# Evaluation of Changes in Vegetation Indices Due to In-field Sensor Angles

*Maicynn Hansen*
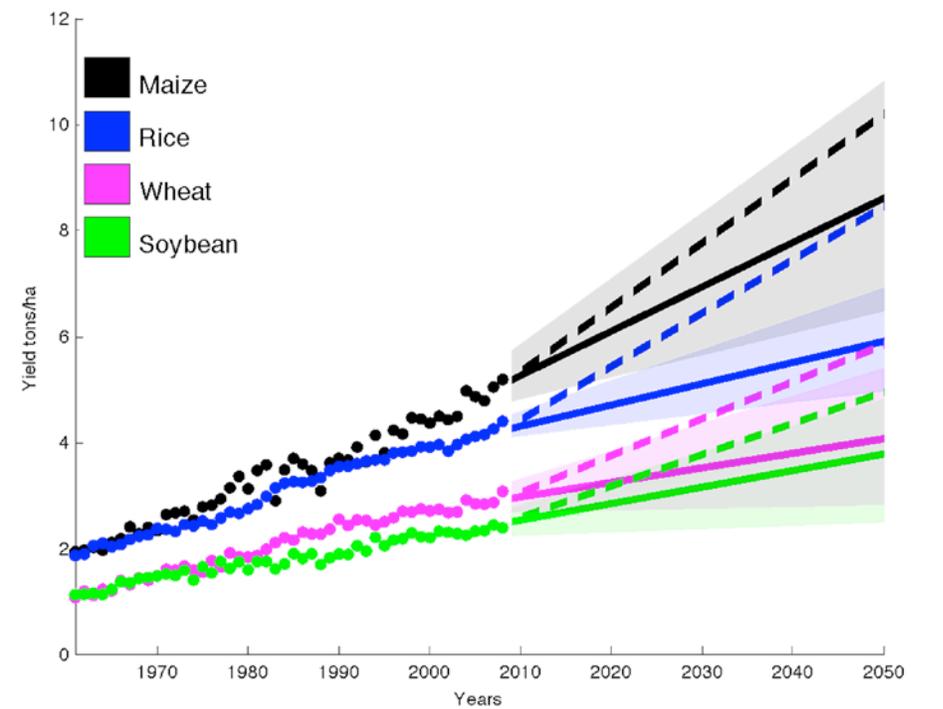
*University of Illinois at Urbana-Champaign*

