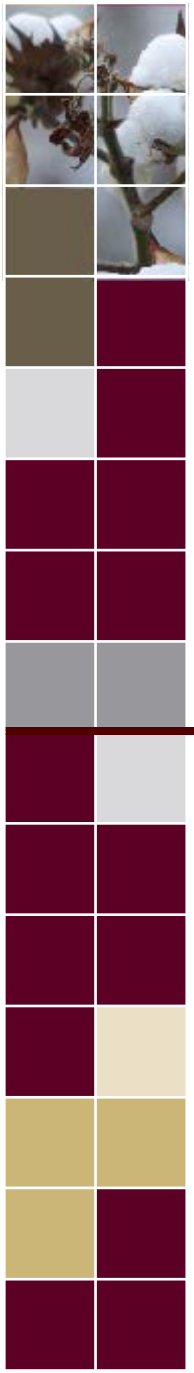


TEXAS A&M AGRILIFE RESEARCH

Using UAVs to Solve Water Stress Issues in Precision Agriculture

Haly Neely, Cristine Morgan, Nithya Rajan, Gregory Rouze, Yeyin Shi, Alex Thomasson, and John Valasek

Managing Resources

Challenges for agriculture:

- Less land
- Soil erosion/degradation
- Fertilizer costs/supply
- Less water

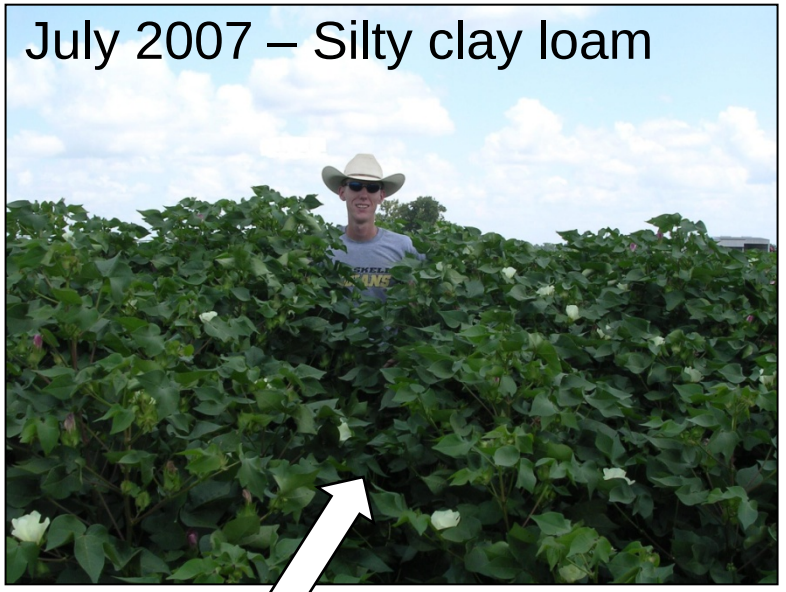
$$G \times E \times M = \text{Yield}$$

Texas A&M AgriLife Research

Soil Variability

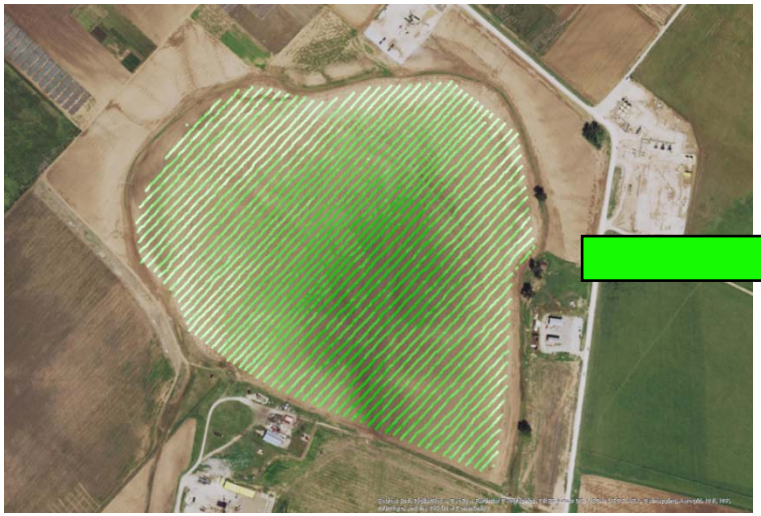
TEXAS A&M AGRILIFE RESEARCH

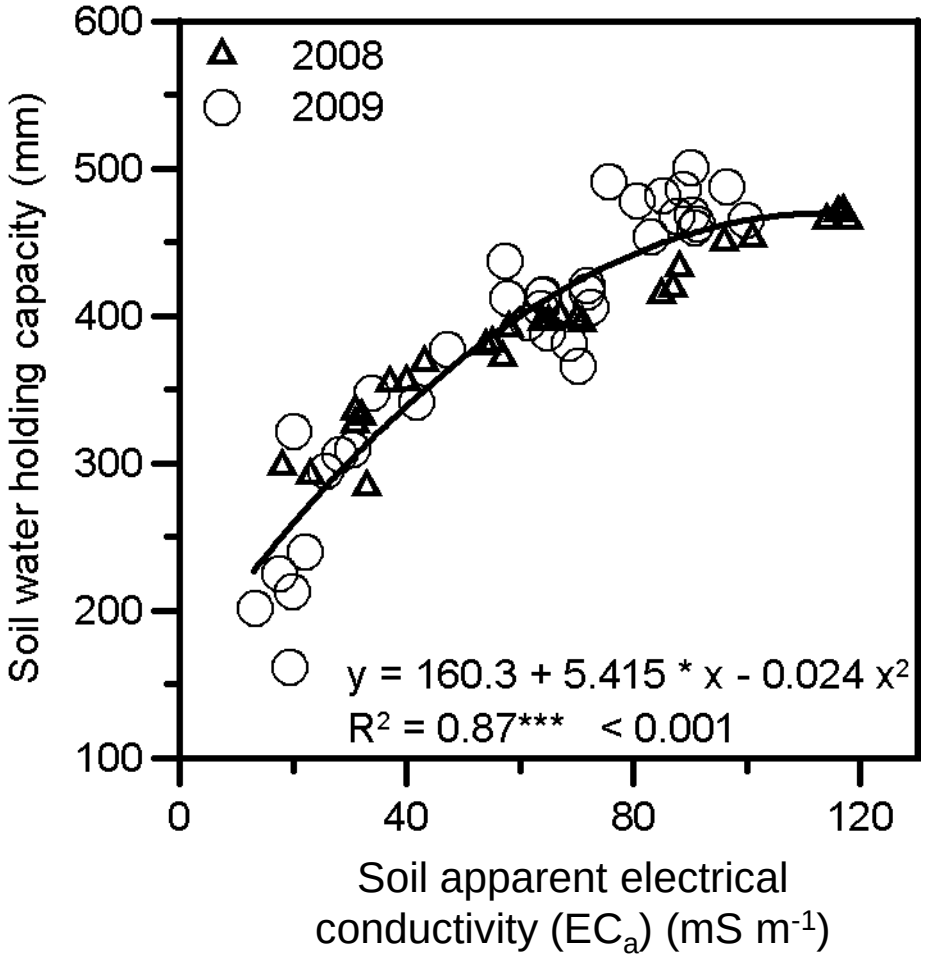
