



# Flying the Family Farm

UAS & Management-intensive Grazing



# INTRODUCTION

## Overview



The McIntire Farm. July 2018. DJI Phantom 3 SE.

- Is there a role for UAS in pasture-based agriculture?



# INTRODUCTION

## Significance

- ▶ “Testing, not guessing, is the rule to success” John Kempf
- ▶ Tradition vs. Technology vs. Time
- ▶ Good, Fast or Cheap: Pick Two!



<https://regenerationinternational.org/Land-Restoration-With-Holistic-Management>

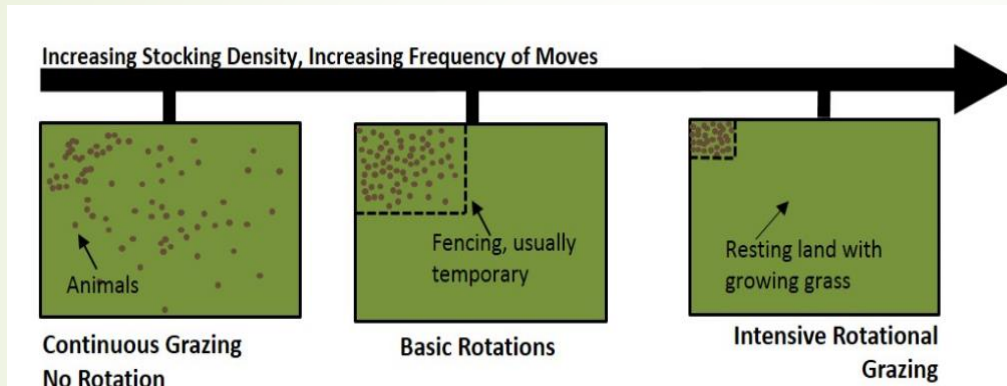






# BACKGROUND

## Management-intensive Grazing (MiG)



<http://pastureproject.org/pasture-management/rotational-grazing-systems/>



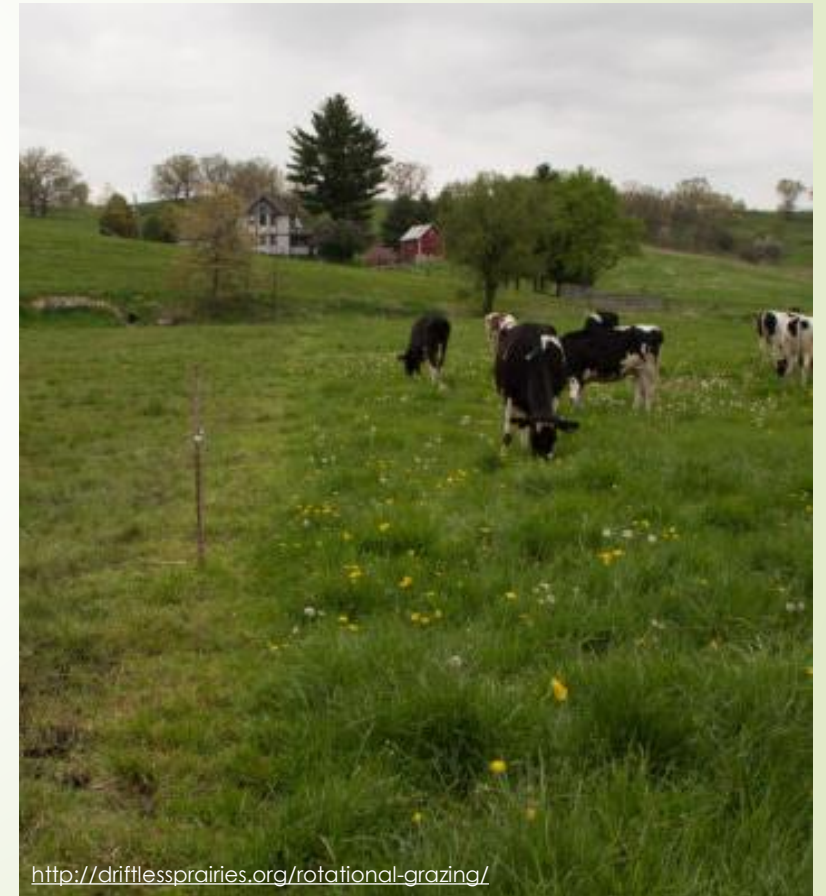
- *High Intensity*
- *Short Duration*
- *Long Recovery*





