

Streamlining the acquisition and analysis of digital images for the assessment of horn fly abundance

Amanda Warner¹, Aaron Tani², Samuel Aggrey³, Thirimachos Bourlai², Romdhane Rekaya¹

¹Department of Animal and Dairy Science; ²College of Engineering; ³Department of Poultry Science



United States Department of Agriculture
National Institute of Food and Agriculture

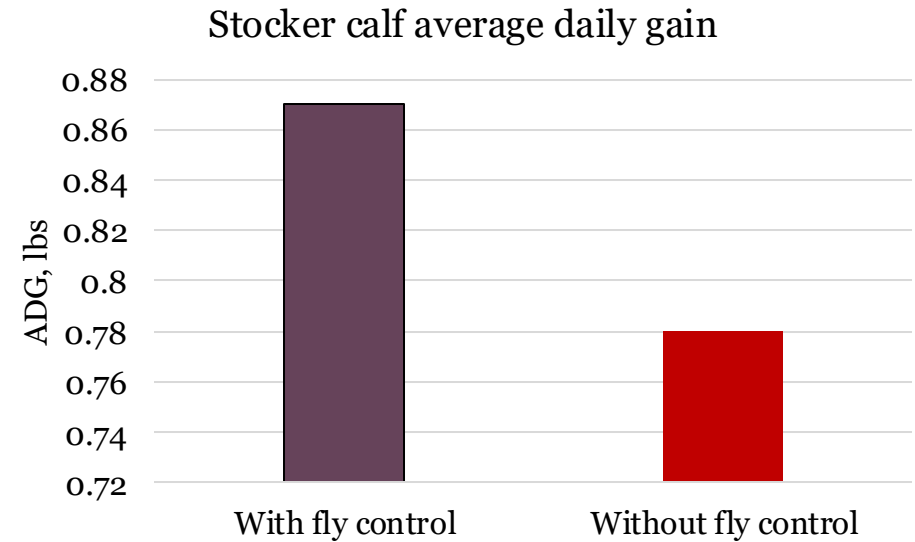
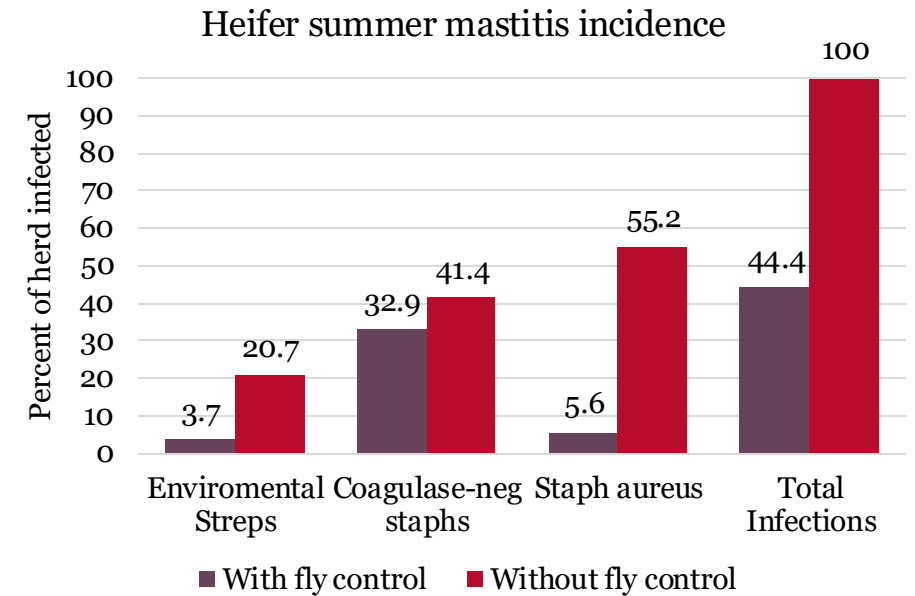


