

# Applying Aerial Sensing Technology to Hops: Year 1



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# Discussion Topics

## **Remote Sensor Data (Images)**

- What is an NDVI?
- Uses in Research

## **Current Uses in Production Farming**

- Remote Capture Methods
- Processing the Data
- How the Images are Used in Production

## **Applying the Technology to Hops**

- What we attempted to do
- Challenges
- Next Moves

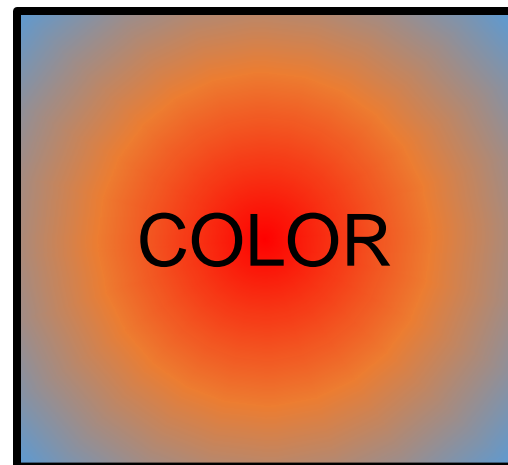
# Multi-Spectral Images



NDVI = Normalized Difference Vegetation Index

*Healthy plants reflect a lot more NIR than stressed plants*

Red + Green + Blue =



$$\frac{\text{NIR} - \text{Red}}{\text{NIR} + \text{Red}} =$$



# Color & NDVI



This is what we see with our eyes



# Research Examples

- Forest Fire Prediction
- Estimates of invasive plants such as wild blackberries
- Drought analysis for predicting aid to regions
- Ag Specific research:
  - Predicting sugar beet yield
  - Estimating evapotranspiration of pear orchards
  - Monitoring ripening and quality of apples
  - Tracking disease spread in vineyards
  - Variable wheat seed planting

# Mature Technology

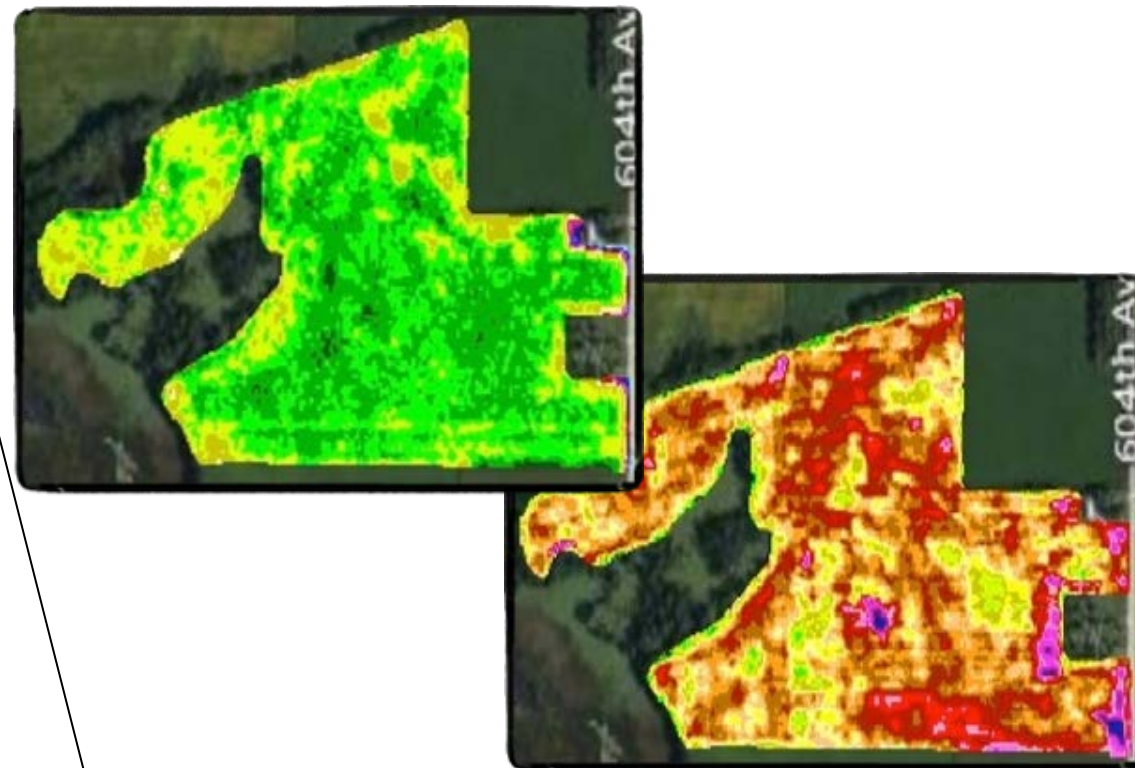
## Ground-based Sensors

- Resolution: Spot - Coarse (10' – 90')
- Cost: ~\$25k per sensor
- Frequency: Limited to ground-based collection only
- Pros: some are self-illuminating, immediate response



## Satellite Imagery

- Resolution: 2 feet – 50 feet
- Cost: \$1-2 per acre
- Frequency: 2-3 weeks, limited by weather
- Pros: Very widespread availability



# Newest Precision Technologies



## UAVs

- Resolution: .1 inch to 3 feet
- Cost: \$15k+, Labor and time intensive
- Frequency: Weather and area limits
- Pros: Accessibility, Small-scale detail

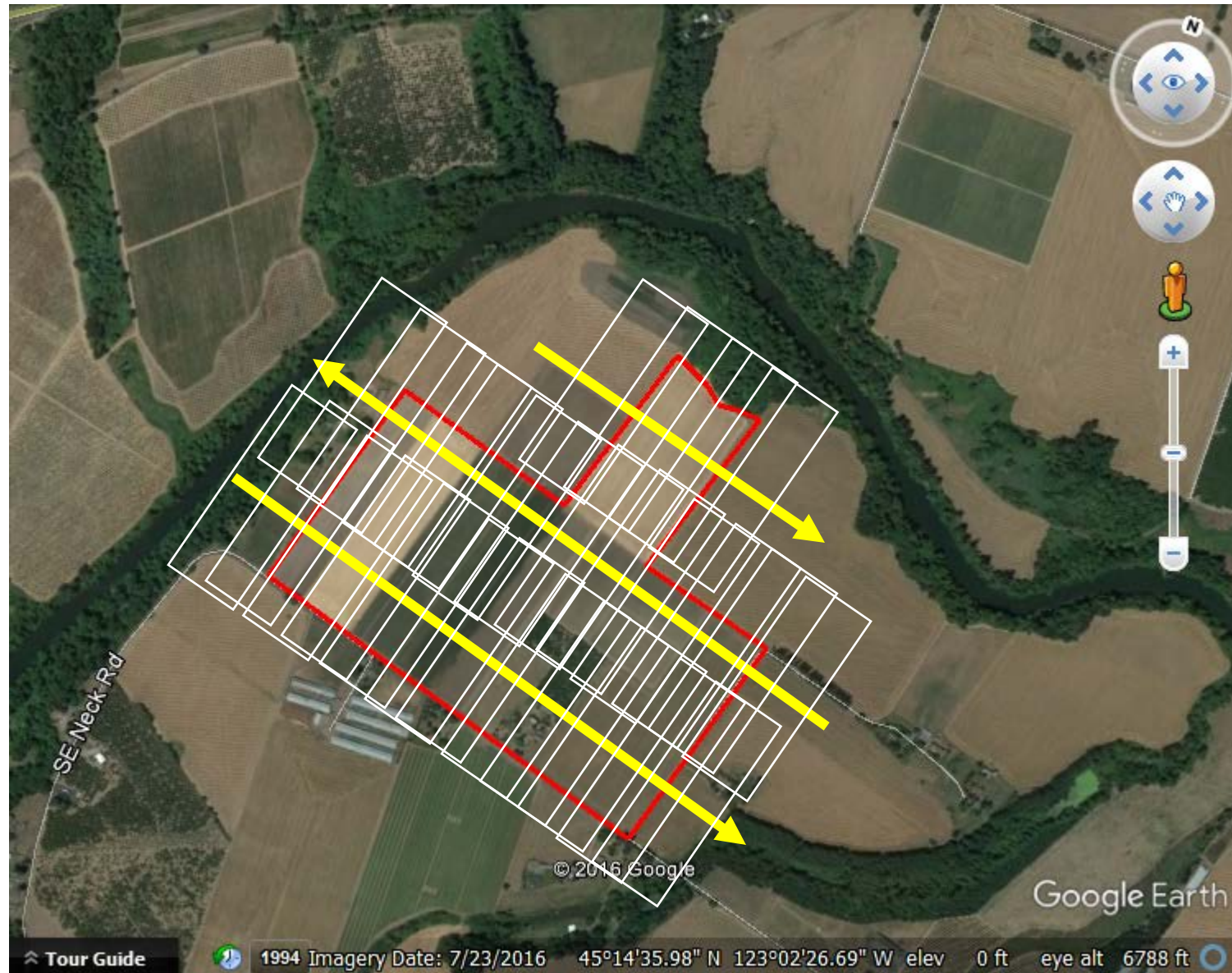


## Manned Platforms

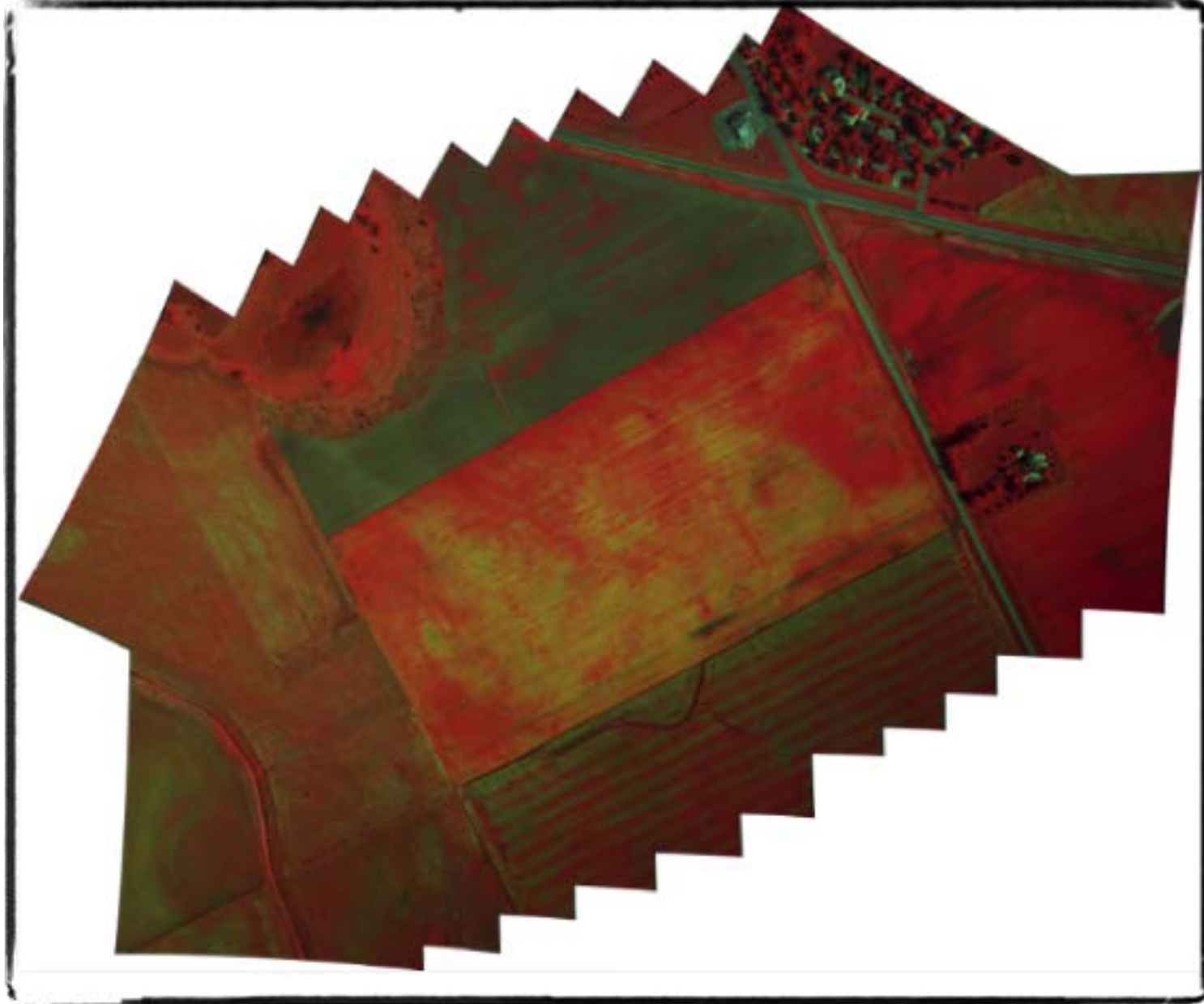
- Resolution: 1 inch to 2 feet
- Cost: \$1 - \$10 per acre
- Frequency: Weather dependent
- Pros: Widespread coverage, economically scalable, latest technology