# BACKGROUND

## MiG: Advantages & Challenges



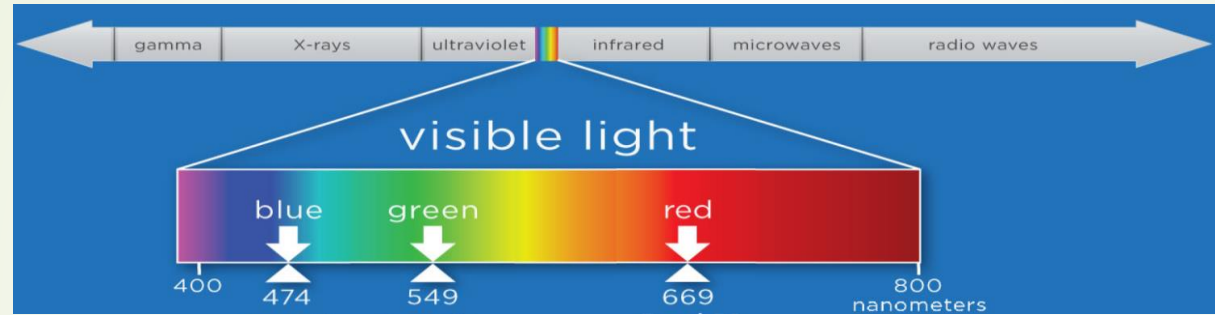




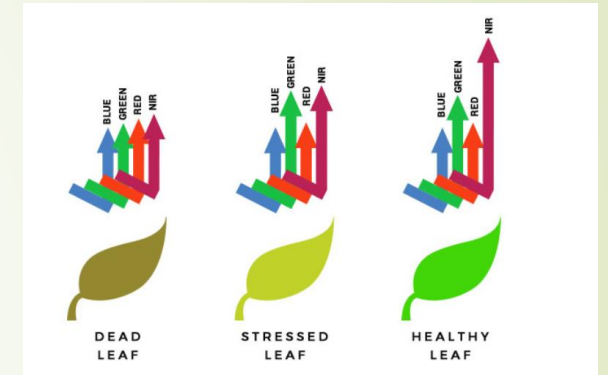


# BACKGROUND

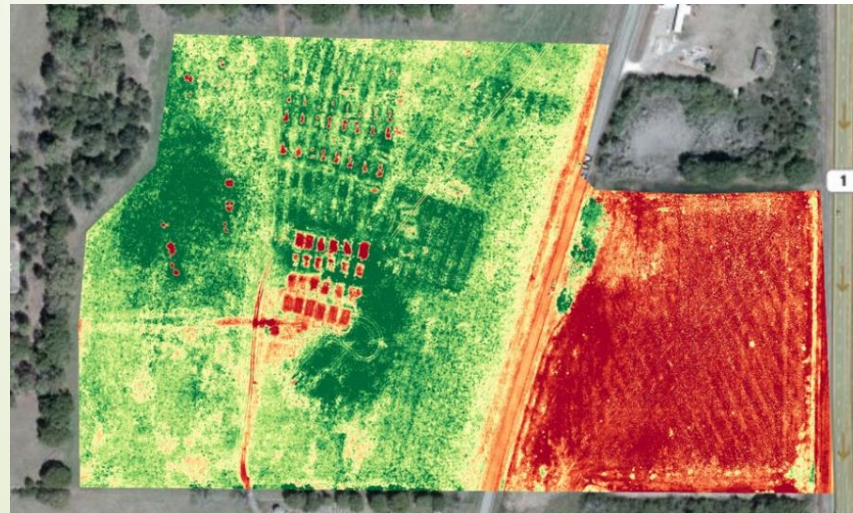
## UAS & Multispectral Data



<https://www.neonscience.org/neon-hsi-aop-functions-tiles-py>



<https://www.riseabove.com.au/page/ndvi/>



White Oak Pastures – Drone Pasture Monitoring



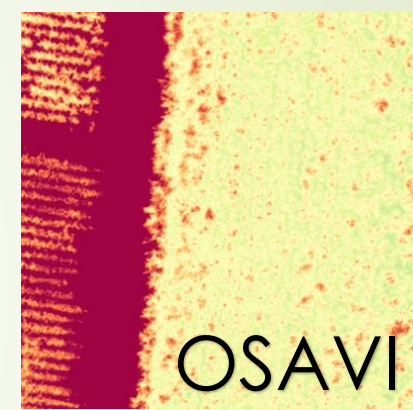
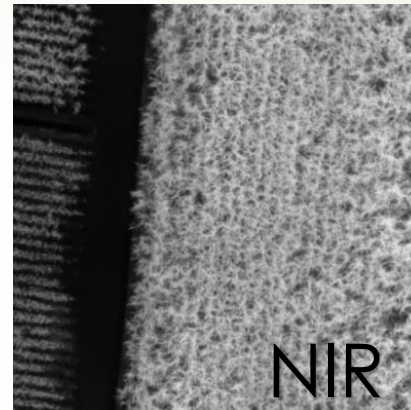
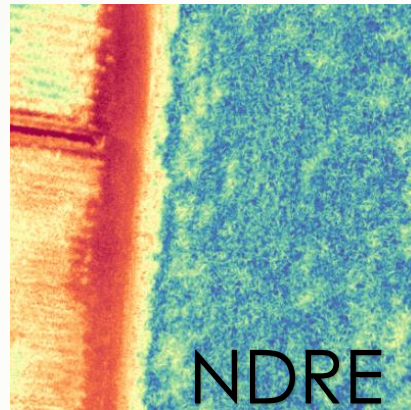
