

# DRONES IN MODERN AGRICULTURE

## Drones vs Satellite

**Greg Adelman PAg**

*Area Manager SK and AB, RoboFlight Systems, LLC*



*@AdelmanGreg*





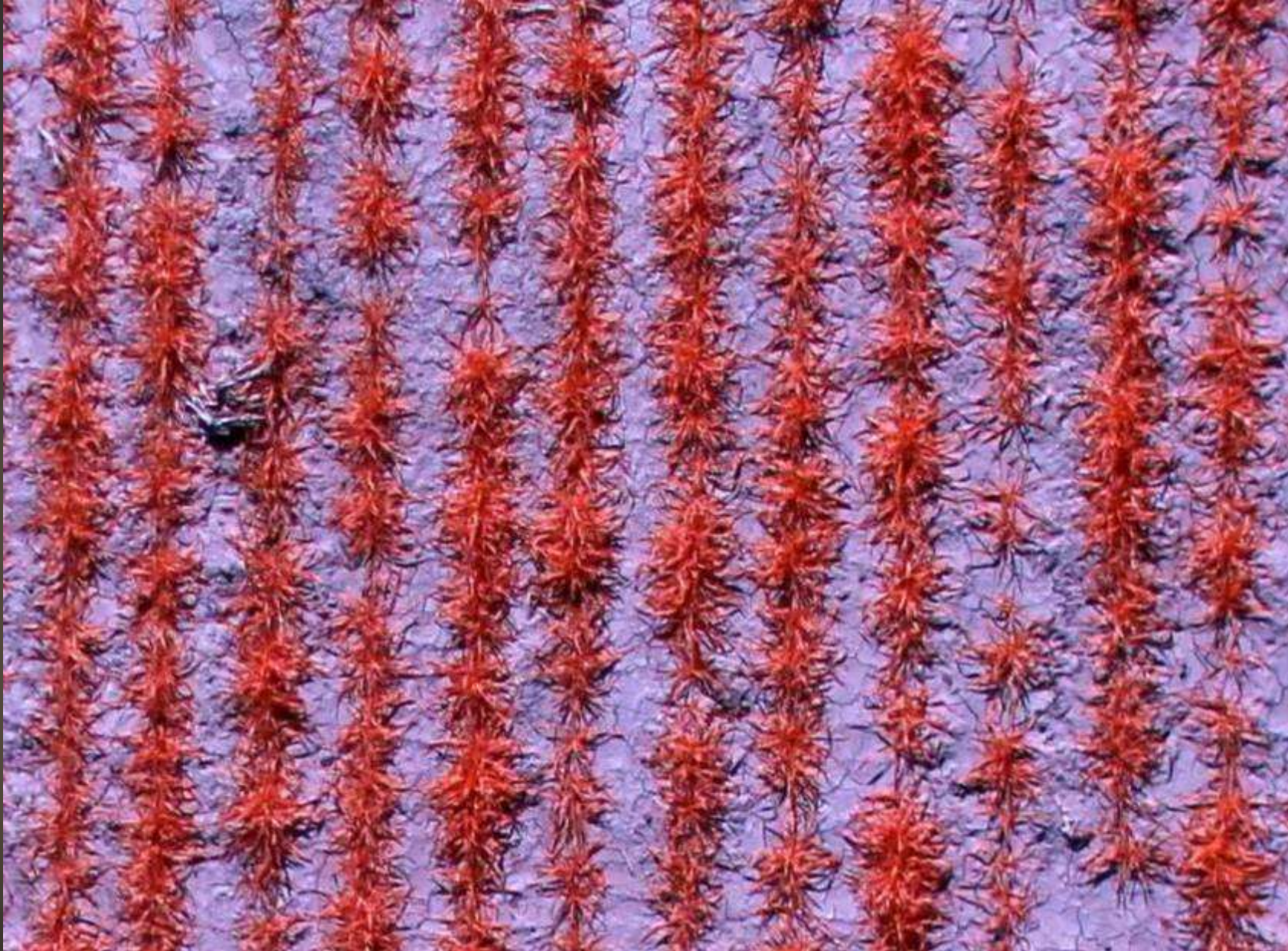
WHAT CAN YOU SEE IN THE  
IMAGES?

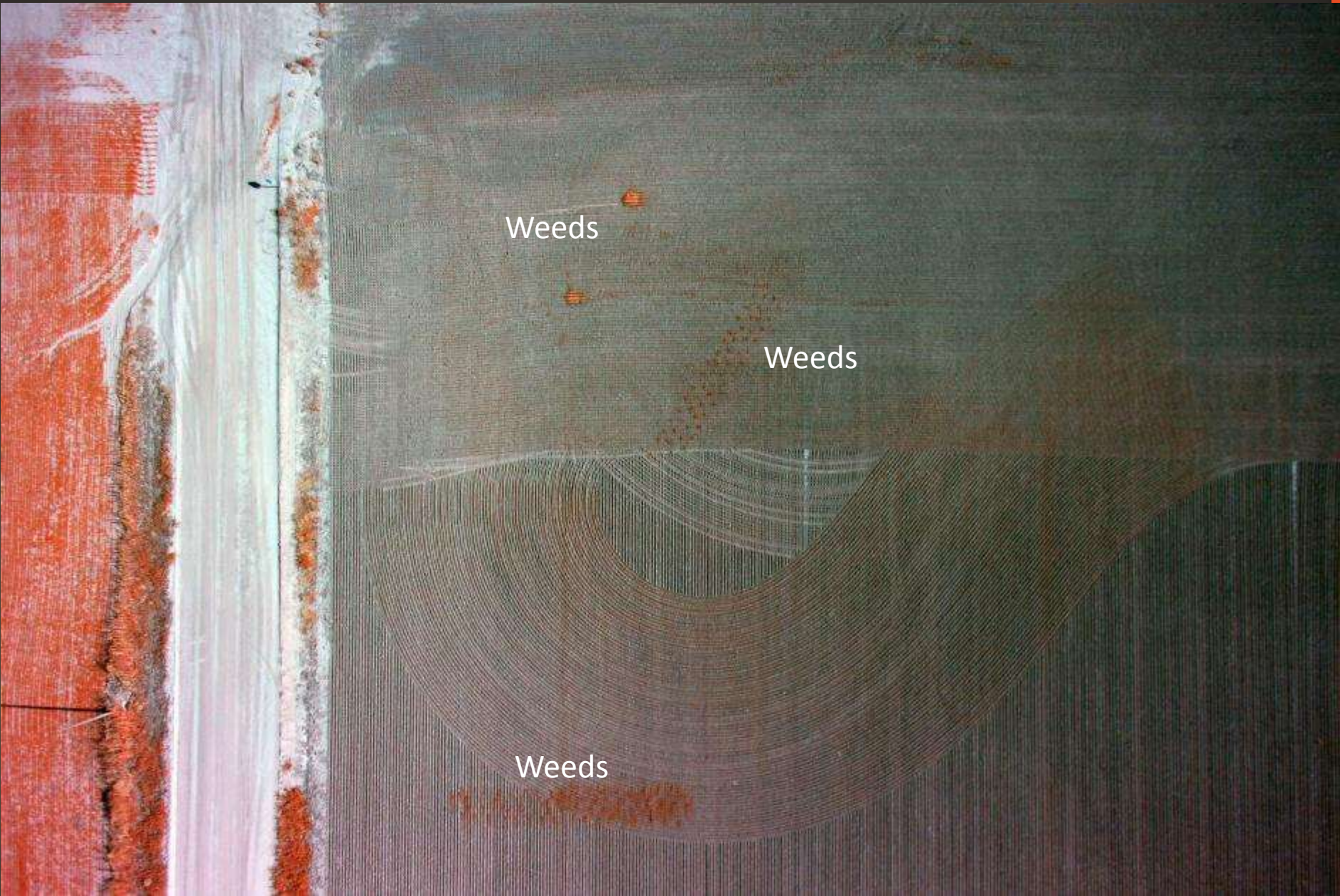


What level of detail do you need?



Or do you need this level of detail?