<https://phil.cdc.gov/Details.aspx?pid=8935>



Introduction

- Impact of horn flies on cattle
 - Increased stress
 - Decreased animal welfare
 - Increased fly avoidance behavior
 - Increased probability of infections
 - Decreased production



Nickerson, et al (2000) and DeRouen, et al. (2010)



Introduction

- Current control methods
 - Heavy reliance on chemical products (environmental impact, resistance)
 - Logistic complexity
 - Limited efficacy



Merck-animal-health-usa.com, edis.ifas.ufl.edu

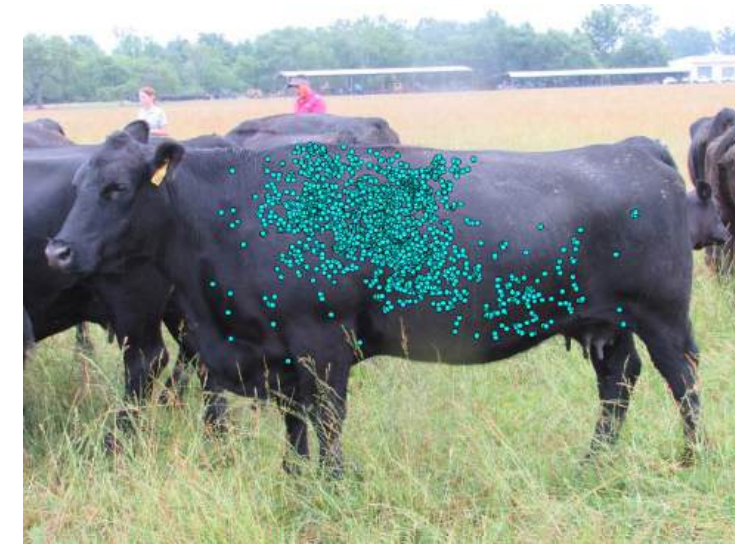
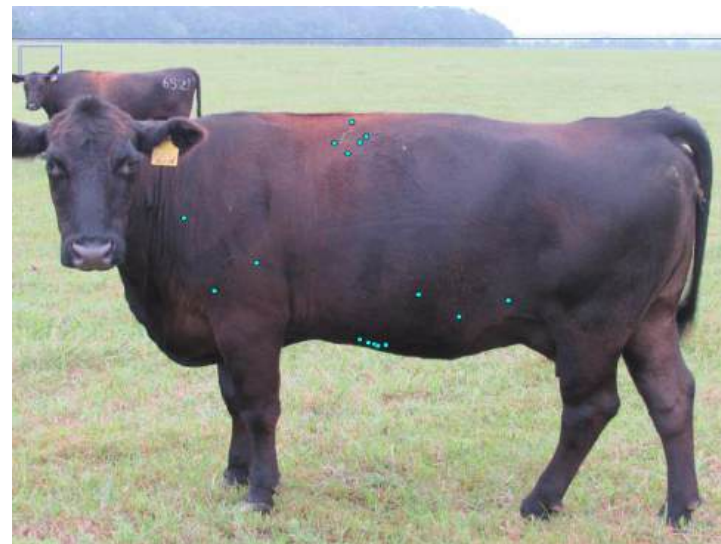
**1.8 billion
dollars**