# Identify the Area

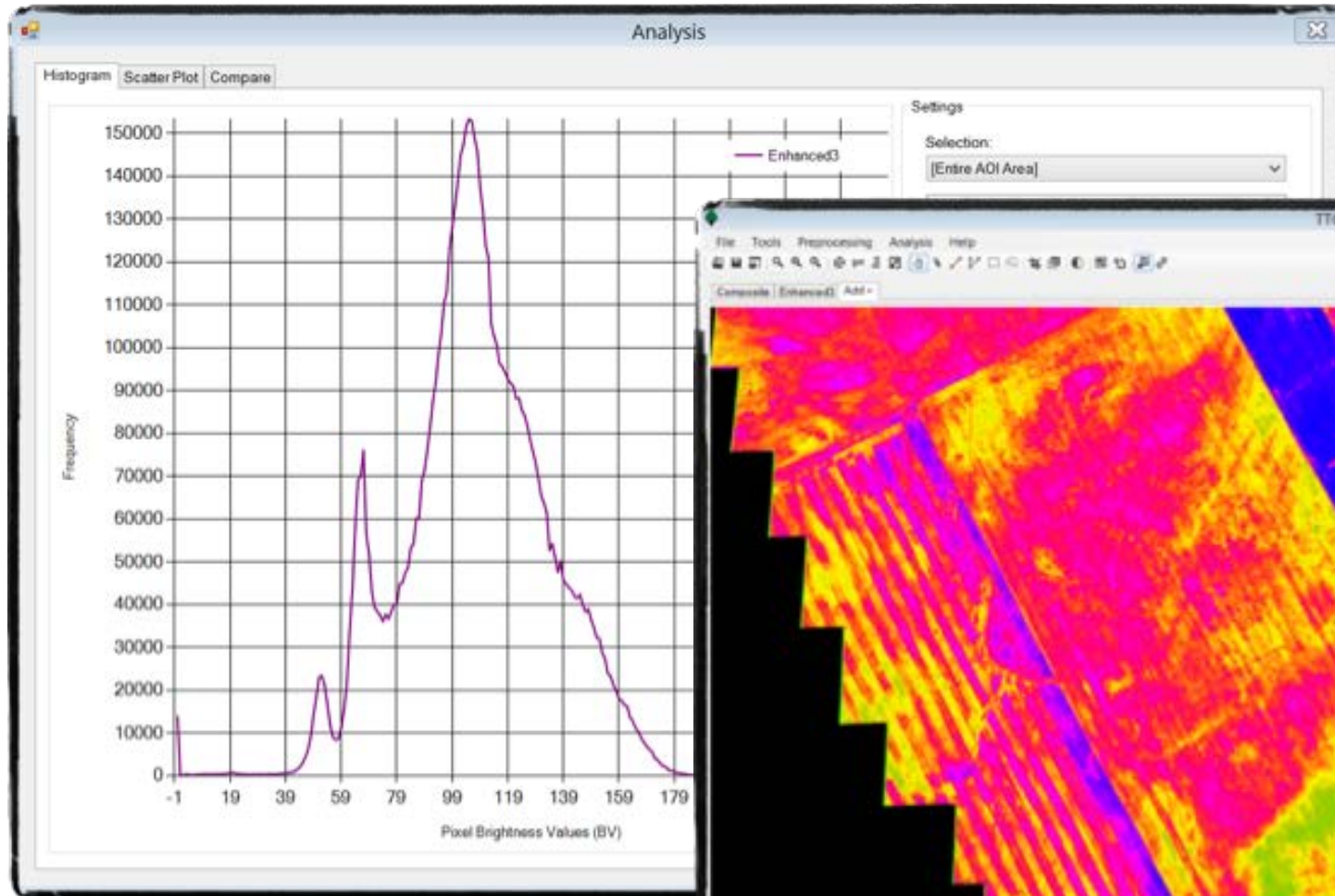


# Stitch the Images into a mosaic

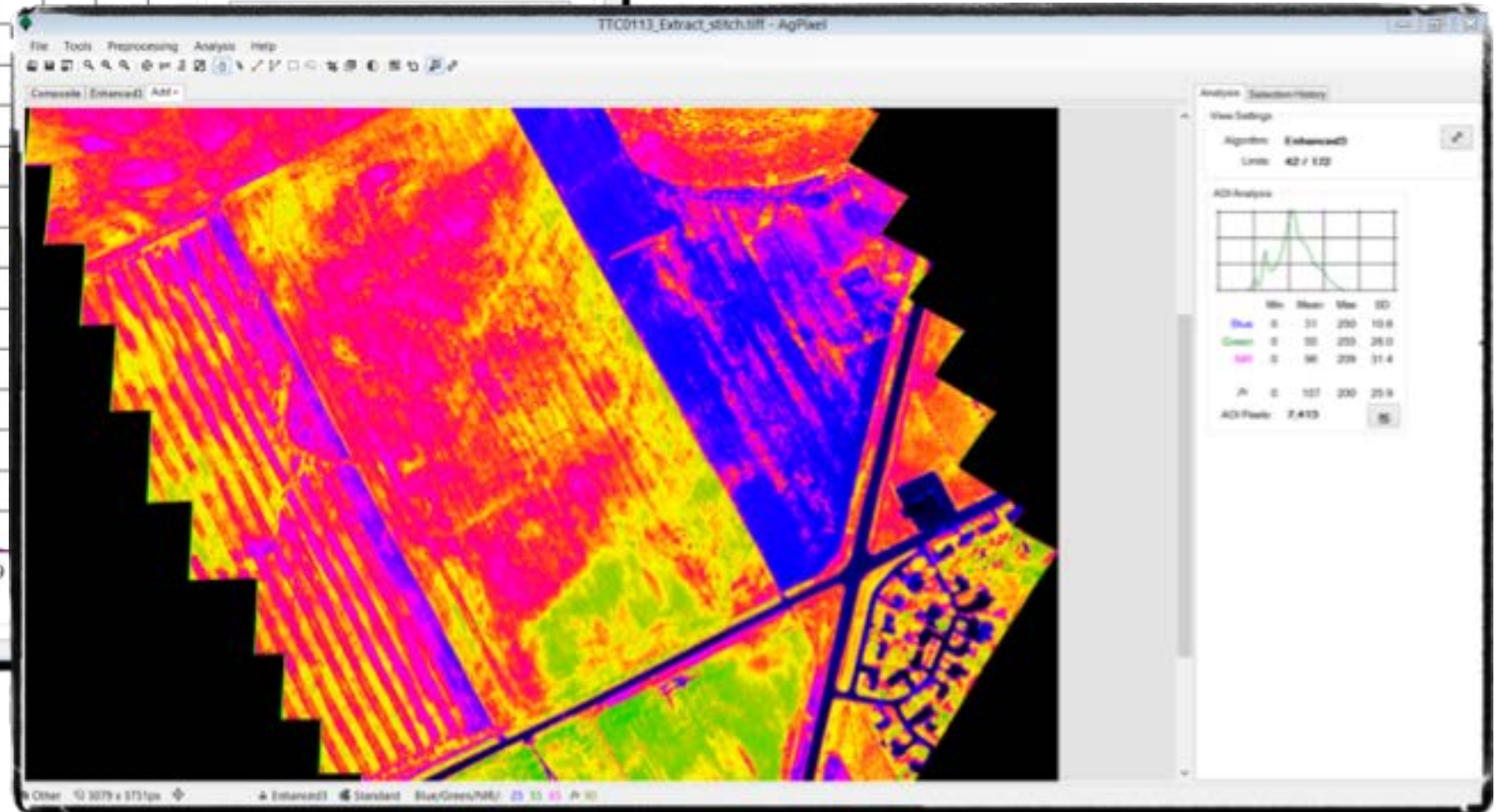


# Process the Layers

Geo-register the images



Calibration



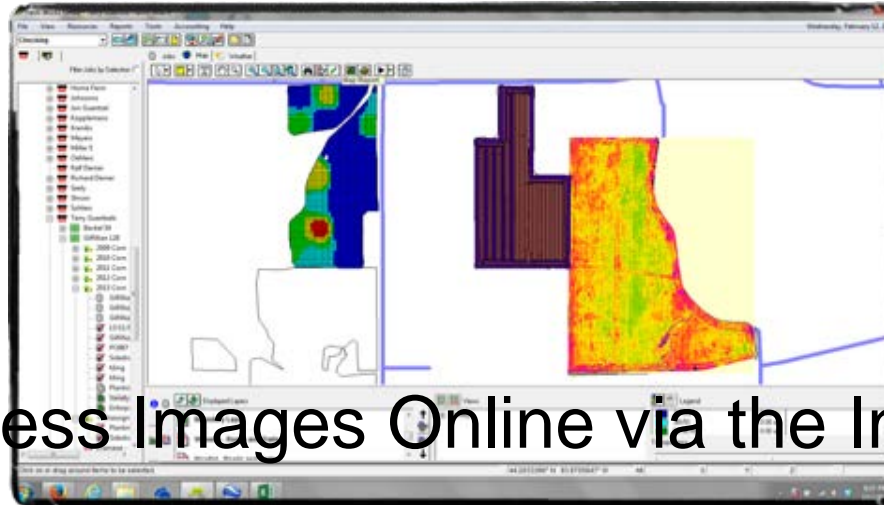
# Product Delivery



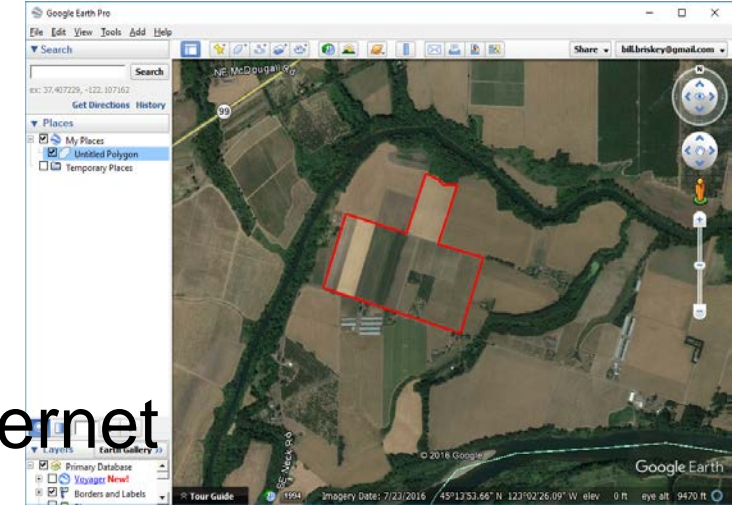
Mobile Device



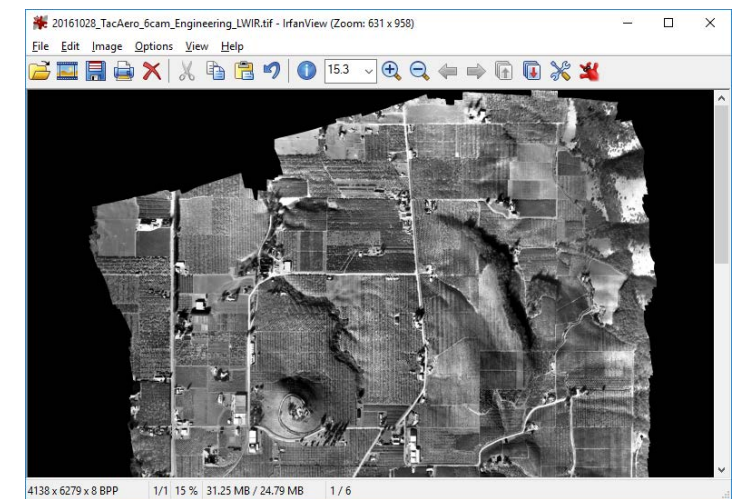
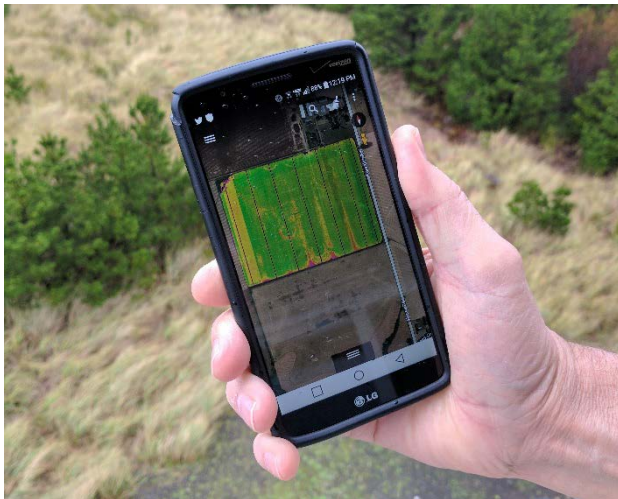
Farm Management Platform



