Application of Real-Time Sensor Systems for Precision Cotton Management

2006 Crop Management Seminar

Sponsored by Cotton Inc.

Memphis, Tennessee

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The University *of* Tennessee

Spectral Reflectance Sensing for Crop Management

1. Opportunities for Variable Rate Control of:
   - Nitrogen
   - Growth Regulators
   - Defoliants

2. Airborne Imagery for Scouting and VR application maps vs. Equipment Mounted Crop Sensors

3. Emerging Technologies

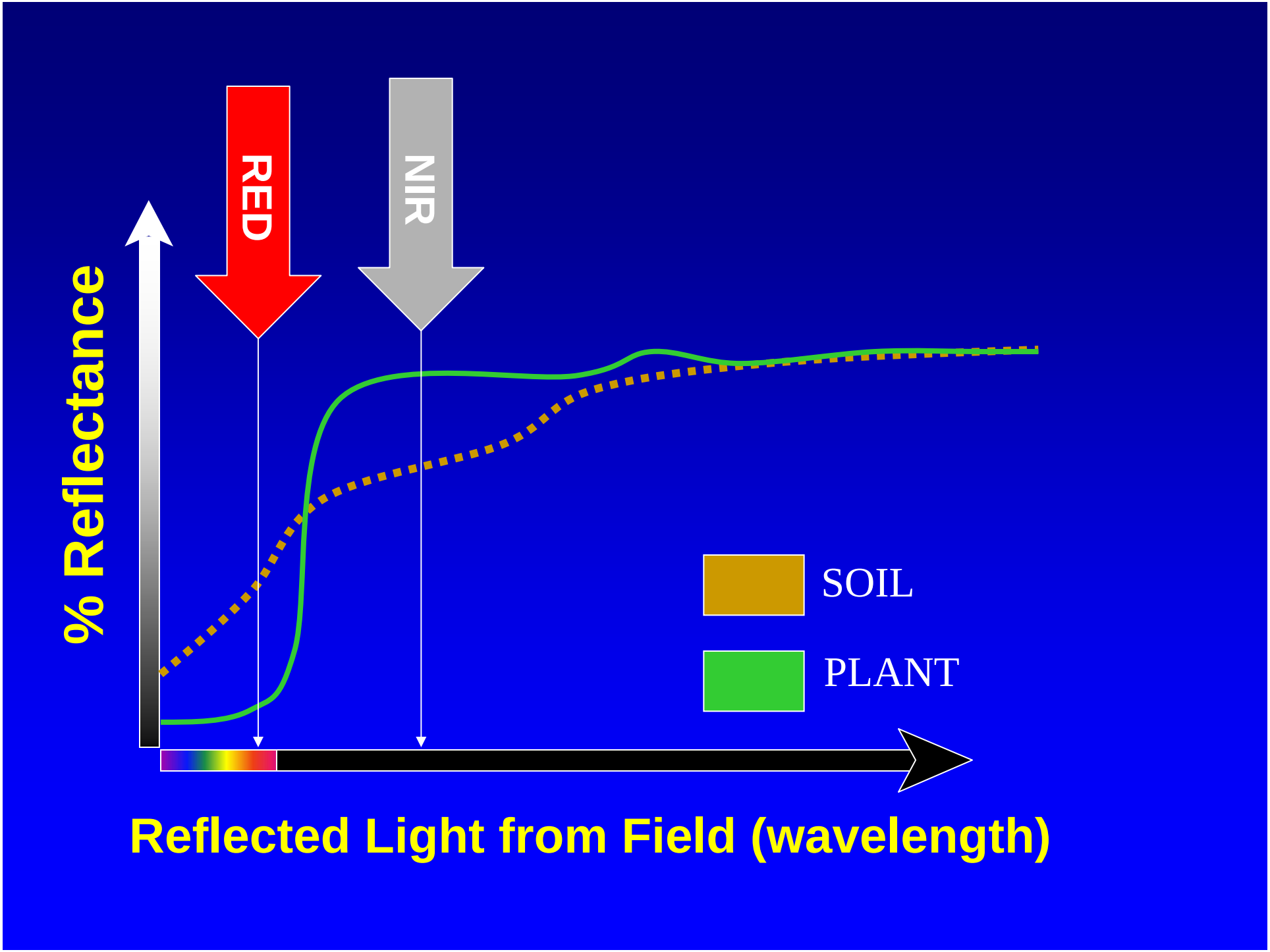
Why use remotely sensed spectral reflectance?