in economic loss in the
United States annually



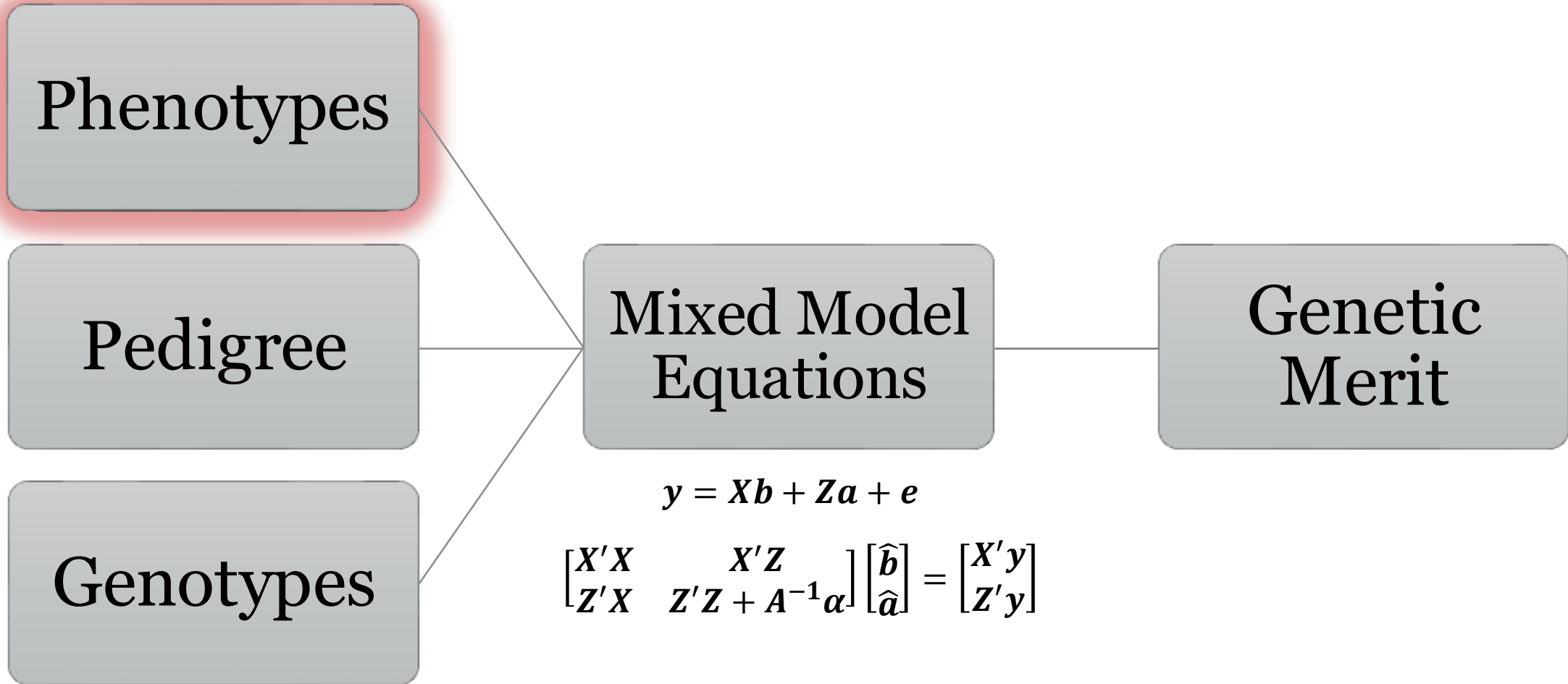
Introduction

- Evidence of genetic variation in resistance to other insects
 - Mosquitoes (humans)
 - Ticks (cattle)
- Genetic basis of fly attraction and tolerance
 - Estimates of h^2 ranged from 0.10 to 0.8
 - Variability in fly attraction within and across breeds



<https://intermountainhealthcare.org/>

Genetic Evaluations



Challenge: Assessment of fly abundance

- Trait Definition
- Assessment under pasture conditions
- Pre-disposition for automation and scalability
- Heritability and potential association with other relevant traits already in the selection index