Weeds

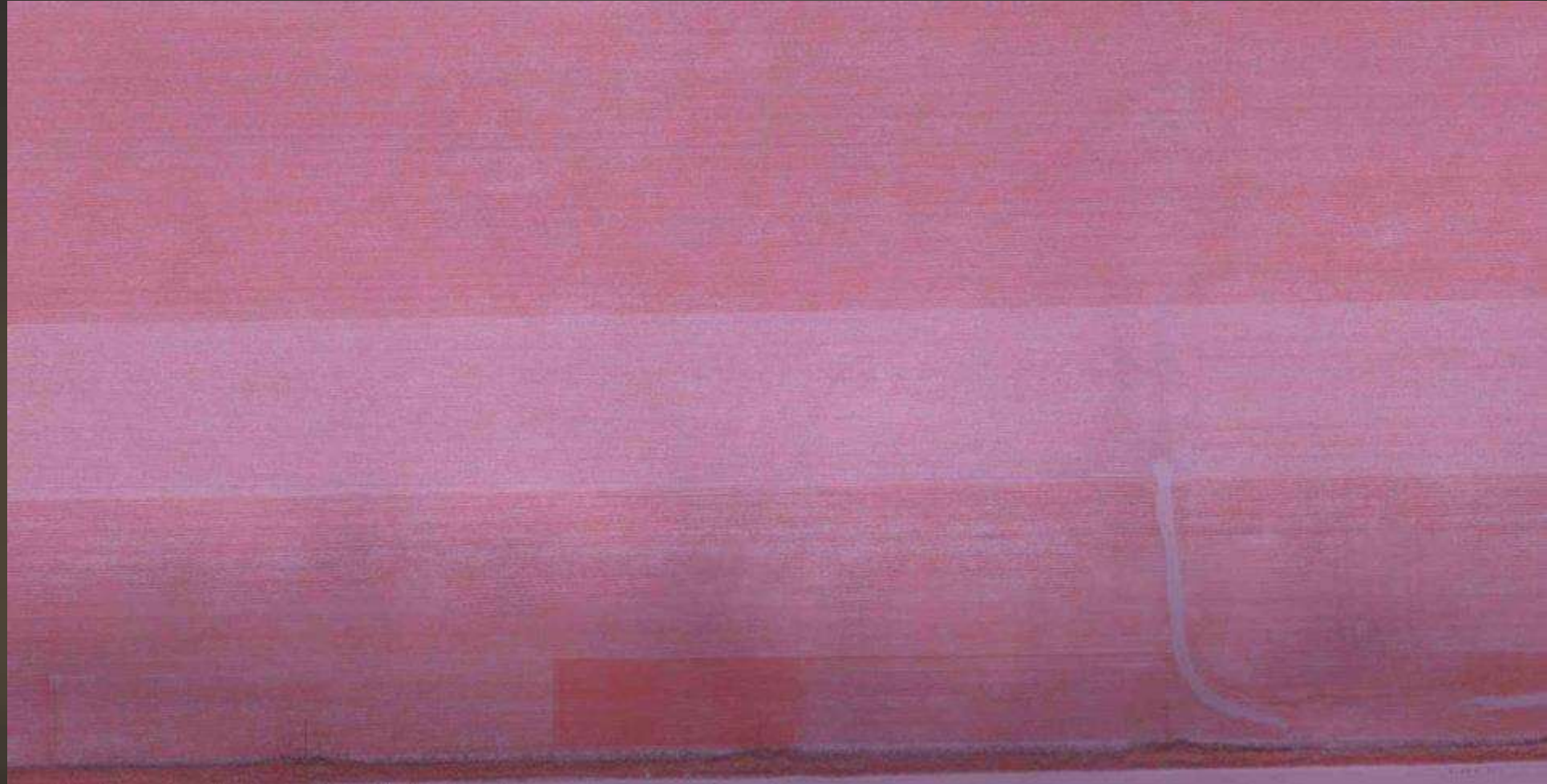
Weeds

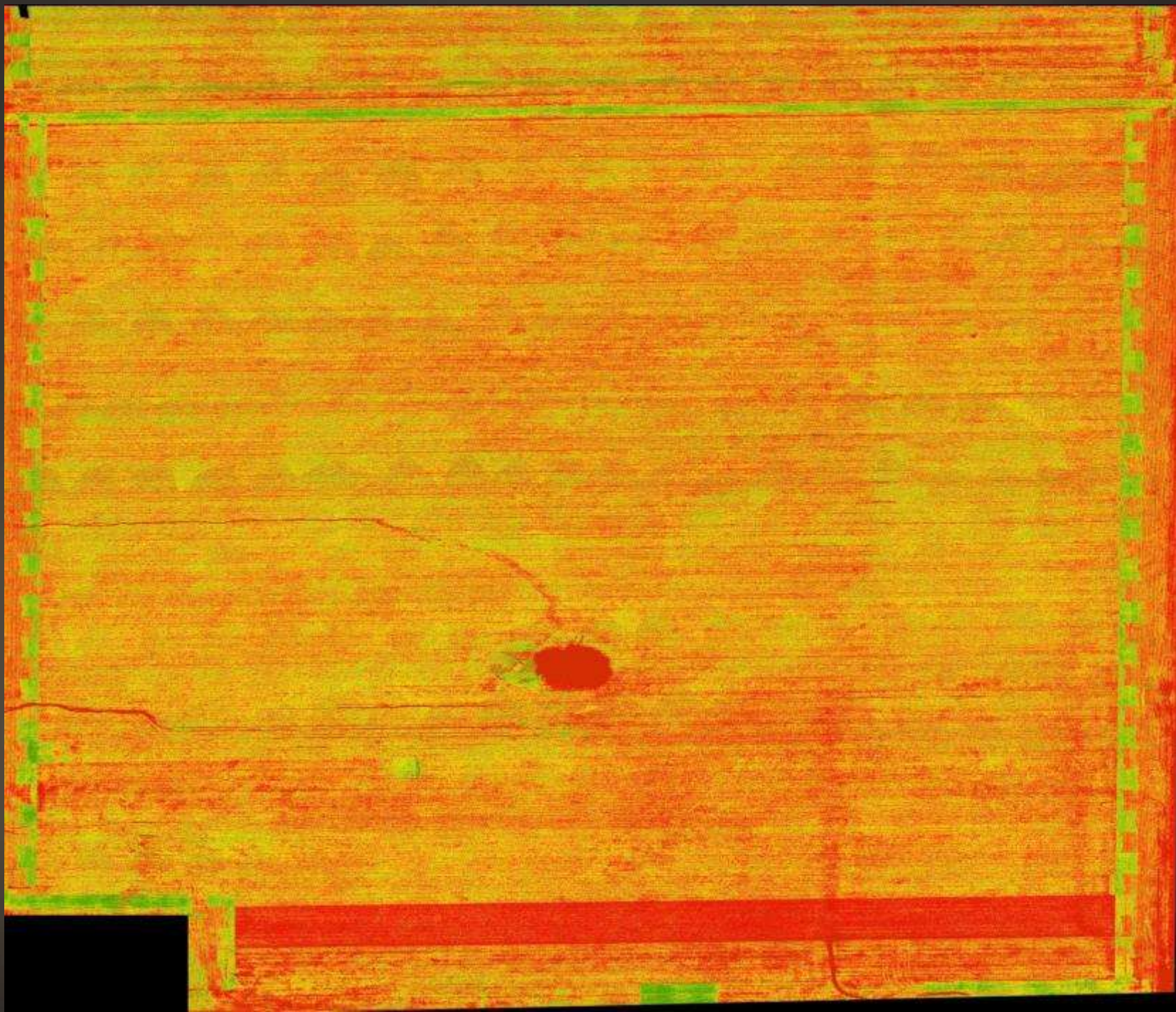
Weeds



Weeds Everywhere

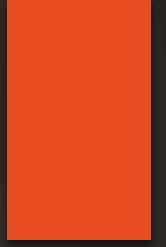
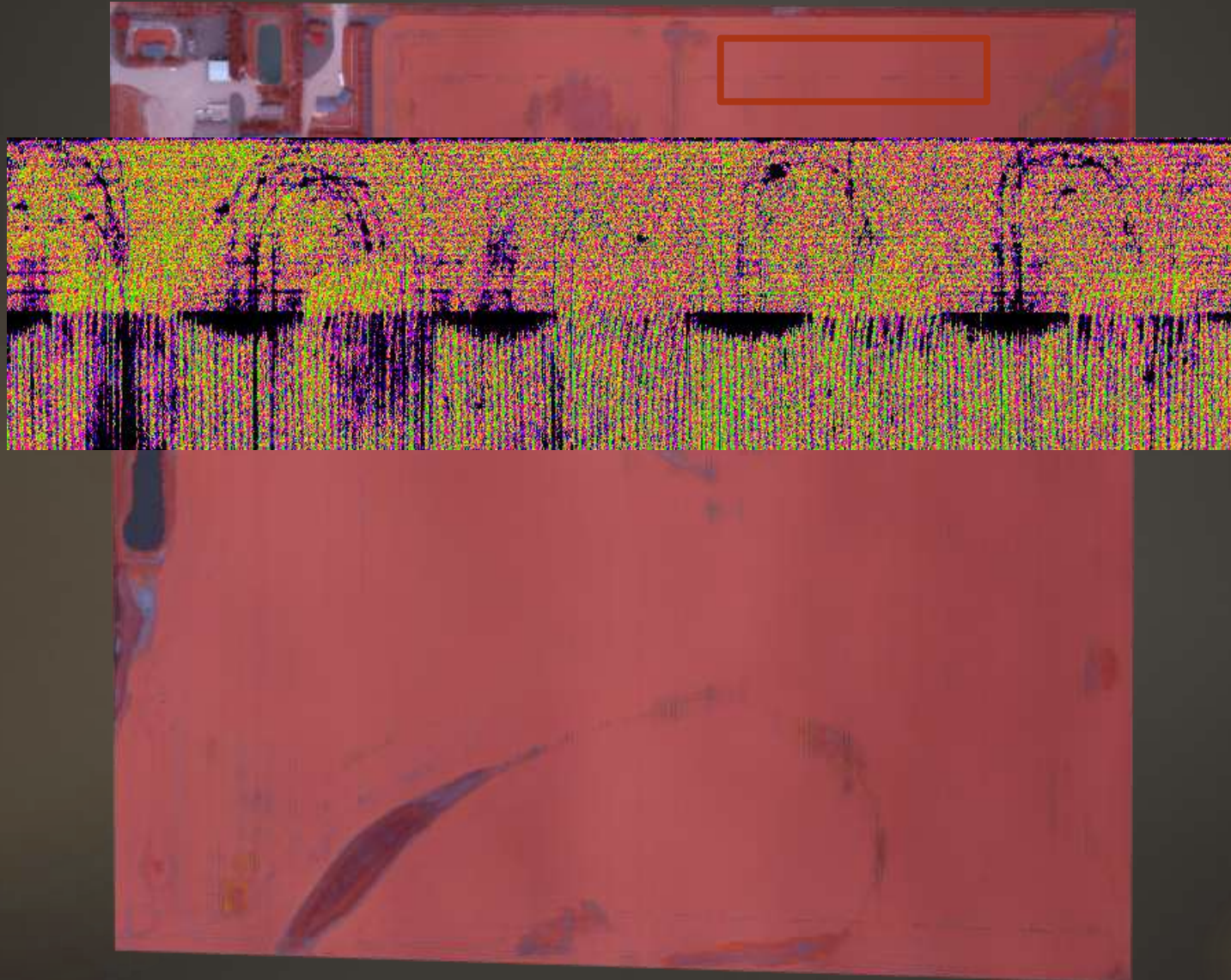
Nutrient issues, double planting, soil erosion, poor emergence







# Willcox, SK Canola Seeding





# Drone, Manned, or Satellite



WHAT WILL WORK BEST FOR YOUR FARM?

# Advantages



## UAS

- On demand service
- High Resolution (1cm)
- Really Fun
- Ability to fly with cloud
- Ideal for 160-1500ac per day
- Can be inexpensive to get started (\$1600-\$16,000)



## Manned Aircraft

- On Demand Service
- High Resolution (2.5cm-25cm)
- Large areas covered
- Ability to fly with cloud
- Ideal for 1500-60,000ac per day



## Satellite

- Large areas covered
- Constantly aloft
- Cost
- Little to no stitching

# Disadvantages



## UAS

- TC Regulations
- Efficiency
- Reliability (In some cases)
- 2 people to operate
- wind



## Manned Aircraft

- Limited by number of planes
- Stitching needed
- TC regulations
- Expensive initial investment (\$100,000)



## Satellite

- Lower Resolution (>2.5m)
- Cloud and Haze
- Not on demand
- Expensive to develop and launch

# Winter Wheat (UAS vs Cessna vs Satellite)

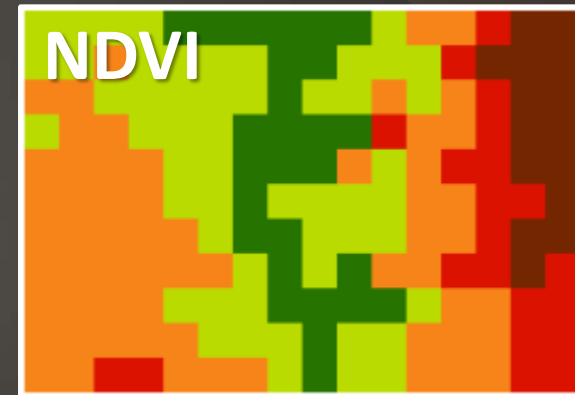
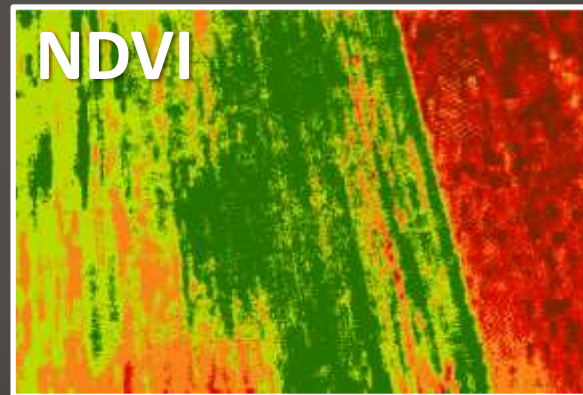
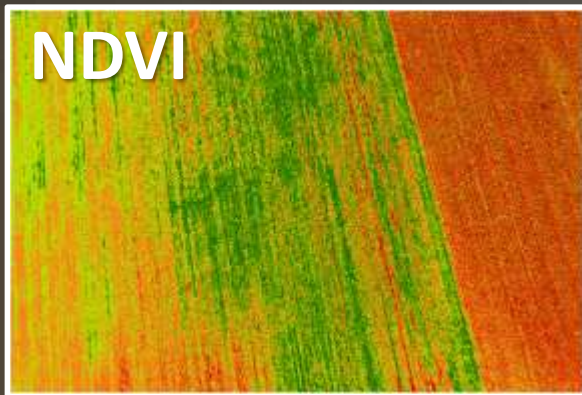
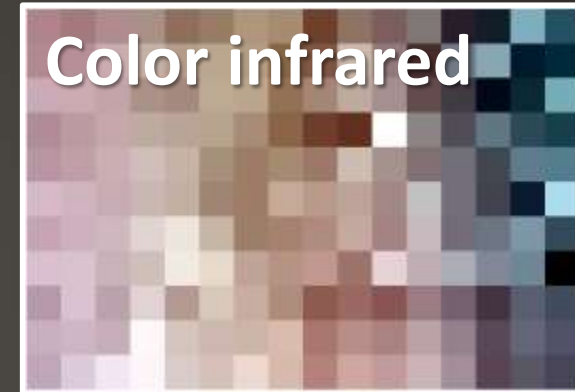
1.0 inch pixels



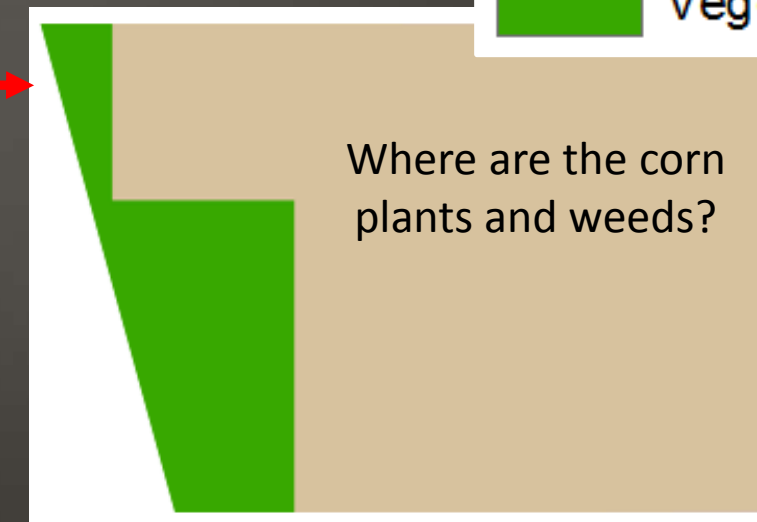
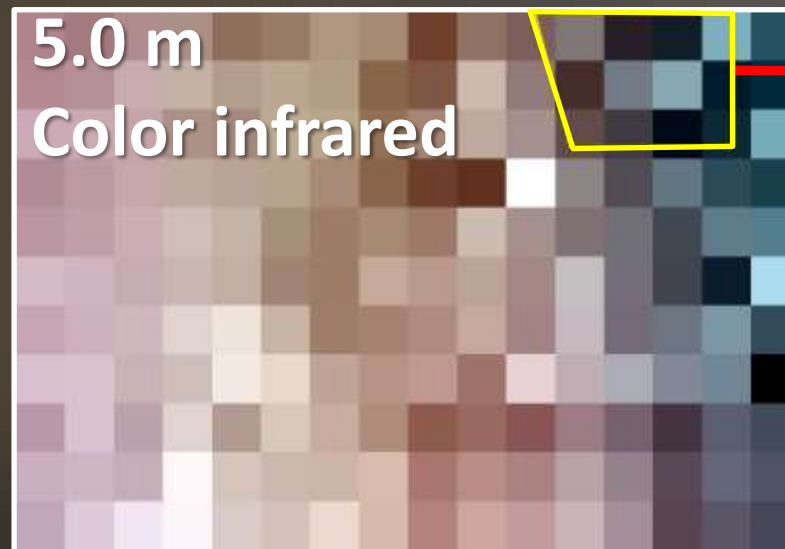
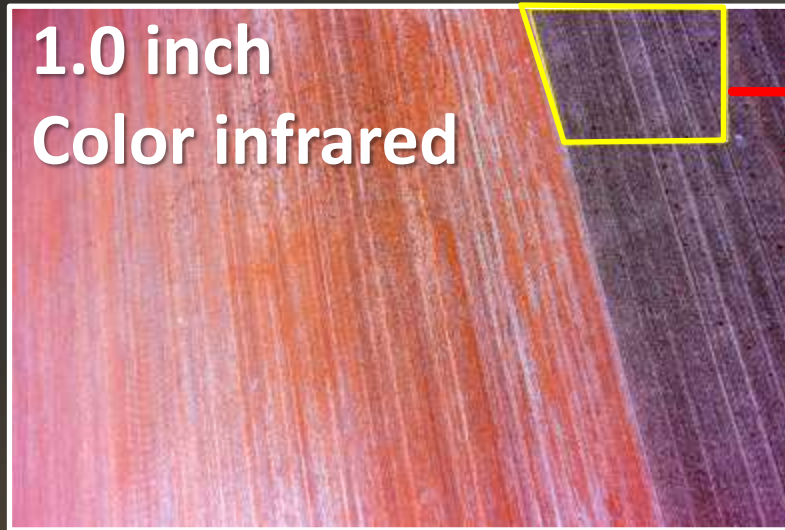
10.0 inch pixels



5.0 m pixels



# Classification of Winter Wheat Emergence



Patterns (spatial arrangement) or context is critical for accurate image interpretation. Below are two weed types with different spatial arrangements that are key to proper identification.