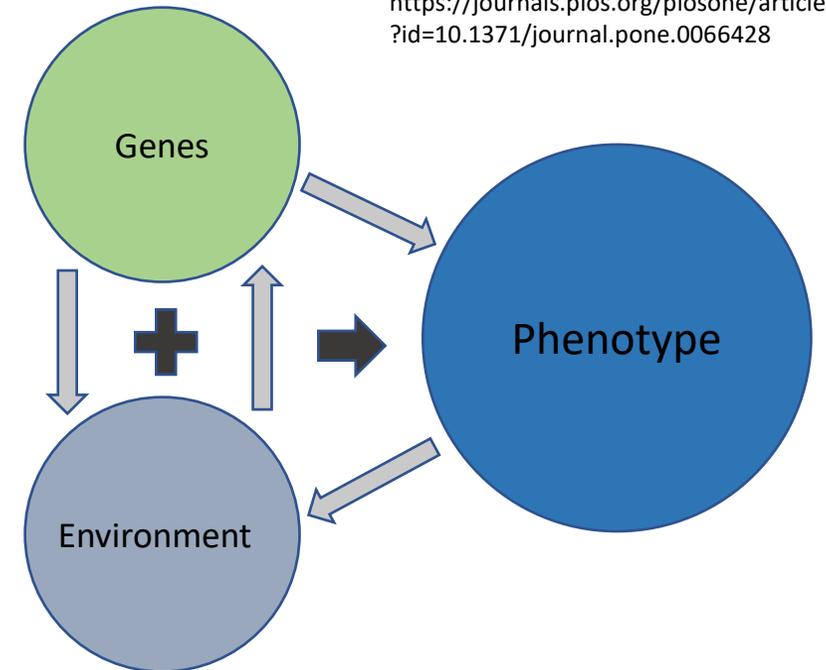*Phenomics Big Data Management*

*Mentor: Dr. Sindhuja Sankaran*

# Strategies to Improve Production

- Fertility

- Pest/Disease Control

- Precision/Other Management

- **Crop Breeding**

  - Phenotyping is often demanding and time intensive



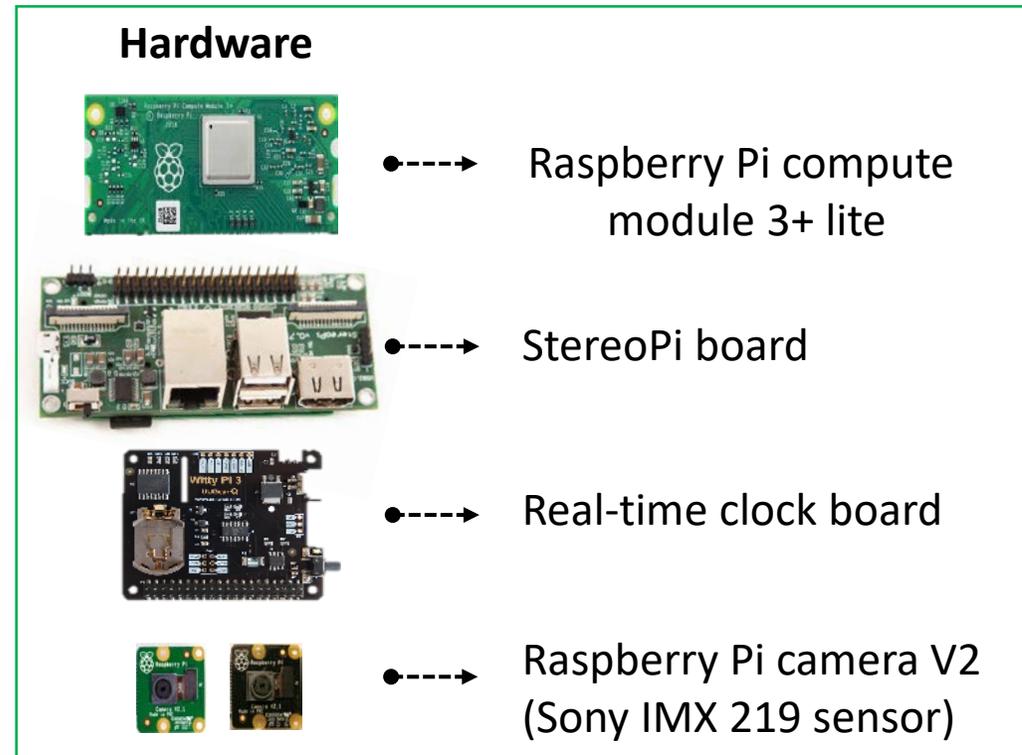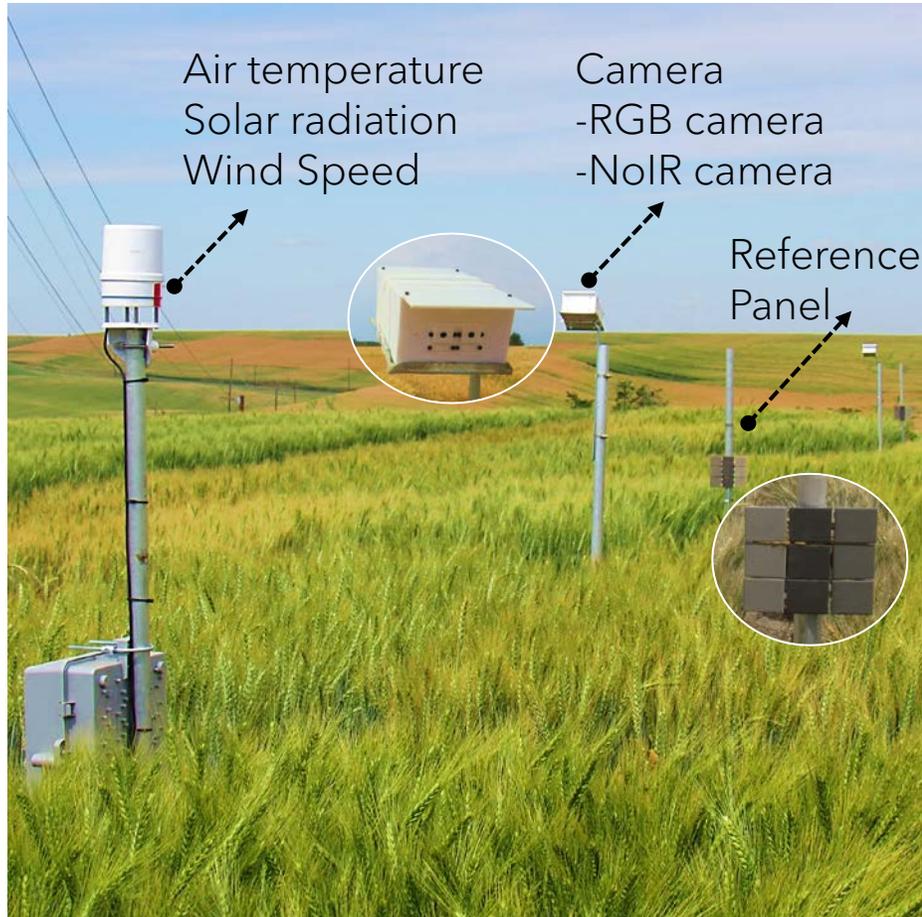https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0066428