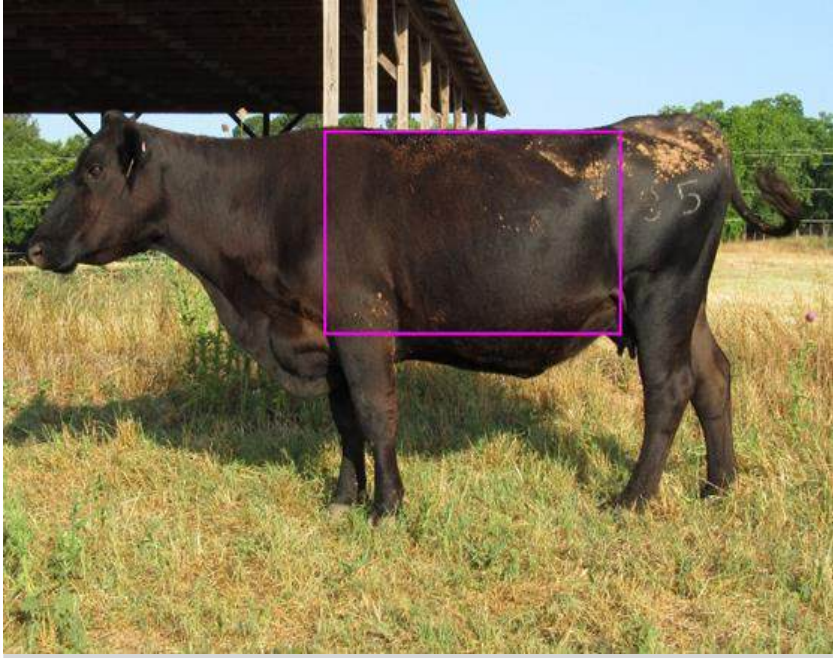


Data Collected

- Eatonton Beef Research Unit and Northwest Georgia Research and Education Center
- Years (2019, 2022-2024)
- Images
 - Best image was selected
 - $n = 314$



Image Analysis



Manual Count

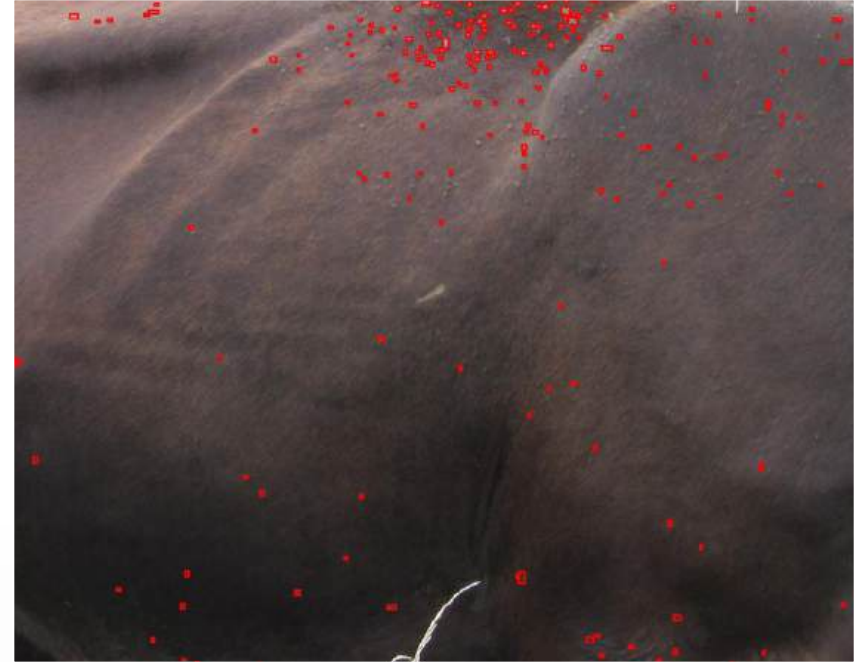
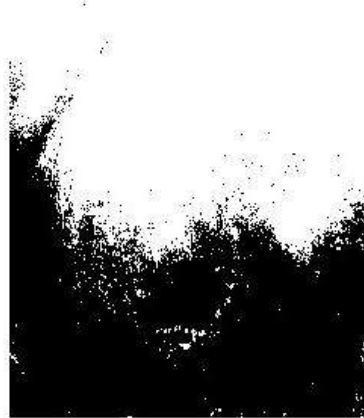