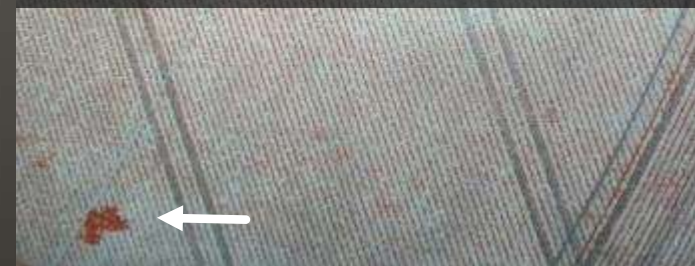
Annual life form, seeds are scattered by the wind



Random Pattern



Creeping perennial that reproduces from vegetative (rhizomes or stolens)



Clustered Pattern

# WHAT CAN WE SEE AND HOW CAN WE USE THE IMAGERY?

SELECTED APPLICATIONS





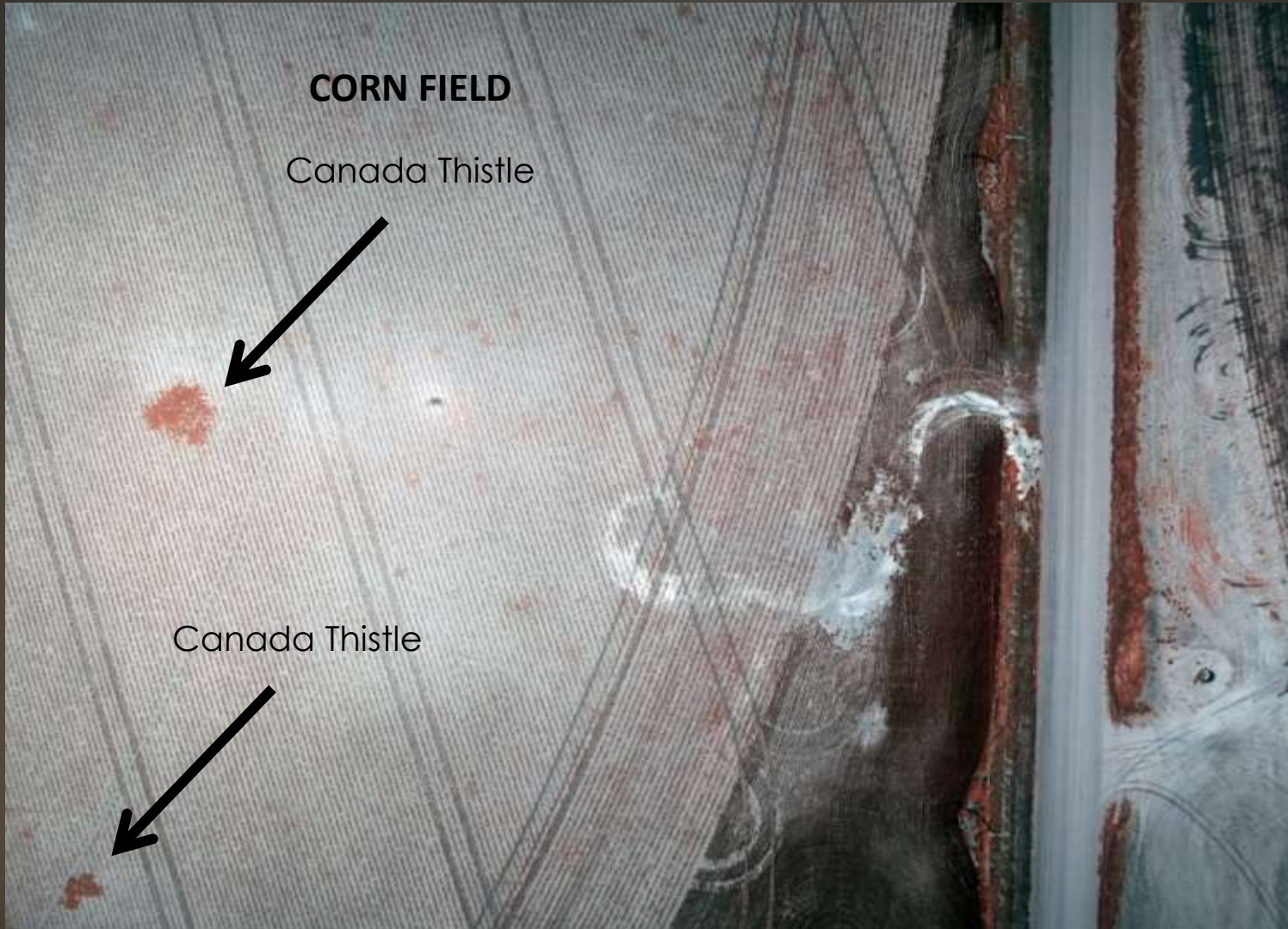
# WEED MANAGEMENT

We are partnering with Agronomists to develop methods for delineating weed patches in crop fields.

Canada Thistle (*Cirsium arvense*)

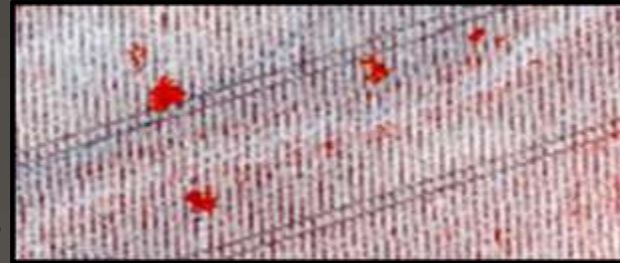
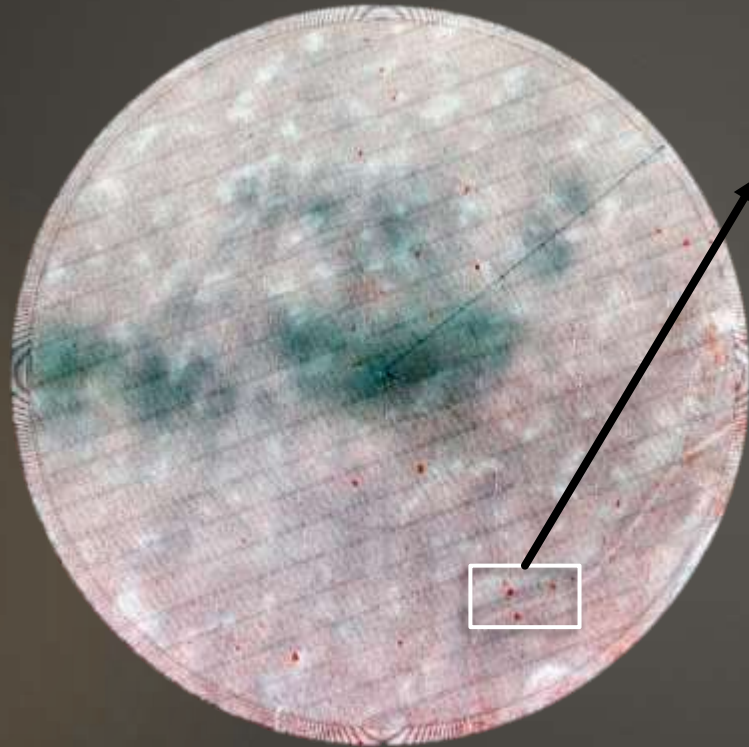


# Canada Thistle Mapping 1.0 inch pixel sizes



## Canadian Thistle Study: Herbicide Application

*Only 0.6 acres affected of 120  
acre pivot*



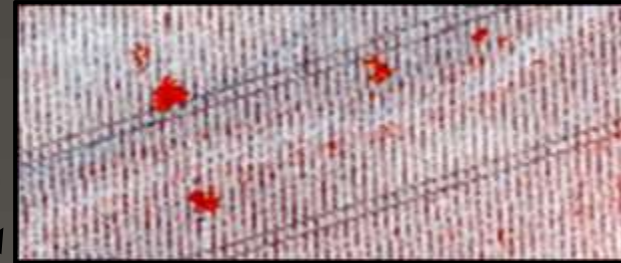
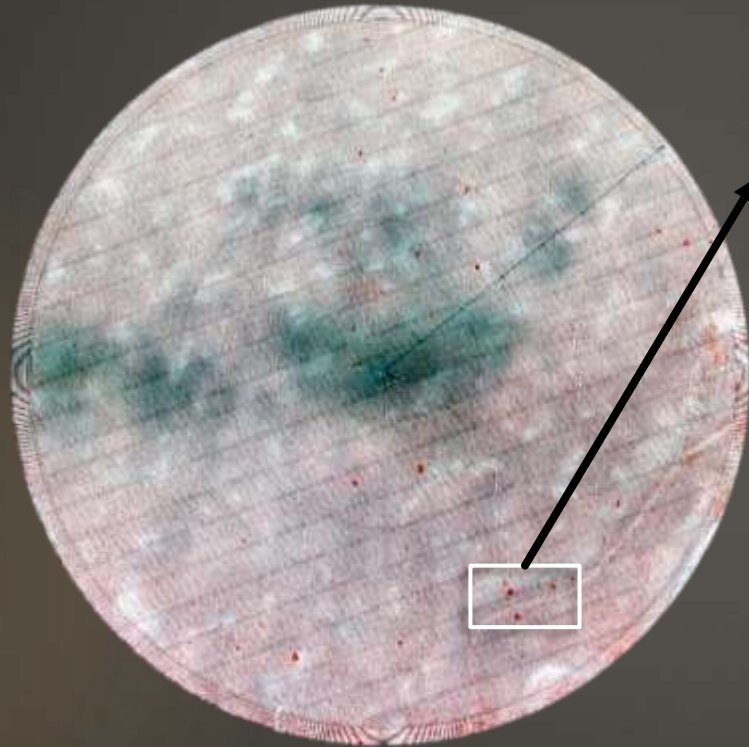
Cost for single rate treatment: **\$700**

Estimated cost for data collection,  
processing, and spot treatment:  
\$500

**Total herbicide savings :  
\$200**

# Canadian Thistle Study: Herbicide Application

*Only 0.6 acres affected of 120  
acre pivot*



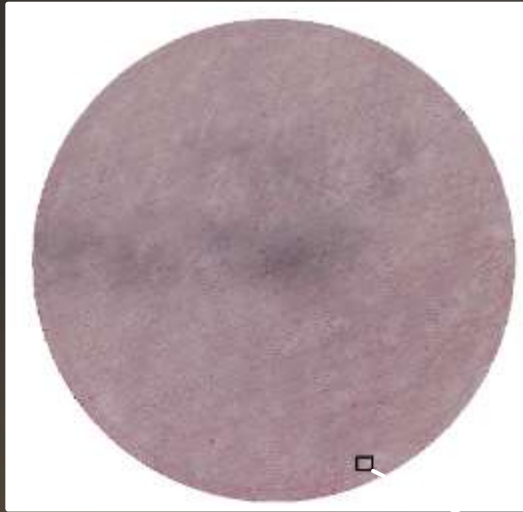
Cost for single rate treatment: **\$2400**  
(\$20/ac Lontrel)

Estimated cost for data collection,  
processing, and spot treatment:  
\$500

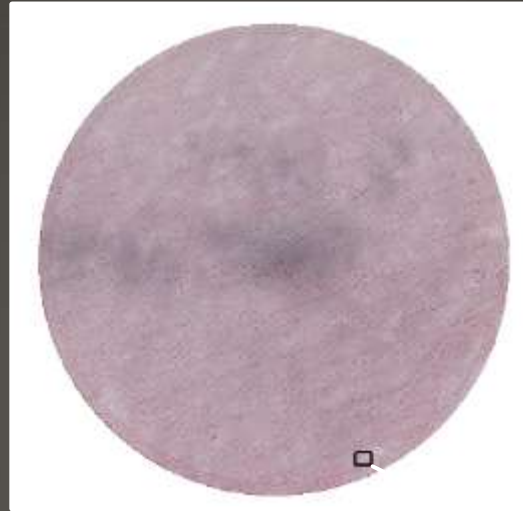
**Total herbicide savings :  
\$1900**

# Where is Canadian Thistle?

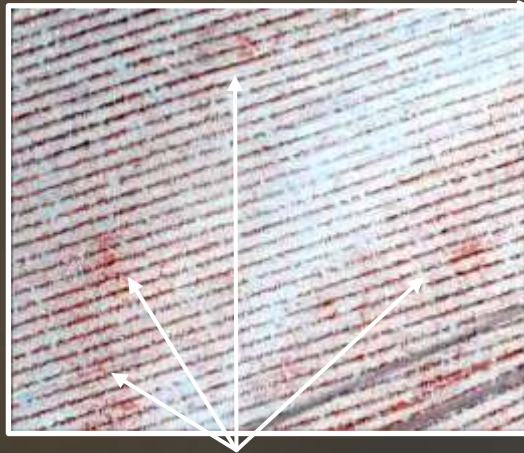
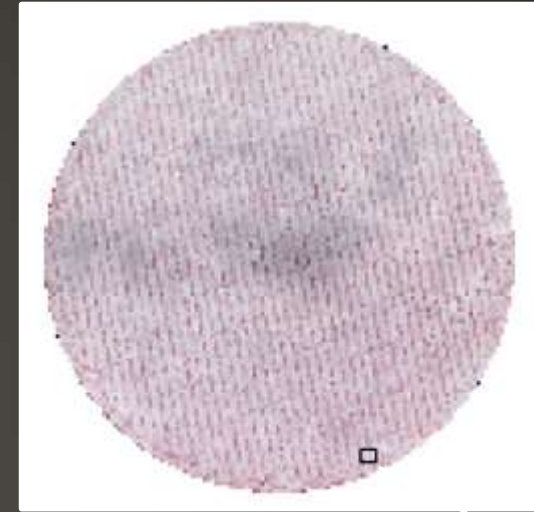
1.5 inch pixels



1.0 m pixels



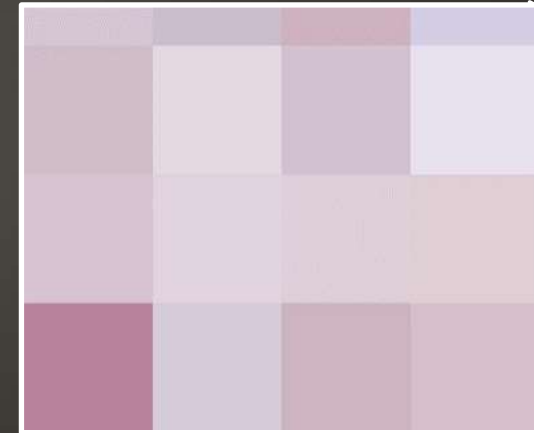
5.0 m pixels



Weeds



Weeds?