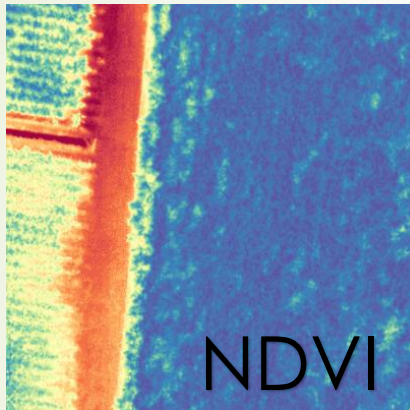
Google Earth Pro (2019)





# BACKGROUND

## Multispectral Mathematics



- **NDVI** (Normalized Difference Vegetation Index)
- **NDRE** (Normalized Difference Red Edge) Index
- **NIR** (Near Infra-Red) Reflectance
- **OSAVI** (Optimized Soil-Adjusted Vegetation Index)
- **CIR** Composite (Color Infra-Red) Composite



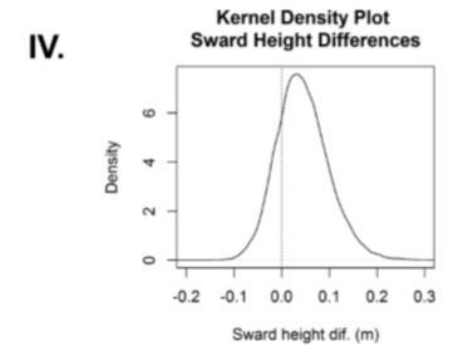
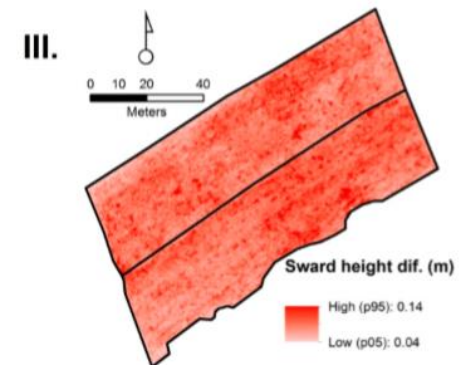
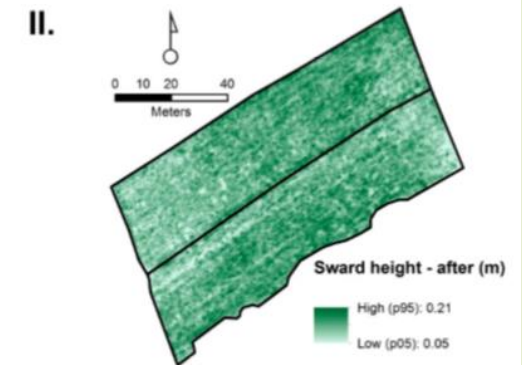
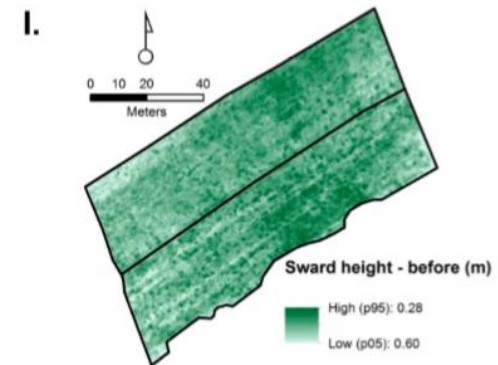