Image Analysis

Fly Count Code Overview

- Adaptive threshold
 - Sensitivity
 - Neighborhood
- Binary Mask
- Connected Components
- Determines if fly...
 - Area
 - Mean intensity > intensity threshold

Global Threshold Binary



Adaptive Threshold Binary

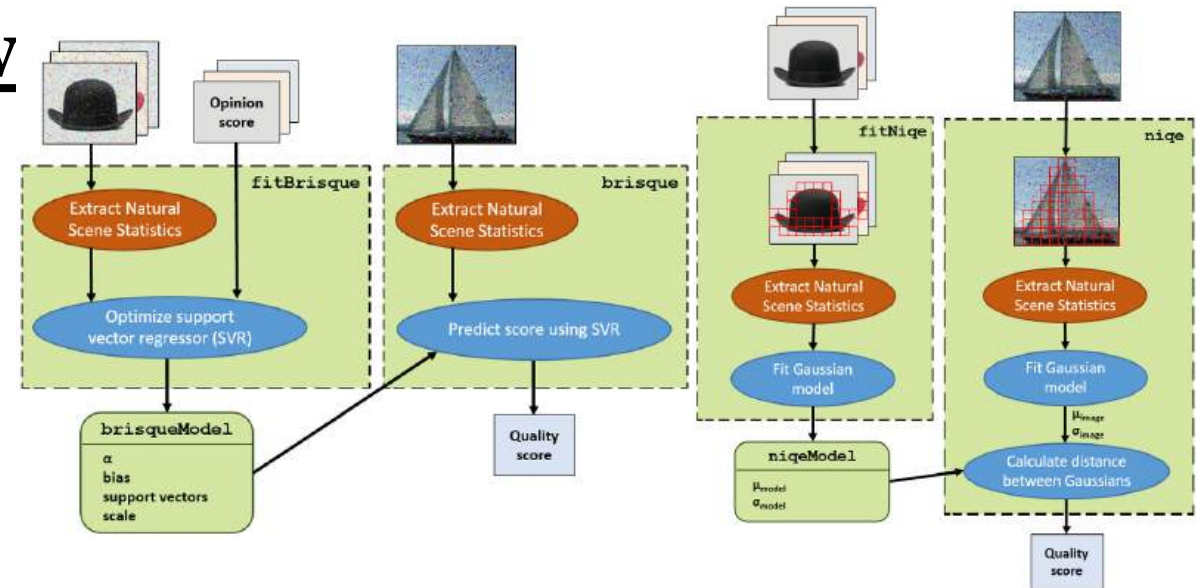


Image with Annotated Flies



Quality Class Code Overview

- Compute Quality Metric
 - BRISQUE
 - NIQE
 - PIQE
- Assigns Class
 - 1st Quartile: High Quality
 - 2nd and 3rd Quartile: Medium Quality
 - 4th Quartile: Low Quality