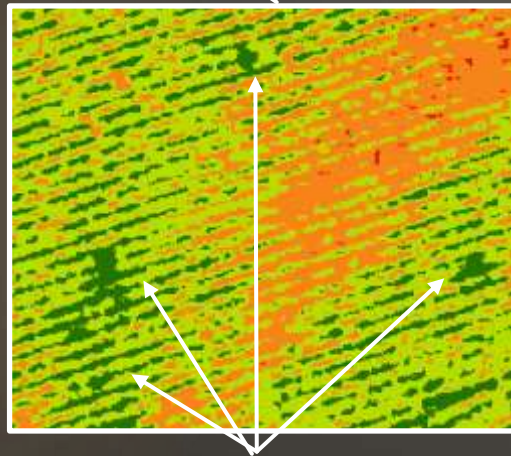
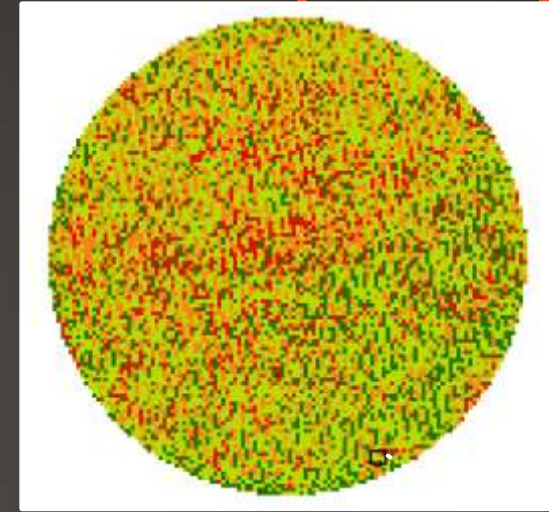
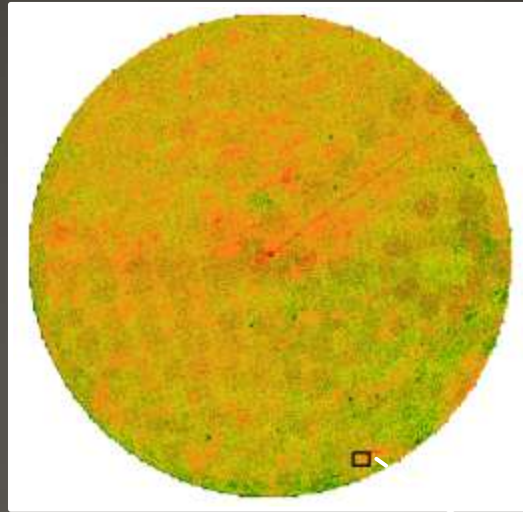
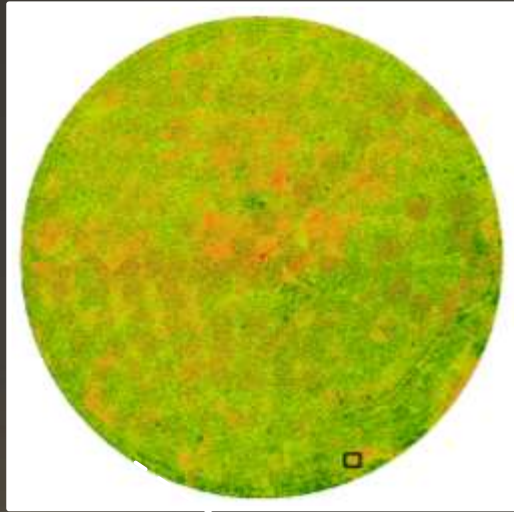
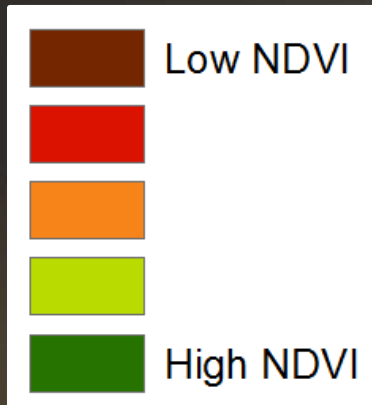
Weeds?

# NDVI of Corn Field with Thistle

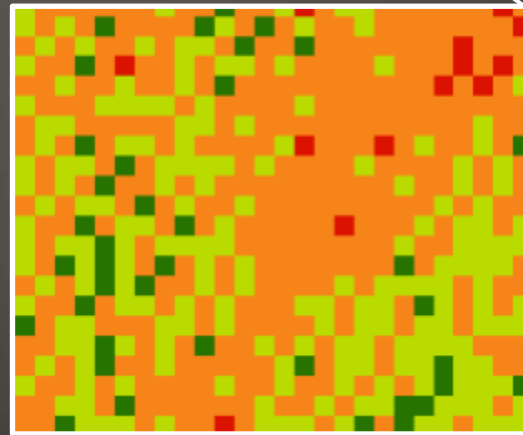
1.5 inch pixels

1.0 m pixels

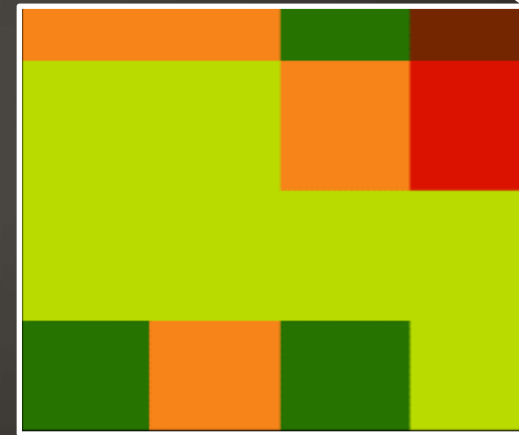
5.0 m pixels



Weeds

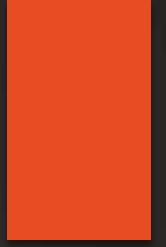


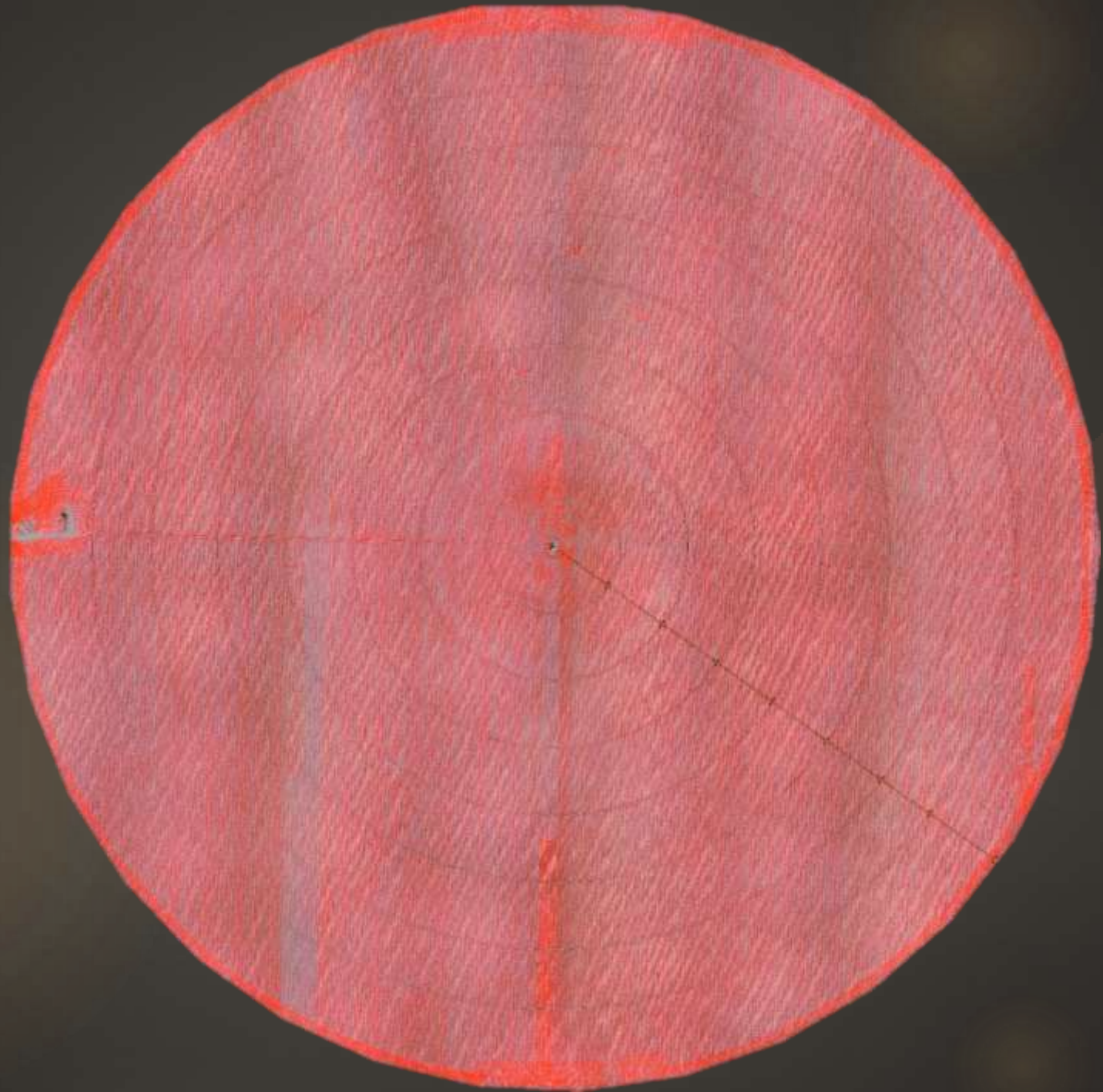
Weeds?



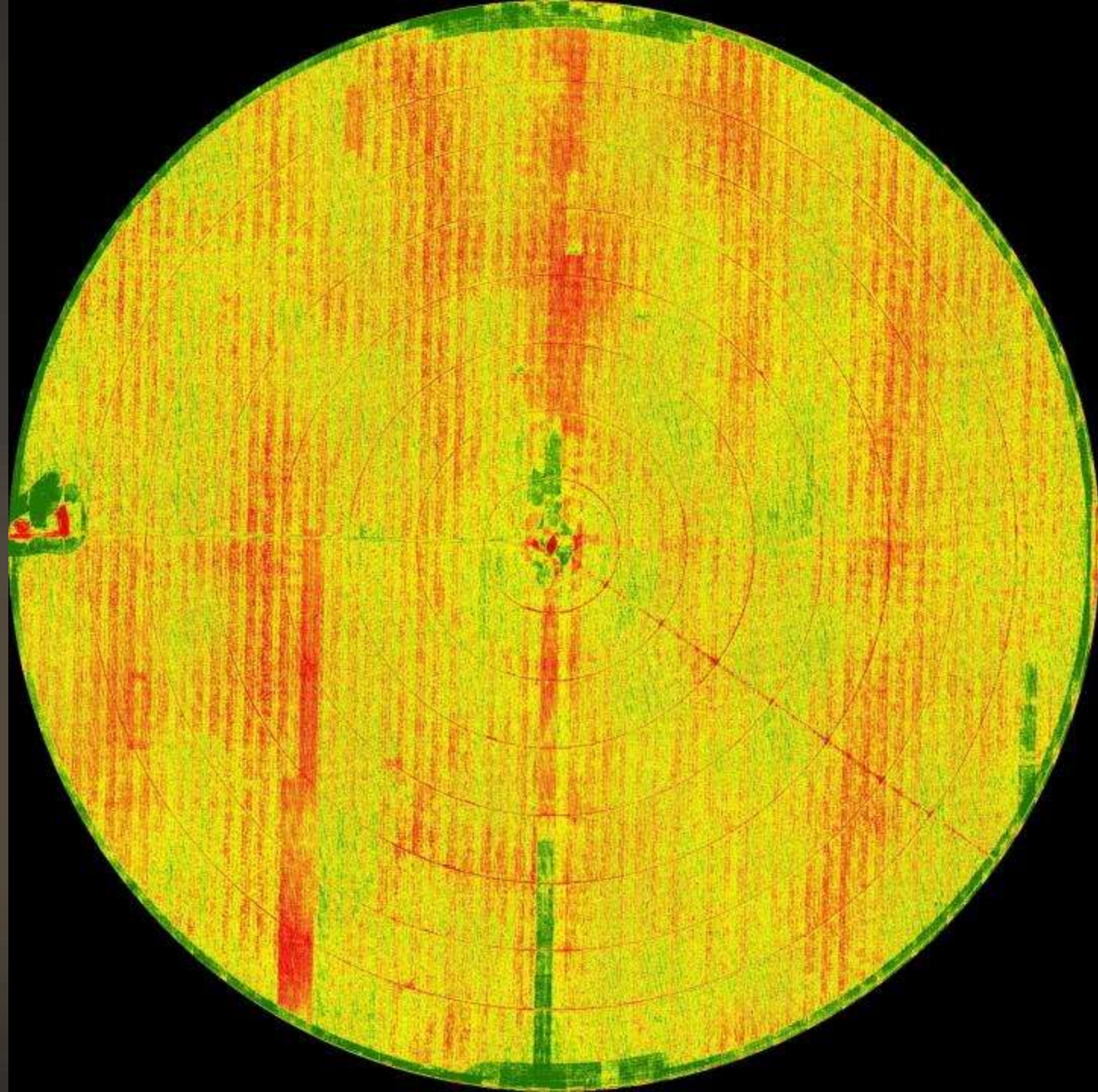
Weeds?