Generic Platform

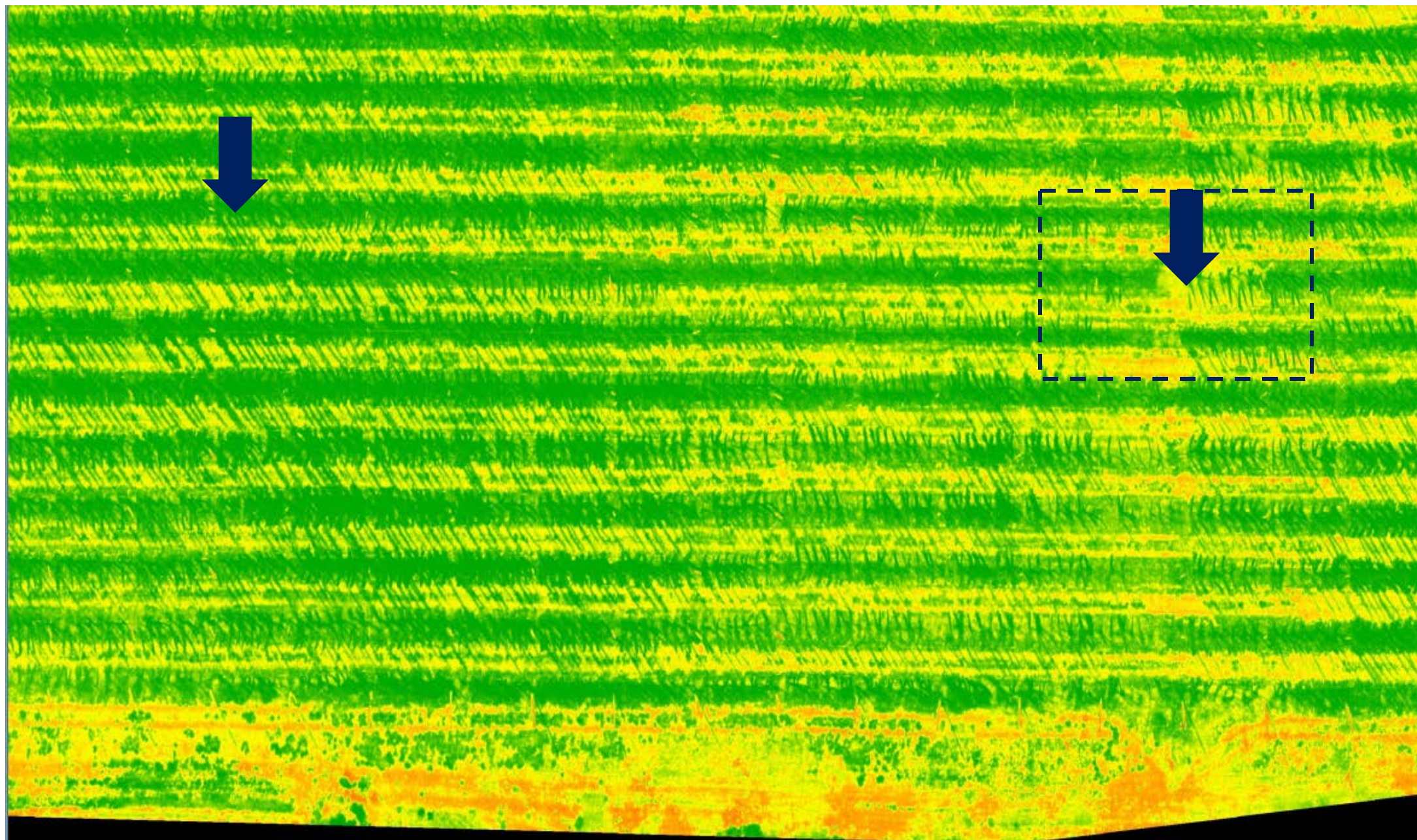


Access Images Online via the Internet

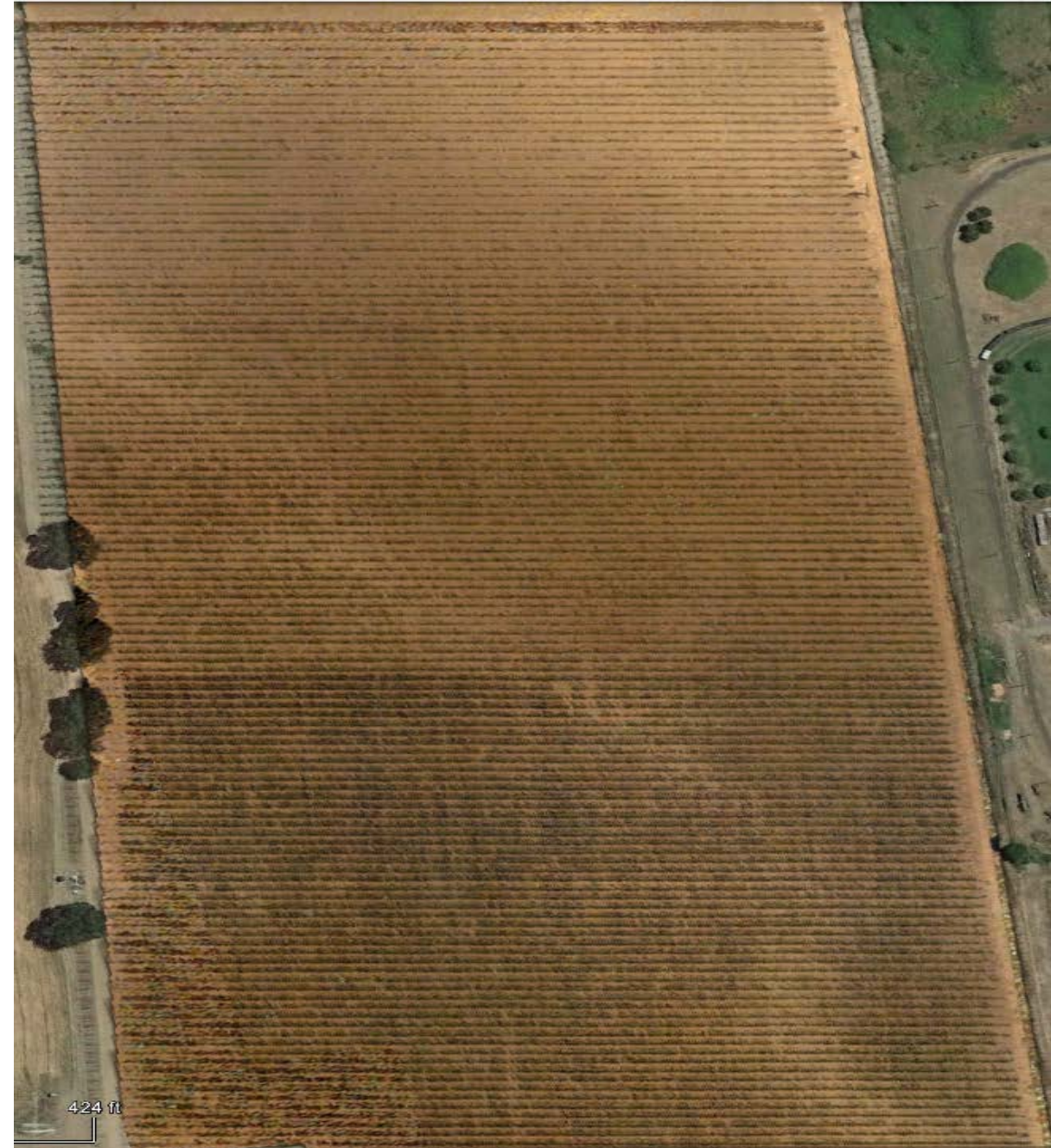


# Variable Application

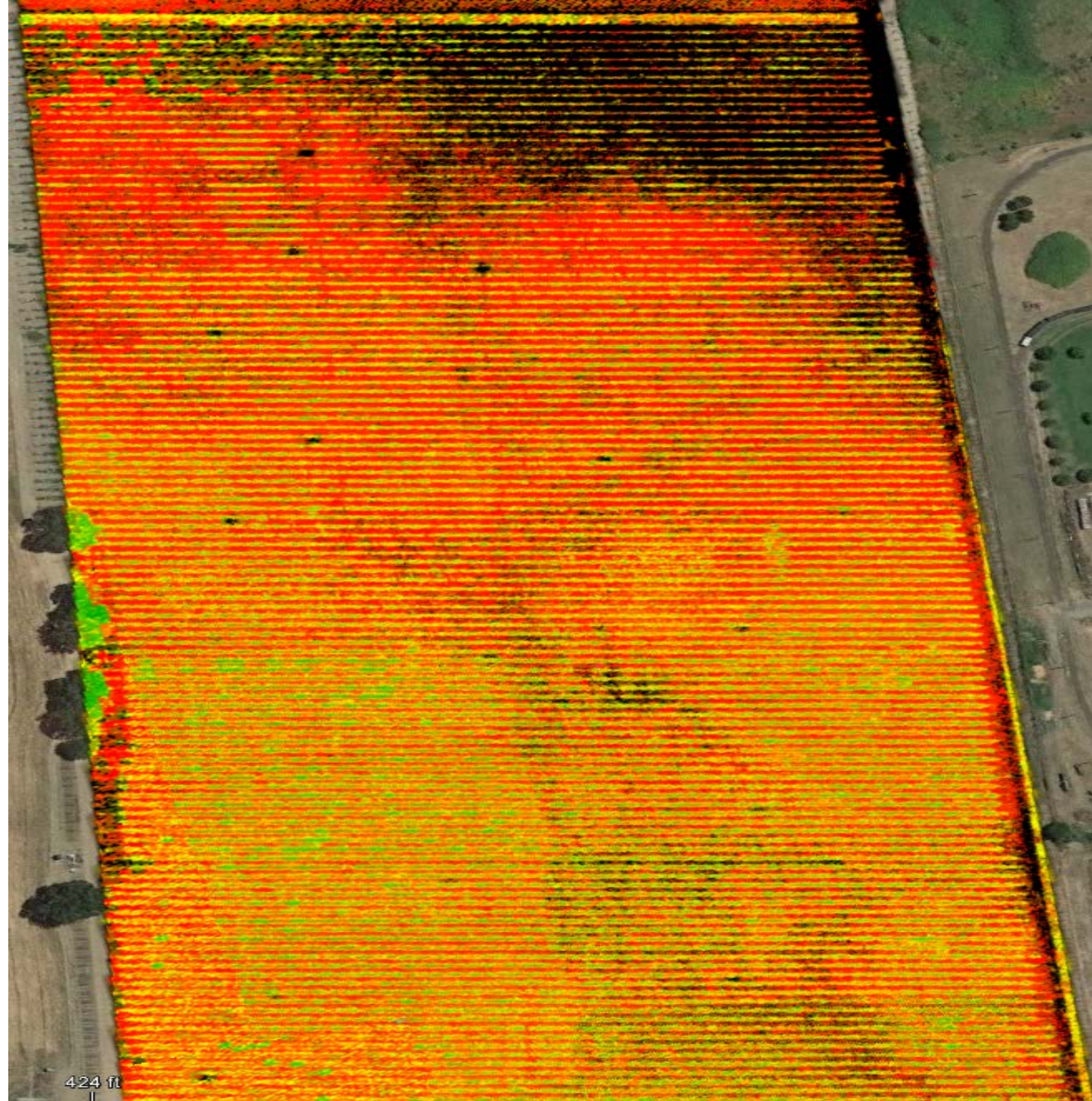








Color

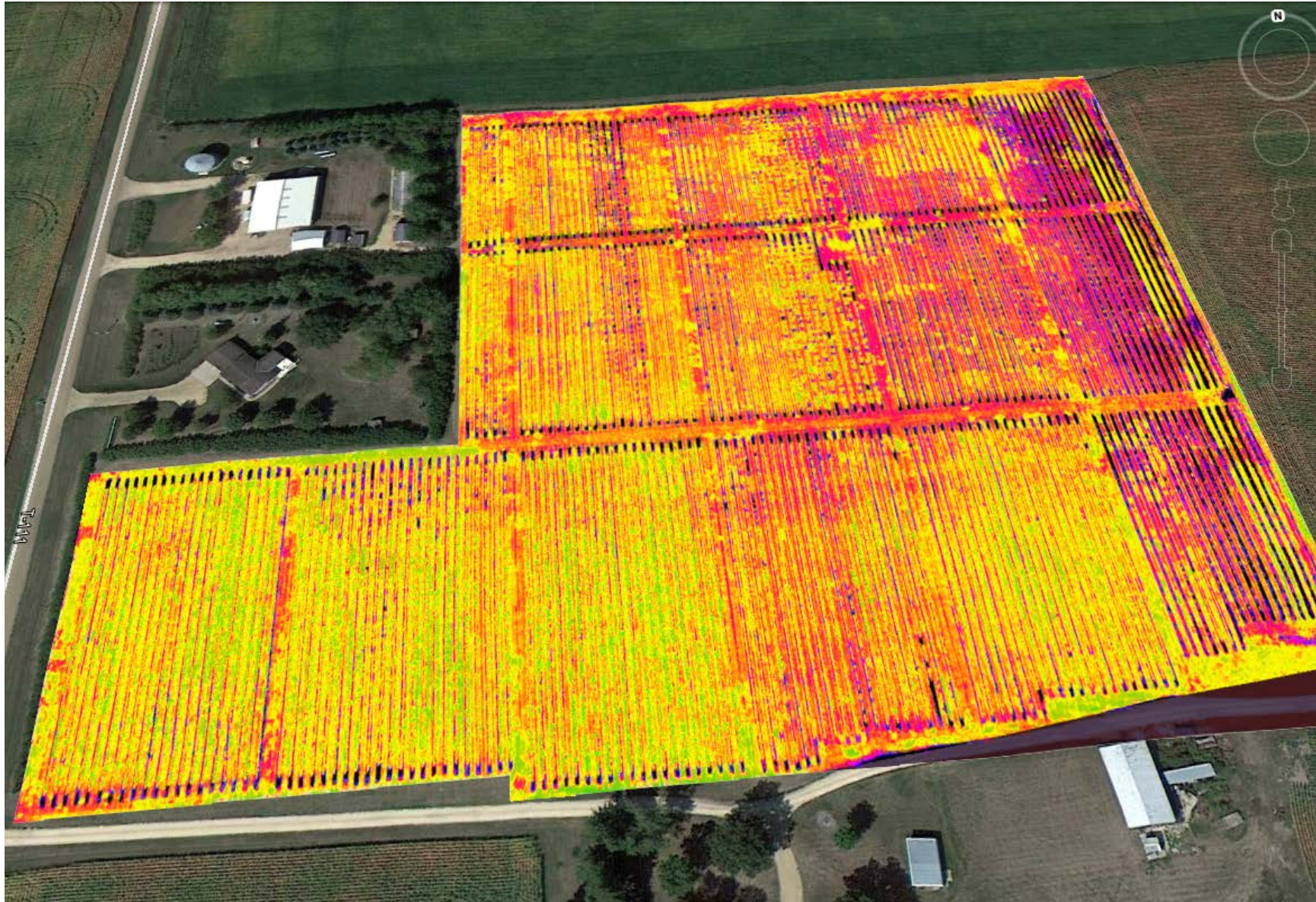


NDVI

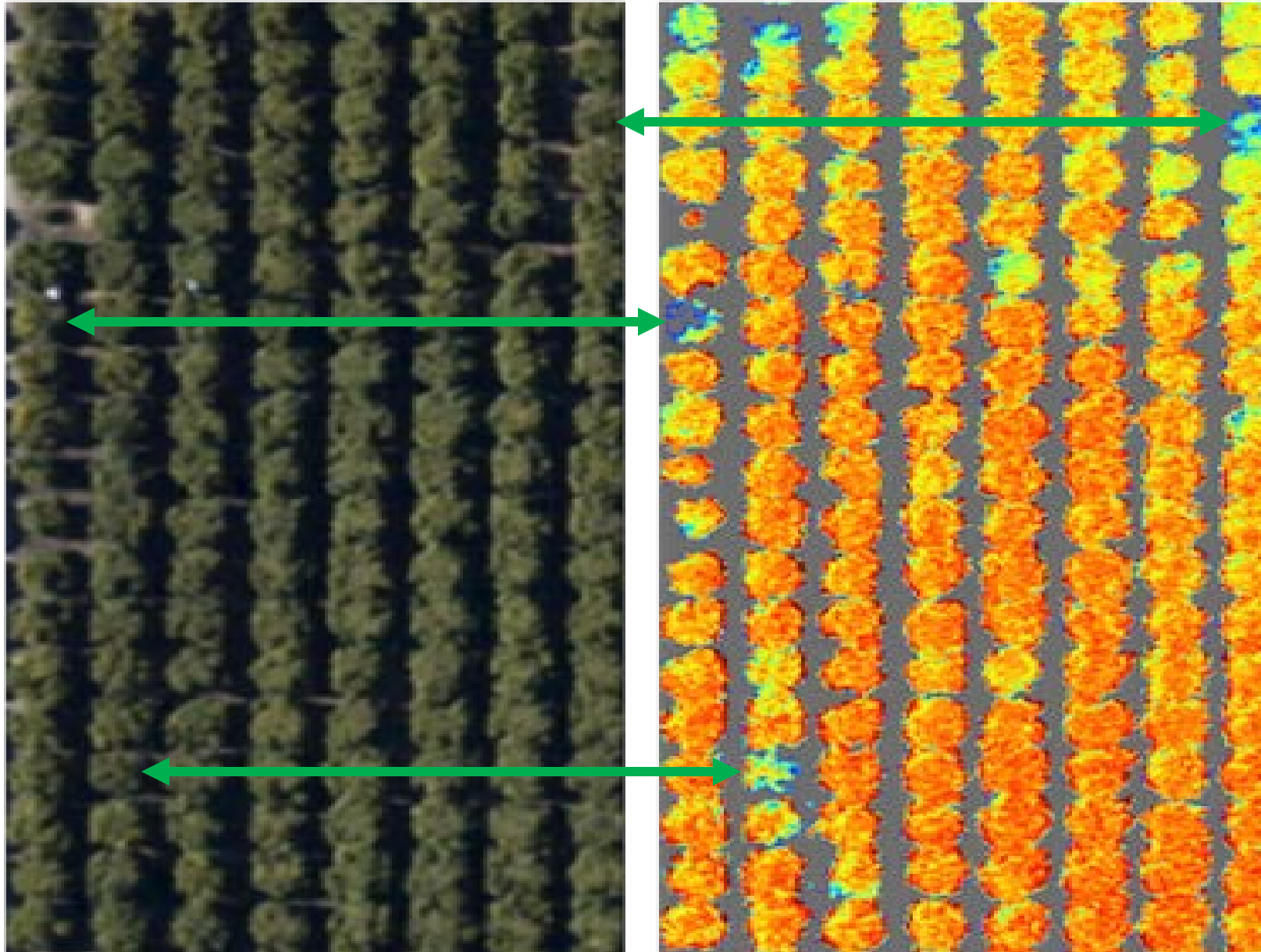
