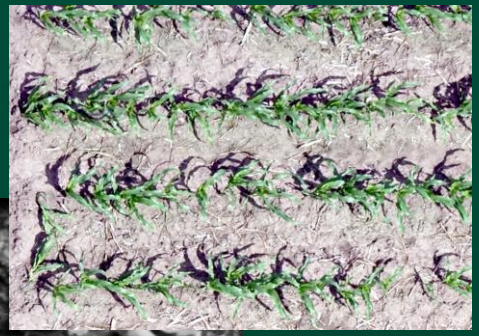
In-field and Remote Sensing for Precision Agriculture

John Nowatzki
Extension Ag Machine Systems Specialist
North Dakota State University



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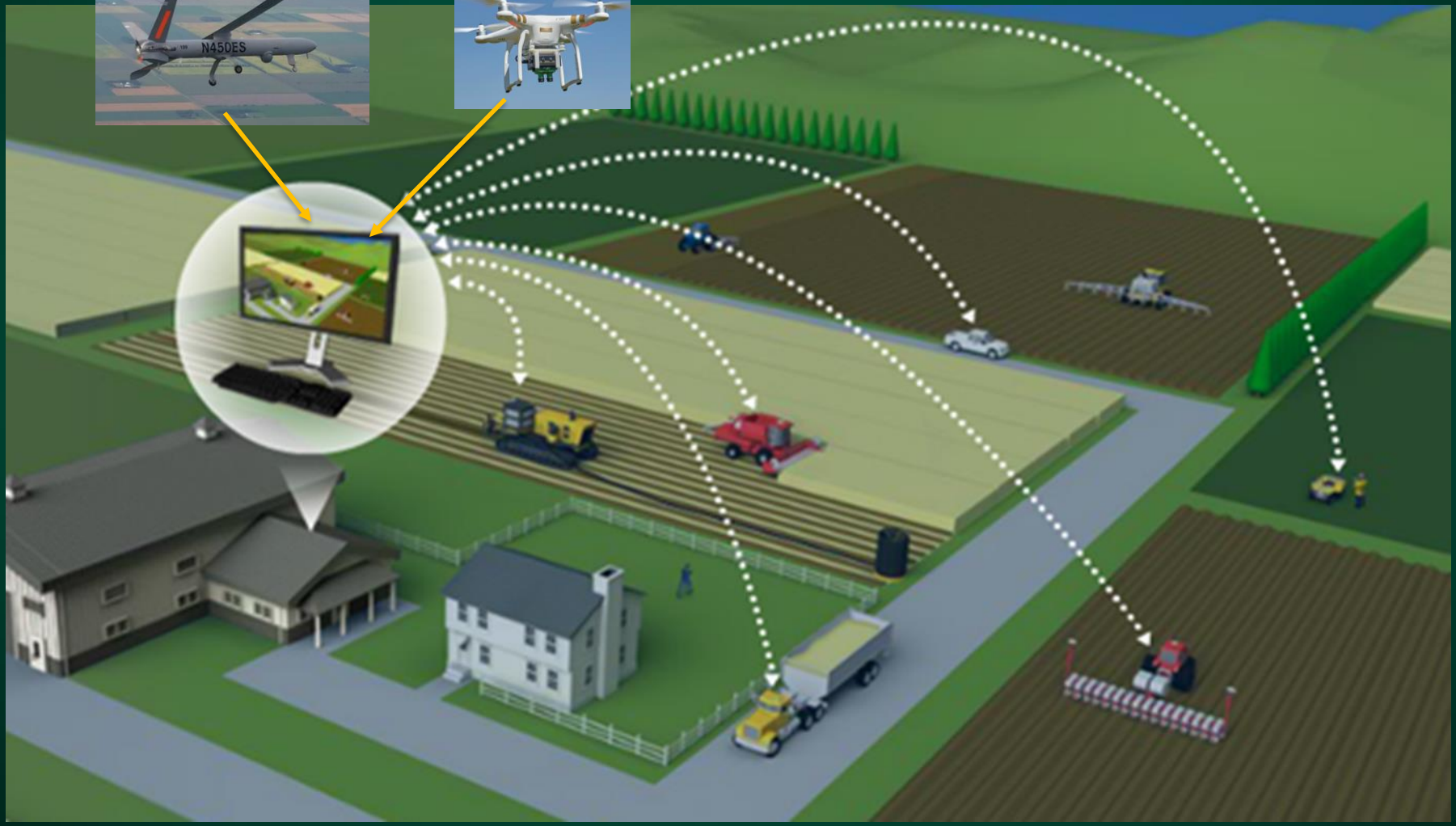
UAS in Precision Agriculture

- In-field Sensors
- Selecting UAS Equipment
- NDSU UAS Activities
- Current UAS Applications
- Future UAS Applications and Needs

Precision Agriculture & Data Management



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Selecting sUAS Equipment for Agricultural Applications

Multi-Rotor 		Fixed-wing 	
Advantages	Disadvantages	Advantages	Disadvantages
Any Camera	Short flight time	Cover larger area	Takeoff space
Ease of use	Small area	Longer flight time	
Ability to hover	Slower Speed	Simpler structure More stable flight	Assistance for takeoff
Vertical takeoff and landing	More complex	Greater payload	Larger in size
Less expensive	Smaller Payload	Multiple sensors	More expensive

https://www.ag.ndsu.edu/agmachinery

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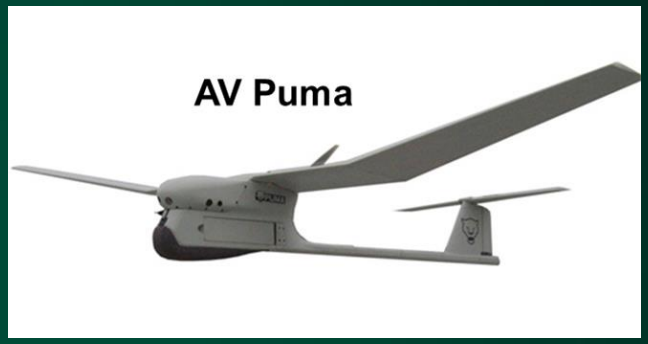
UAS Platforms

Small UAS Rules



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Small UAS Rules

- Less than 55 lbs.
- Remote Pilot Airman Certificate
- Line of Sight
- Daylight Hours
- 400’ or Below

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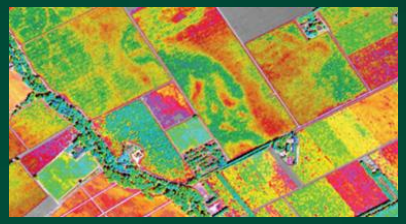
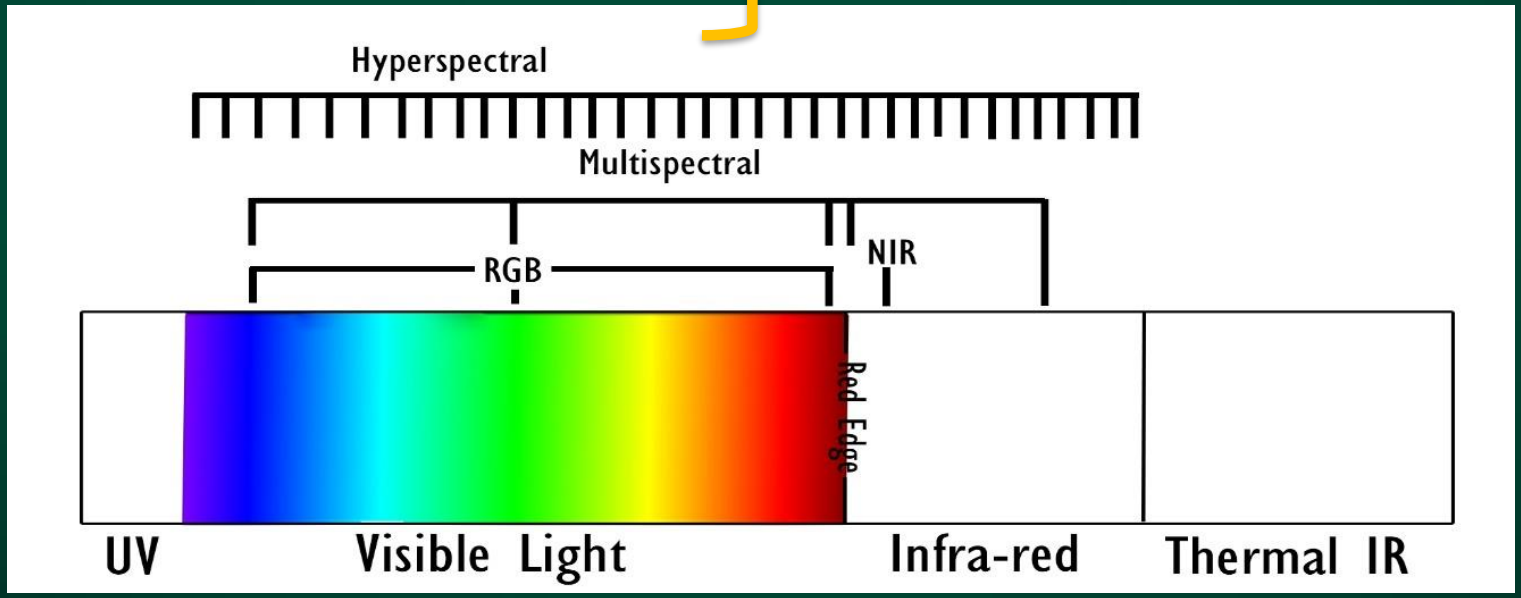
Remote Sensing for Agricultural Applications

- Color – RGB
- Multi-spectral
- Hyper-spectral



Vegetative Index
NDVI



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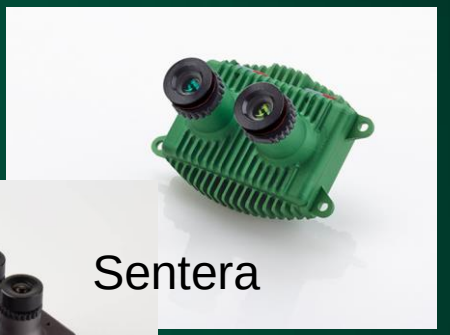
UAS Sensors

Cameras

- GoPro Camer
- ICI 9640 S Thermal camera
- Large area scanning EO/IR/NIR camera
- Sony NEX-5R camera with NIR
- Tetracam ADC
- Sentera dual sensor (4 band)
- Sentera Quad sensor (6 band)
- MicaSense Rededge
- Ximera Hyperspectral sensor
- Rikola Hyperspectral sensor



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NDSU UAS Activities
Small and Large UAV