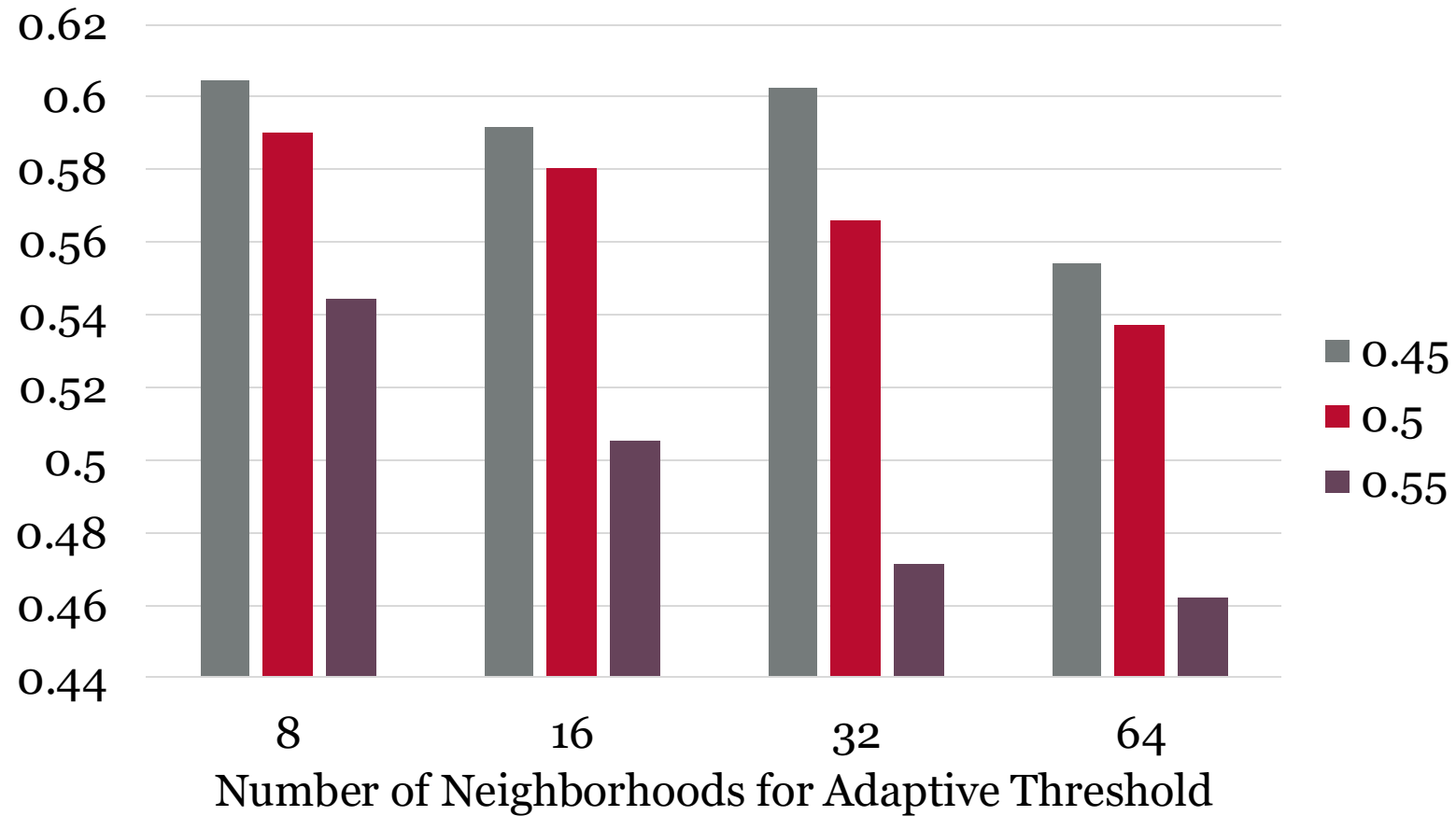


Original Image: PIQE score = | Noisy Image: PIQE score = | Blurred Image: PIQE score = 85.7362



Results: Image Analysis

Correlation between predicted and manual fly count



Results: Image Analysis

Sensitivity*	Number of Neighborhoods*	Intensity Threshold*	Corr	MSE	R ²
0.4	8	0.6	0.668	64758.18	0.446
0.4	16	0.6	0.65	63753.25	0.443
0.5	8	0.5	0.470	72487.54	0.221
0.55	128	0.5	0.226	303440.75	0.051
0.55	128	0.55	0.207	688211.47	0.043