# BACKGROUND

## Existing Research

- On-site vs. Remote
- UAS vs. Satellite
- Passive vs. Active

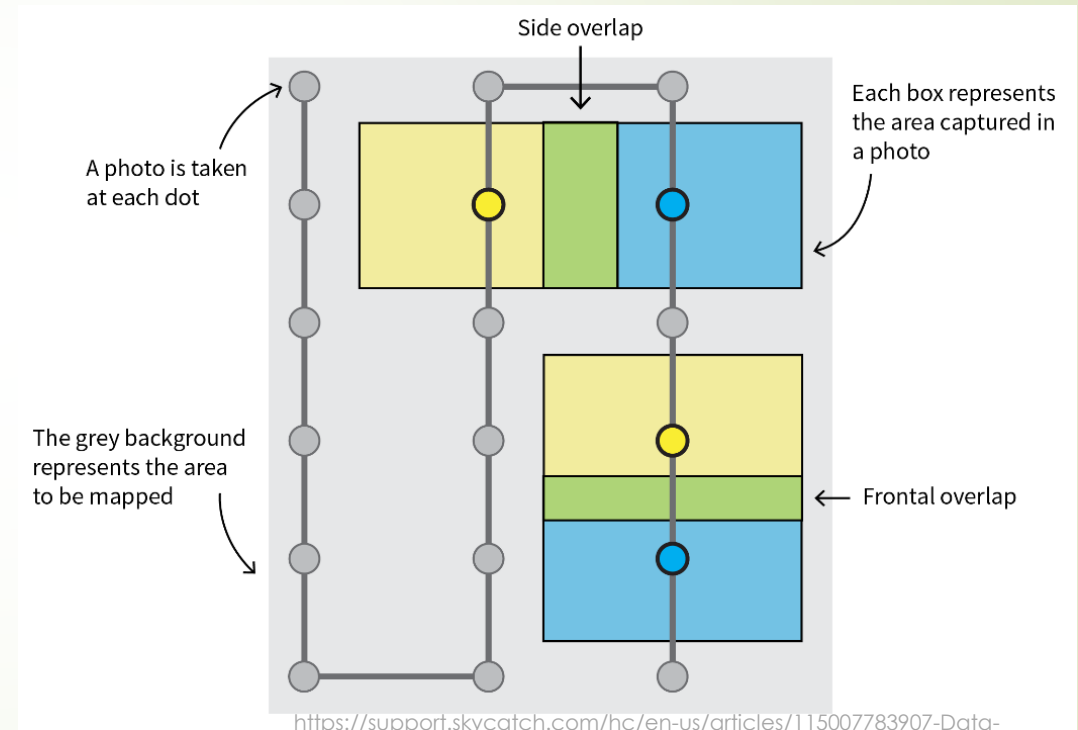




# OBJECTIVES

## Identify Best Practices

- Study Variables
  - Image Overlap
  - Flying Height
  - GCP Target Size
- Optional Variables
  - UAV Speed
  - Solar Angle



[https://support.skycatch.com/hc/en-us/articles/115007783907-Data-Capture-Guidelines-for-Producing-Great-Maps?mobile\\_site=true](https://support.skycatch.com/hc/en-us/articles/115007783907-Data-Capture-Guidelines-for-Producing-Great-Maps?mobile_site=true)