Phantom 3


Trimble UX5

Large-scale UAS Project

Imagery in May, June, July and August

- Color, Infrared Sensor
- 4,000, 6,000 and 8,000 ft

Small UAS, Satellite, Ground and Yield Data

All Imagery Securely Stored on NDSU Computers

Objectives

Uses for Crop Management

Economic Value to Producers

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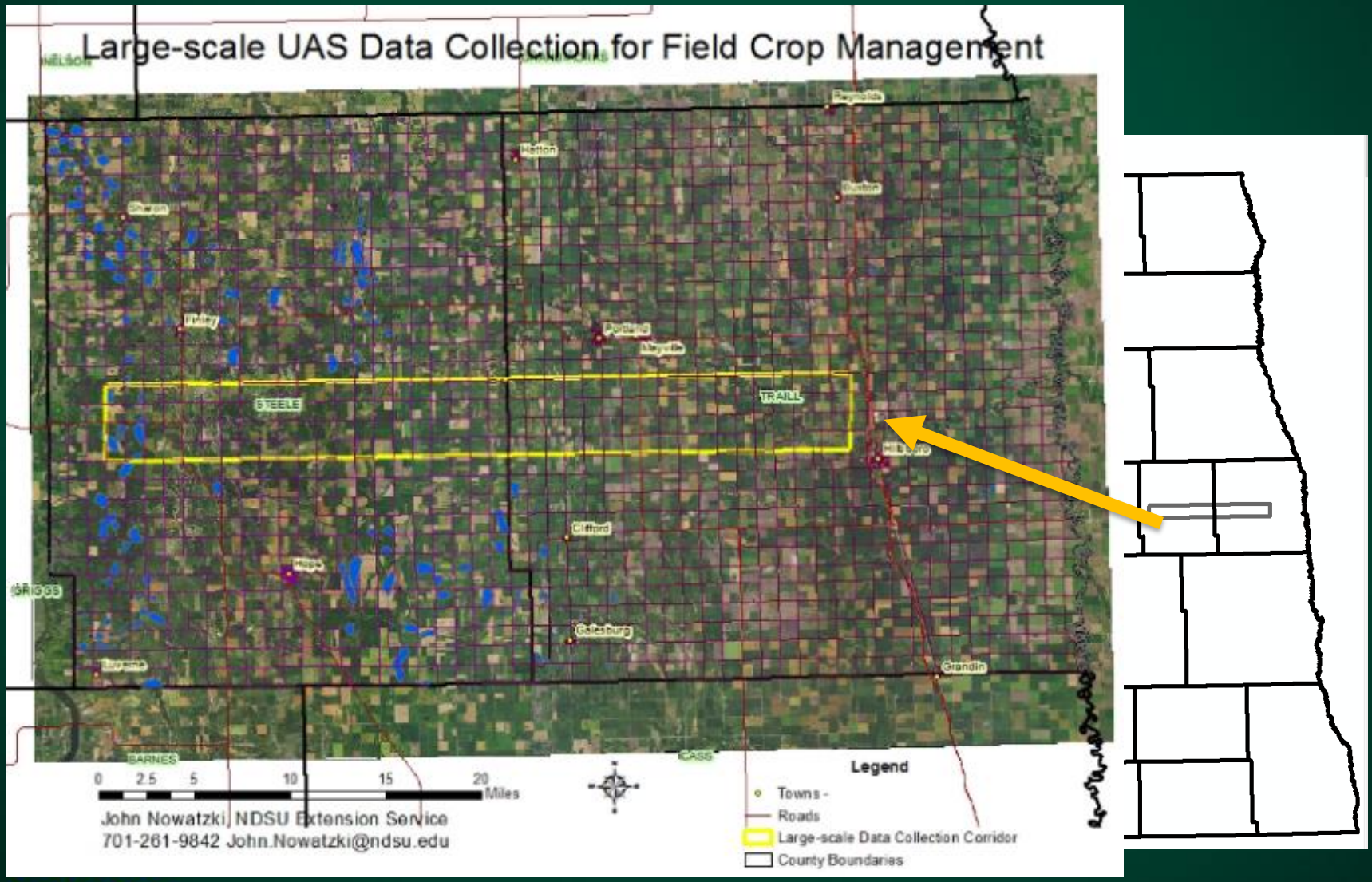
Project Location – Eastern ND



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Hermes 450 UAS

Hermes 450 UAS – Control Center

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NDSU EXTENSION SERVICE

Hermes 450 UAS – Control Center

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Flight Coordination and Preparation

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First Large UAS Civilian Flight in North Dakota

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Landing the Hermes 450

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View from CAP Chase Plane

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Data Management

Large UAS – Entire Corridor Each Date

Date	May 23-27	June 20-24	July 18-22	August 15-19
Altitude	4,000’ 6,000’ 8,000’	 6,000’ 8,000’	 6,000’ 8,000’	4,000’ 8,000’
Image Quantity	2.0 TB 1.5 TB	 1.5 TB	 1.5 TB	2.0 TB
Total Size	0.5 TB 4.0 TB	0.5 TB 2.0 TB	0.5 TB 2.0 TB	0.5 TB 2.5 TB

Total Quantity of Imagery Collected during the Project: 10.5 TB

Plus Small UAS Imagery

Plus Image Analyses

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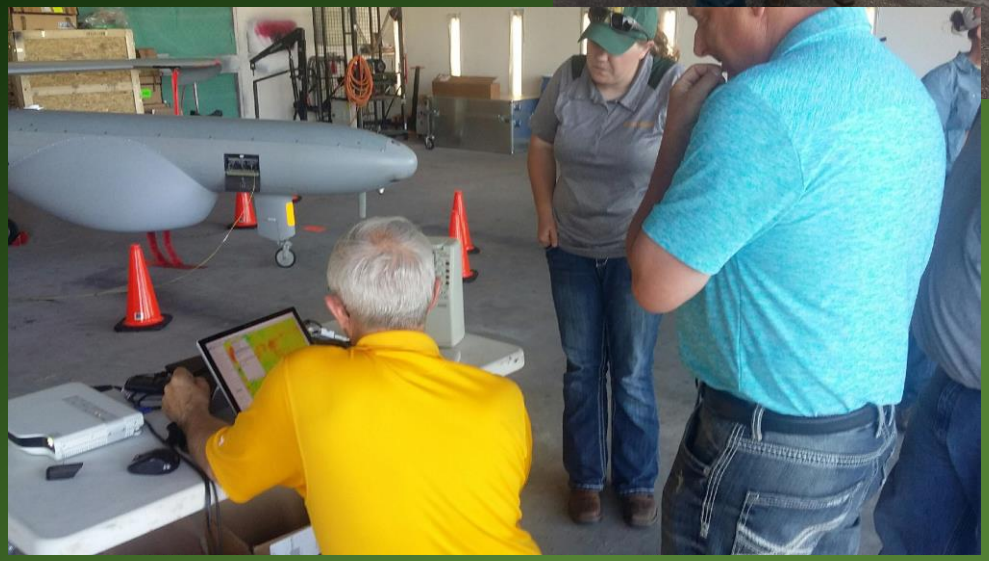
NDSU Extension Role

- Facilitate
- Collaborate
- Educate



May Imagery: 4,000’ – 6,000’ – 8,000’

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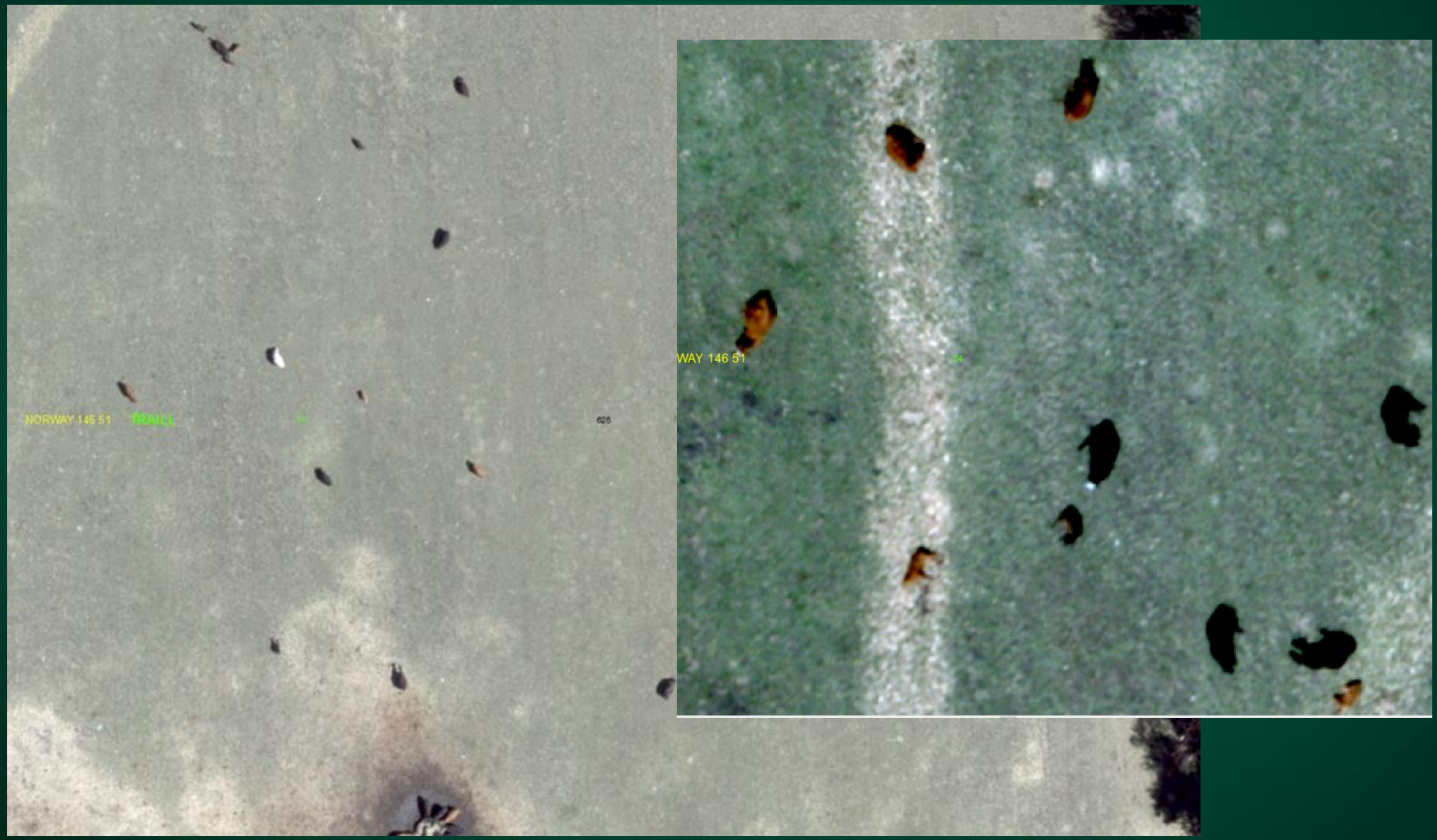
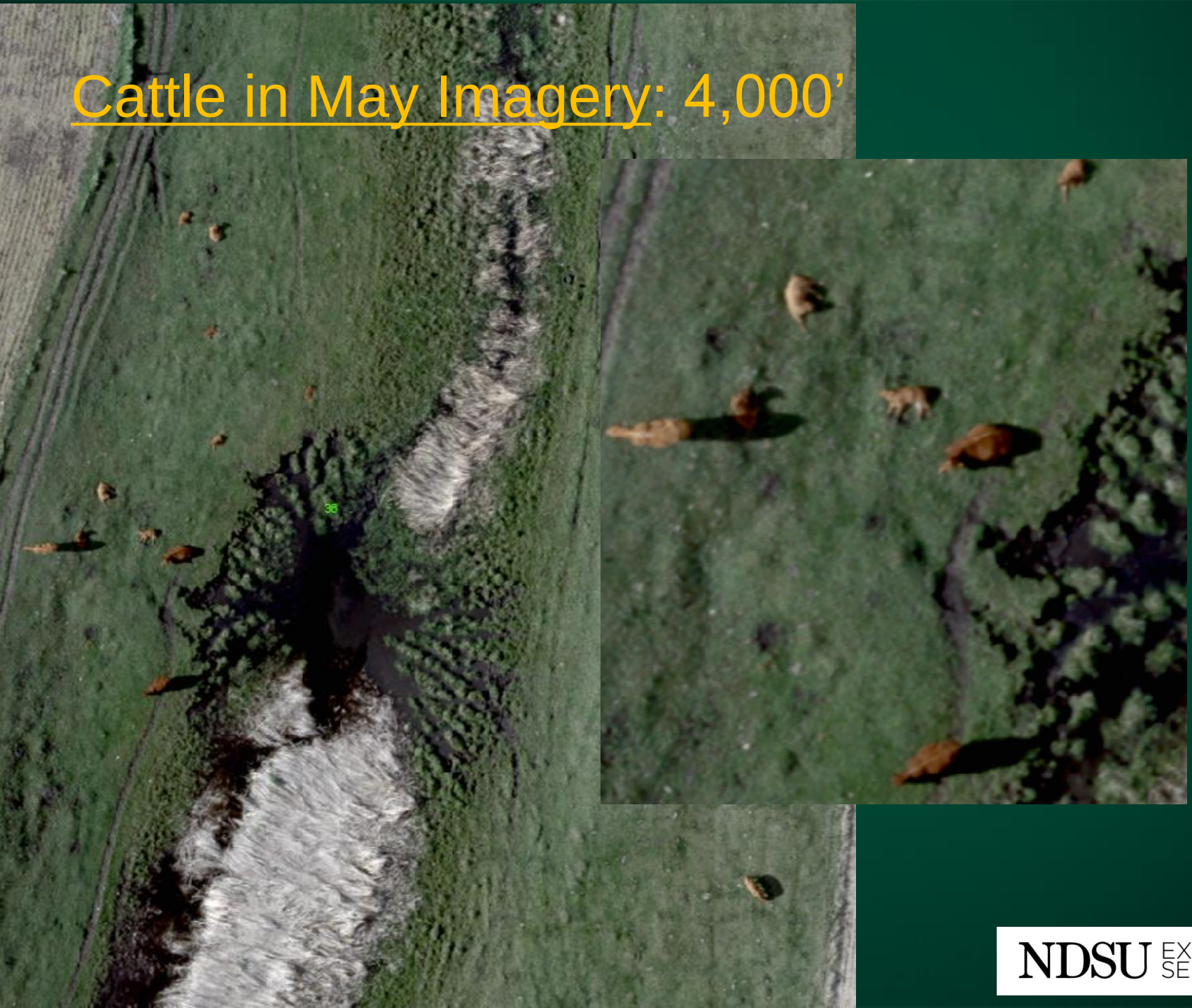
Analyses from Imagery: Cattle from 8,000’