# Vineyards & Orchards



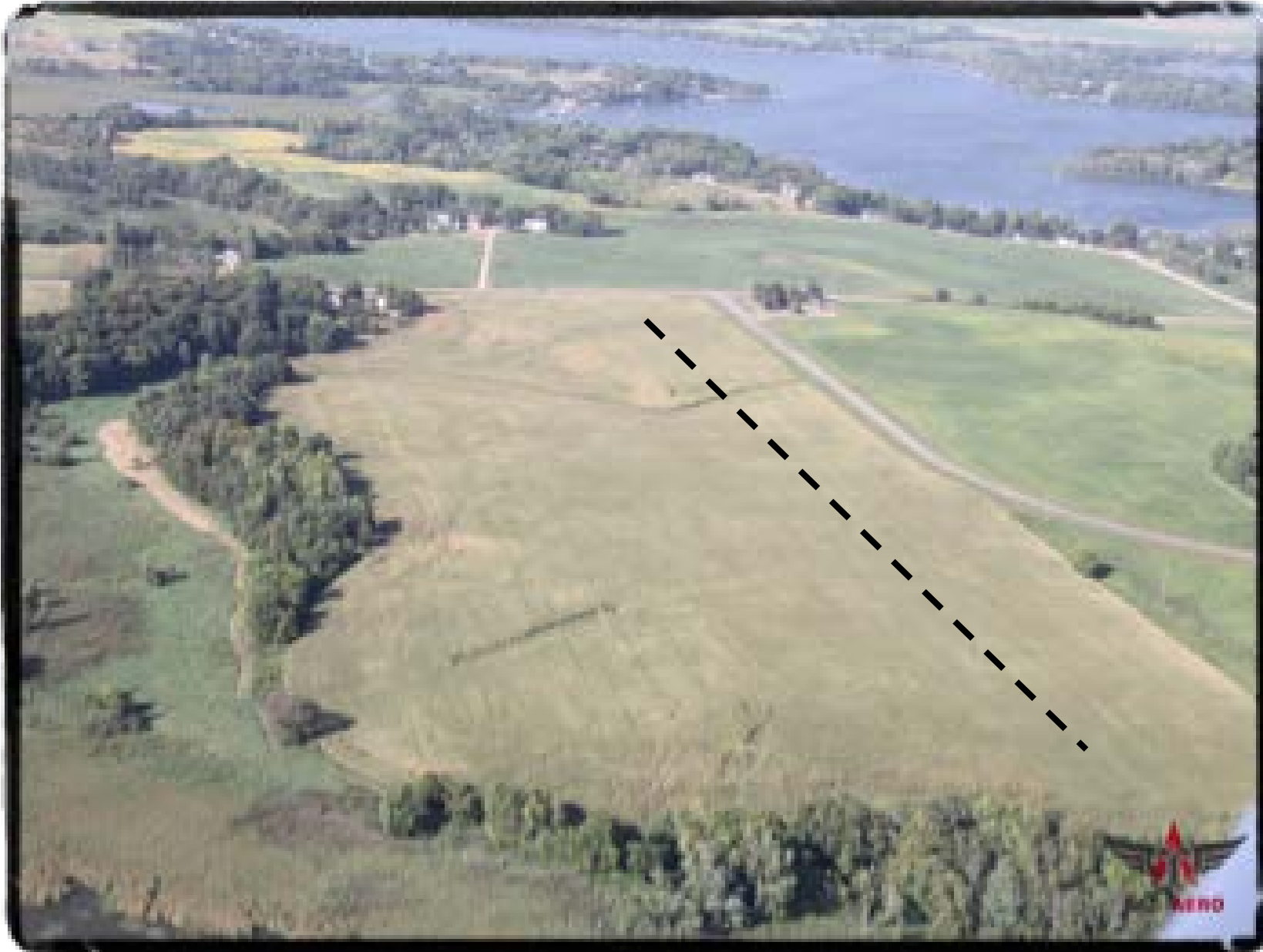
# Vineyards & Orchards



# Census or Anomaly Detection



# Fungicide Performance



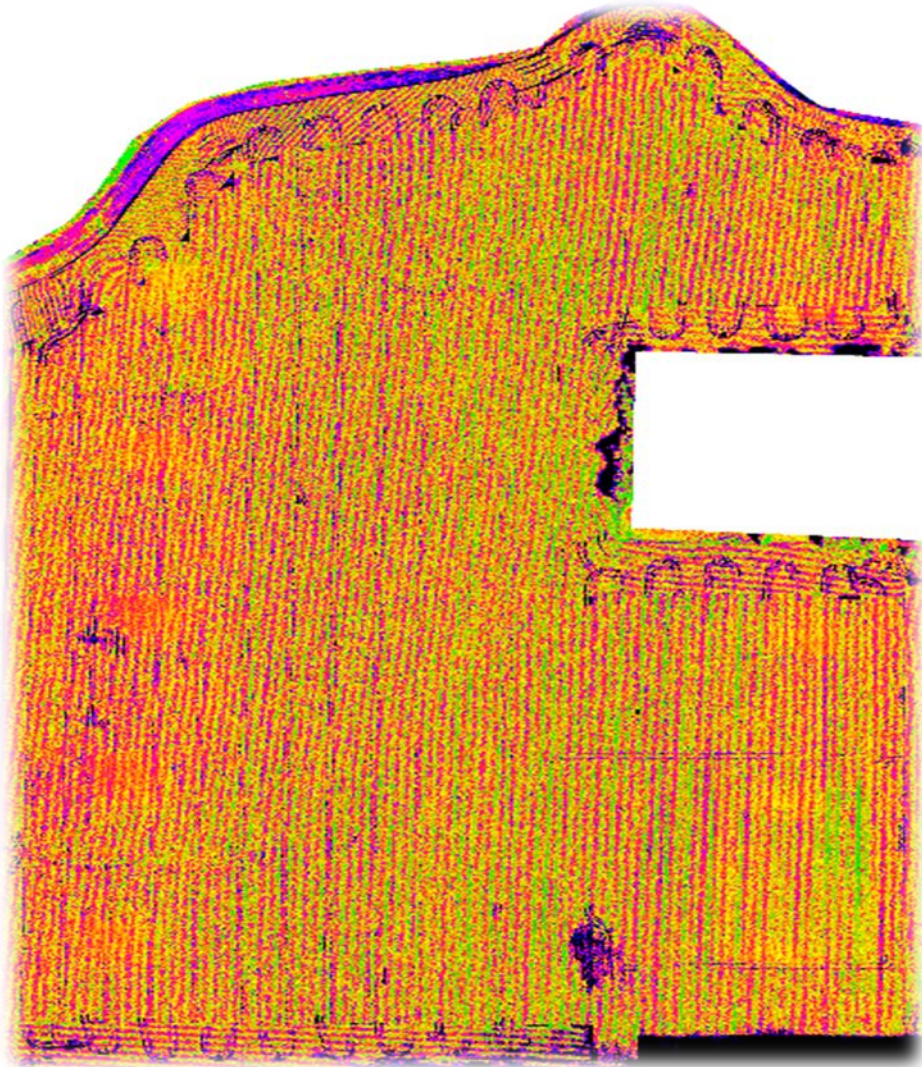
# Fungicide Performance



# Fungicide Performance

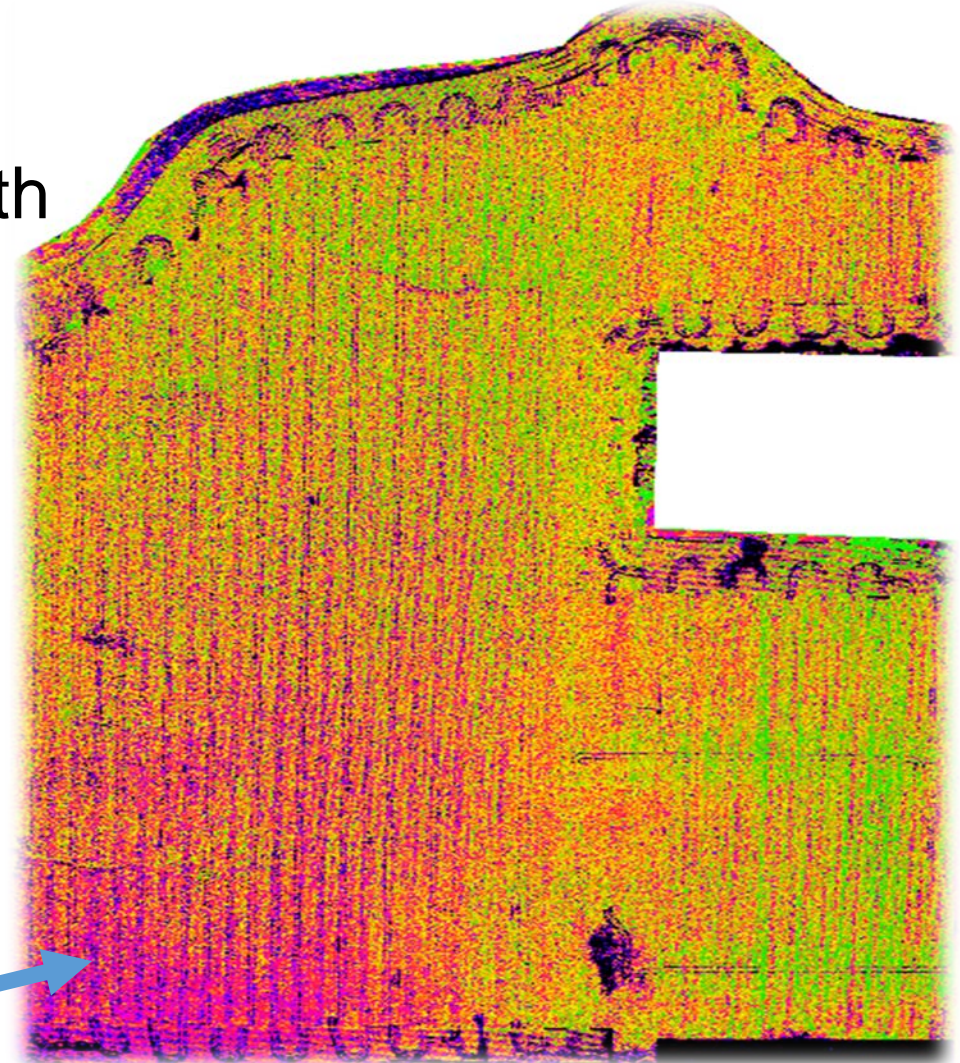