# Introduction

- Phenomics is useful for large scale phenotyping

- RGB and multispectral imagery capture crop reflectance measurements

- Vegetation indices (VIs) based on reflectance data provides insight into crop responses

# Internet of Things (IoT) Sensor System



Air temperature
Solar radiation
Wind Speed

Camera
-RGB camera
-NoIR camera

Reference
Panel

https://www.mdpi.com/2411-5134/6/2/42

**Hardware**

Raspberry Pi compute module 3+ lite

StereoPi board

Real-time clock board
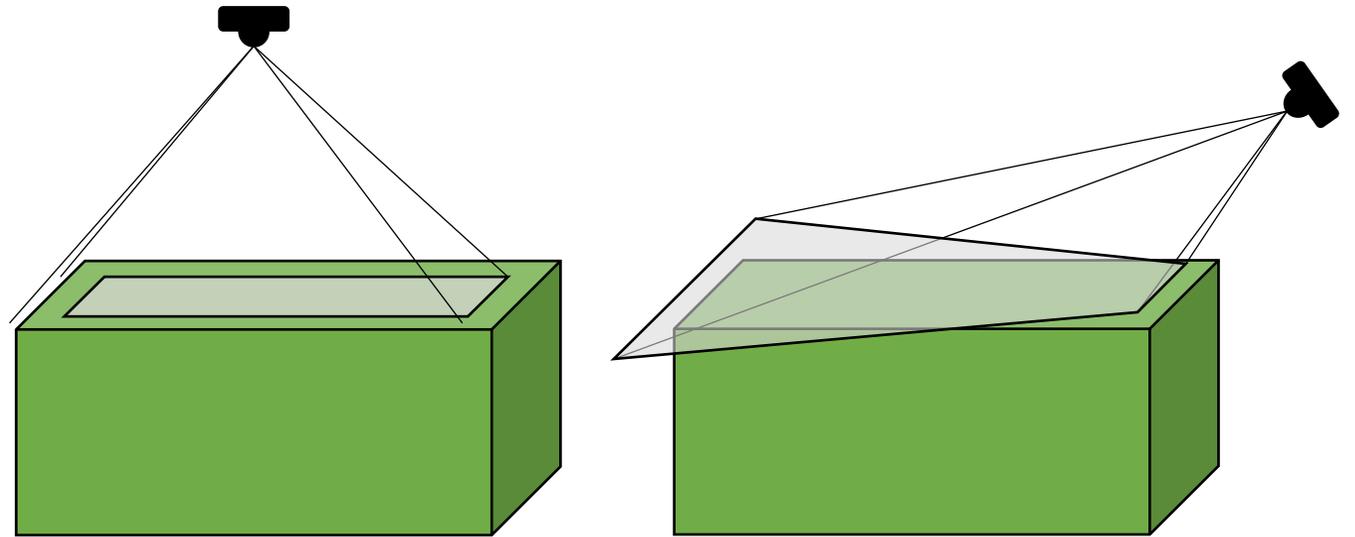
Raspberry Pi camera V2 (Sony IMX 219 sensor)

Worasit Sangjan

# Introduction

- IoT sensor systems enable real time imaging and management decisions



Does the sensor angle affect the estimated crop vegetation indices?