Cattle in May Imagery: 4,000’



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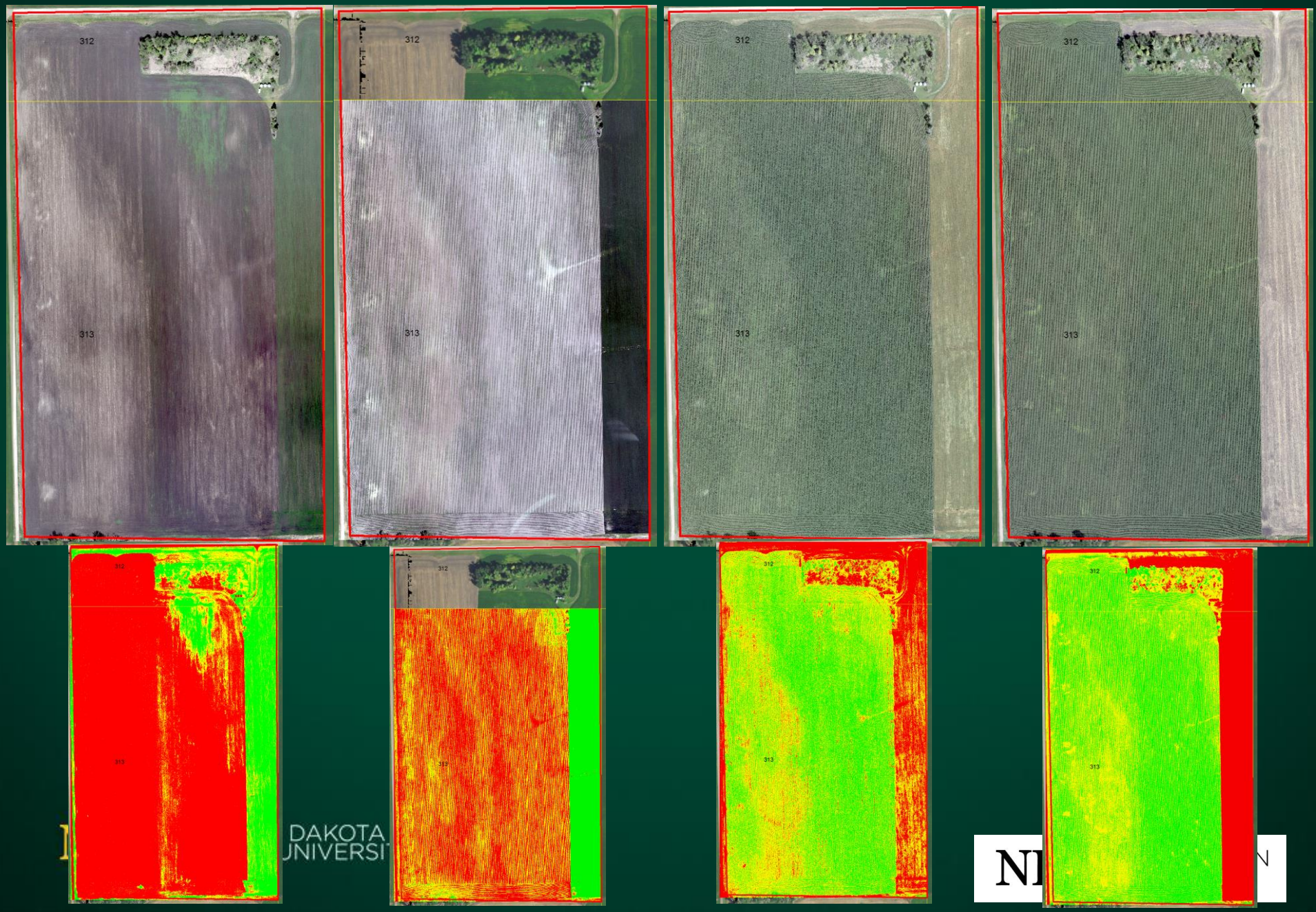
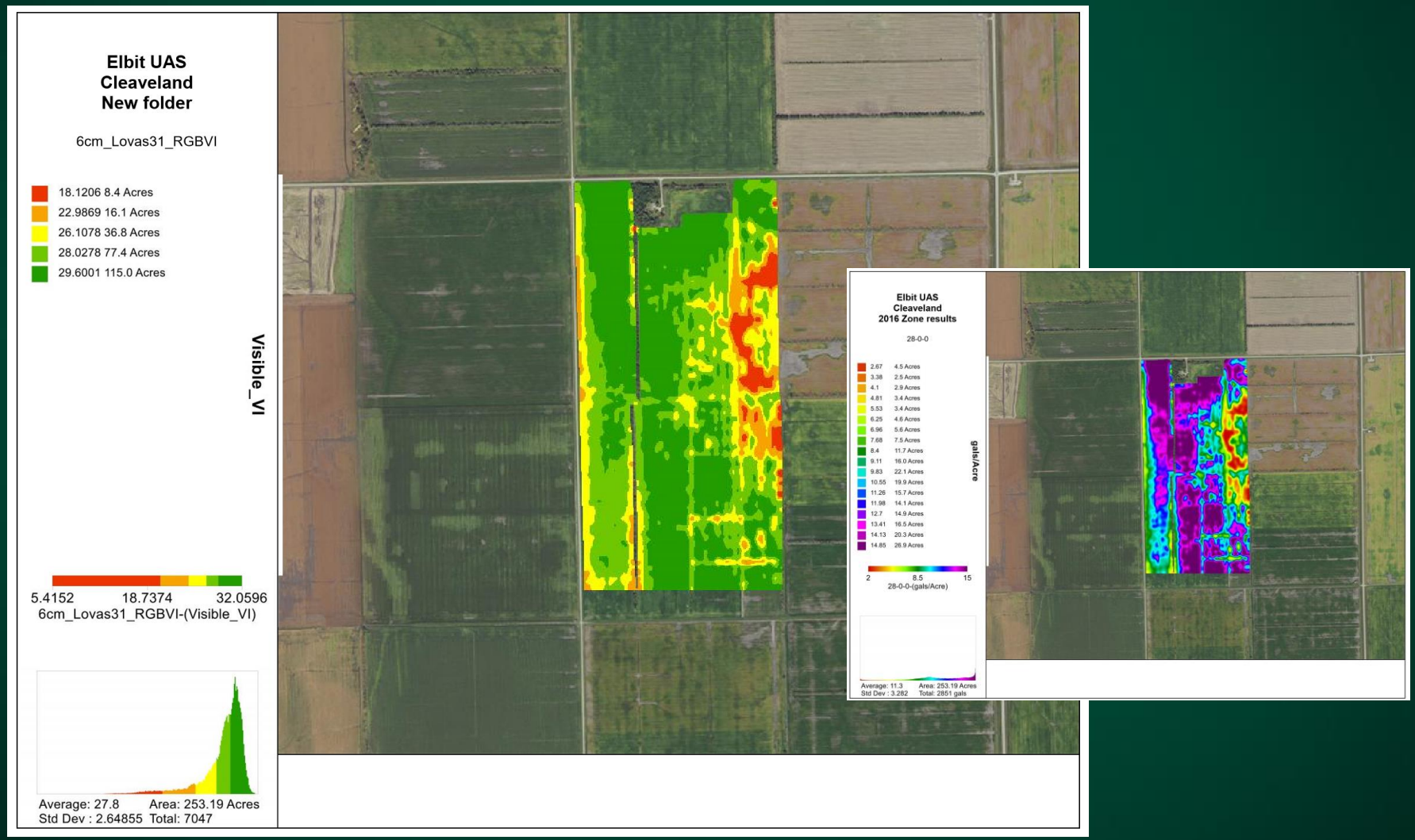
Corn Imagery: May – June – July - August



Analyses from Imagery: Zone Map



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~ 40 Acres

Imagery 4,000’