Results: Quality Class

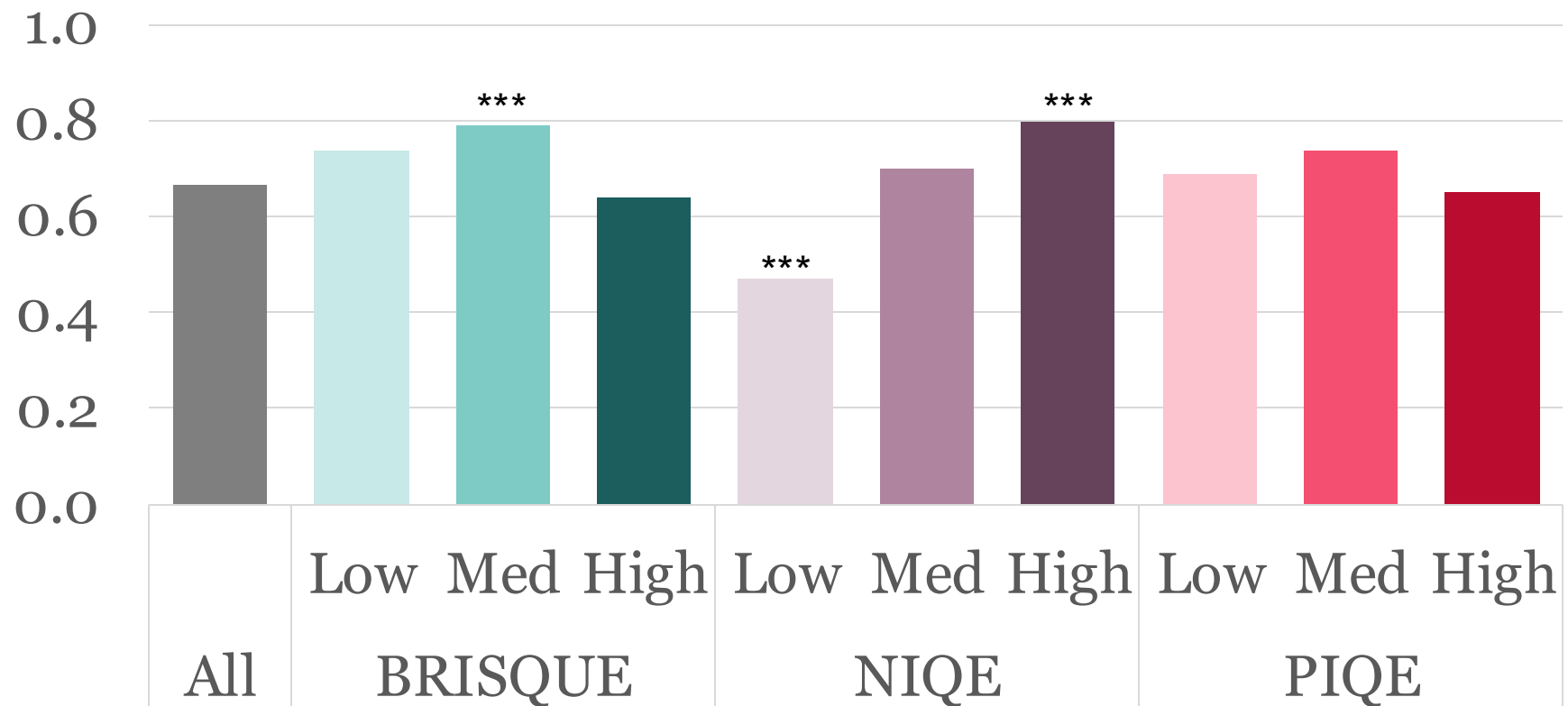
Class	Subjective	BRISQUE	NIQE	PIQE
Low	74	96	93	96
Medium	170	122	126	122
High	70	96	95	96
Concordance w/ Subjective	1	0.33	0.47	0.34

Results: Quality Class

Quality Metric	Quality Class	Sensitivity	Number of Neighborhoods	Intensity Threshold	Corr	MSE	R ²
BRISQUE	Low	0.4	16	0.65	0.74	57761.57	0.54
	Med	0.45	8	0.55	0.79	50804.03	0.62
	High	0.4	8	0.6	0.64	77382.41	0.41
NIQE	Low	0.4	16	0.65	0.47	57728.51	0.22
	Med	0.4	8	0.6	0.70	91922.98	0.48
	High	0.45	16	0.65	0.80	52706.48	0.63
PIQE	Low	0.4	16	0.65	0.69	63999.5	0.47
	Med	0.4	8	0.6	0.74	72641.04	0.55
	High	0.45	8	0.6	0.65	65106.61	0.43