# Methods

- Crops: Winter wheat & spring pea
- IoT data angles: 30°,45°, 60°
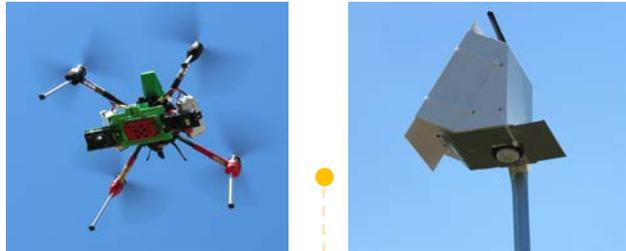- Drone data: at nadir (ground-reference data)
- Data type: RGB and NoIR images

https://www.oreilly.com/library/view/hands-on-image-processing/



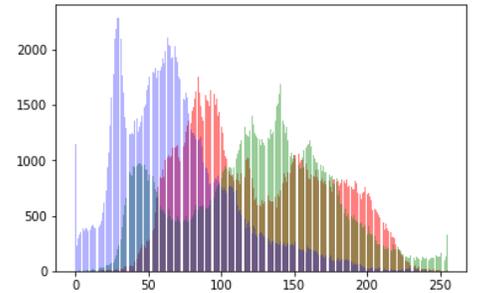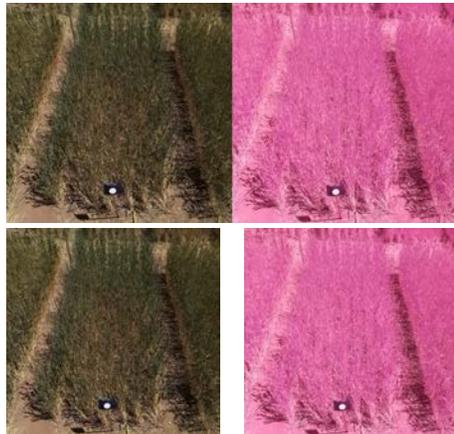**Image acquisition**  **Image separation**  **Radiometric correction**  **Plot segmentation**  **Histogram analysis**
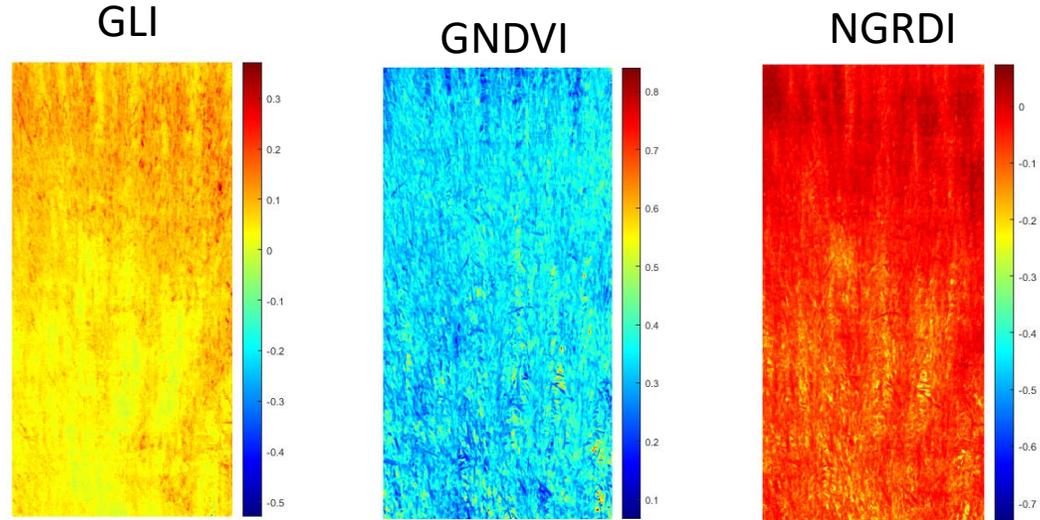
# Methods