RGB Image

4 cm Pixel Size

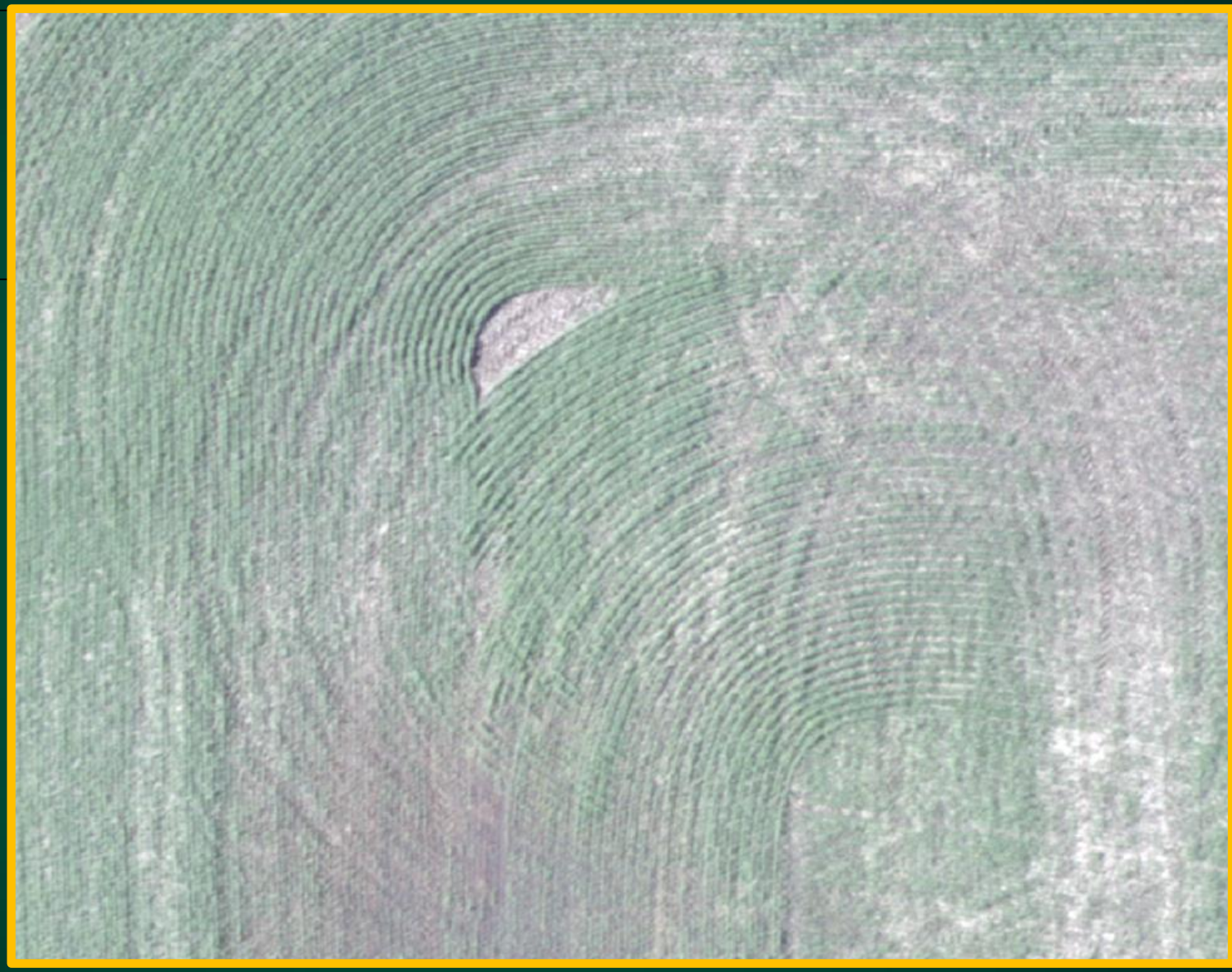
NDSU EXTENSION SERVICE

~ 200’x200’

Imagery 4,000’

RGB Image

4 cm Pixel Size



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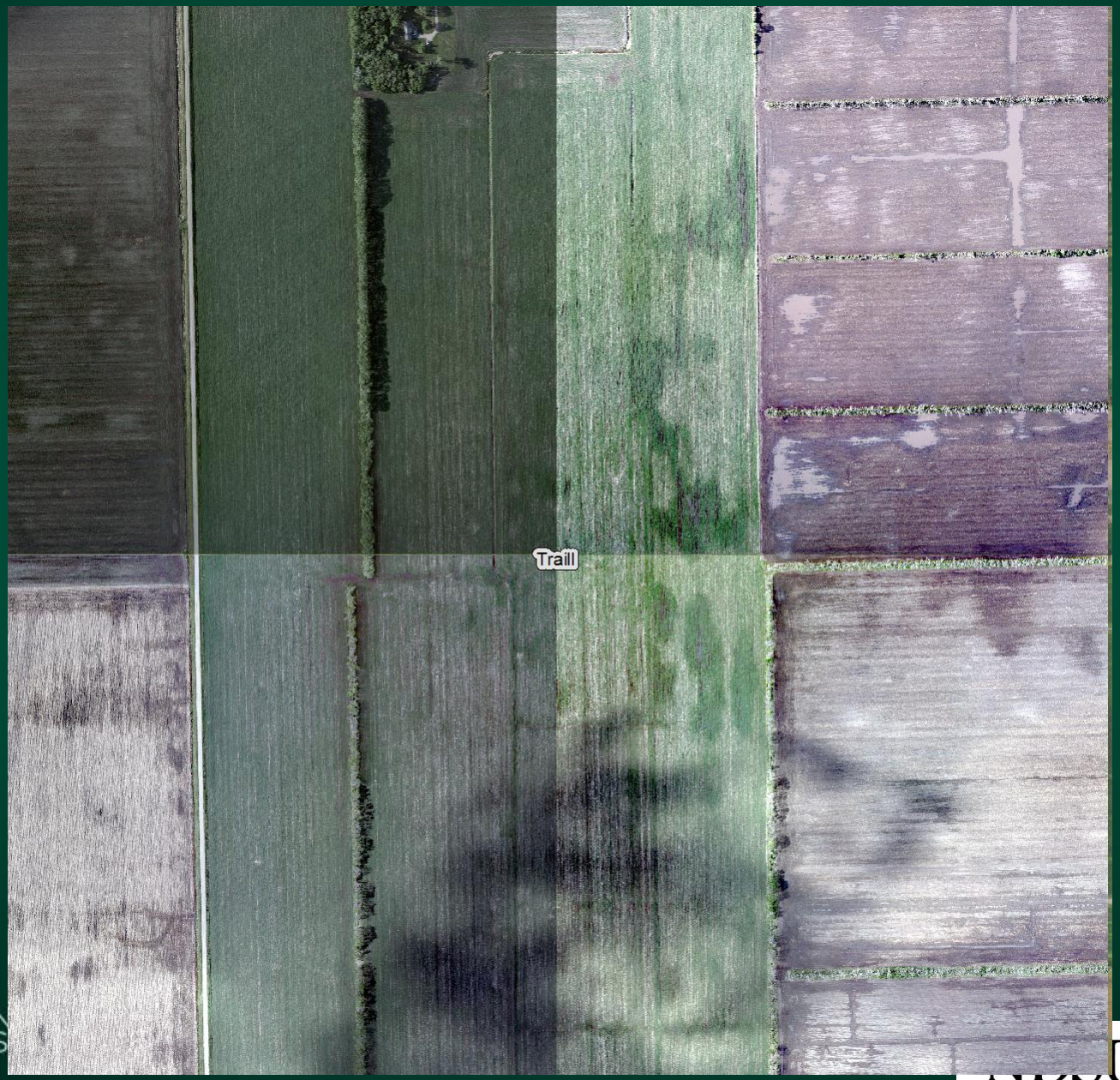
Imagery Issues: Time Between Images

Imagery Issues: Time Between Images

Color Image



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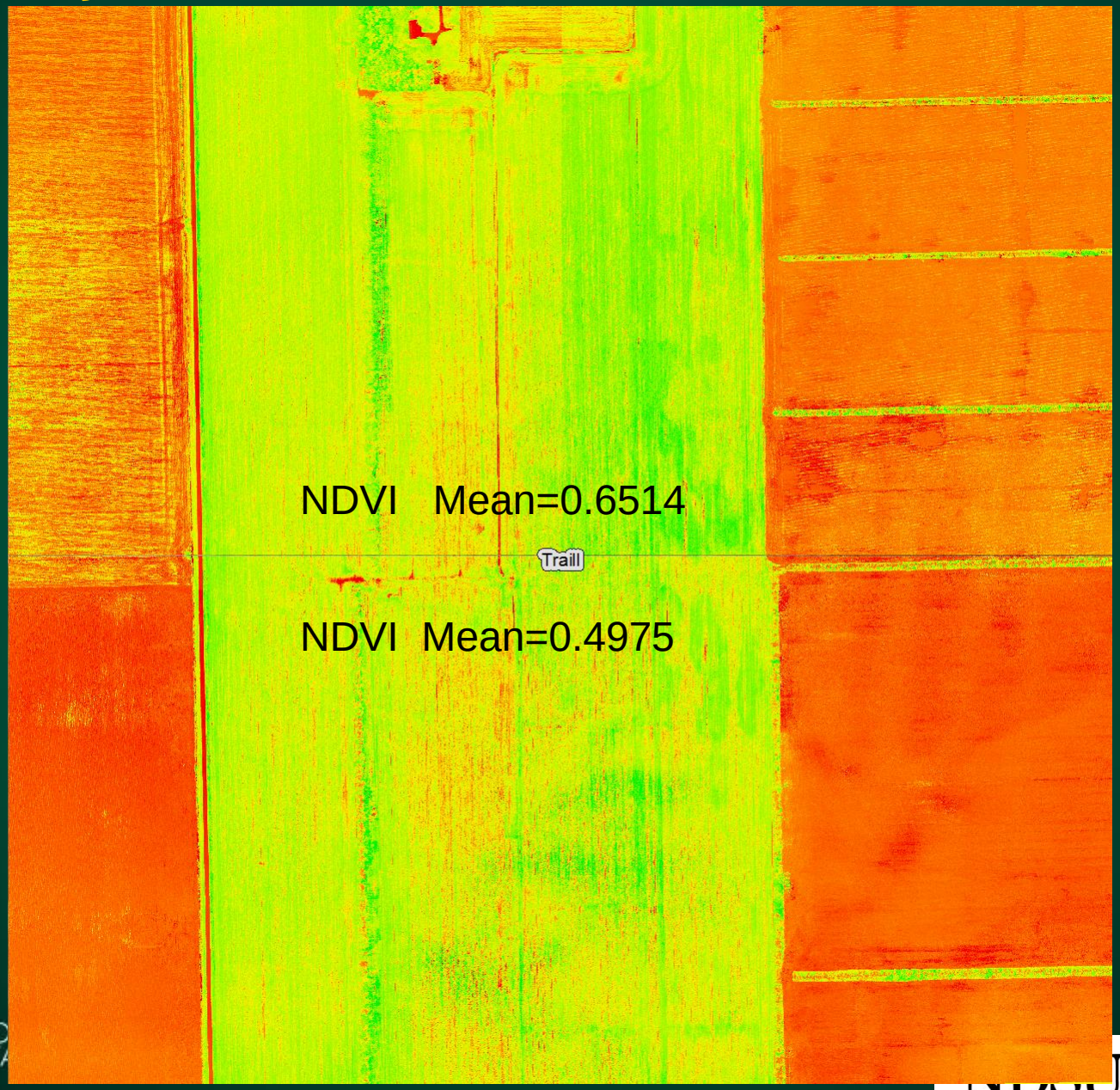
Imagery Issues: Time Between Images

NDVI Image



Sensors

Ag Leader OptRx

Available Crop Sensors

- OptRx – Ag Leader
- CropSpec – Topcon
- GreenSeeker – Trimble
- Crop Circle – Holland Scientific

FIELDSCOUT® GreenIndex+ App

$100

iPad – iPhone app Android coming soon!