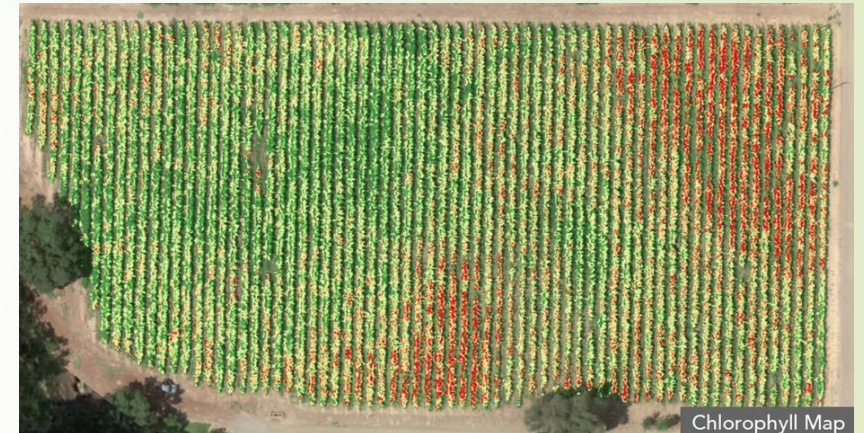
# OBJECTIVES

## Correlate Remote & Ground Data



RGB Color

www.micasense.com



Chlorophyll Map

www.micasense.com

Vegetation Index	Formula	Parameter
Normalized Difference Vegetation Index (NDVI)	$(NIR - RED)/(NIR + RED)$	Photosynthetic activity, plant stress
Normalized Difference Red Edge (NDRE)	$(NIR - REEDGE)/(NIR + REEDGE)$	Chlorophyll and nitrogen content More sensitive to
Green NDVI (GNDVI)	$(NIR - GREEN)/(NIR + GREEN)$	chlorophyll-a concentration, monitoring of plant stress
Green Ratio Vegetation Index (GRVI)	$NIR/GREEN$	Photosynthetic activity

Remote Sensing, 11(5), 473. doi:10.3390/rs11050473



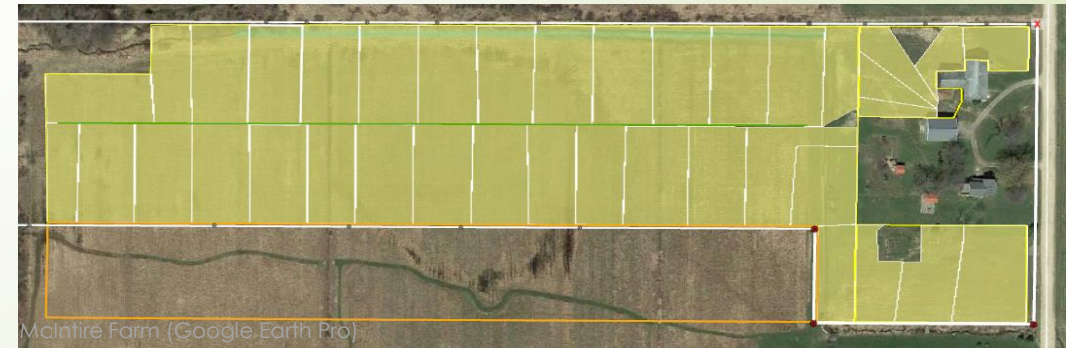


# METHODOLOGY

## Site Description



- Pasture
- Silvopasture
- Control



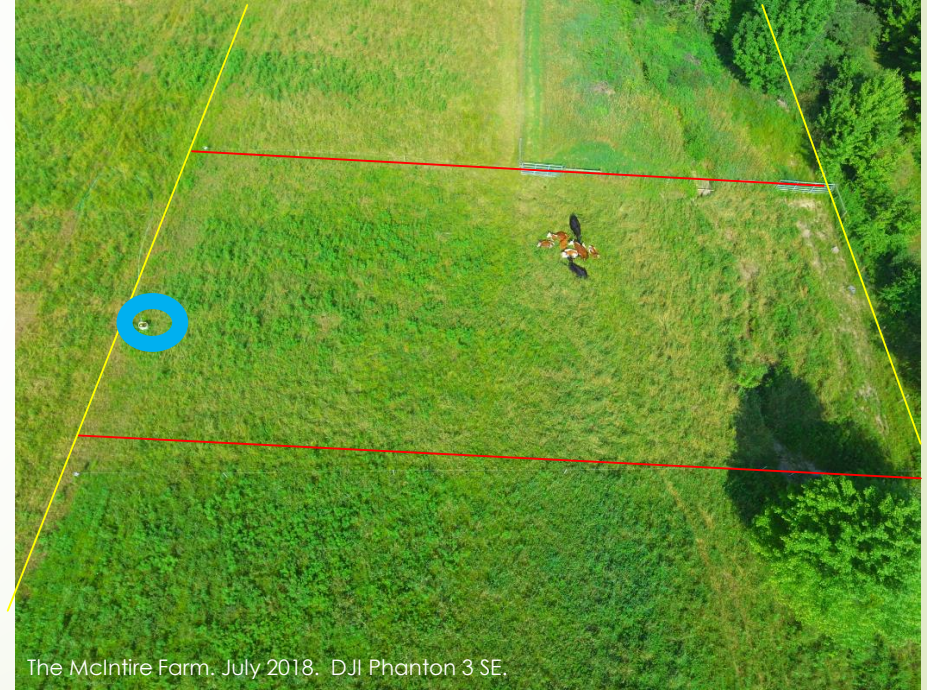


# METHODOLOGY

## Workflow: MiG



The McIntire Farm. July 2018. DJI Phantom 3 SE.