Soil Water = Yield Potential



Texas A&M AgriLife Research

Proximal Soil Information

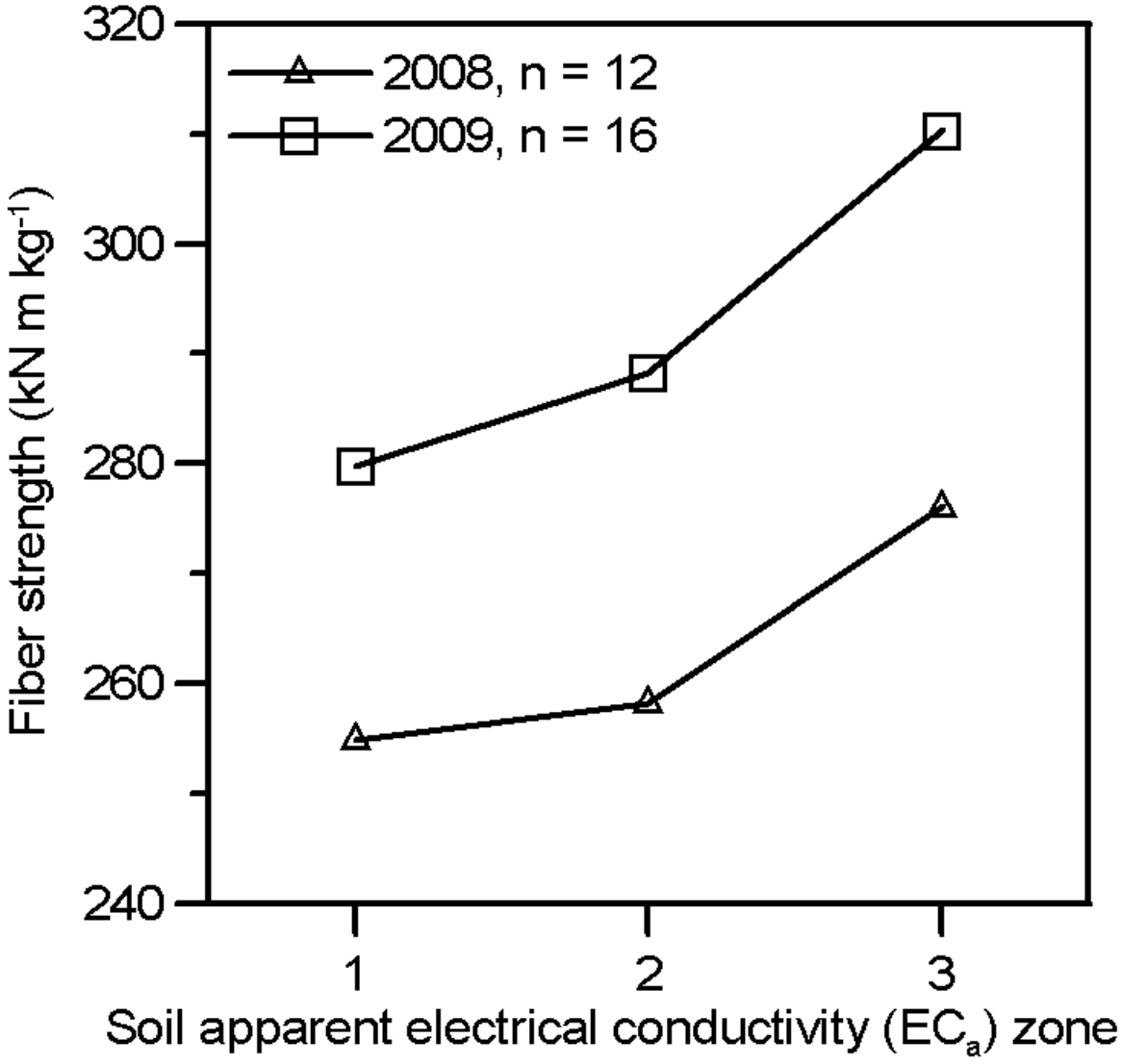


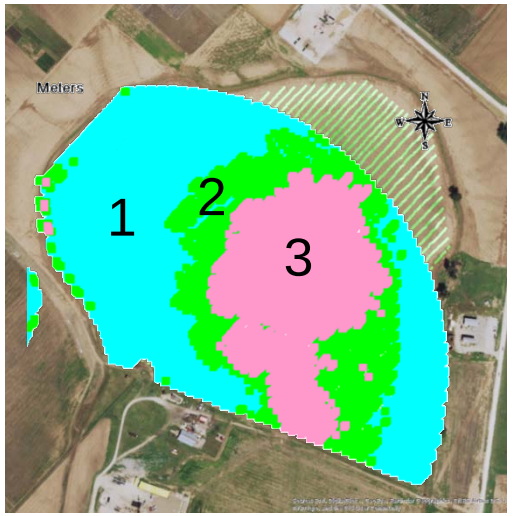


Soil Water = EC_a

Texas A&M AgriLife Research

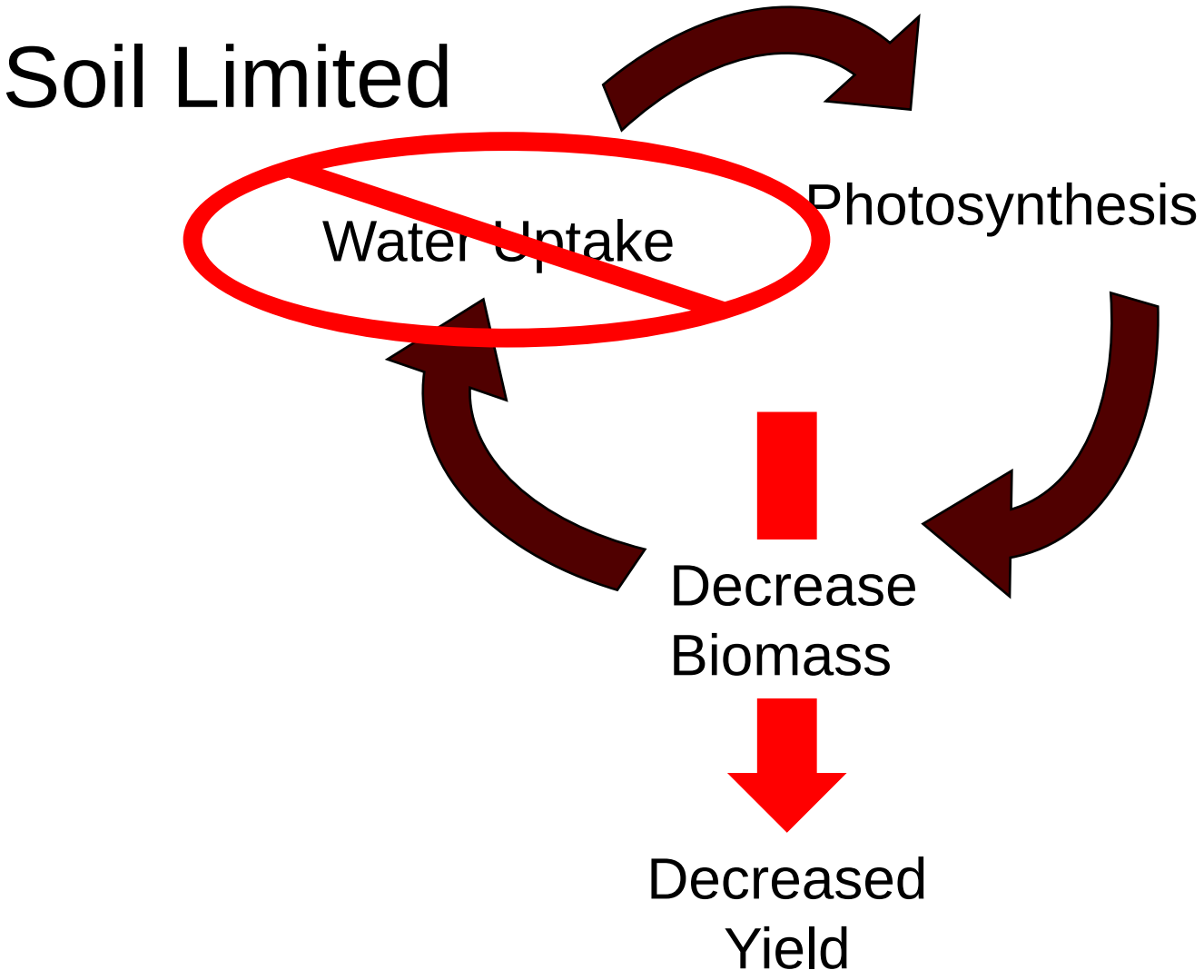
Results: Lint Quality (Strength)