Spectrum Technologies, Inc.

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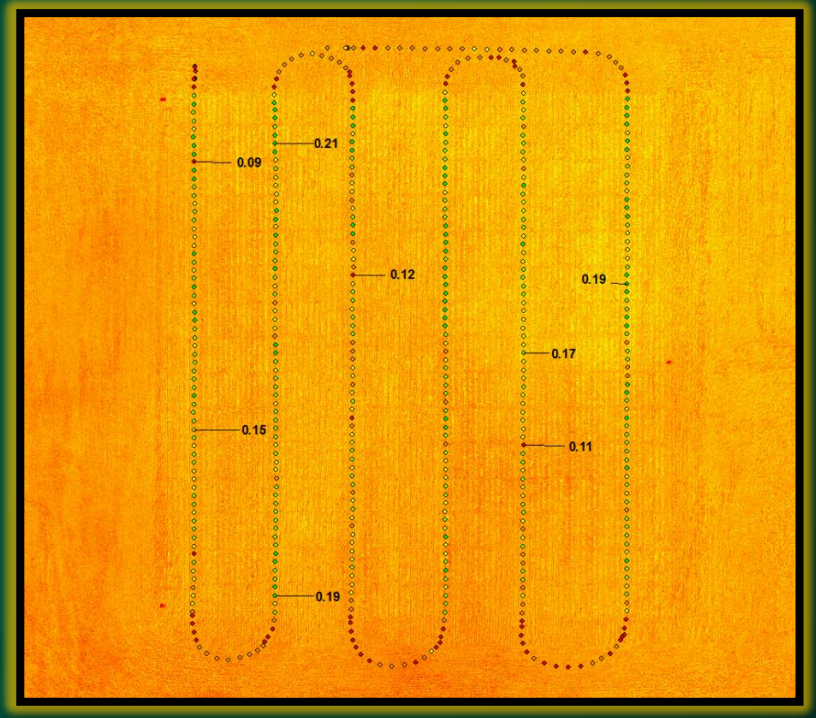
Collecting NDVI with Ground Sensors



Collecting In-field OptRx Sensor Data.

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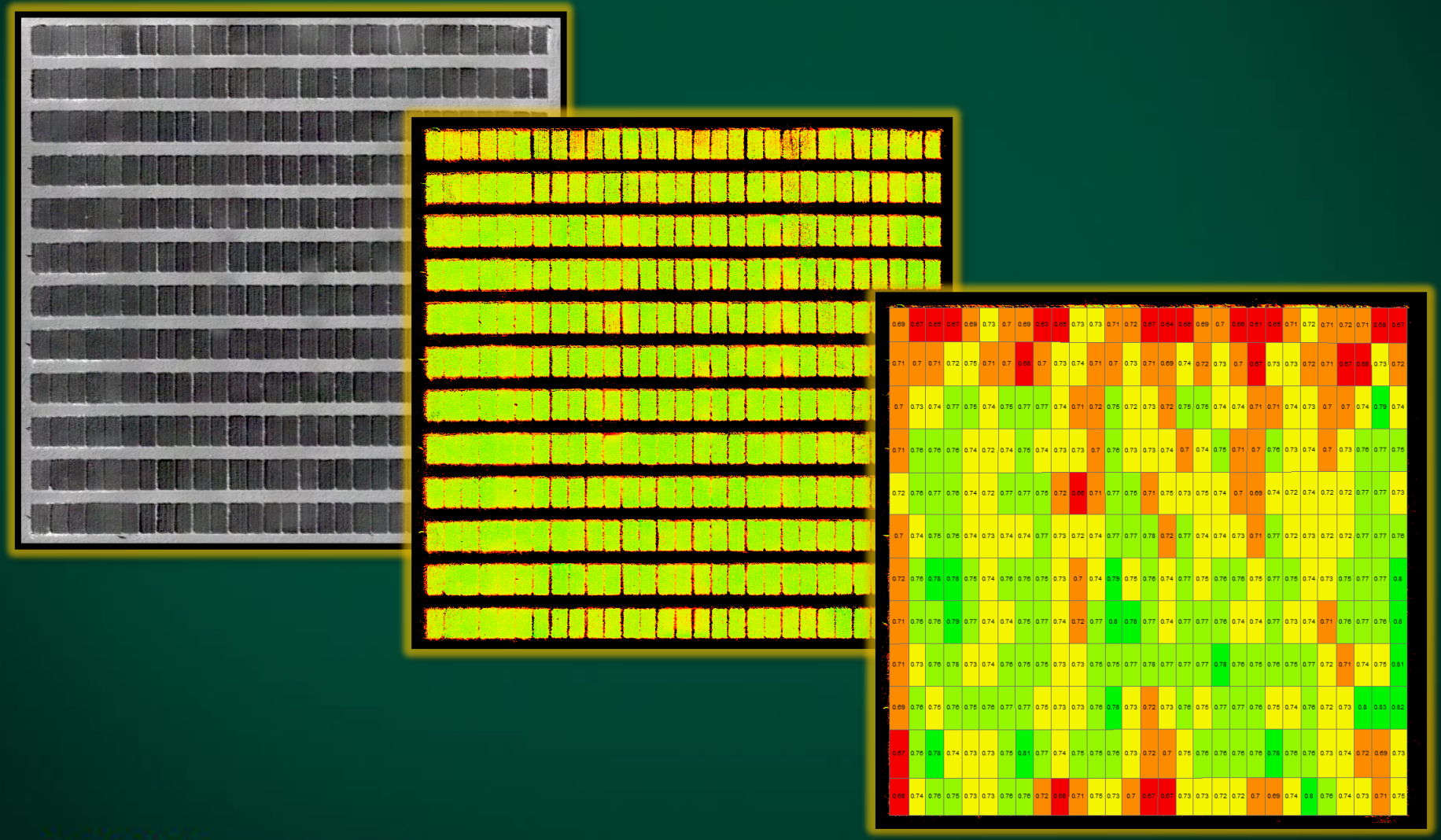
NDSU Soybean Plots



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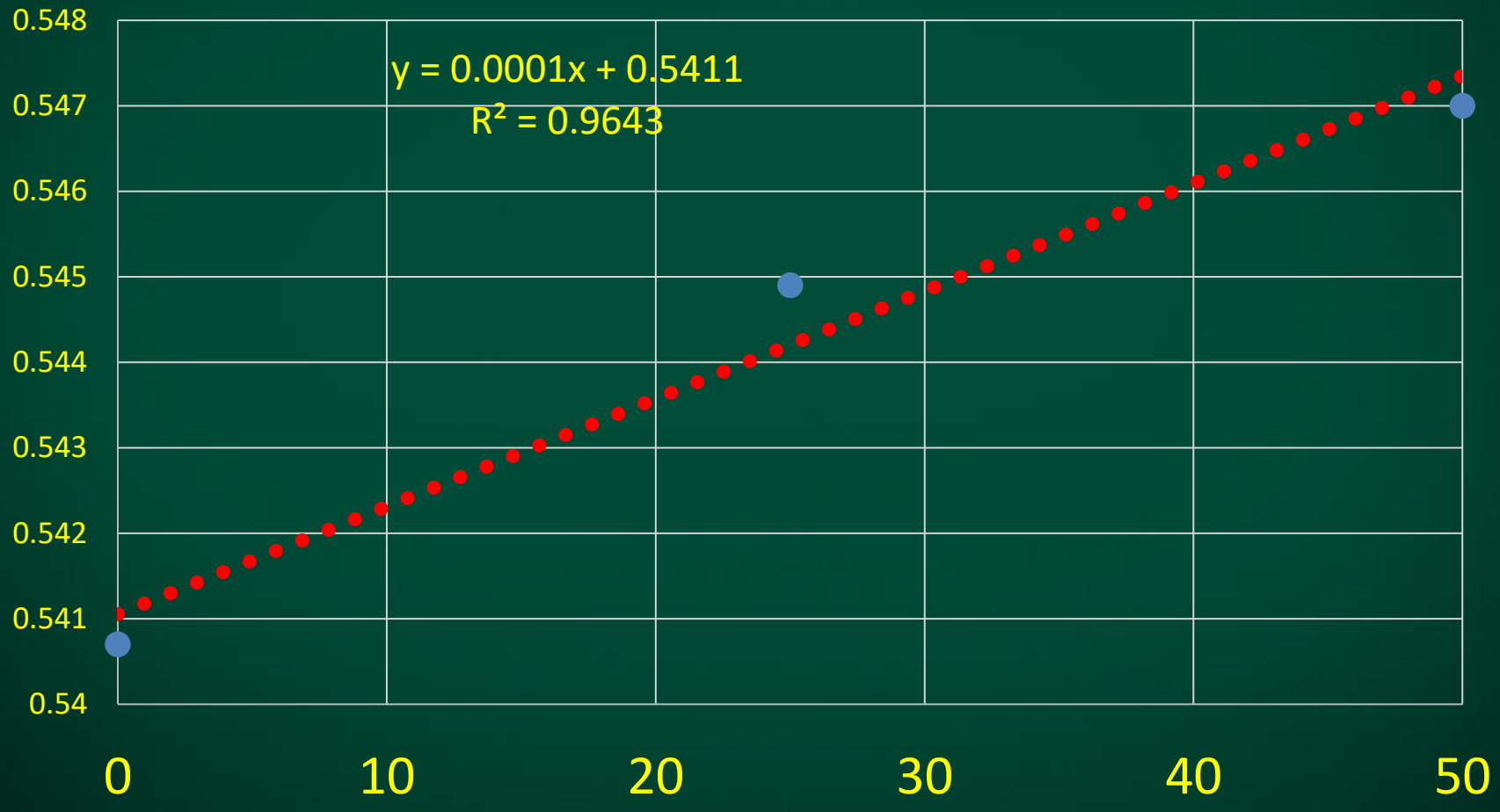
Variety 1: lb N and Aug NDVI
NDSU Steele County Plots