Multispectral
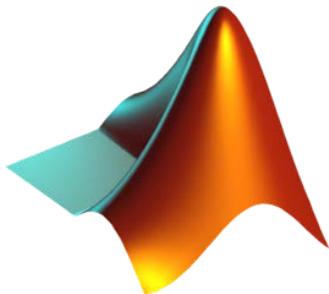- Green normalized difference vegetation index (GNDVI)

RGB
- Normalized green red difference index (NGRDI)
- Green leaf index (GLI)

GLI

GNDVI

NGRDI

**Extraction of vegetation indices**
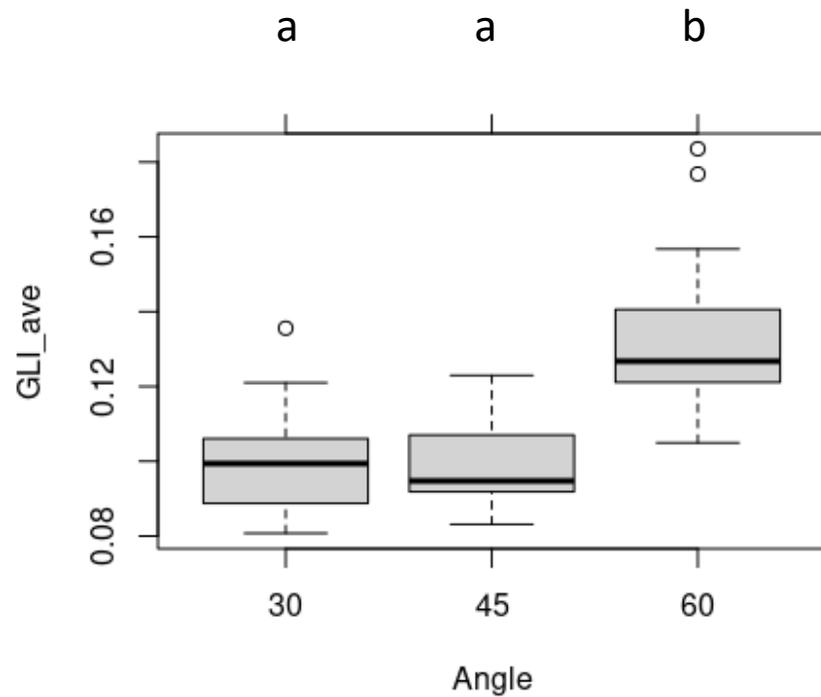