# Crop Fertility







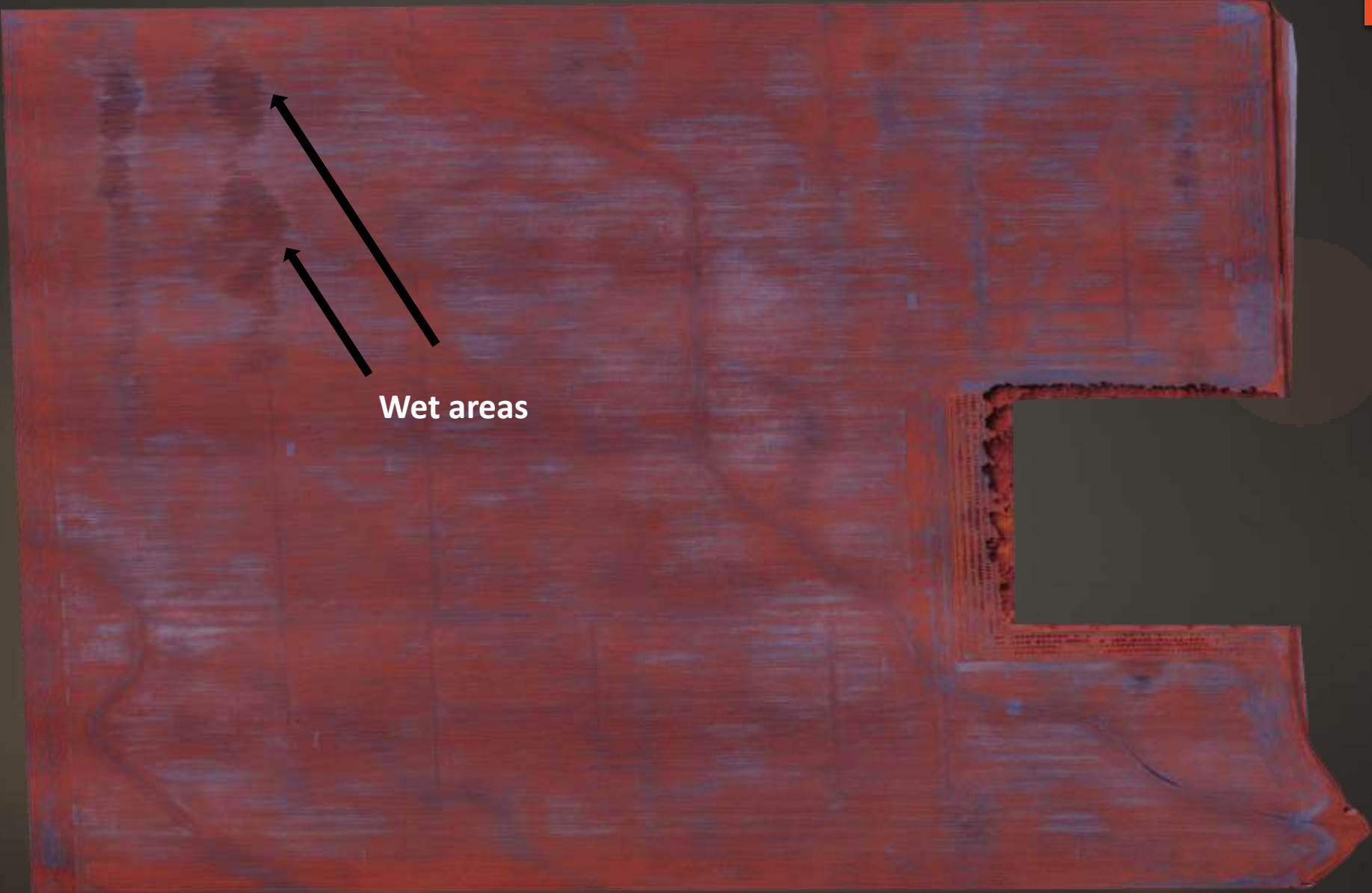




# Crop Damage Assessment

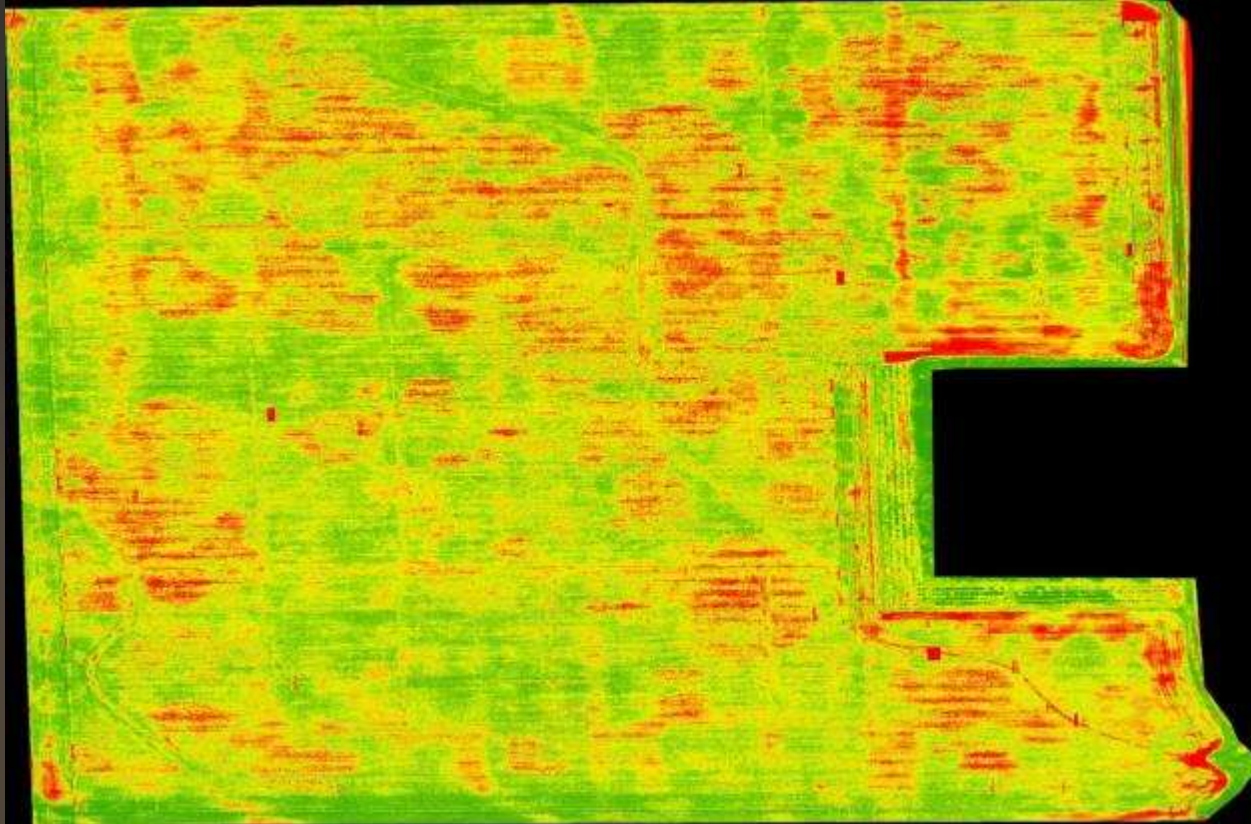


SUGAR BEETS SPRINGTAIL DAMAGE



Wet areas

## SUGAR BEETS



### Springtail

Picture by North Dakota  
State University

Red and yellow areas  
of the NDVI image are  
associated with the  
springtail damage.

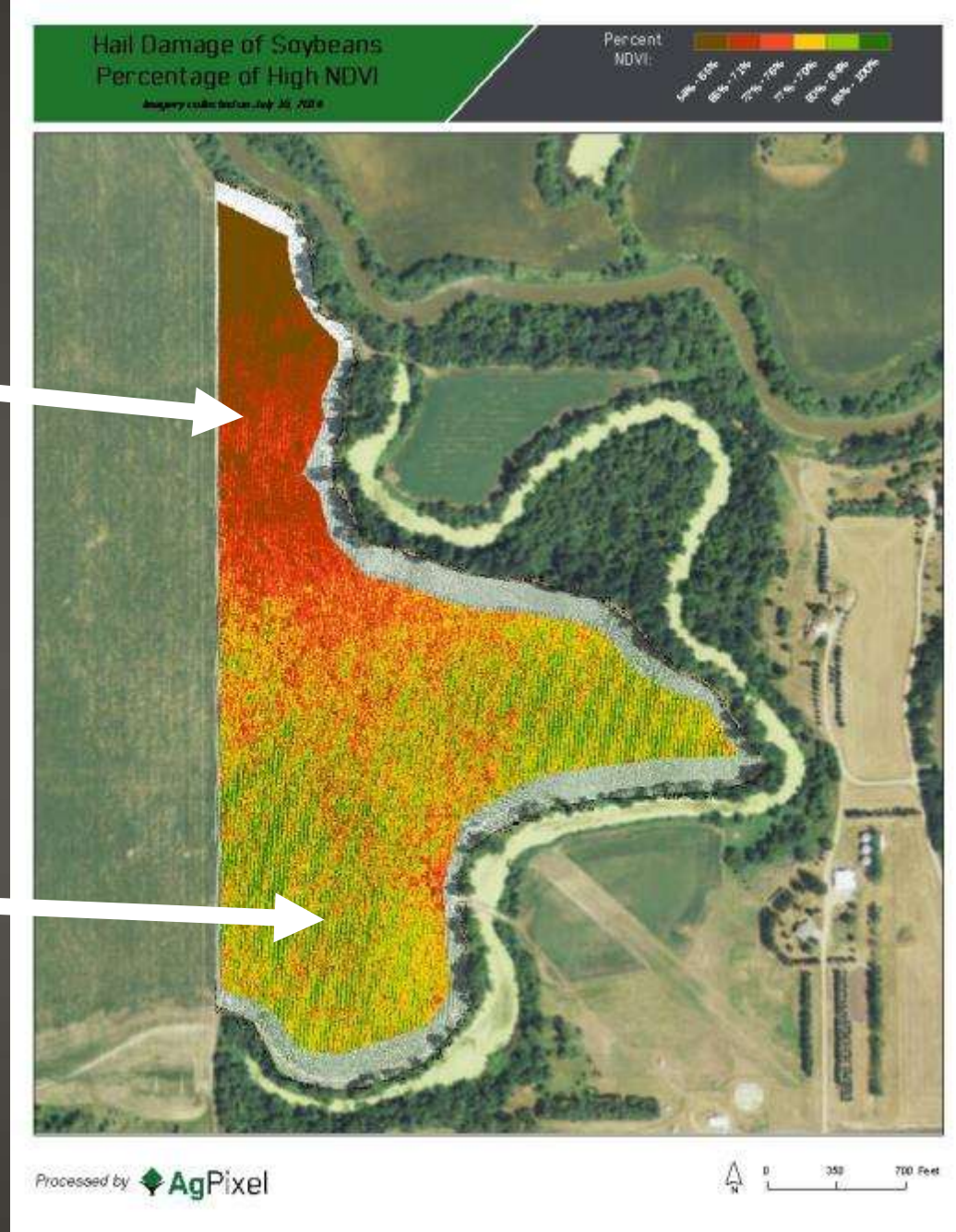


hail damaged

Hail damage event took place June 21, 2014 in a soybean field near Hillsboro, North Dakota. Field was flown on July 16, 2014.



No hail damaged



Crop scout or insurance adjuster's view from outside the corn field.



Crop scout or insurance adjuster's view from within the corn field.