# Time Stress Analysis



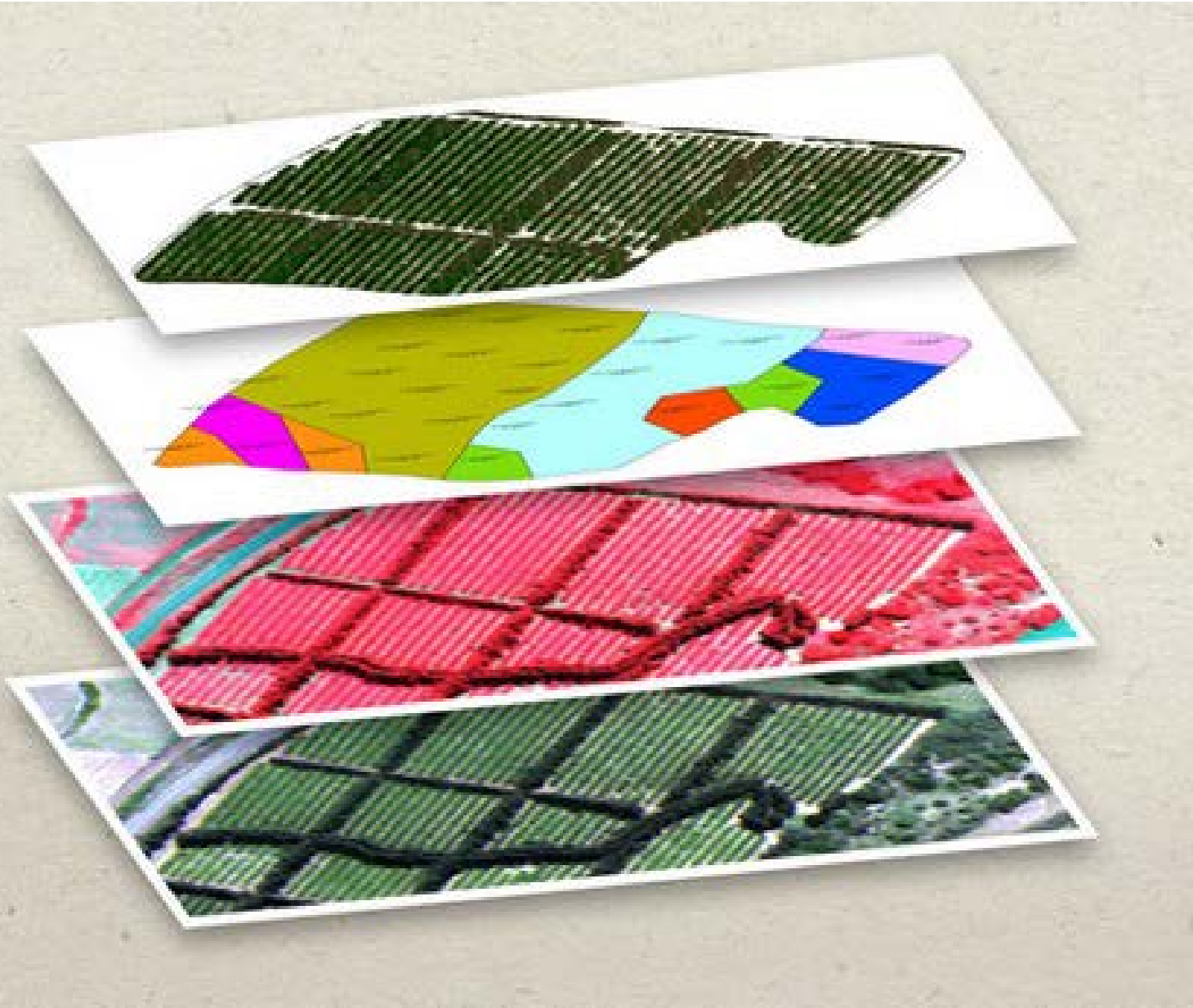
July 31<sup>st</sup>

Aug. 25th



*Increased insect pressure*

# Big Data



## Layers of data - *history*

- Yield/Quality
- Insect/Disease
- Applications
- Soil Type/Tests
- Petiole data
- Weather events
- Aerial Imagery