The McIntire Farm. July 2018. DJI Phantom 3 SE.





# METHODOLOGY

## Research Methods & Timeline

- Initial Monitoring
  - GCPs
  - Ortho Base Map
  - Soil Compaction
  - Soil Analysis
- Ongoing Monitoring
  - Multispectral
  - Forage Analysis
  - Brix Measurements

	MAY	JUN	JUL	AUG	SEP	OCT	NOV
GCPs	█						
Orthomosaic	█	█	█	█	█	█	█
Soil Compaction	█						
Soil Analysis	█						
Multispectral	█	█	█	█	█	█	█
Forage Sampling	█		█		█		█
Brix Measurements	█	█	█	█	█	█	█

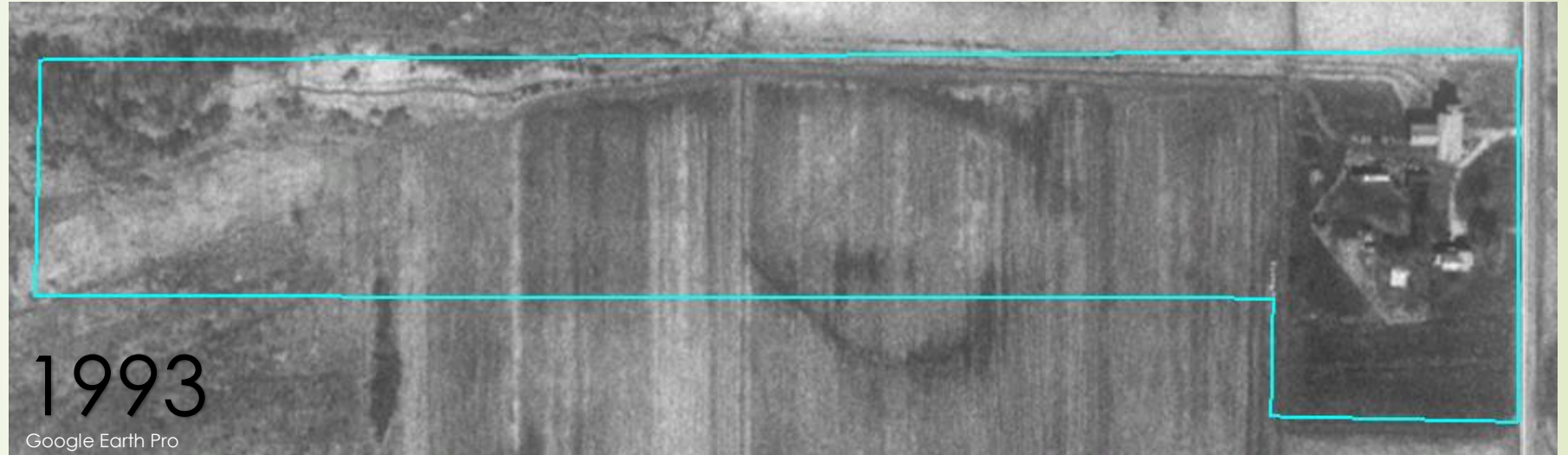






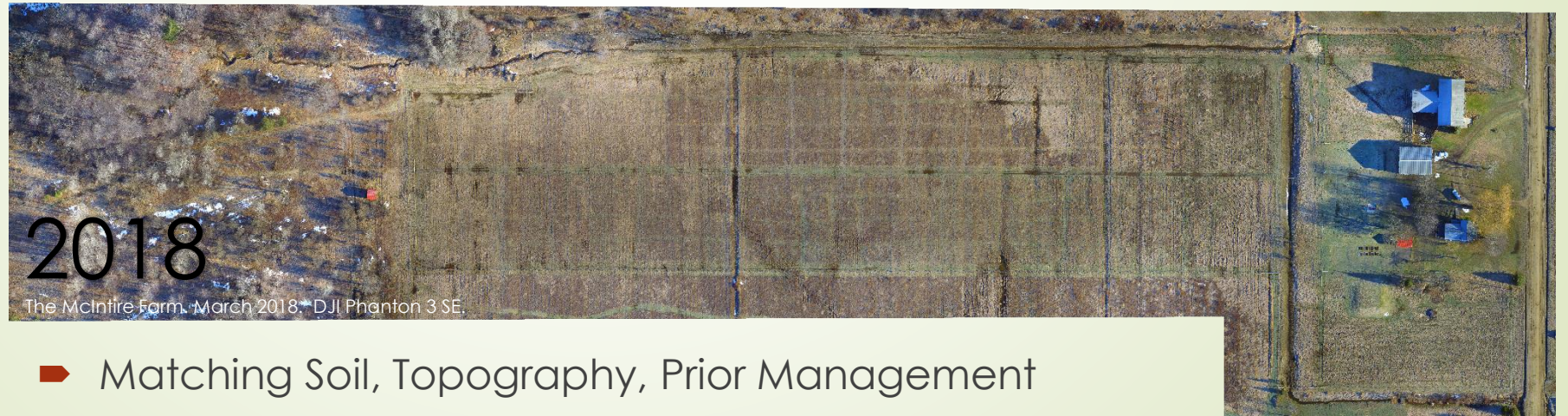
# METHODOLOGY

## Research Control



1993

Google Earth Pro



2018

The McIntire Farm, March 2018, DJI Phantom 3 SE.

➤ Matching Soil, Topography, Prior Management





# METHODOLOGY

## Accuracy: GNSS Positioning

### ► Survey Grade GNSS



<https://cengineermag.com/partnership-enables-collection-of-centimeter-accurate-3d-data-in-gnss-impaired-environments/>

POINT TYPE	AGM #	NORTHING (US Ft.)	EASTING (US Ft.)
Surveyed	3	550415.0436	1763488.334
Bluetooth GPS	3	550415.0173	1763488.309
	<b>Residual Values</b>	<b>-0.026255</b>	<b>-0.02497</b>
	<b>Horizontal Distance (Ft.)</b>	<b>0.036</b>	
POINT TYPE	AGM #	NORTHING (US Ft.)	EASTING (US Ft.)
Surveyed	4	548061.4953	1763951.597
Bluetooth GPS	4	548061.5566	1763951.574
	<b>Residual Values</b>	<b>0.061319</b>	<b>-0.02323</b>
	<b>Horizontal Distance (Ft.)</b>	<b>0.066</b>	