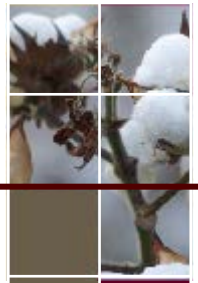


TEXAS A&M AGRILIFE RESEARCH

When adding more water is not an option



TEXAS A&M AGRILIFE RESEARCH



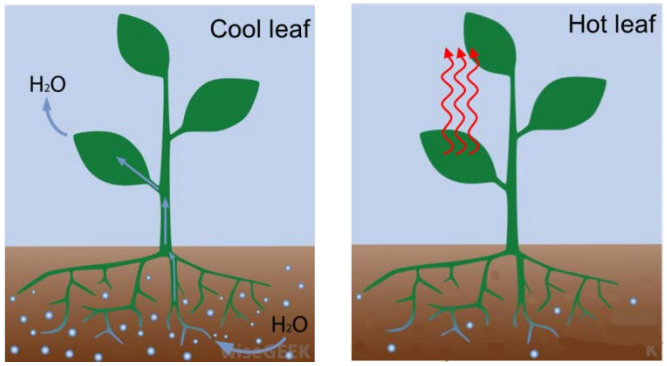
2016 Project Objectives

1. Map stress between and within corn varieties with visNIR and thermal UAS-based sensing
2. Estimate transpiration in cotton using thermal imagery, and validate with sensible-latent heat flux data
3. Evaluate how differences in soil properties affect uncertainty of UAS-based plant sensing

TEXAS A&M AGRILIFE RESEARCH

What We Know

- Canopy temperature is a good indicator of crop stress
- Soils will influence crop stress
- Must balance the energy budget
  - Differences in temperature not enough
  - Energy in = energy out