# Hops 101



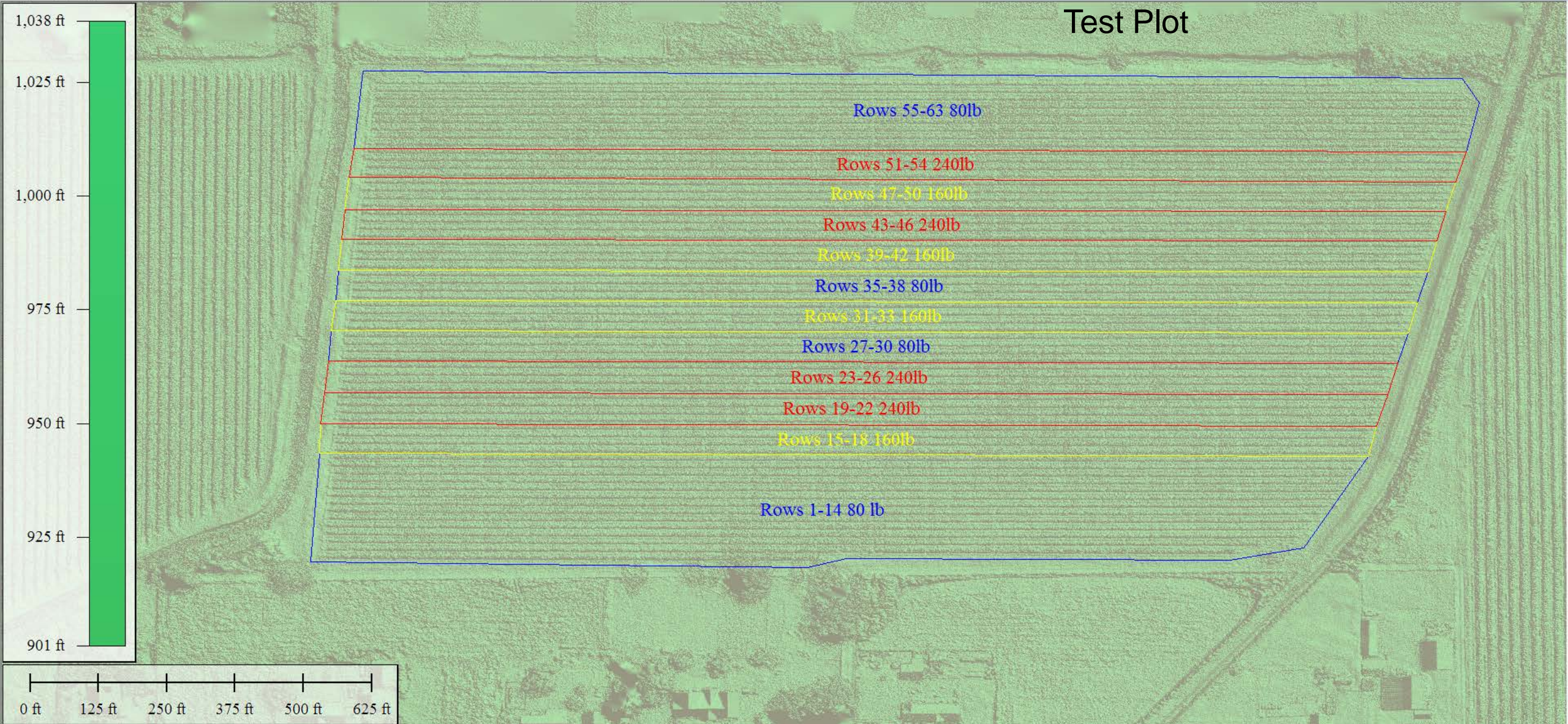
- Captured image data for 9 growers both weekly and bi-weekly
- Resolution: 4-inch pixels
- Huge file sizes and 100GB+ per flight
- Processing time increased

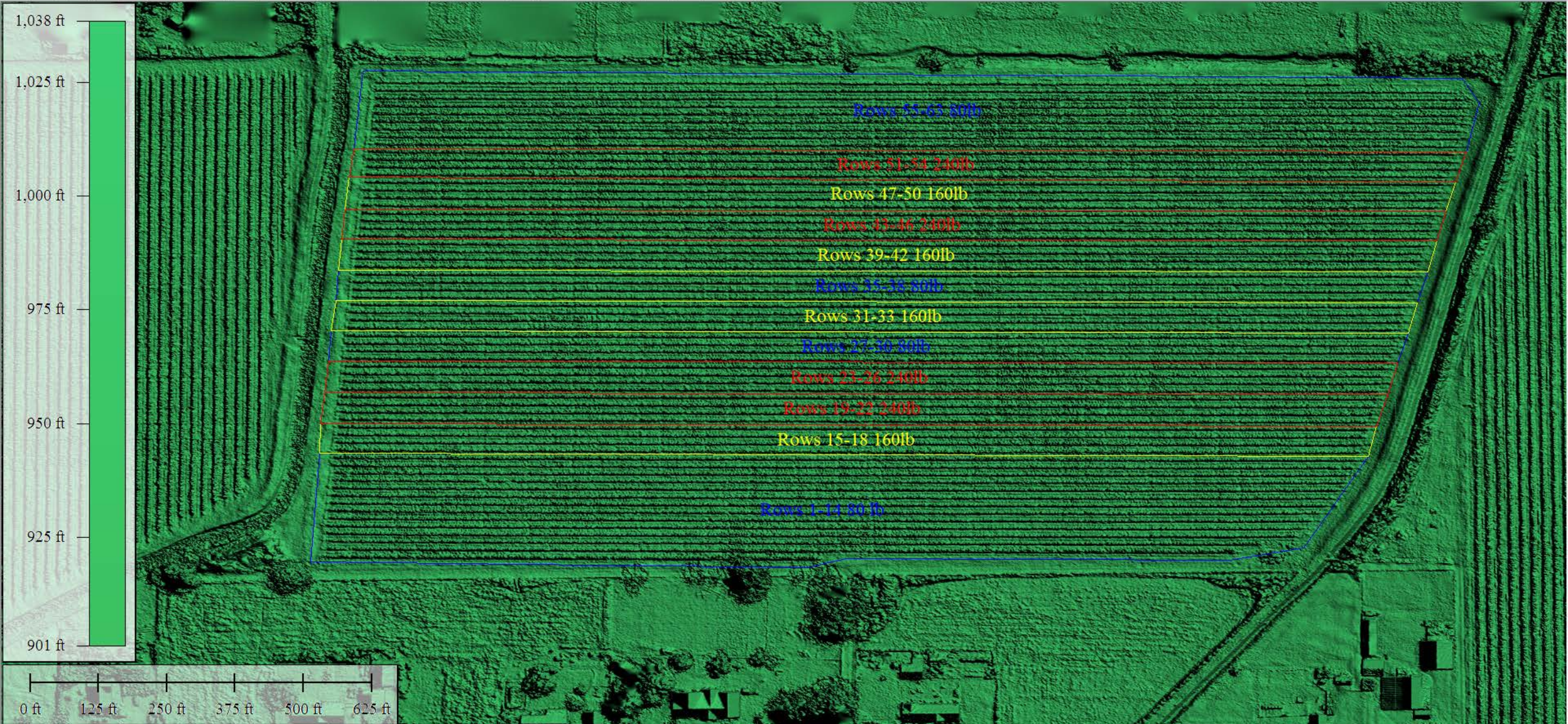
Some positives –

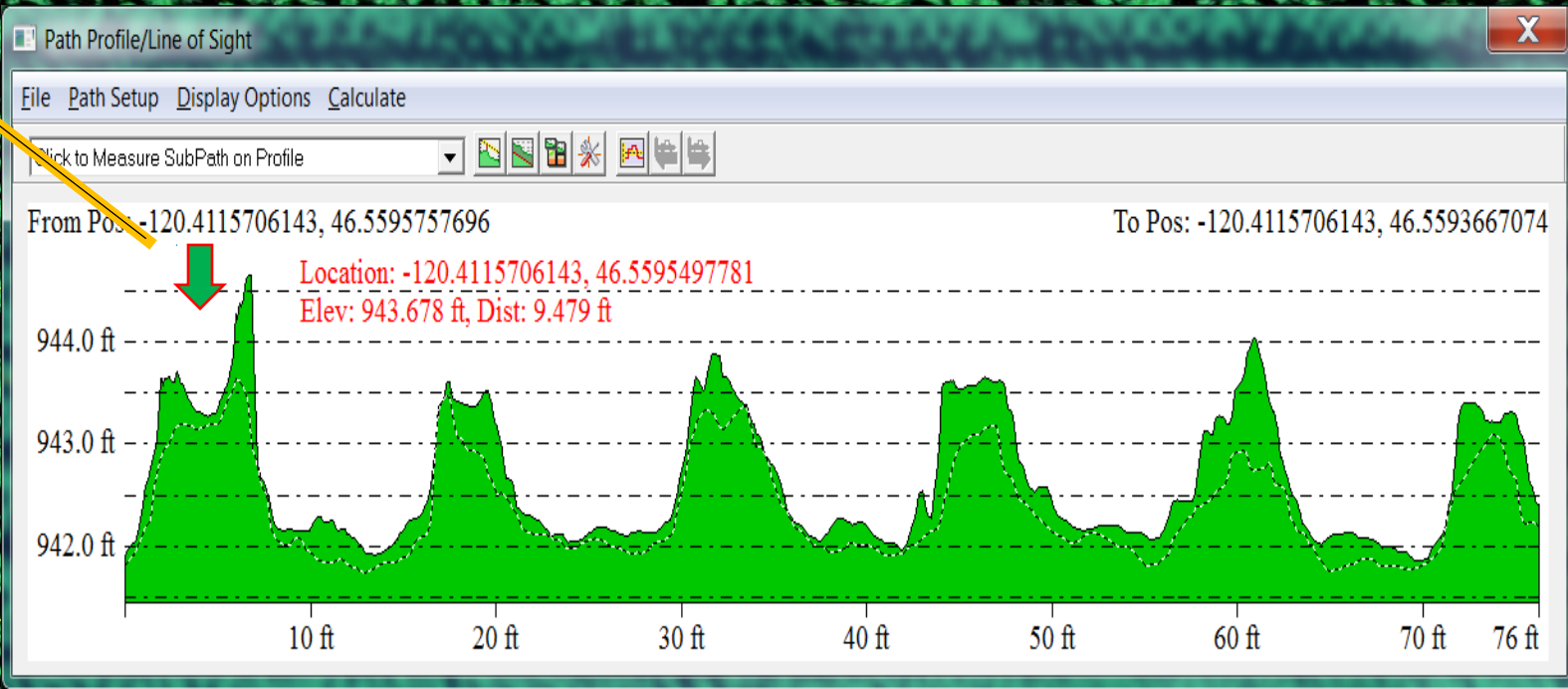
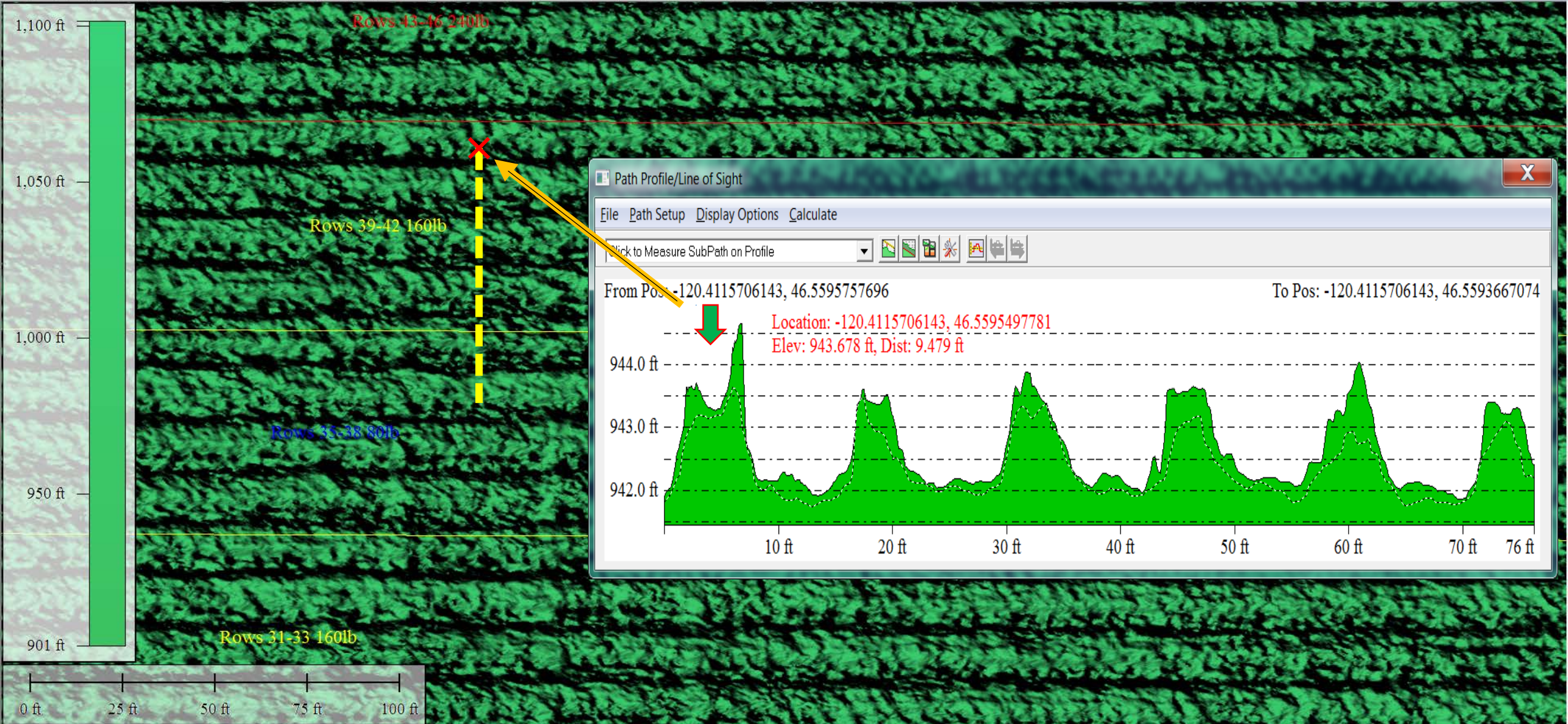
- Locate individual plants
- Easy to spot things that are sometimes missed
- DSM...