**Statistical analysis**

- ANOVA test for comparison between angles
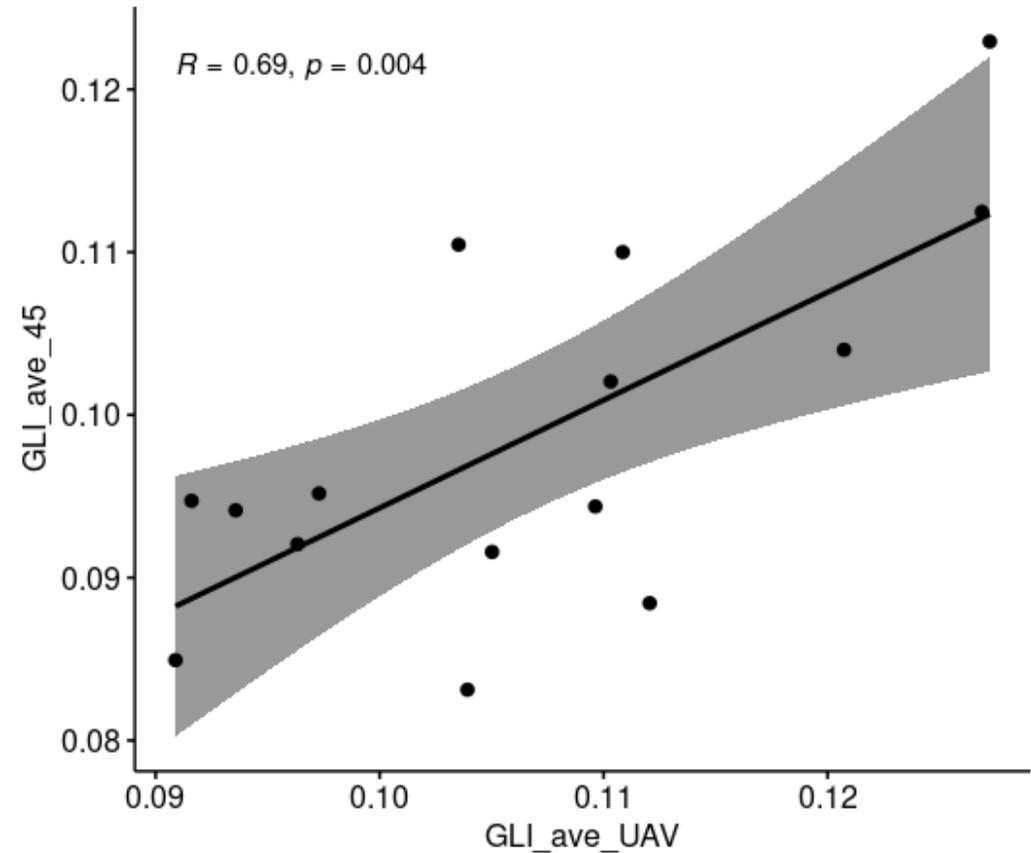- Pearson correlation for comparison between drone with IoT data

# Spring Pea Results

The angles of 30° and 45° are most similar for GLI and NGRDI
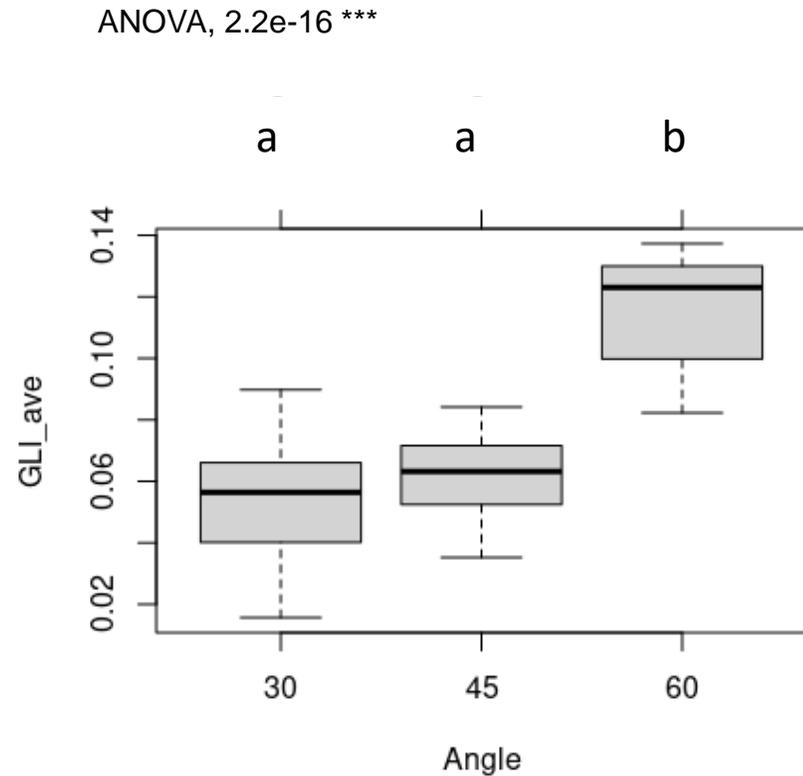