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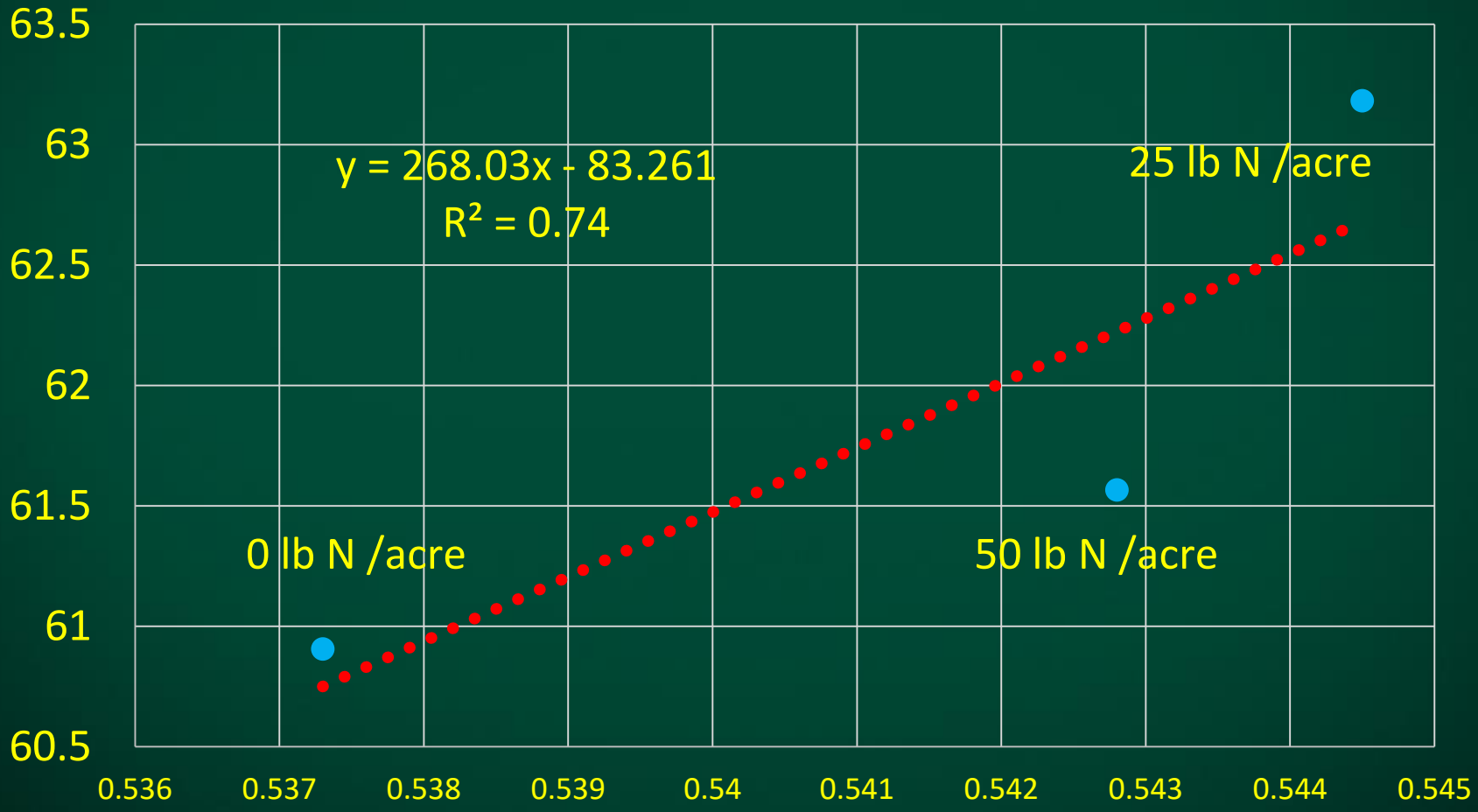
August NDVI and Yield for 0, 25, 50 lb N NDSU Steele County Plots



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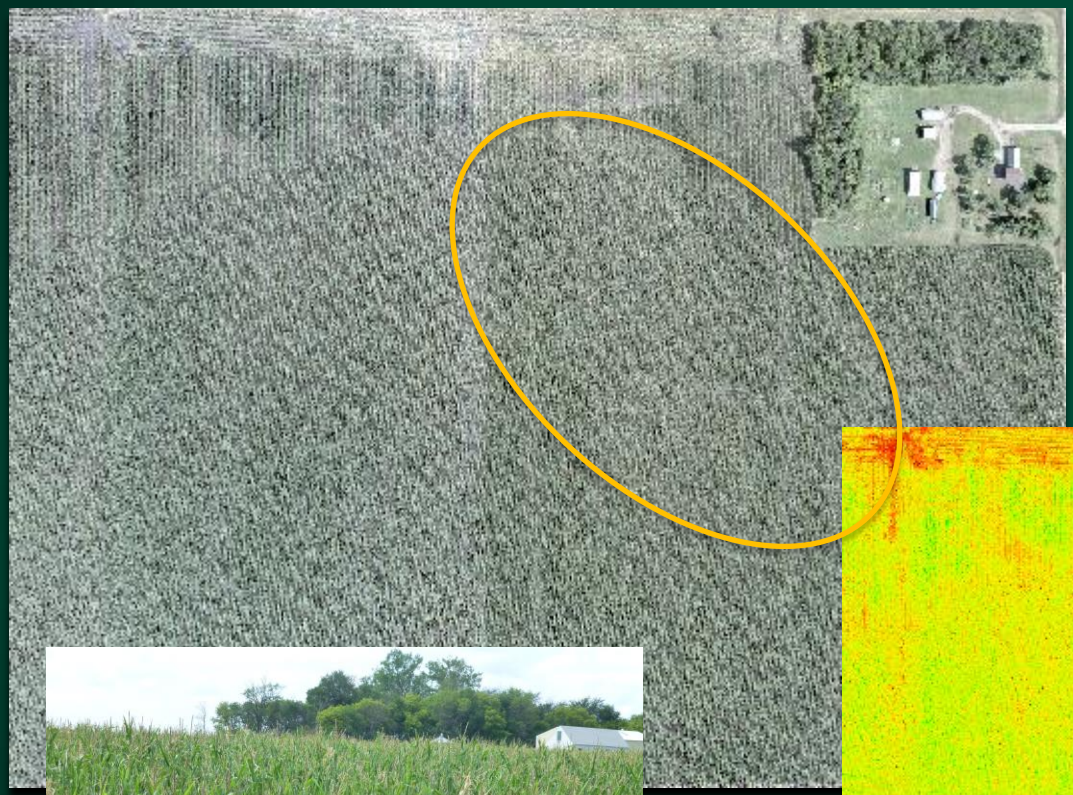
Hail Damage: Corn from 4,000’



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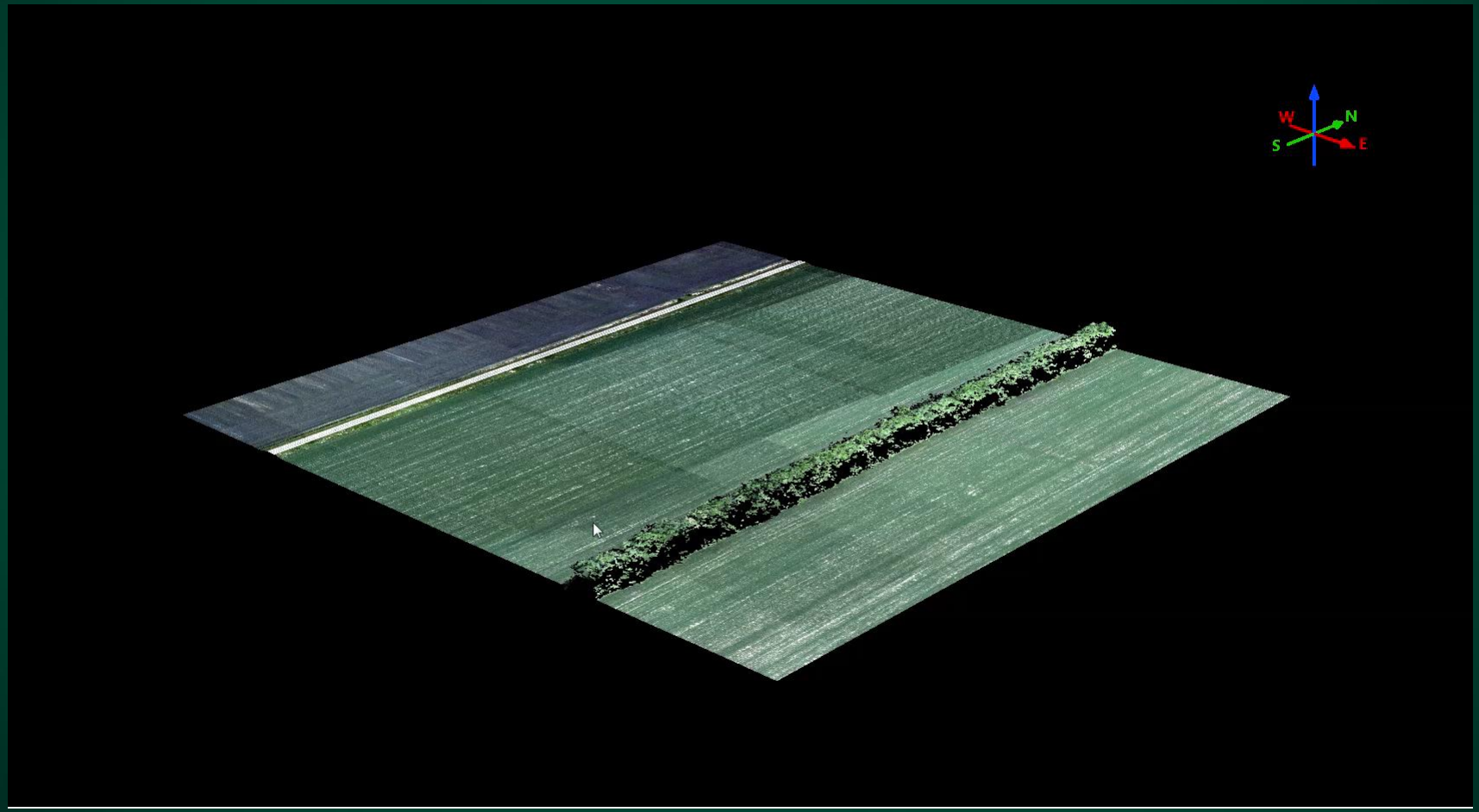
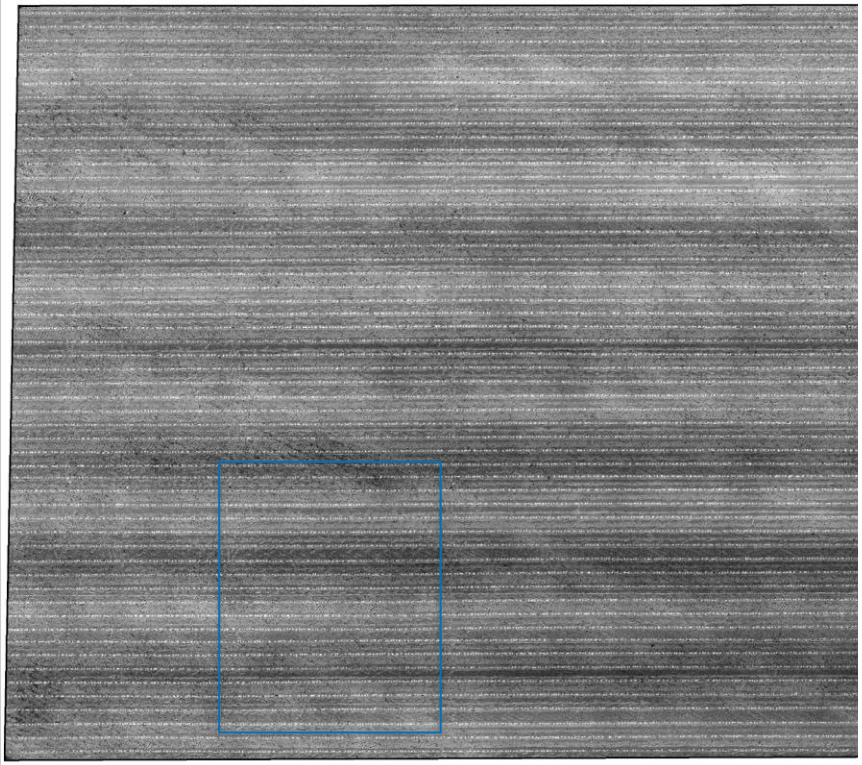
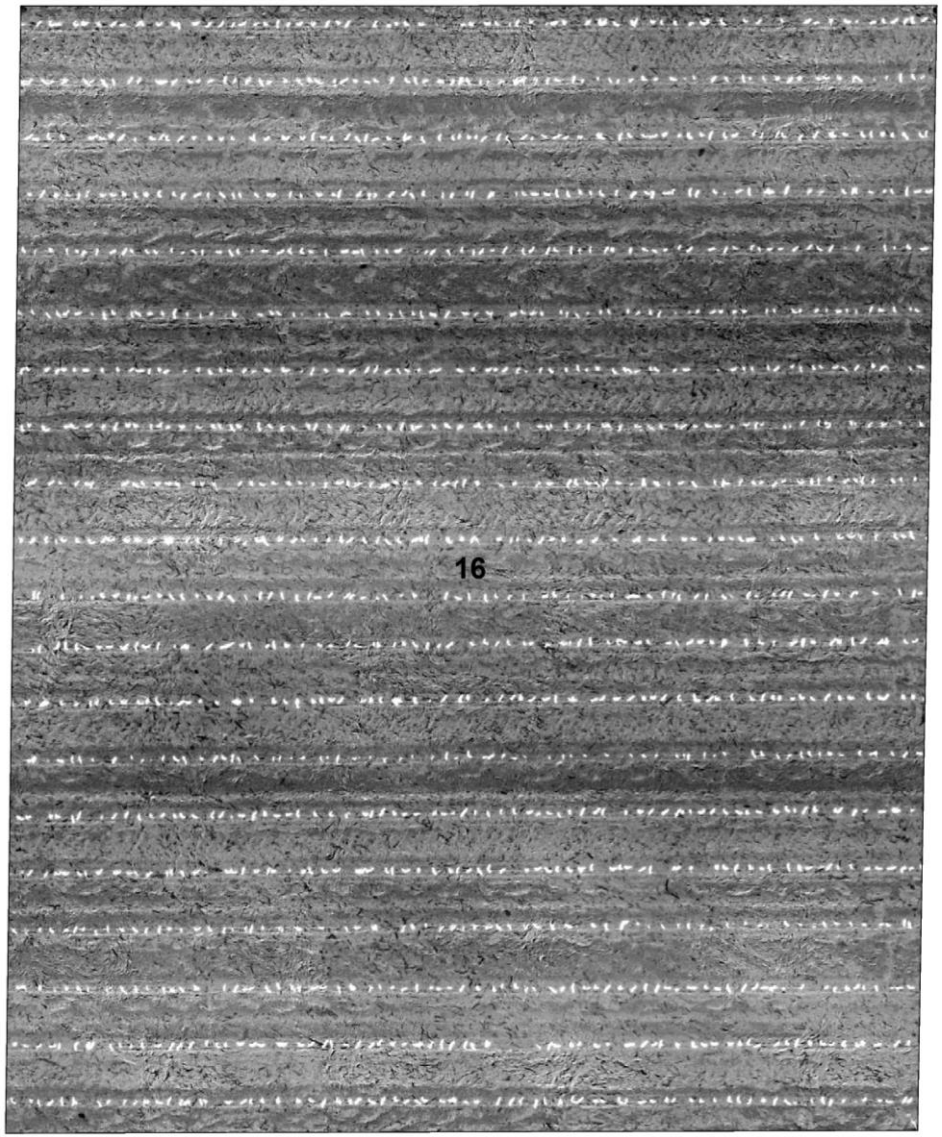
Digital Elevation Model Using Large UAV