## Root-Lodged Corn With Range of Severity for Root Damage

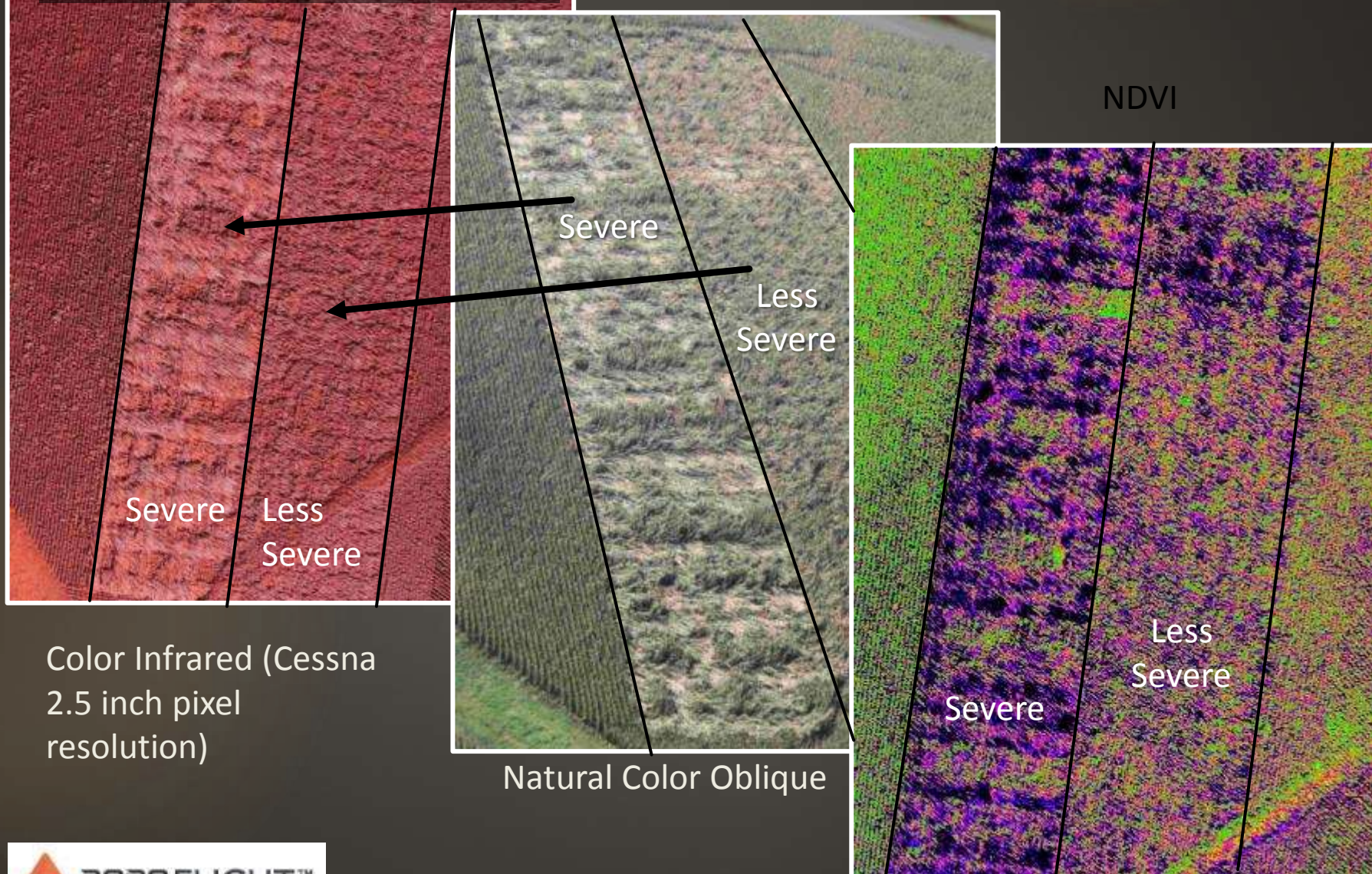


© 2011 Purdue Univ, RL Nielsen

<http://www.agry.purdue.edu/ext/corn/news/articles.13/WindDamage-0712.html>

# Corn Root Lodging in University Genetic Breeding Plots

Corn Genetics susceptible to root lodging



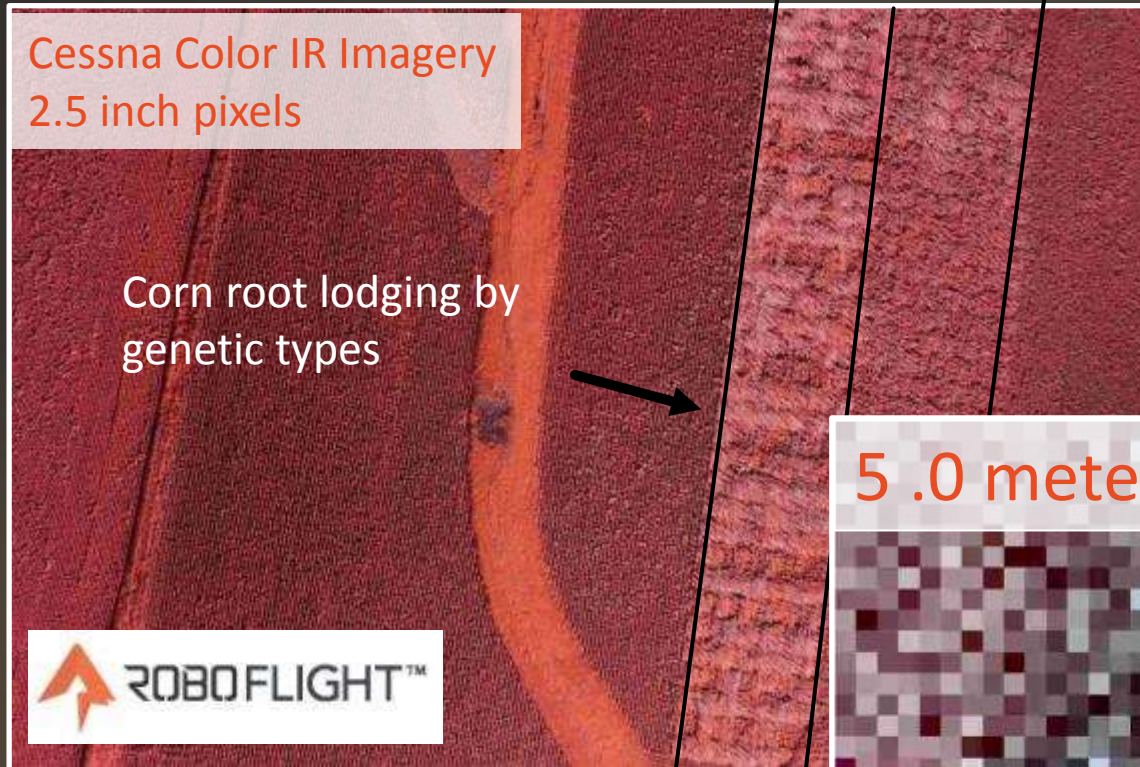
Color Infrared (Cessna 2.5 inch pixel resolution)

Natural Color Oblique

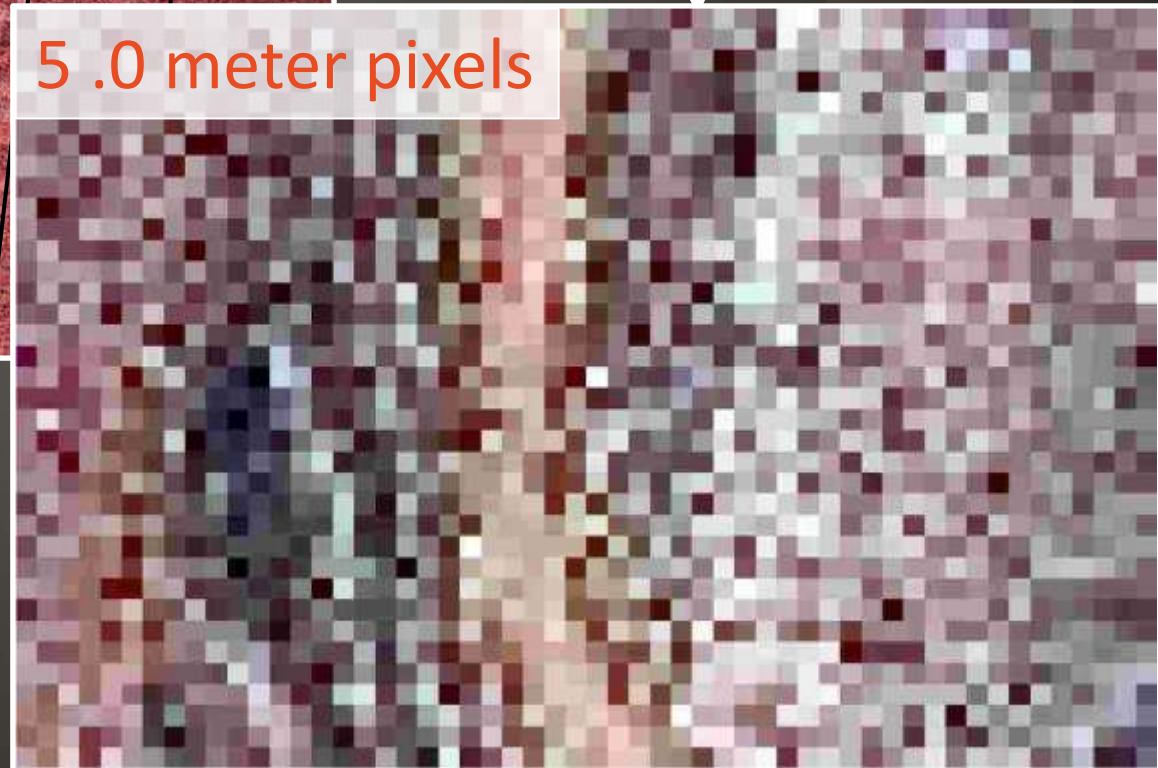
NDVI



# Corn Root Lodging comparison between 2.5 inch and 5.0 m resolution



Same image resampled to 5.0 meter. Where is the root lodging?



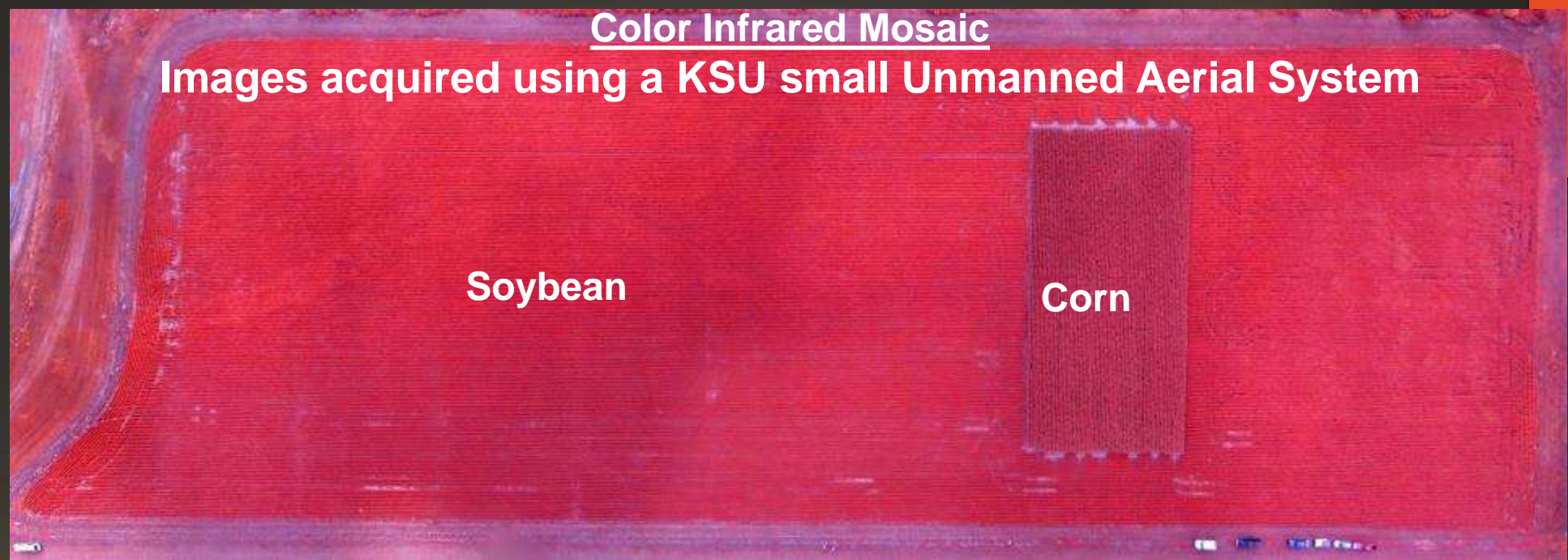
If one is missing something as obvious as the root lodging above, what else is being missed using satellite imagery?