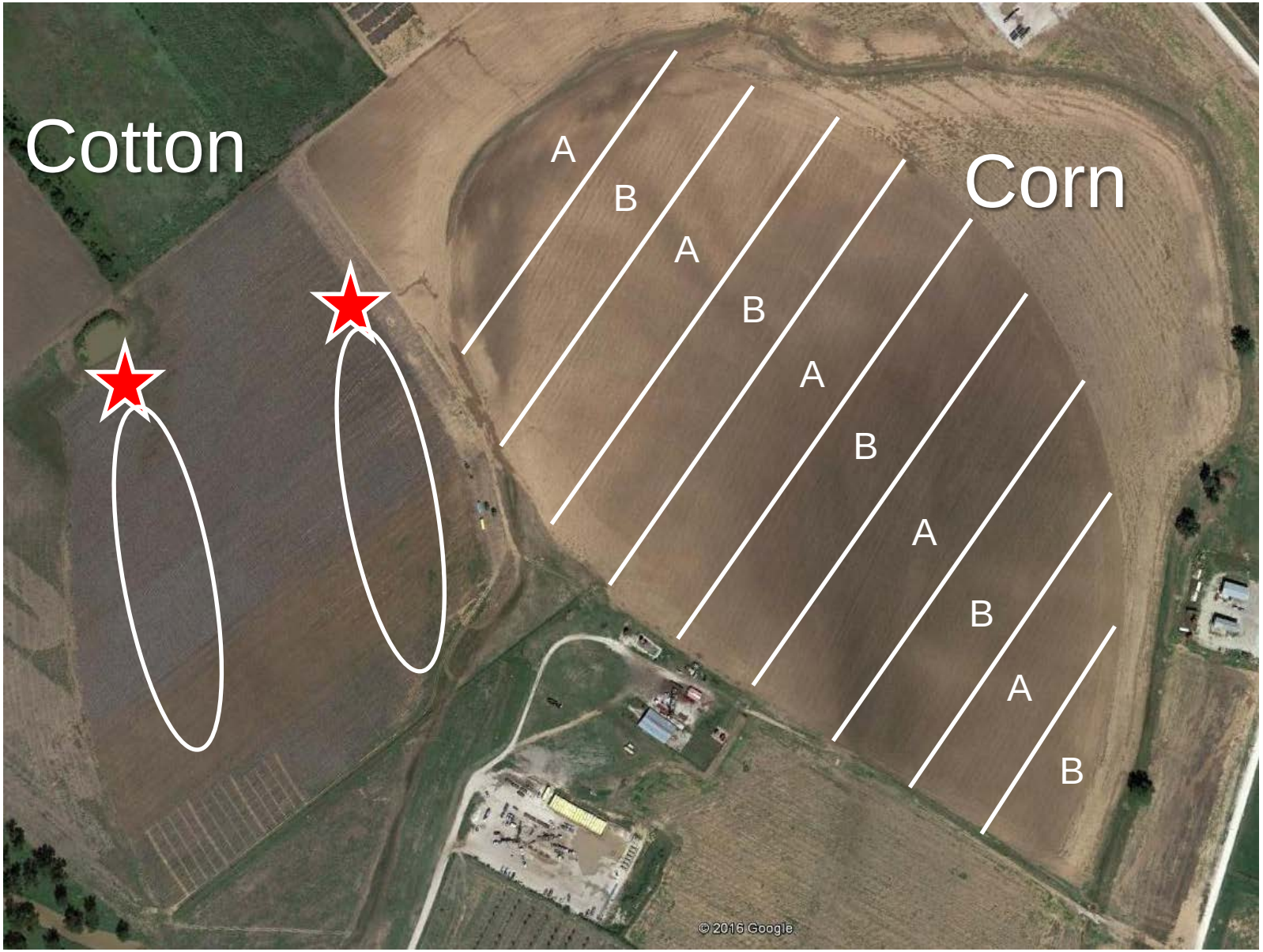


SEBAL, 2002

$$R_{abs} - L_{oe} - H - \lambda E = 0$$

$$R_{abs} - \varepsilon_s \sigma T_L^4 - c_p g_{Ha}(\boldsymbol{T_L} - T_a) - \lambda g_v \frac{e_s(T_L) - e_a}{p_a} = 0$$

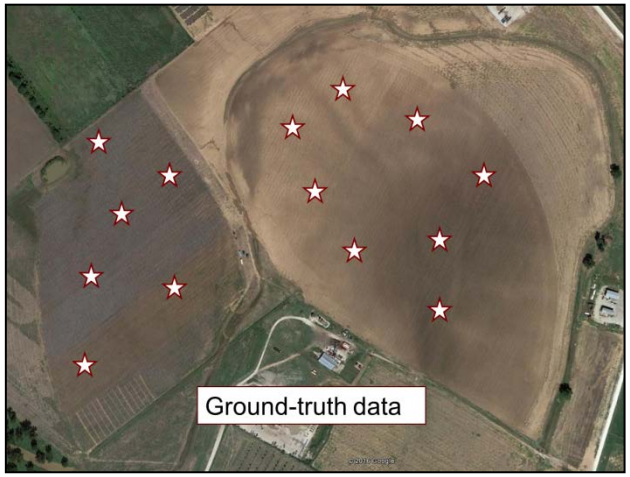
TEXAS A&M AGRILIFE RESEARCH



TEXAS A&M AGRILIFE RESEARCH

Ground-truth Data

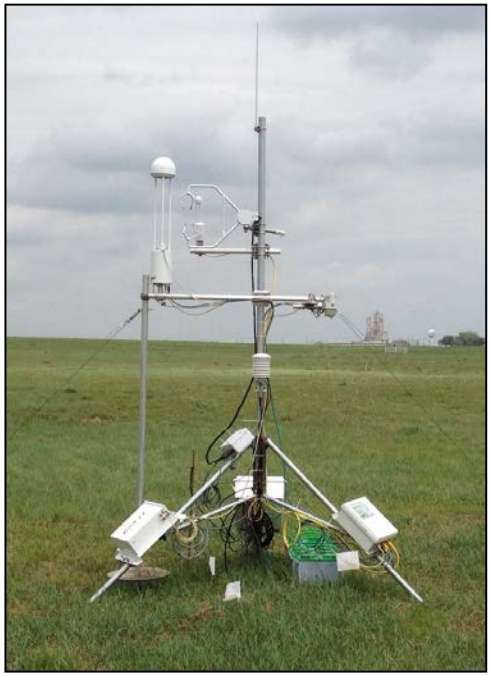
- Soil moisture
  - Neutron moisture meter
- Canopy temperature
  - IRT, **at time of flight**
- NDVI
- Leaf area index
- Plant height
  - Other basic crop notes

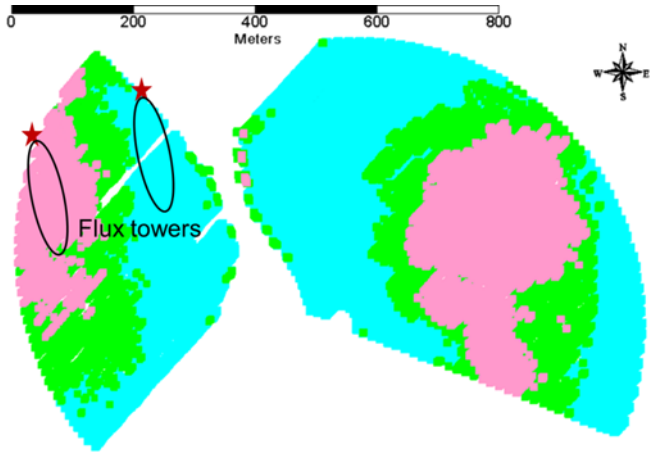


Texas A&M AgriLife Research

Eddy Covariance Systems

- Collaboration with Dr. Bill Kustas (USDA Beltsville, Maryland)
- Soil-specific fluxes of latent and sensible heat
- 2 towers