ANOVA, p = 2.2e-16 ***

Drone ground reference data had the strongest correlation with images from 45°
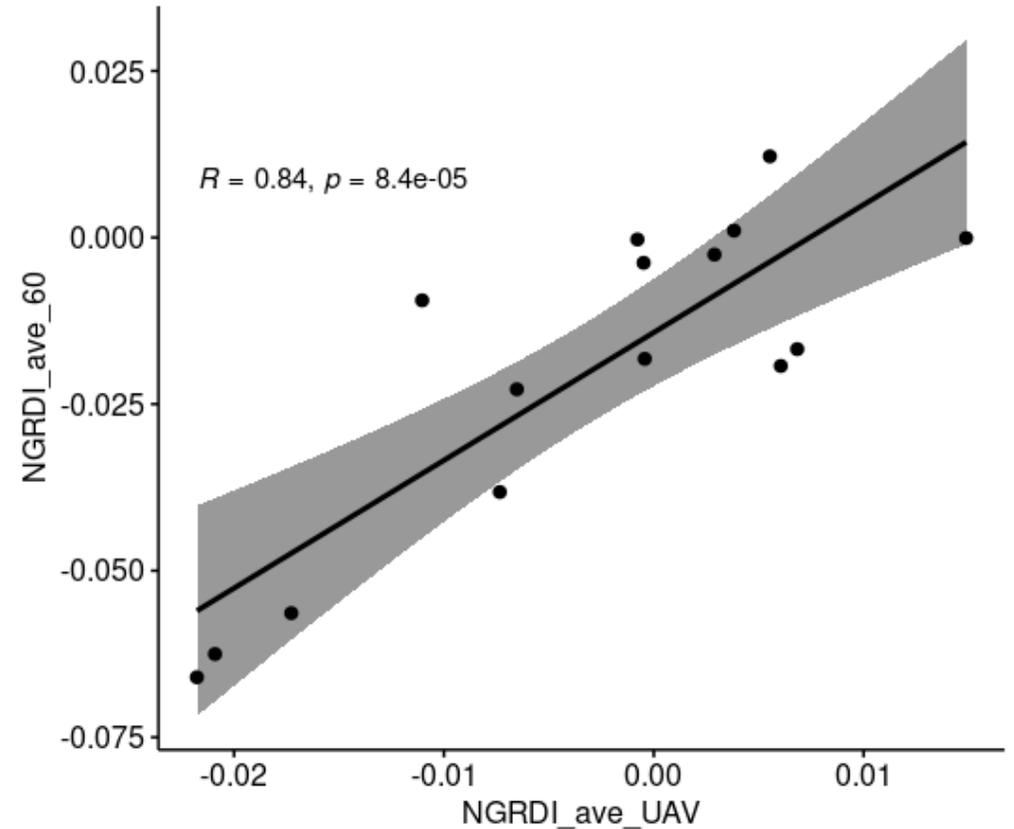


$R = 0.69$, $p = 0.004$

# Winter Wheat Results

30° and 45° were most similar for all three vegetation indices

Drone ground reference data had the strongest correlation with 60°



ANOVA, 2.2e-16 ***



R = 0.84, p = 8.4e-05

# Discussion

- Angles have an affect on calculated vegetation indices
- Image processing methods can be better optimized for data extraction
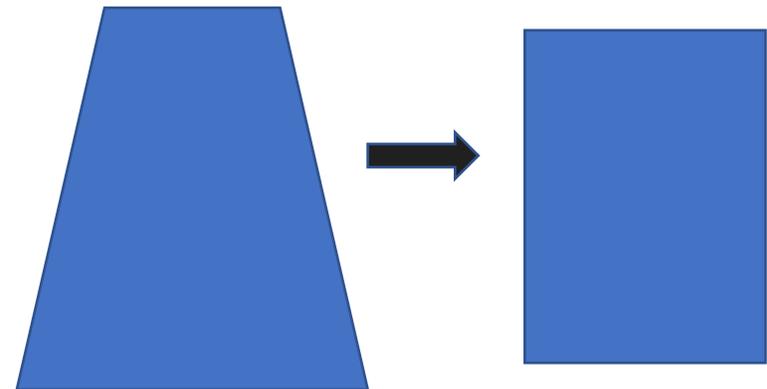
Challenges

- Soil
- Plant senescence
- Reference panel position

Future Work

Distortion correction techniques to correct inaccurate VIs

# Acknowledgements

Worasit Sangjan

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# Washington State University

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FACT: Research Experience for Undergraduates on Phenomics Big
Data Management

## USDA

United States Department of Agriculture
National Institute of Food and Agriculture

# Questions?