# WORK WITH HERBICIDE DRIFT

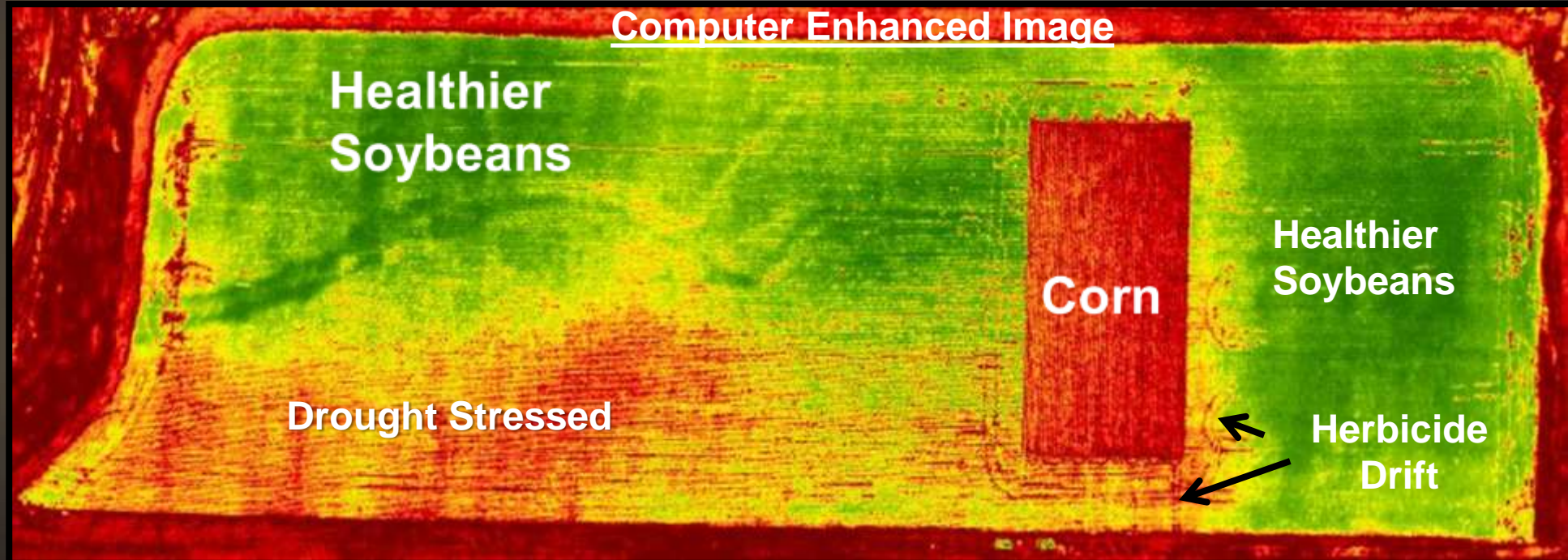


Color Infrared Mosaic

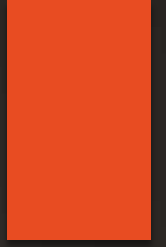
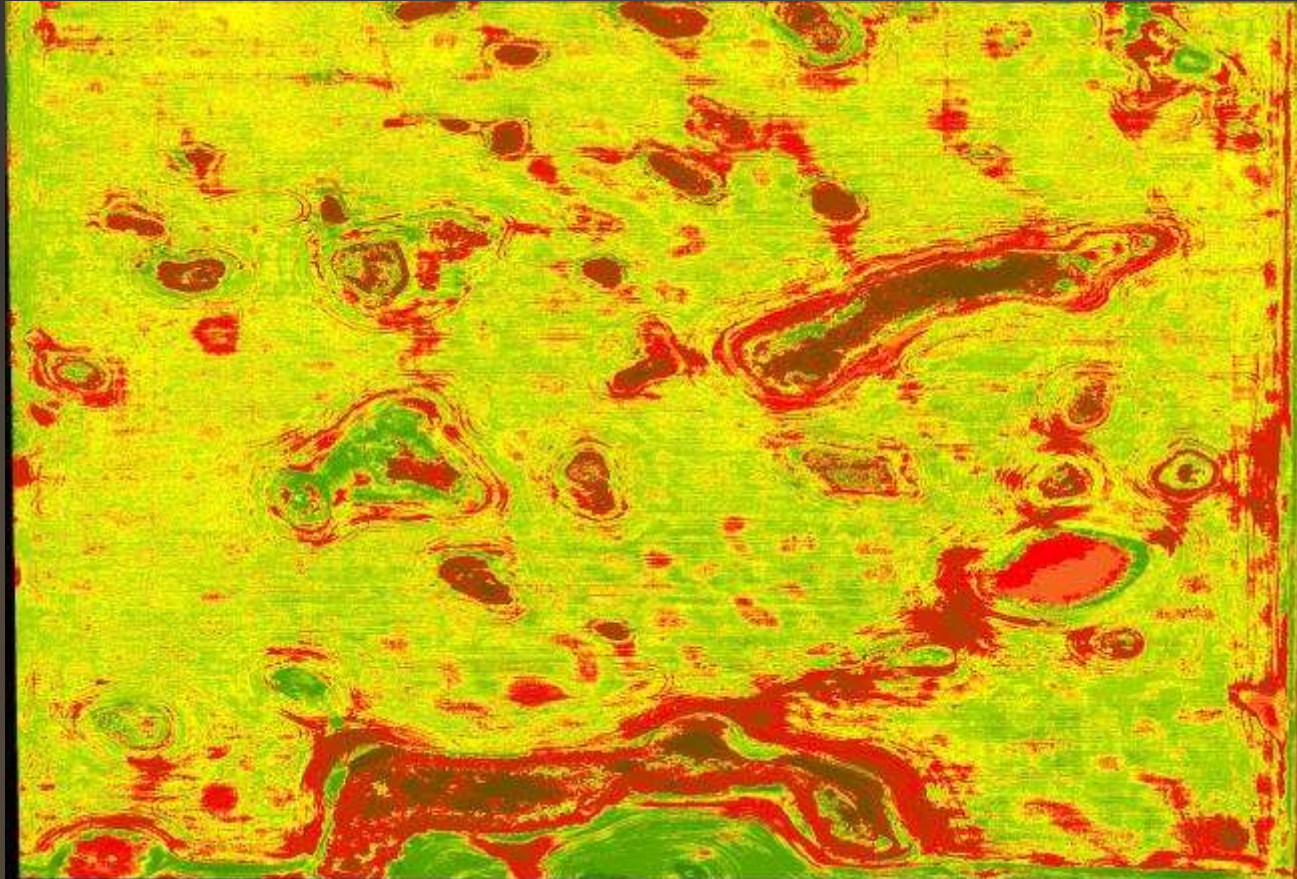
Images acquired using a KSU small Unmanned Aerial System



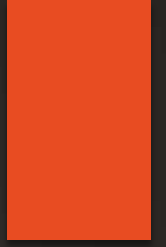
Computer Enhanced Image



# Herbicide Drift Semans, SK



# Crop Yield Potential



# BRINGING THE ORTHOMOSAICS INTO THE FARM MANAGEMENT PROGRAMS YOU ARE USING TO PRODUCE MANAGEMENT ZONES

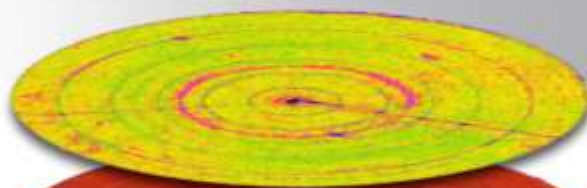


**CONTACT US:**  
info@roboflight.com  
1 (844) fly-robot  
ROBOFLIGHT.COM

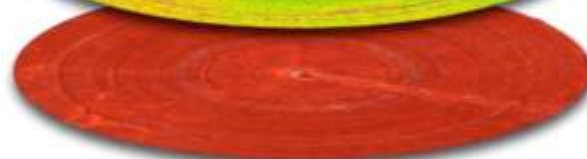
The **Normalized Difference Vegetation Index (NDVI)** is useful for identifying problem areas in fields. NDVI is then used to create management zones into which different treatments will be applied. This NDVI Shapefile (SHP) product is compatible with most farm management software packages.

## CORN PIVOT STUDY:

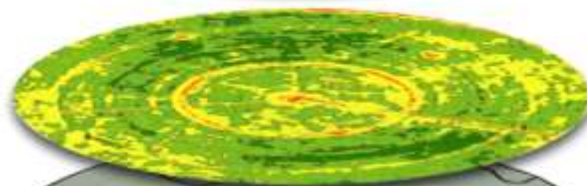
August 2014



COLORIZED NDVI MAP



COLOR INFRARED ORTHOMOSAIC



YIELD MAP (Previous Year)



SOIL MAP (Previous Year)

POWERED BY:



## MANAGEMENT ZONES

Crop management zones can assist agronomists in mapping nutrient prescriptions, yield forecasting, and many other precision farming applications.



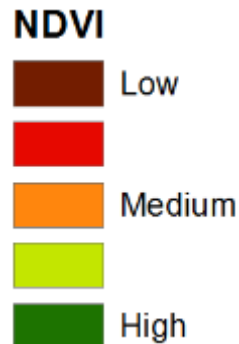
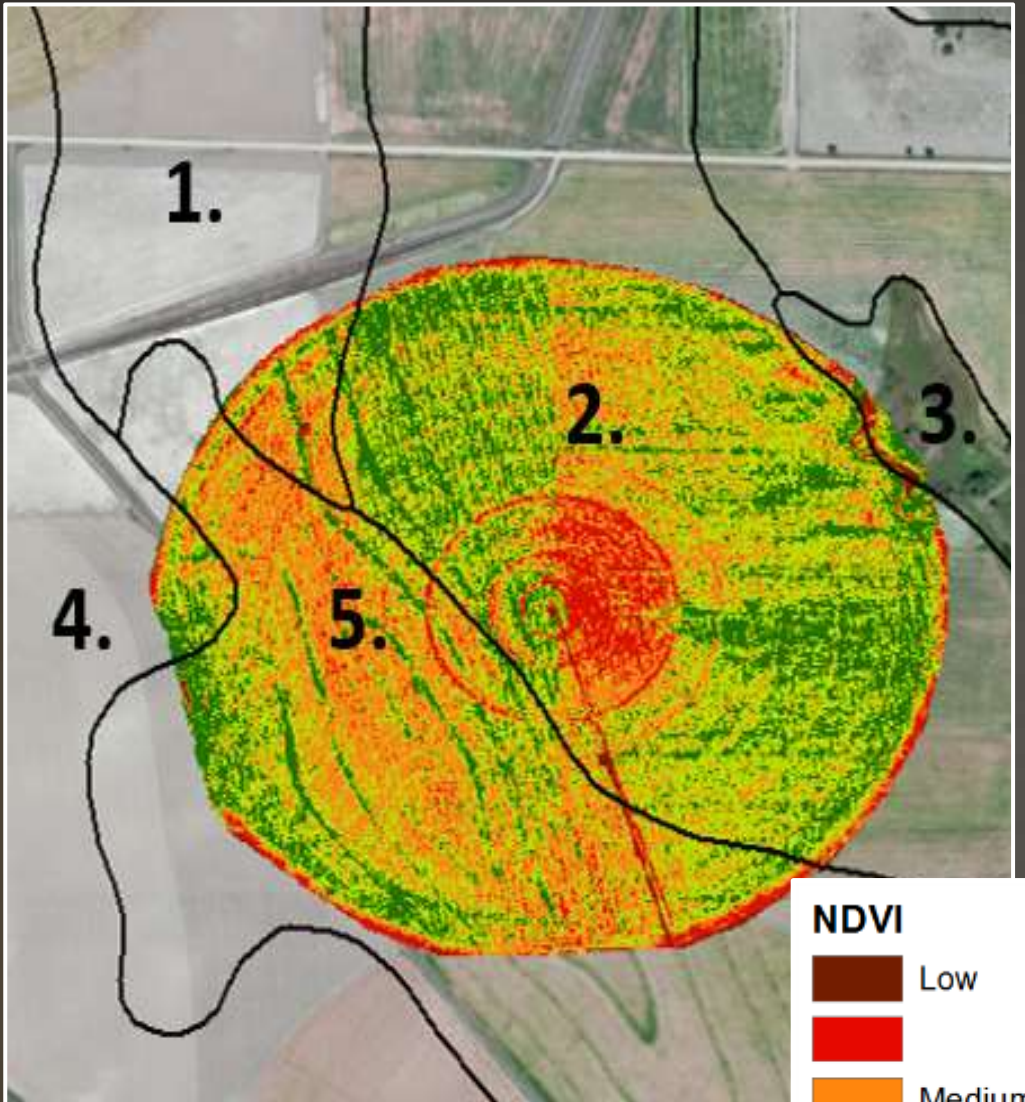
## NITROGEN REQUIREMENTS:



Assessing crop  
yield potential 2.5  
months ahead of  
harvest

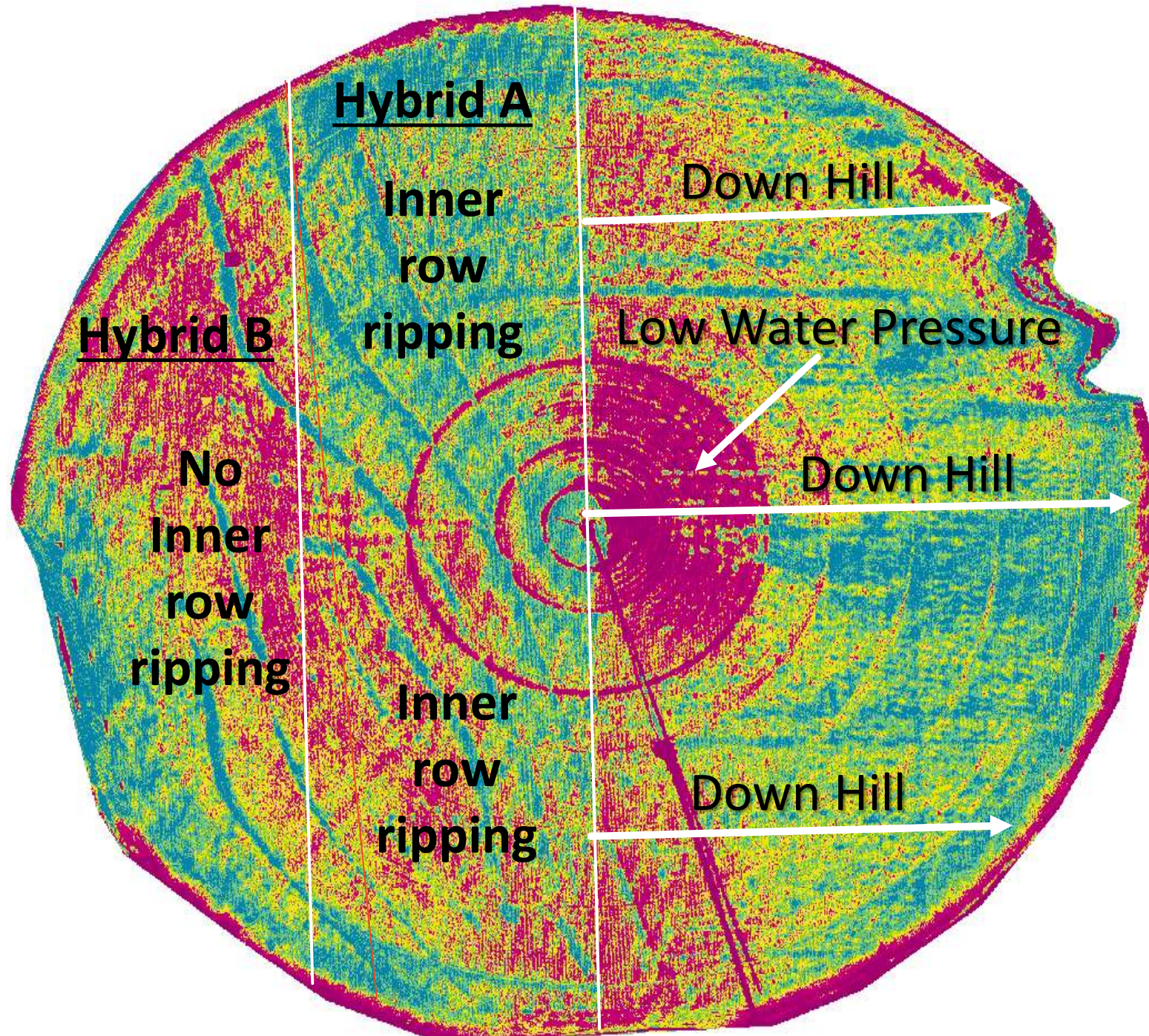


# SOILS MAP SUPERIMPOSED ONTO AN NDVI MAP



1. Keith silt loam, 3 to 6 % slopes, eroded
2. Keith silt loam, 1 to 3 % slopes
3. Sulco-Ulysses silt loams, 9 to 30 percent slopes, eroded
4. Keith silt loam, 1 to 3 % slopes
5. Keith silt loam, 1 to 3 % slopes, eroded