TEXAS A&M AGRILIFE RESEARCH

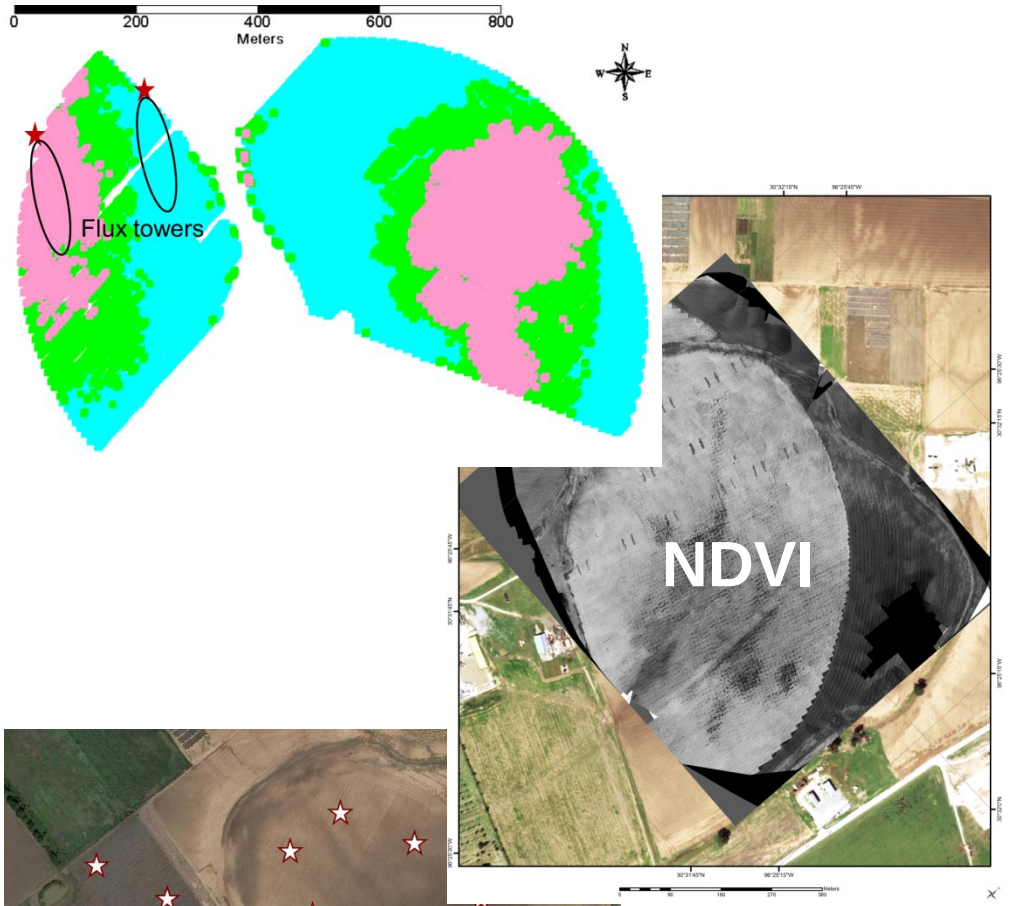
UAV Data

- Anaconda fixed-wing UAV
- Imaging sensors
  - DSLR
  - Multi-spectral
  - Thermal
- Need targets, calibration

