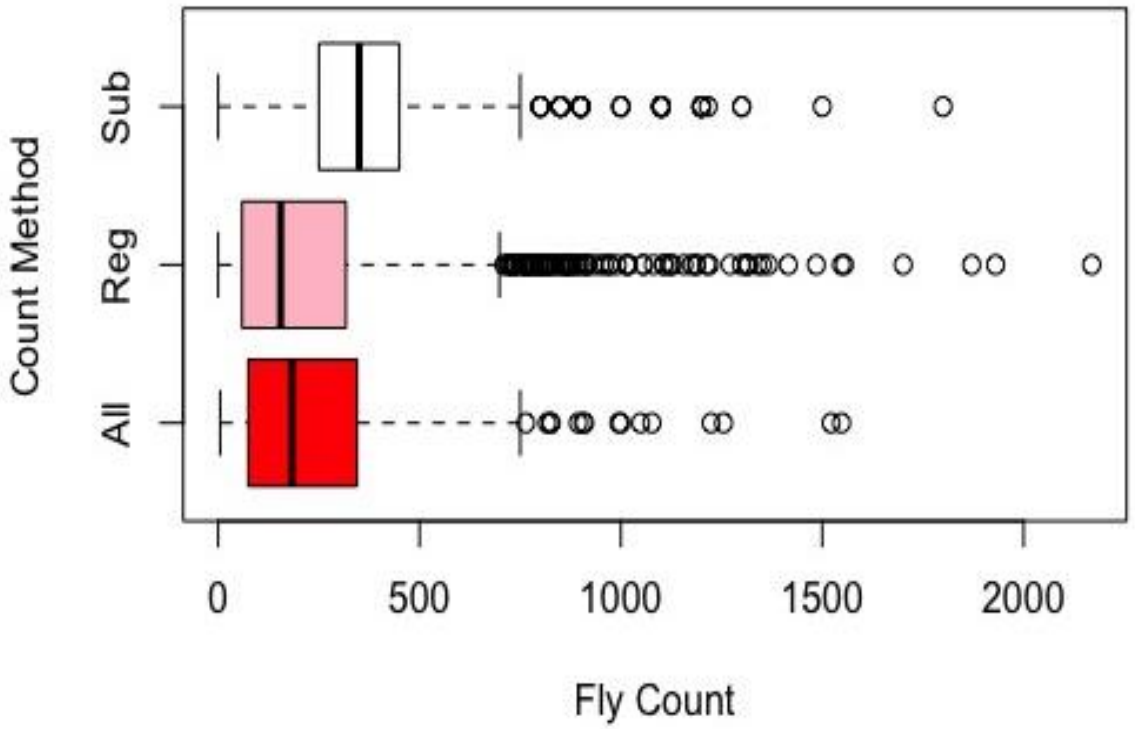
Correlation between Subjective Evaluations

	Evaluator 1	Evaluator 2	Evaluator 3
Evaluator 1	1	0.433	0.448
Evaluator 2	0.40	1	0.517
Evaluator 3	0.452	0.443	1

Continuous (upper diagonal) and discrete (below diagonal) assessment



Comparison between Count Methods



	Image_All	Image_Region	Subjective
Image_All	1	0.953	0.651
Image_Region		1	0.459[1]
Subjective			1

Heritabilities

	Image_all	Image_region	Subjective
Continuous	0.149 (0.023)	0.101 (0.014)	0.112 (0.013)
Discrete	0.163 (0.018)	0.142 (0.017)	0.140 (0.017)

Repeatability

	Image_all	Image_region	Average subjective
Continuous	0.153 (0.041)	0.105 (0.031)	0.119 (0.042)
Discrete	0.173 (0.061)	0.153 (0.058)	0.150 (0.058)

Genetic Correlation

Linear Model

	Image_all	Image_region	Subjective
Image_all	1.00	0.66	0.44
Image_region		1.00	0.48
Subjective			1.00

Discrete Model

	Image_all	Image_region	Subjective
Image_all	1.00	0.66	0.65
Image_region		1.00	0.67
Subjective			1.00

Conclusions

- Sufficient genetic variation in horn fly abundance phenotypes
- Limited concordance between evaluators
- Image based count can provide a reasonable assessment of fly abundance
- No major differences between continuous and discrete assessments of fly abundance
- Automation of data collection is needed
  - Better image collection and analysis
  - Non-count-based methods

Thank you!