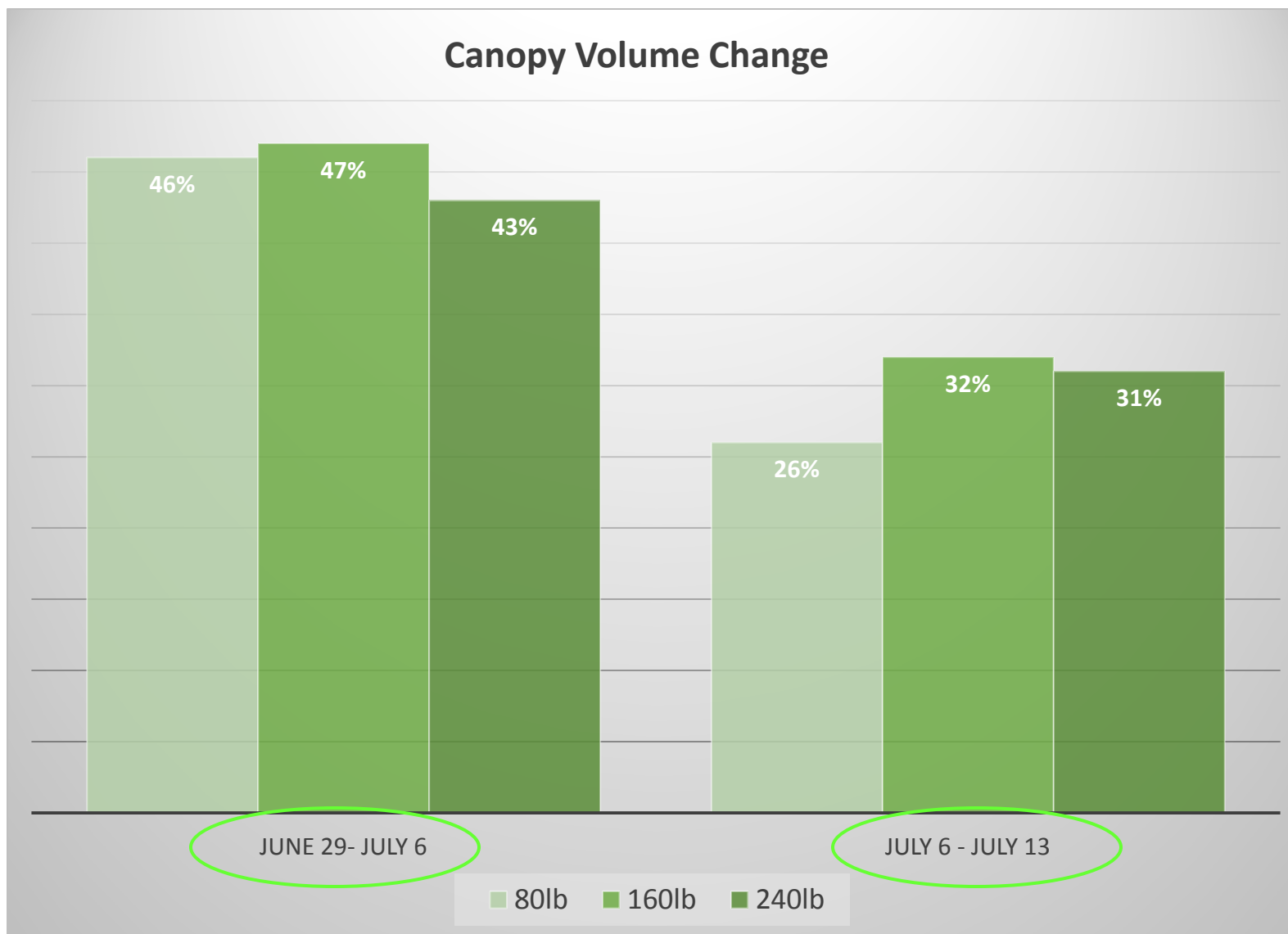
# Loftus Ranches, Inc.

## Test Plot









# Hops 101

## 2016 Challenges

- Huge file sizes meant it took more time to get them to the grower
- There were no simple tools the grower could use to analyze the images
- The weather got us a few times – clouds block NIR

# Hops 101

2017

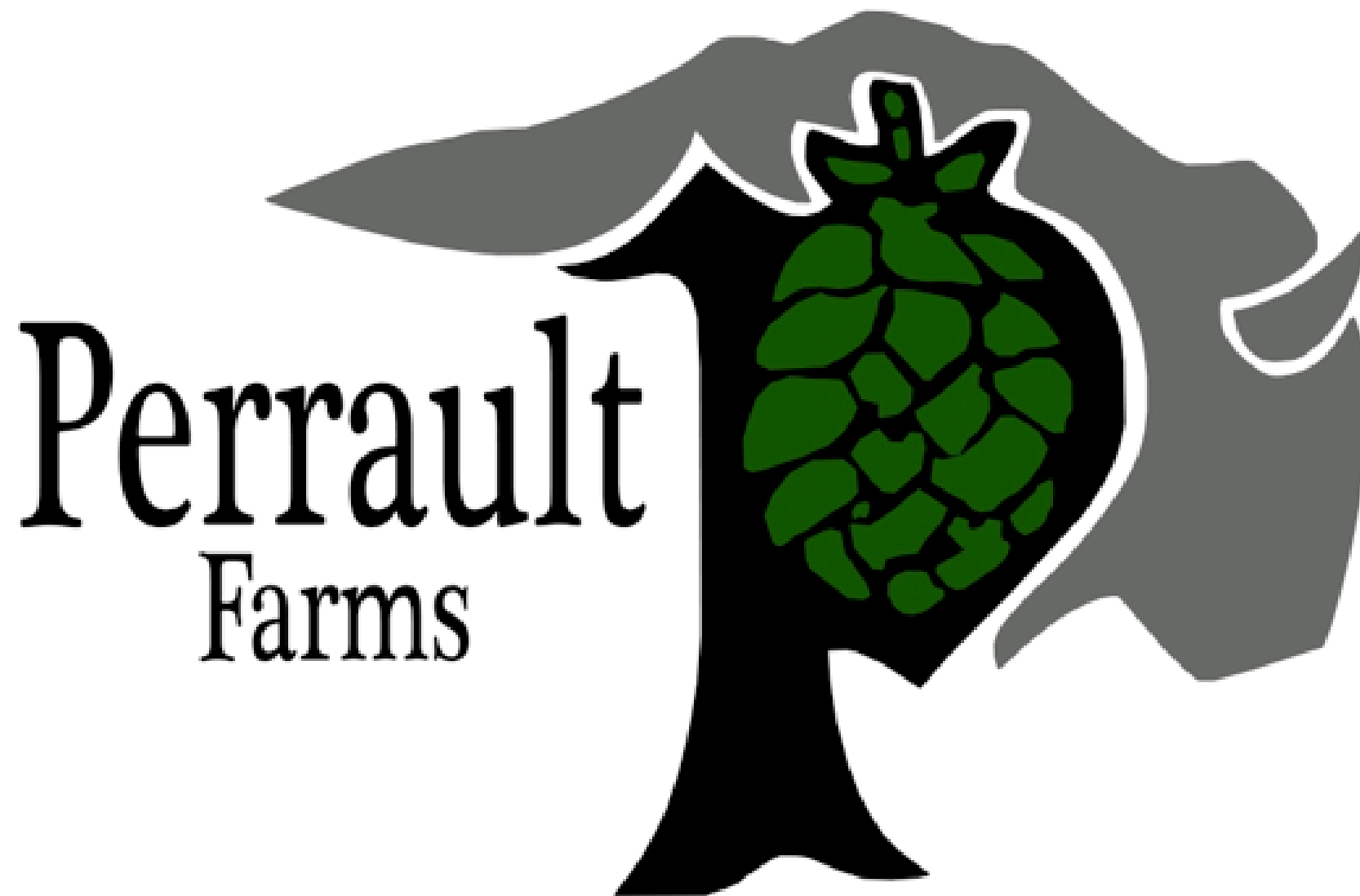
- Resolution
- Camera Payload
- Processing Power
- Tools
  - Remove Cover Crop
  - Time-Series Comparison
  - Partnering with a Midwest company who will provide scouting tools
- Testing – working with growers and supporting researchers
- Weather App