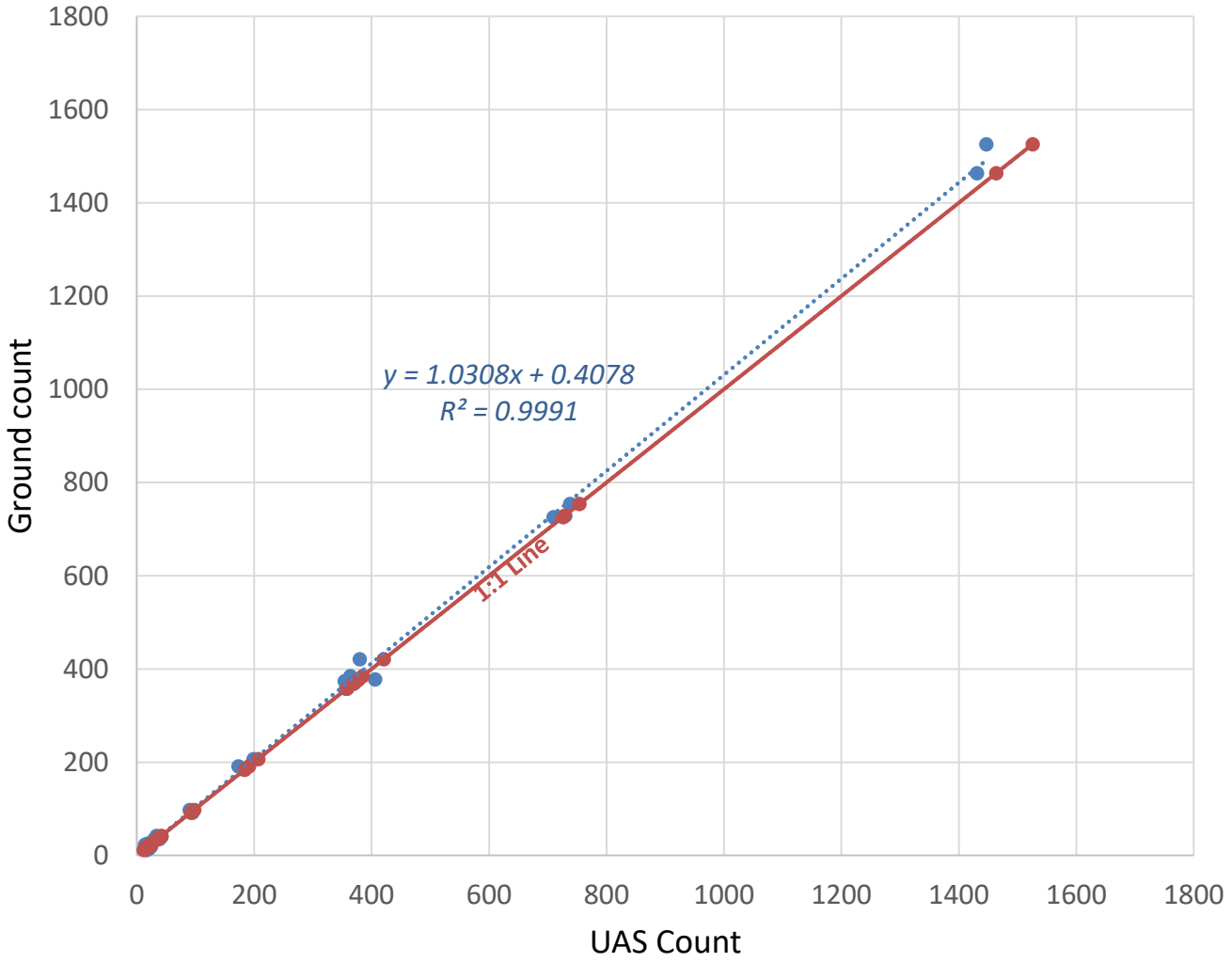


Corn Field – May 23, 2016
Flight Altitude: 50ft
NDVI Mosaic

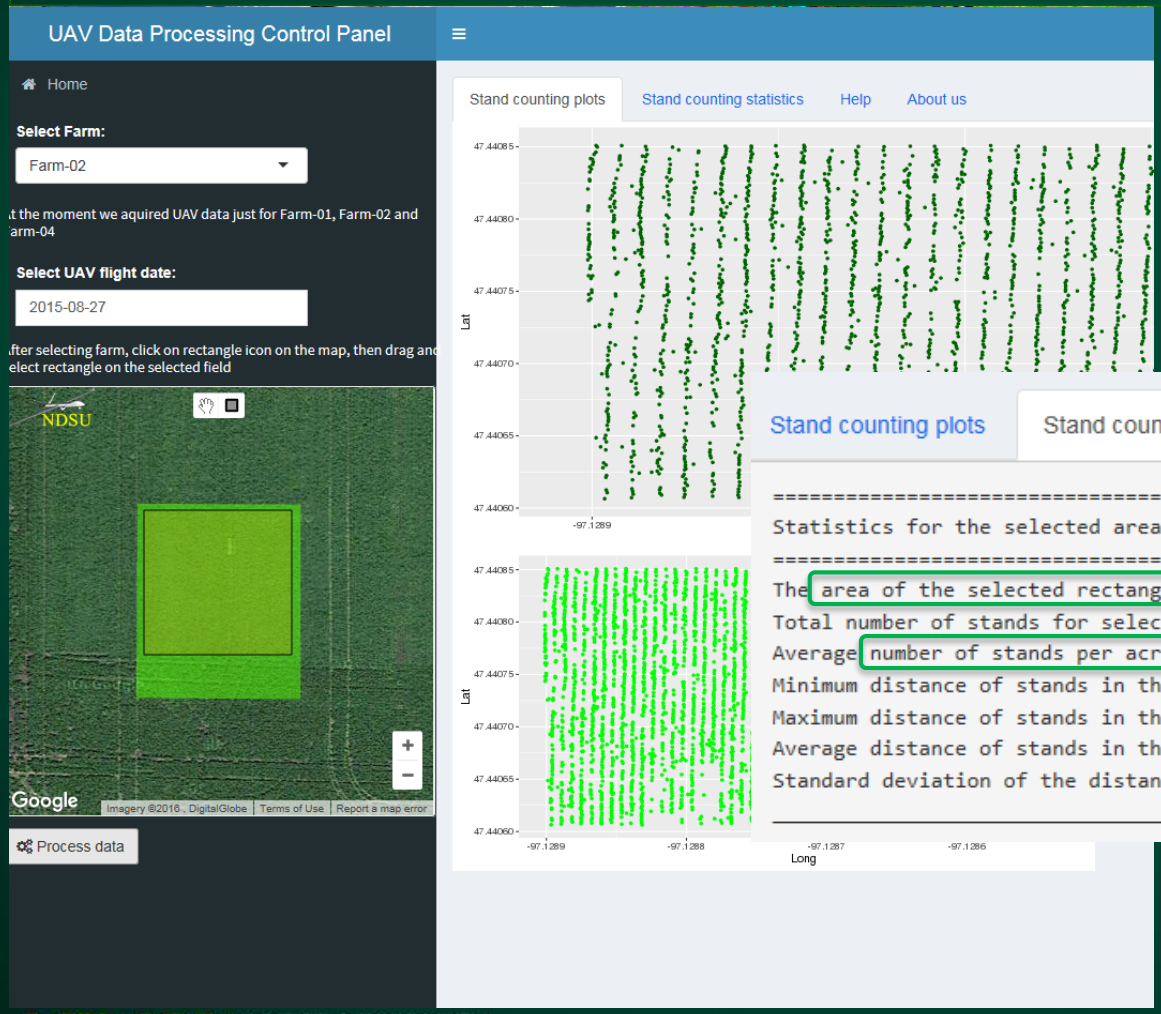


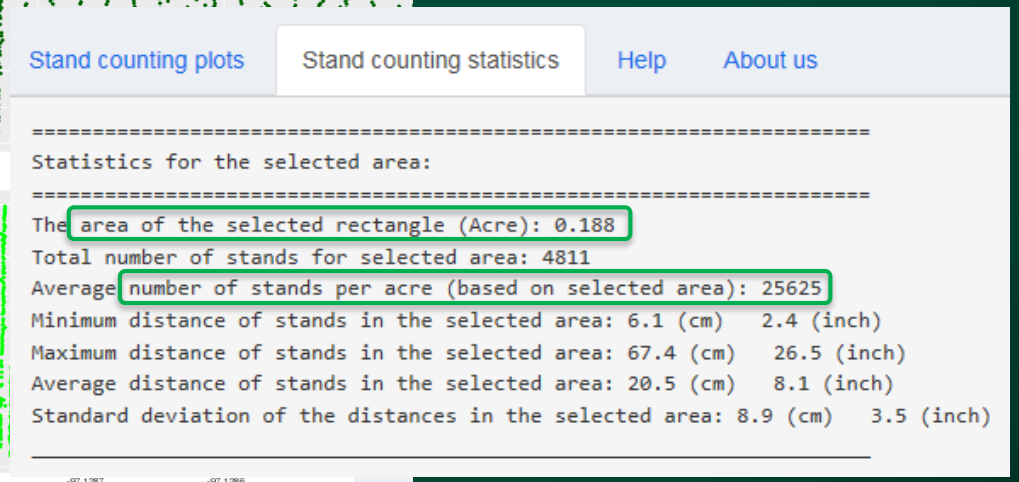


Corn plants detection and counting – ground truth



Web Application for Stand Count Analyses from UAS Imagery





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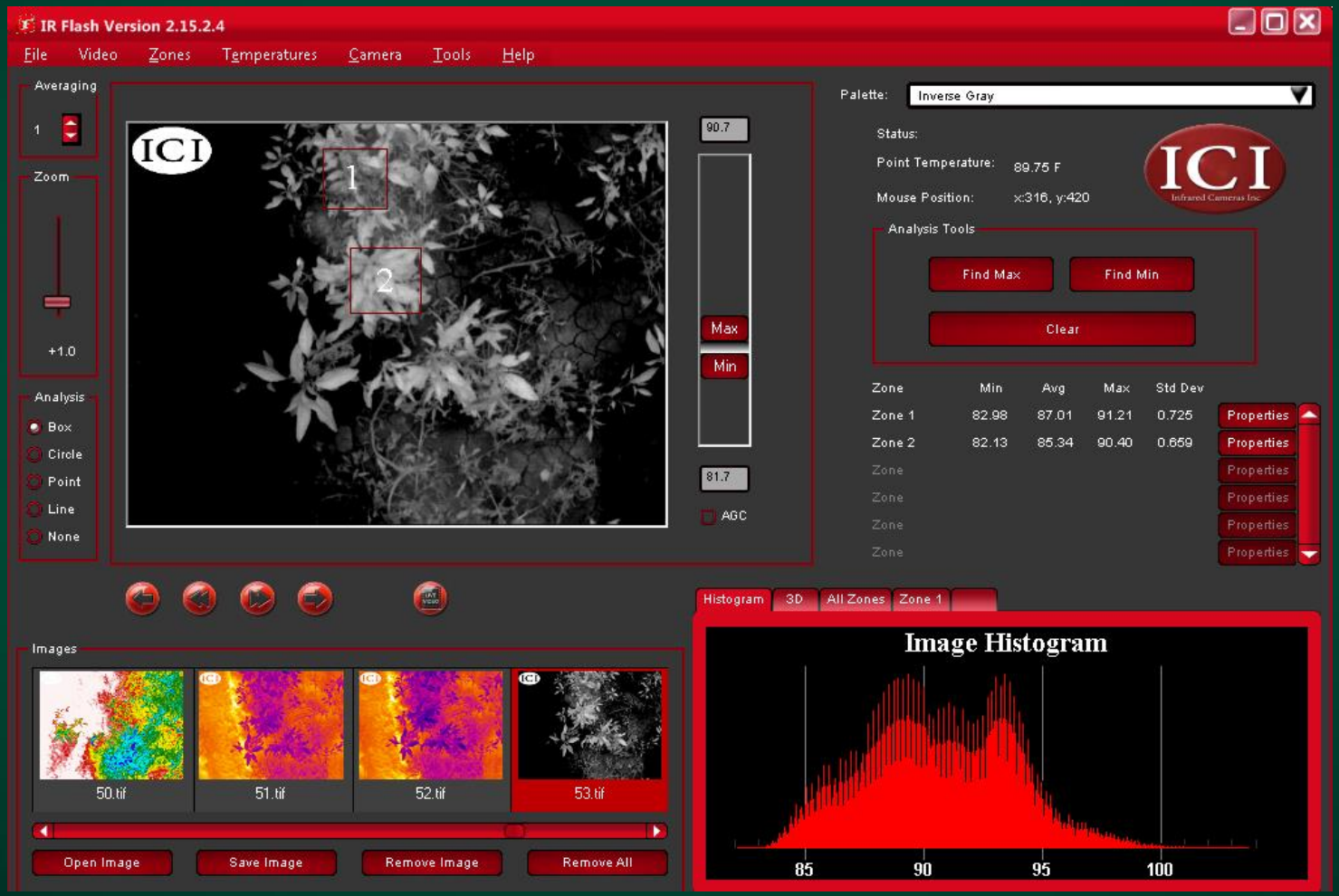
Identifying Herbicide-resistant Weeds



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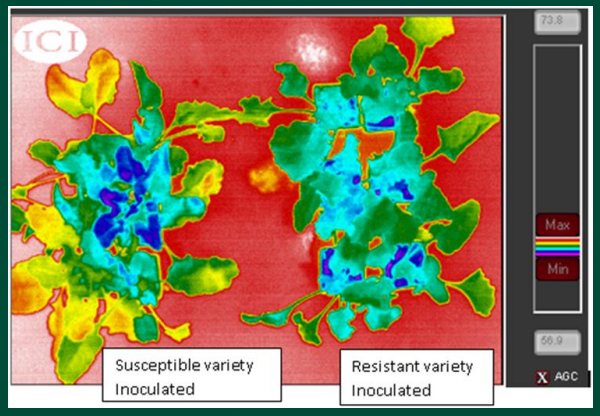
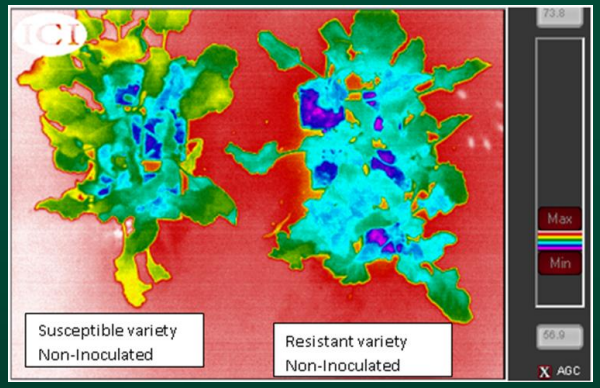
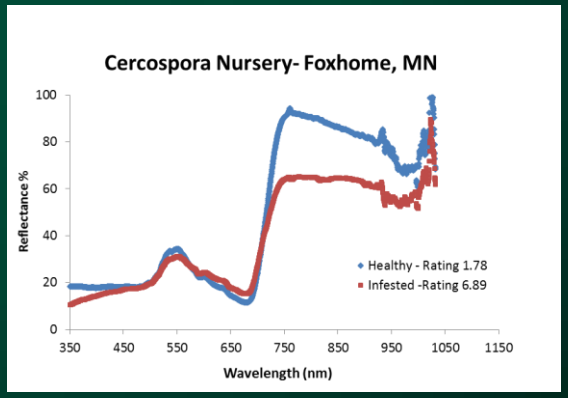
Sugarbeet Disease Detection with UAS

***Rhizoctonia solani* infestation**





Cercospora infestation



What Has Gone Well

- Collaboration: NDSU – NP UAS Test Site – Elbit - CAP
- FAA and FCC
- NDSU County Extension Service
- Hillsboro Airport Authority
- Image Quality
- Objectives:
  - Imagery from 4,000’ – 6,000’ – 8,000’
  - Transfer and Storage of Imagery at NDSU
  - Analyses