SENTEK SYSTEMS
WHEN PRECISION MATTERS

TEXAS A&M AGRILIFE RESEARCH

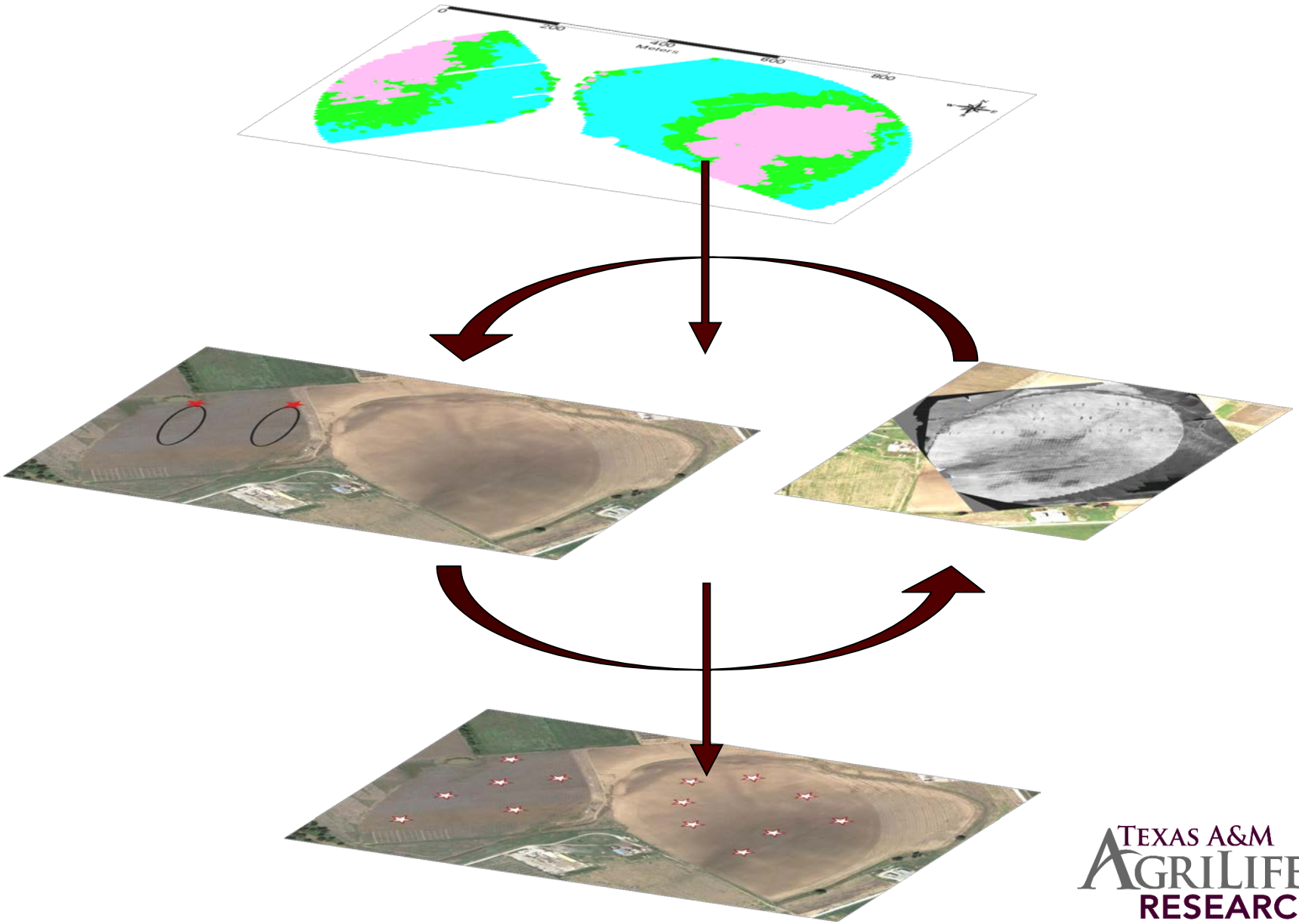
Data Layers



- Soils information
  - Fine spatial
- Flux information
  - Coarse spatial
  - Fine temporal
- Canopy temperature
  - Fine spatial
  - Coarse temporal
- Ground truth data
  - Coarse spatial
  - Coarse temporal