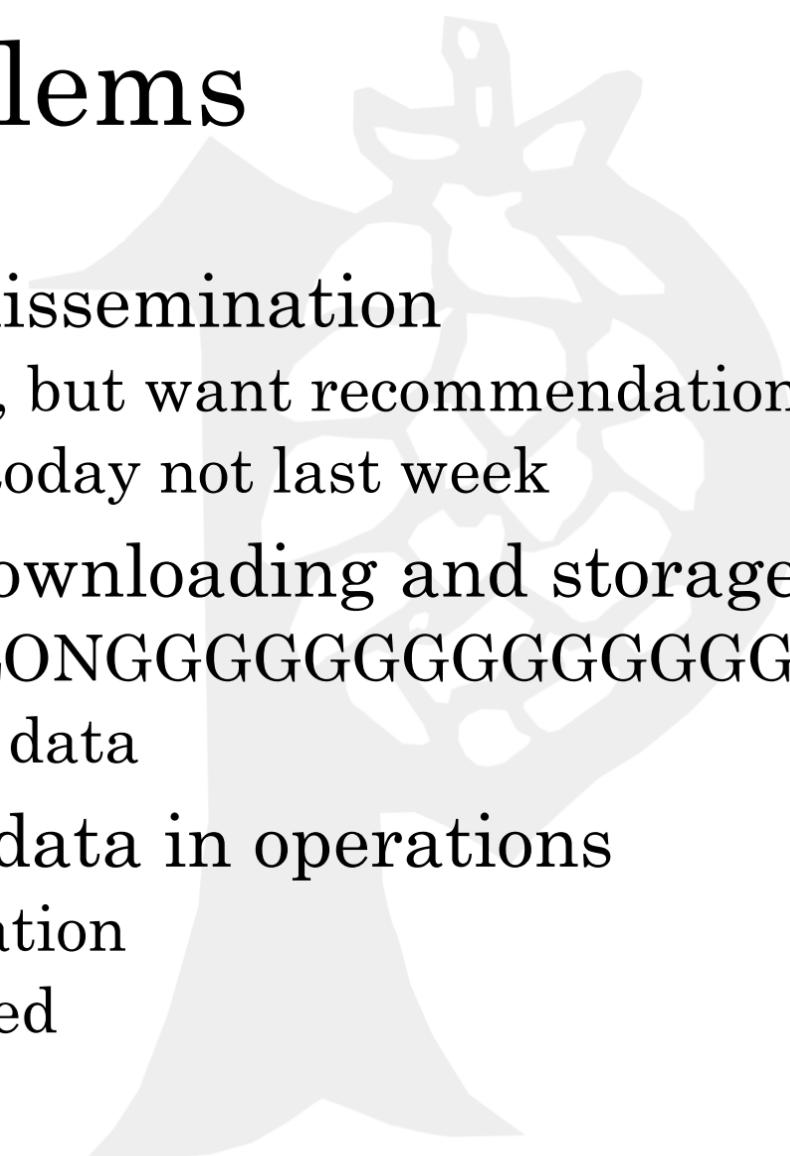


TAC AERO



Booth 34





blems

dissemination

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downloading and storage

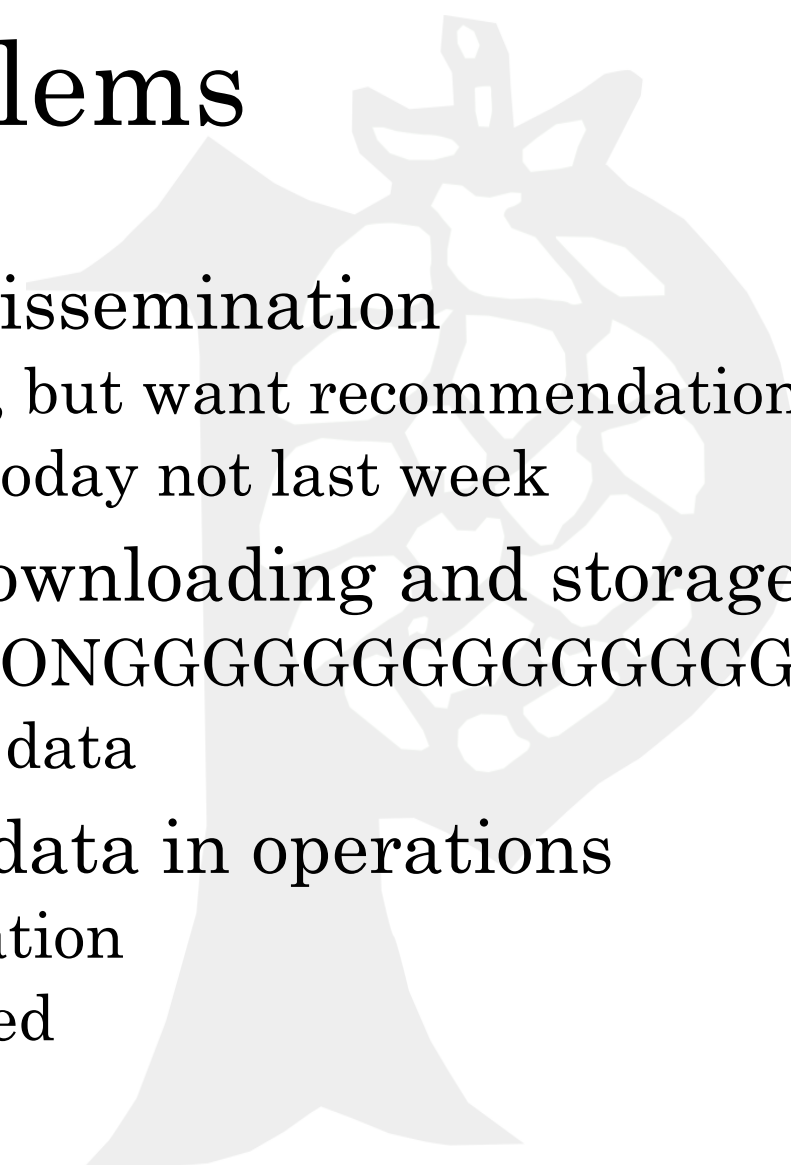
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- today not last week
- downloading and storage
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# Data Paradigm Shift

*Training ol' dogs*

**The easier it is to relate different data to what you see in the field the more relevant the information becomes**

- We reference data to time, why not location as well?
- What you gain is the ability to see why one area outperforms another and how that changes season to season
- Nuts-n-bolts
  - We tried google earth, QGIS, ArcGIS, and actual paper PDF reports
  - If you can get buy-in, GIS is the best solution but takes expertise and training

# Recommended Data Processing Solutions

*Solutions to 'too slow'... and the best I have for 'too busy'*

- Dropbox upgrade
  - More storage, quicker sync, more accessibility
  - 1 user – business level is \$13/m
- External hard drive
  - \$150-250 each
- GIS capability
  - Free
  - Able to use information
  - Able to layer information to see trends
- Or, use third party ag management software
  - Expensive but plug-n-play easy

# My Plan for 2017

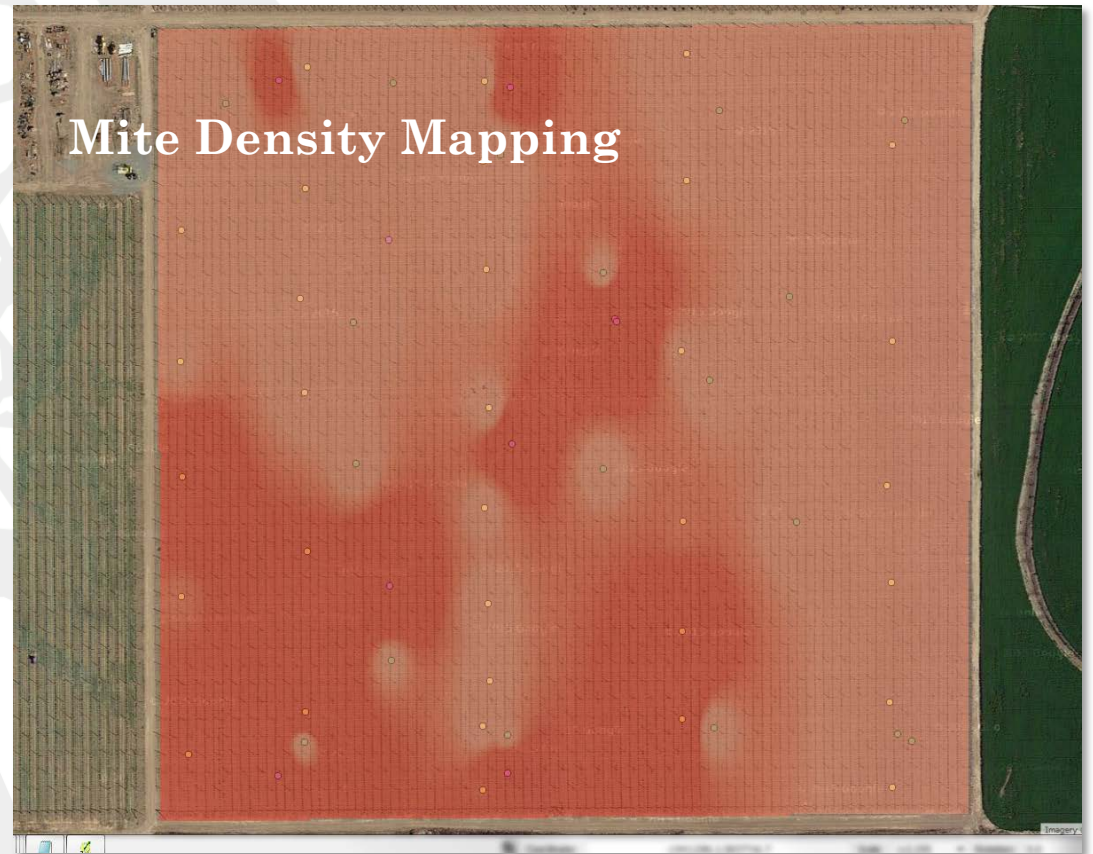
*We'll see what Steve says...*

1. Georeferenced scouting data
  - Scouts will generate scouting maps at the end of the day so they are available the next morning
  - Want scouts to reference earlier maps to make recommendations
  - Would have a layer for each value (TSSM, Aphids, different beneficials)
2. Georeferenced soil data, and collect more of it
  - GIS layer of each value of interest on the soil report (Ca, N, P, K, CEC, etc.)
  - EC mapping on a small scale
3. Georeferenced petioles
  - Same as soil samples
4. Remote sensing data

# Example:

## Really simple!!

- Take IPM scouting data and add GPS to it
- Plug this point data into a GIS program
- The computer uses an algorithm to fill in the gaps called interpolation
- It's not perfect but it is very close



# Where the Rubber Meets the Road

- This is bigger then it seems
- Don't start collecting data without a plan on how to handle data and how to use it
- Be able to make the information relevant to you
- Understand that you will learn things you don't want to know
- Be comfortable that we don't know where this is ultimately going
- Data is valuable but make the ROI work for you every step of the way
- Ask the simple questions and don't be intimidated by the technology
- Be leery of anyone with all the answers



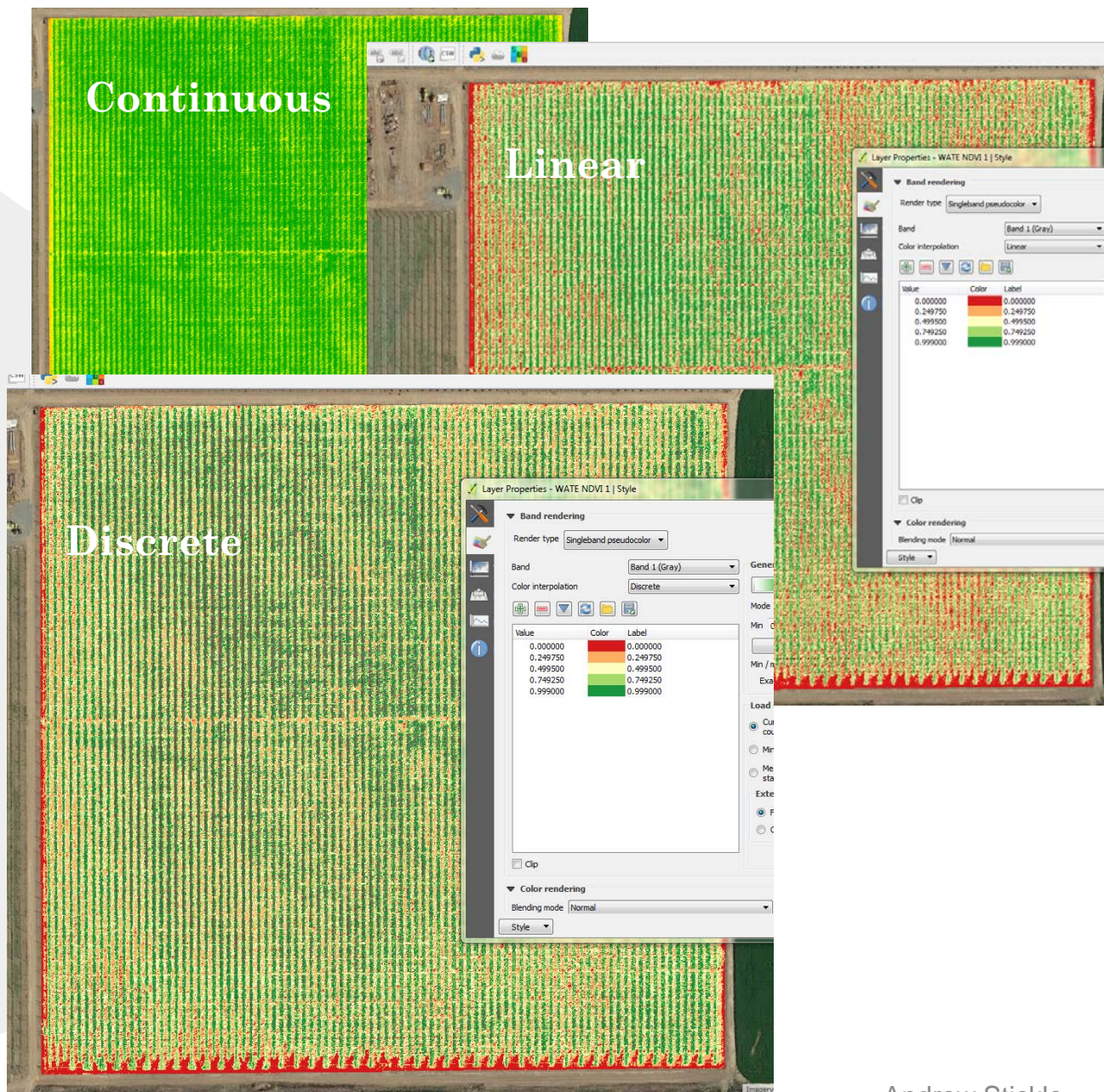
1/19/2017

2017 American Hop Convention

Andrew Stickle  
Perrault Farms Inc.

# GIS Tip

- Image interpolation is key
  - Imagery comes as continuous interpolation
    - How the computer displays the data
  - **Continuous** is like putting *stew in a blender*
  - **Linear** is just *stew in a bowl* and is great for field level overviews
  - **Discrete** is like *deconstructed stew* and is great for row-to-row level comparisons



# GIS Tip

- **Make it simple so you can see what you need to see**
- This layer is only NDVI values of 1 (highest level)
- We can assume that the areas with the most white are the healthiest areas