    - Nitrogen Management
    - Stand Count
    - Disease Identification
    - Hail Damage
    - Elevation Model

Future of UAS in Agriculture

Small UAS

- Plant Stand Count
- Monitoring and Scouting
- In-season Fertility

Yamaha RMAX
8 liters x 2 tanks

Large and Small UAS

- Digital Elevation Model
- In-season Fertility
- Yield Predictions
- Insect and Disease Movements
- Identification of Management Issues

AeroDrone

One More Layer for Big Data Precision Agriculture

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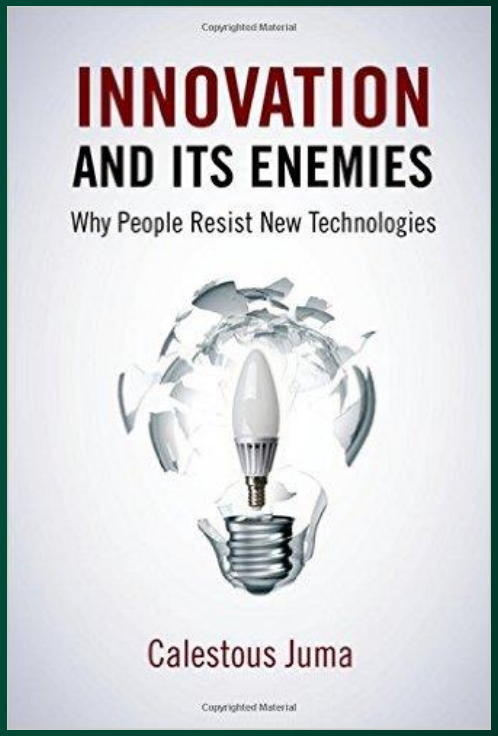
Book for Technology Early Adopters

"Innovation and It's Enemies. Why People Resist New Technologies"

Calestous Juma



- Moral Values
- Human Health
- Environmental Safety
- Socioeconomic

Coffee
Printing Press
Margarine
Farm Mechanization
Electricity
Refrigeration
Recorded Music
Transgenic Cops
Transgenic Animals

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Questions - Comments

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