Hybrid A

Inner  
row  
ripping

Down Hill

Hybrid B

No  
Inner  
row  
ripping

Low Water Pressure

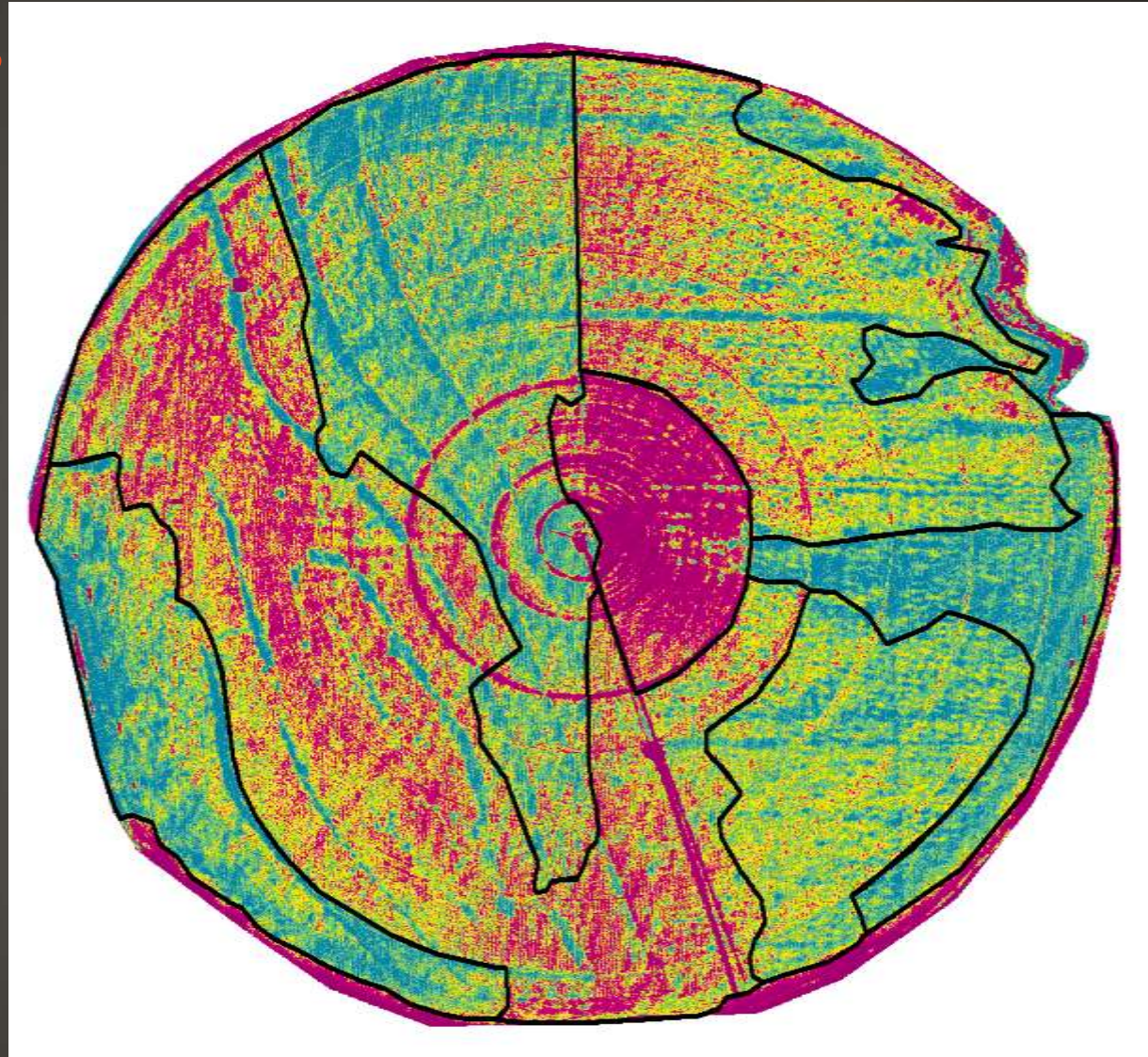
Down Hill

Inner  
row  
ripping

Down Hill

# Nutrient management zones

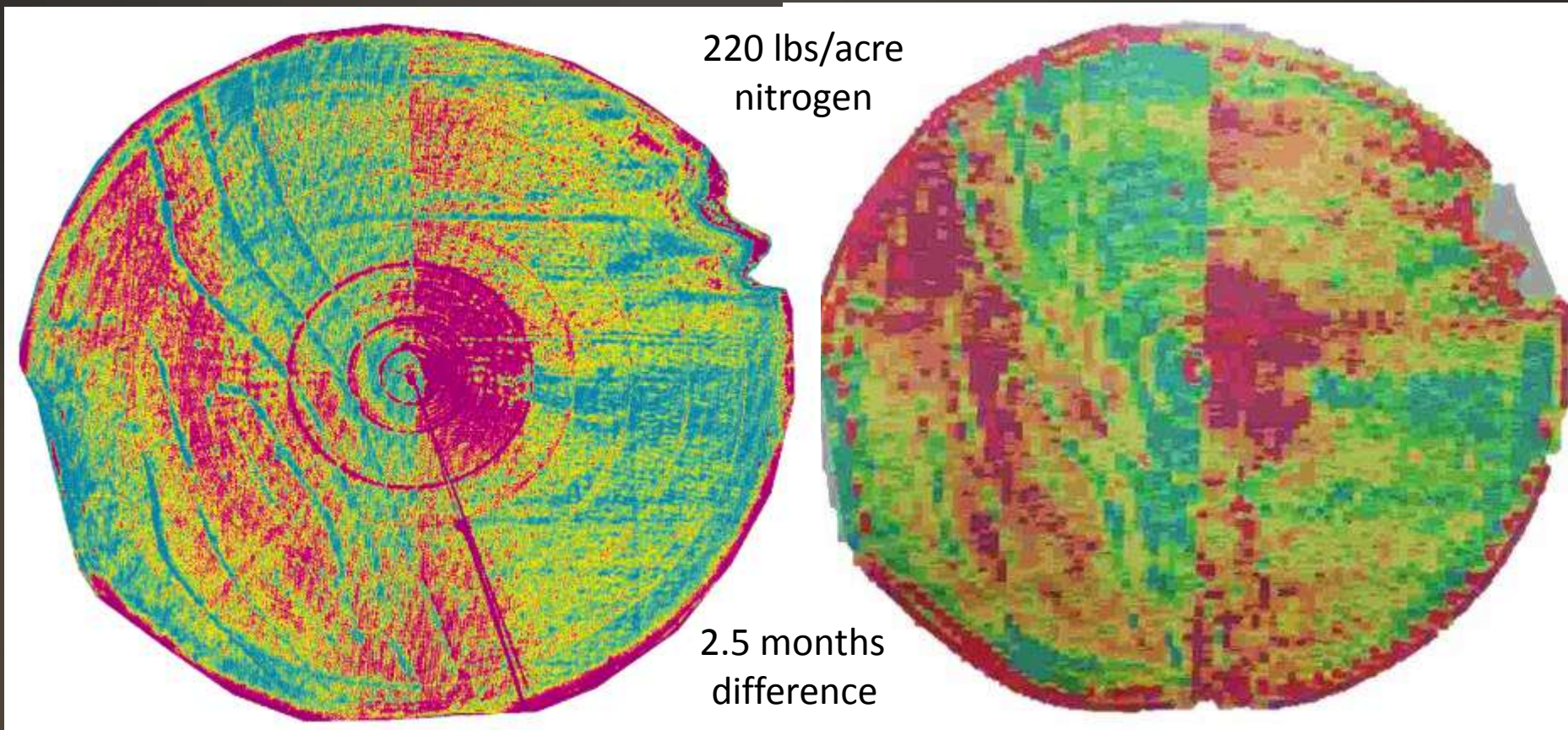
For variable rate nitrogen  
applications



# COMPARISON BETWEEN NDVI AND CROP YIELD MONITOR MAPS FOR CORN

**NDVI Map**  
Flown August 1, 2014

**Crop Yield Monitor Map**  
Harvested October 16, 2014



Lower Yields

Higher Yields

Bushels



Low NDVI

High NDVI

## CONSIDERATIONS FOR POTENTIAL UAS OWNERS

- Rapidly-developing technology and constant improvements
- Declining cost as technology becomes widely available
- Potential for inaccurate results without proper aircraft and training
- Research is ongoing and now is the time to ask questions



# ABOUT ROBOFLIGHT SYSTEMS

“RoboFlight Systems assists our clients in acquiring, processing, analyzing, and managing remotely sensed data in order to make intelligent precision agriculture management decisions.”

A screenshot of the RoboFlight website. The top navigation bar includes the RoboFlight logo and links for Home, Services, Products, UAS Academy, Company, News, and Contact. The main banner features an aerial view of a green agricultural field with a white irrigation line, overlaid with the text "IMAGERY TO INFORMATION". Below the banner, a text block describes the company's services, followed by a bulleted list of data sources and a video player icon.

**RoboFlight™** turns your aerial imagery into actionable intelligence. Our expert team is able to collect, process, analyze, and manage data from a variety of sources, including:

- Unmanned aerial systems (UAS)
- Piloted aircraft
- Satellite imagery services

View your business from a new perspective. Contact us for more information.

Orthomosaic

NDVI Map

NDVI Management Zone



**GEORECTIFIED ORTHOMOSAIC OF SURVEY ZONE**

**GEORECTIFIED NDVI MAP OF SURVEY ZONE**

**NDVI MANAGEMENT ZONES**

Map-quality image products that allow agronomists and farmers to identify problem areas in their fields, such as diseases, insect infestations, nutrient deficiencies, and water stress. These images can also be used to identify areas where replanting is necessary early in the growing season.

The Normalized Difference Vegetation Index (NDVI) is useful for identifying problem areas in fields, often with better contrast than a color infrared image.

NDVI is used to create management zones into which different treatments will be applied. The Shapefile format is compatible with most farm management software packages.

**SPATIAL RESOLUTION (PIXEL SIZE):**  
10 inches

**SPATIAL RESOLUTION (PIXEL SIZE):**  
10 inches

**SPATIAL RESOLUTION (PIXEL SIZE):**  
10 inches

**FILE FORMAT:**  
GeoJPEG/GeoTIFF

**FILE FORMAT:**  
GeoJPEG/GeoTIFF

**FILE FORMAT:**  
Shapefile

**OUTPUT PRODUCTS:**  
Natural Color (Red, Green, Blue) or  
Color Infrared (Near-Infrared, Green, Blue) Image

**OUTPUT PRODUCTS:**  
NDVI Image (Single Band)

**OUTPUT PRODUCTS:**  
NDVI Management Zones in Shapefile Format



We have our own state of the art computing facilities in Des Moines, Iowa. This also houses our research and development lab.



# UNMANNED AIRCRAFT SYSTEMS

## Fixed Wing



## Multicopter (Hexacopter)



Multicopter systems are appropriate for small scale and research operations under 50 acres. The Fixed Wing can cover over 1000 acres at 1.0 inch resolution a day.



## DJI S800 with gimbals and camera mounted



Disadvantage is one cannot cover larger areas (10 to 50 acres)

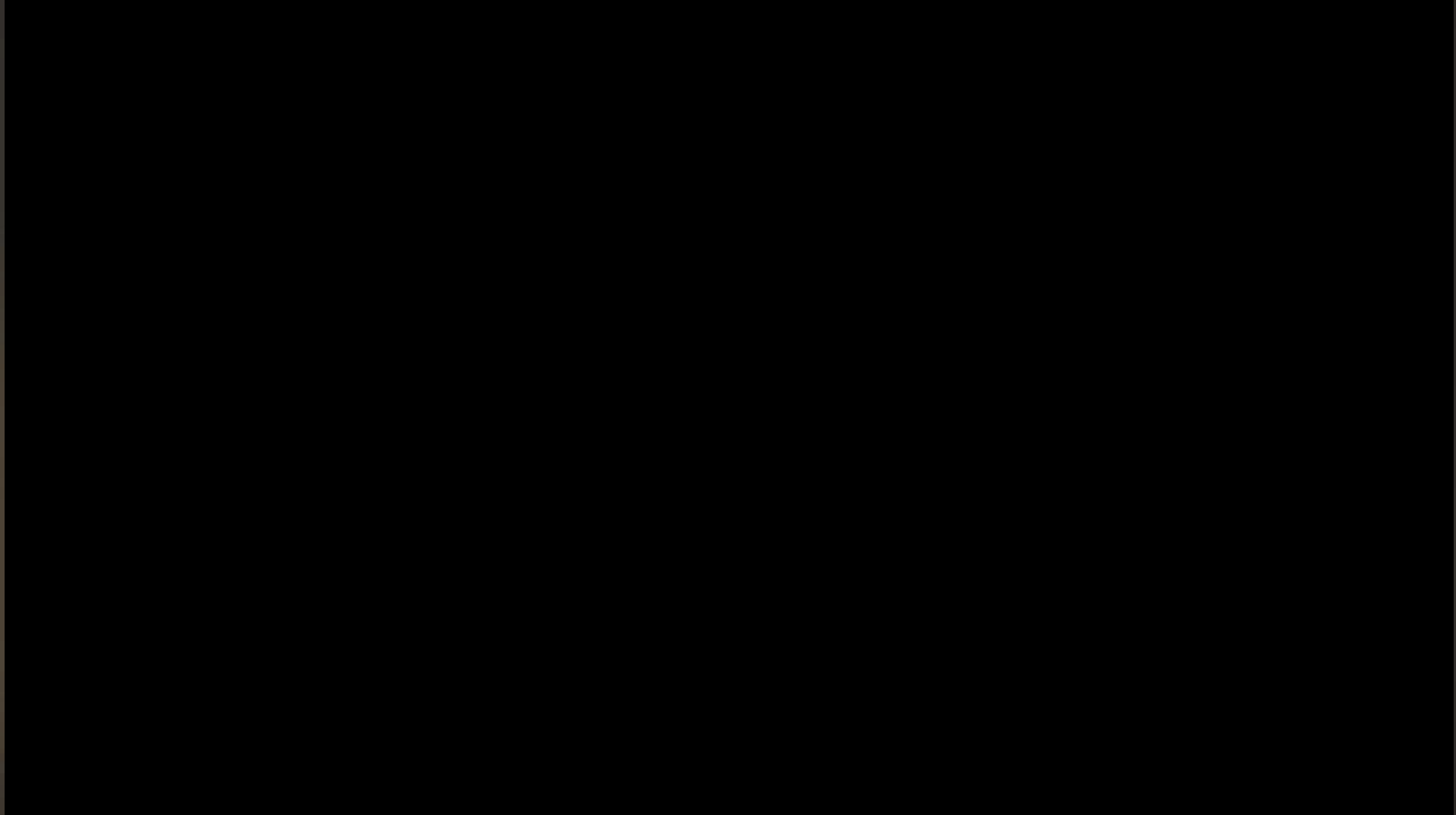


An Advantage is you can have gimbals and carry heavier payload

## **RF70 Fixed Wing Unmanned Aircraft**

Designed as a mapping aircraft that is significant step above the hobbyist aircraft, but under military aircraft level.

Can fly for 45 to 120 minutes on single battery charge.



# Manned Aircraft

Our company is committed to collecting and processing quality remotely-sensed data, whether it be from unmanned aircraft, manned aircraft, or satellites. We are platform agnostic.



Cessna pod camera mount



Aerial imagery collection with a Cessna aircraft

# RoboFlight



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(306) 725-7544



# Authorized RoboFlight Service Providers

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**Agronomist Edmonton**

**(780)977-8726**