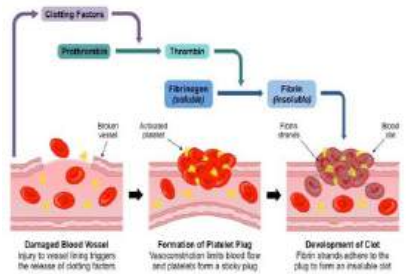
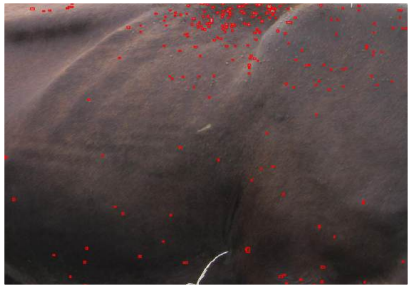
Results: Quality Class

Correlation between manual and predicted counts

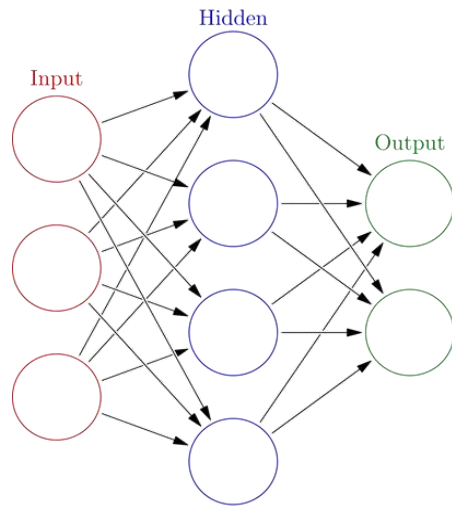


Impact of Research

Images and Biological Data



Deep Learning Model

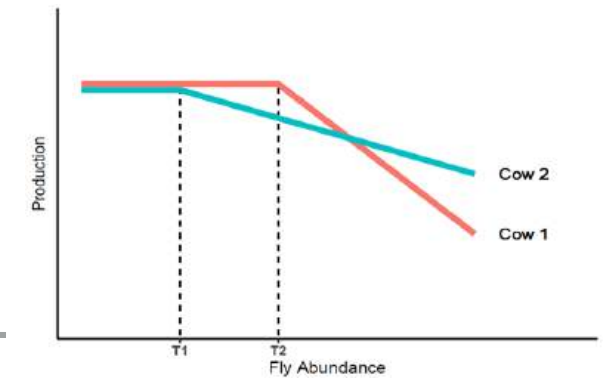
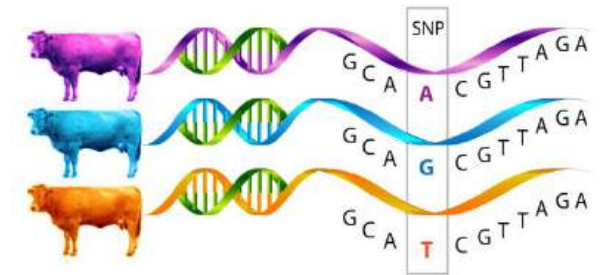


Fly Abundance Phenotypes



Outcomes

$$EBV = (Z'Z + A^{-1}\alpha)^{-1}Z'(y - X\beta)$$



Conclusions

- Image processing tools can be used to efficiently estimate horn fly abundance from digital images
 - Parameter selection has a significant effect on prediction accuracy
- Blind Reference Quality Metrics can be used as a guide for image filtering and parameter selection
 - Combination of NIQE and BRISQUE
- Further improvements could be made by using machine learning or deep learning algorithms

Thank you!
Questions?



United States Department of Agriculture
National Institute of Food and Agriculture