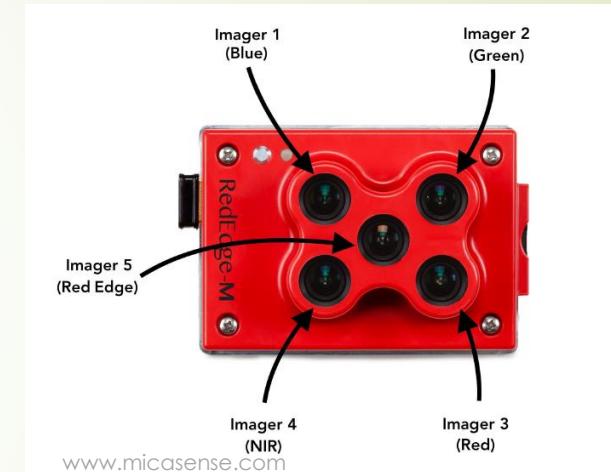


# METHODOLOGY

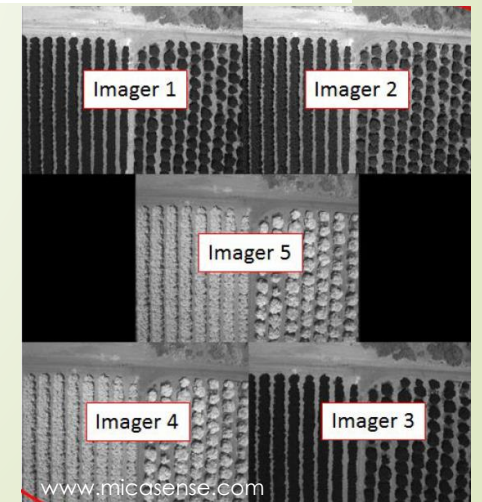
## UAS Platform & Sensor Package



- DJI Matrice 600 Pro & Micasense RedEdge



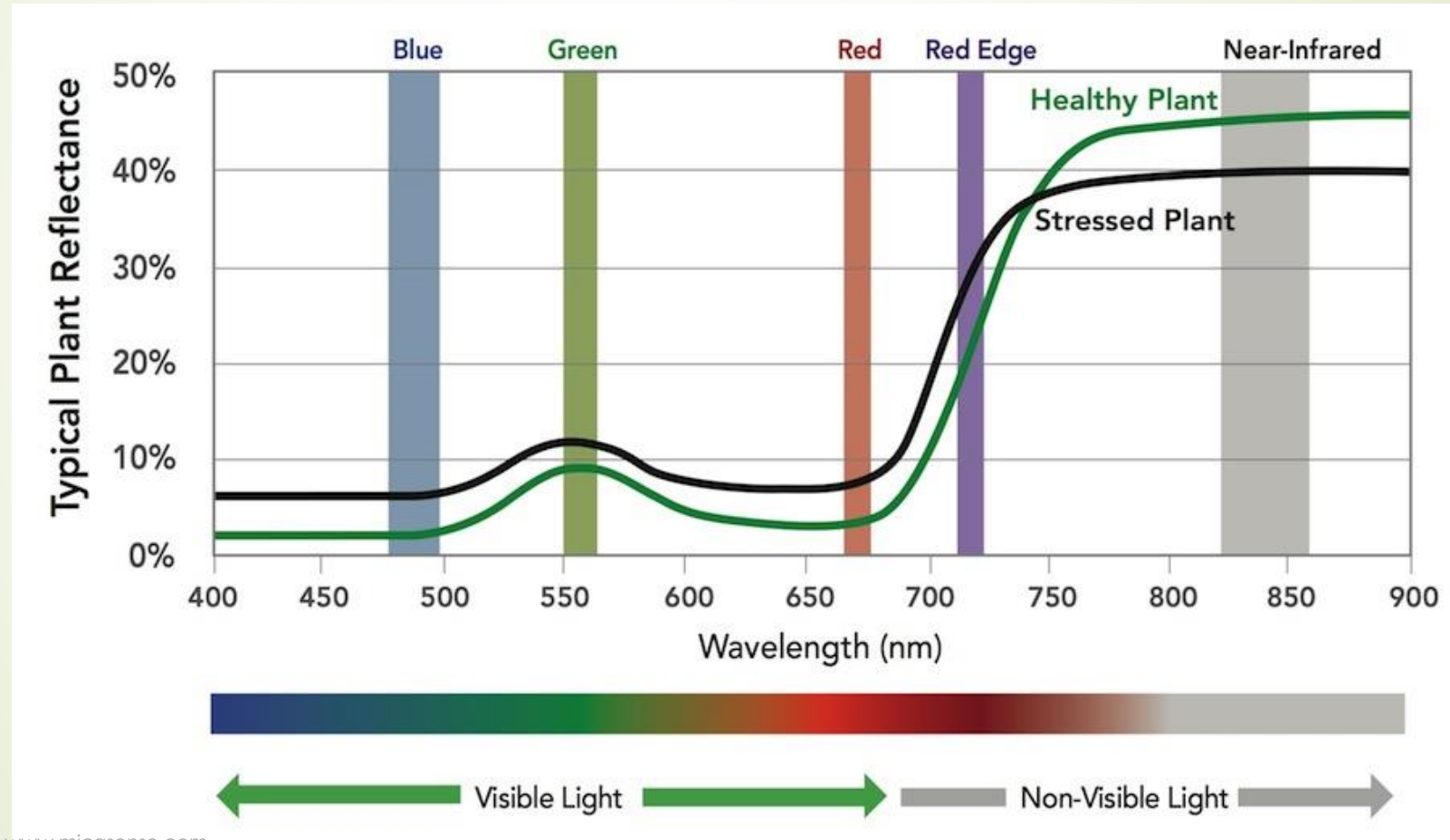
- PSU Mobile Geospatial System Group (MGSG)





# METHODOLOGY

## Data: Multispectral Sensor







# OUTCOMES

## Anticipated Results

- ▶ UAS/Multispectral cannot replace ground measurements  
*----but---*
- ▶ UAS/Multispectral can bridge the gap between guessing and testing  
*----and---*
- ▶ UAS/Multispectral can add real value to ground measurements at scale





# OUTCOMES

## Knowledge Dissemination



**Pennsylvania Grazing Lands Coalition**  
Working together to maintain and improve the Management, Productivity, and Health of the nation's privately-owned grazing land.





# CITATIONS



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- [www.micasesense.com](http://www.micasesense.com)