TEXAS A&M AGRILIFE RESEARCH

Data Fusion



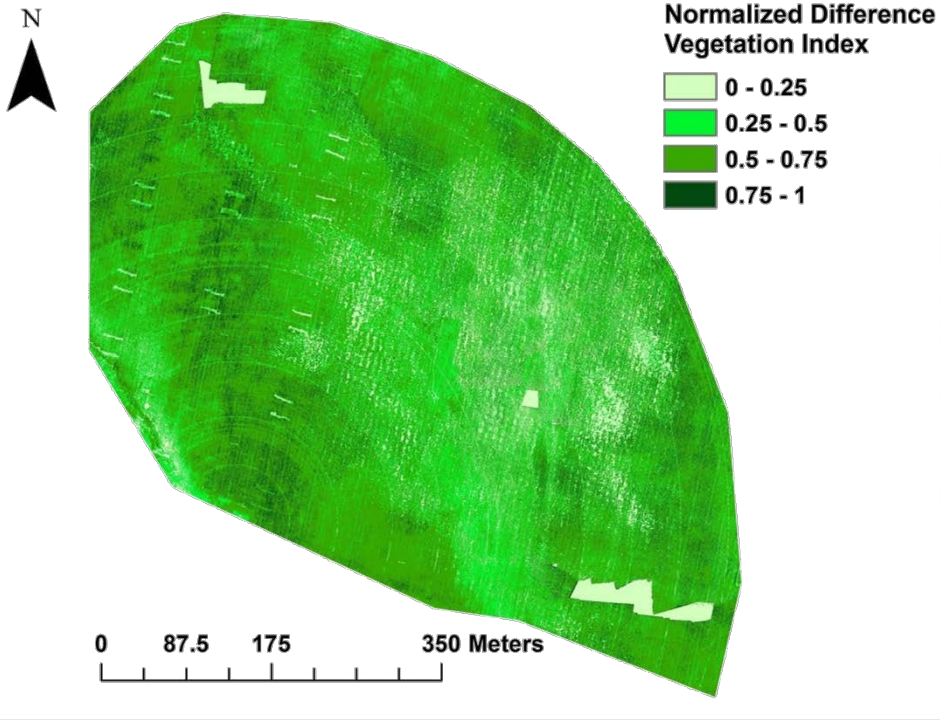
TEXAS A&M AGRILIFE RESEARCH

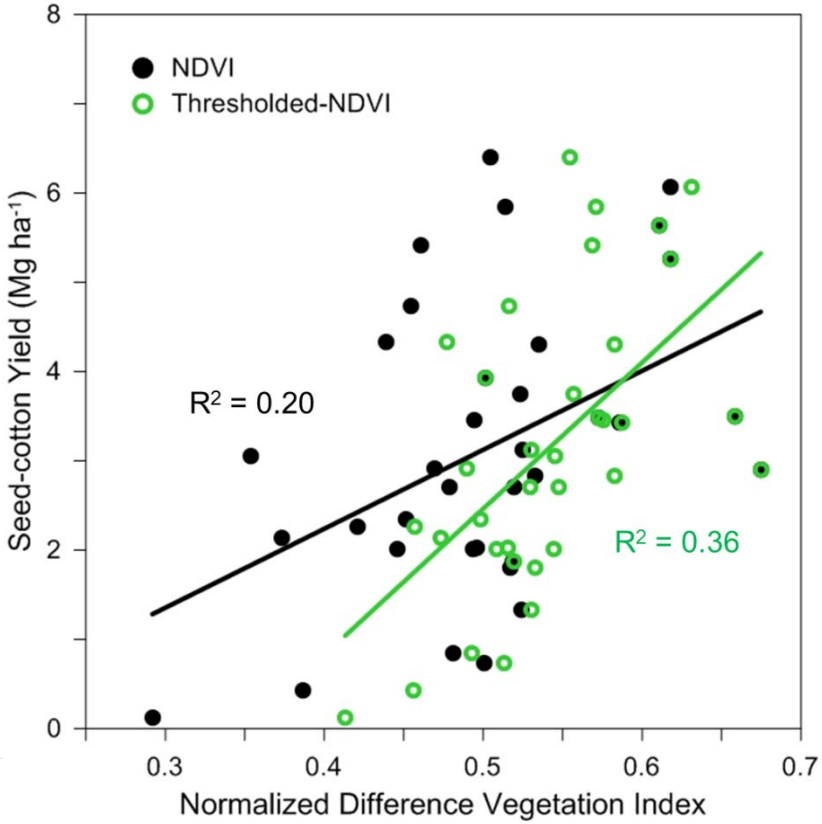
Questions We Can Answer:

- Threshold of detectable stress between and within varieties
- New techniques for using soil information for site-specific genetics
- Track plant water use strategies
- Use this information to recommend efficient irrigation management
- Develop protocols for use by plant breeders and agronomists

TEXAS A&M AGRILIFE RESEARCH

Texas A&M
AgriLife
RESEARCH
Questions ?

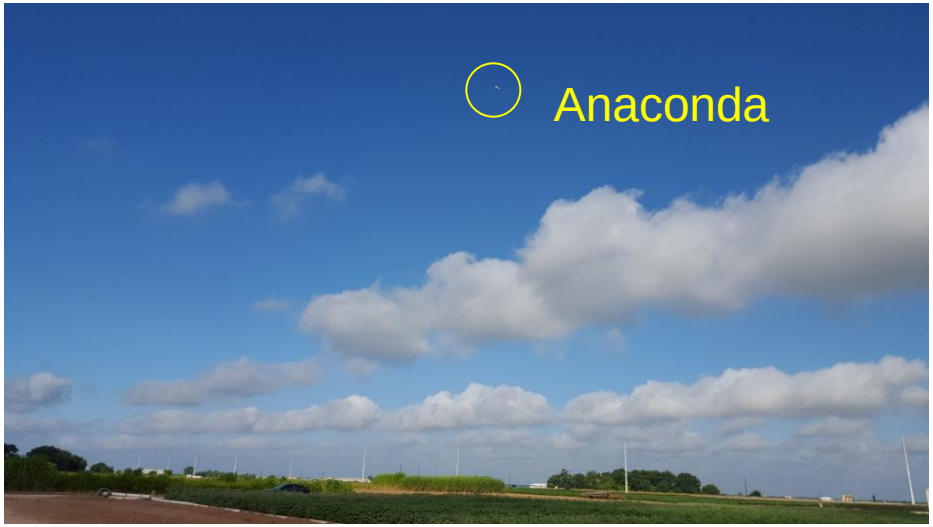




$$\mathrm{NDVI} = \frac{\mathrm{NIR} - \mathrm{Red}}{\mathrm{NIR} + \mathrm{Red}}$$

TEXAS A&M AGRILIFE RESEARCH

Challenges 1

Variable sunlight and cloud conditions strongly affect image quality

FAA mandated Line of Sight (LOS) operations and altitude restrictions negatively impact operational efficiency and data quality