- Scouting **Aid** (not a replacement)
- Mid-season decisions on variable rate:
  - Nitrogen
  - Growth Regulators
  - Defoliants

Approach

Remote Sensing of Reflected Light

- Satellite Imagery
- Airborne Imagery
- Real-time on-the-go sensing (ground-based)


RED
NIR
% Reflectance
SOIL
PLANT
Reflected Light from Field (wavelength)

NDVI

Normalized Difference Vegetation Index

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

Low NDVI **High NDVI**

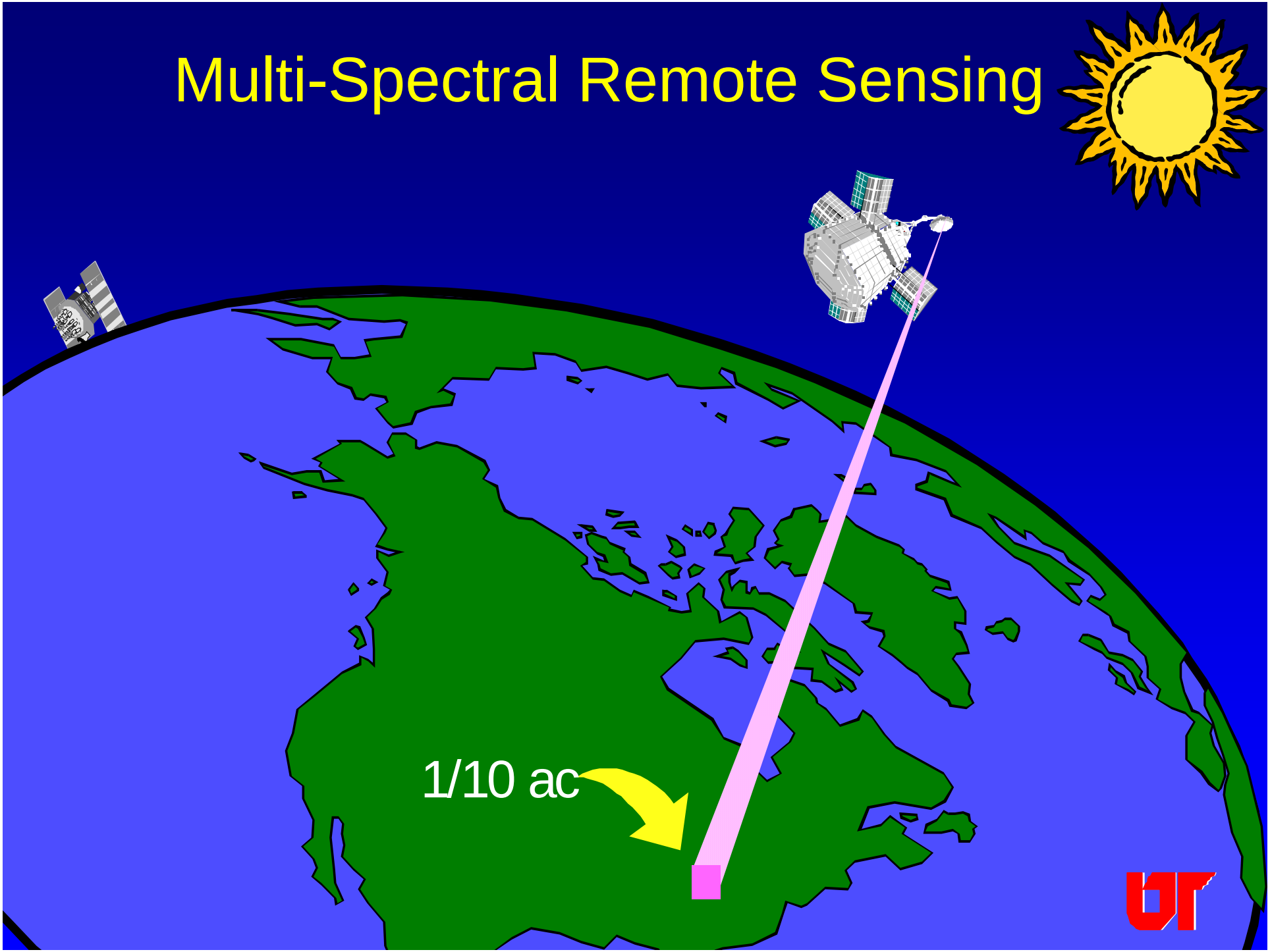
Lowest Biomass

Highest Biomass

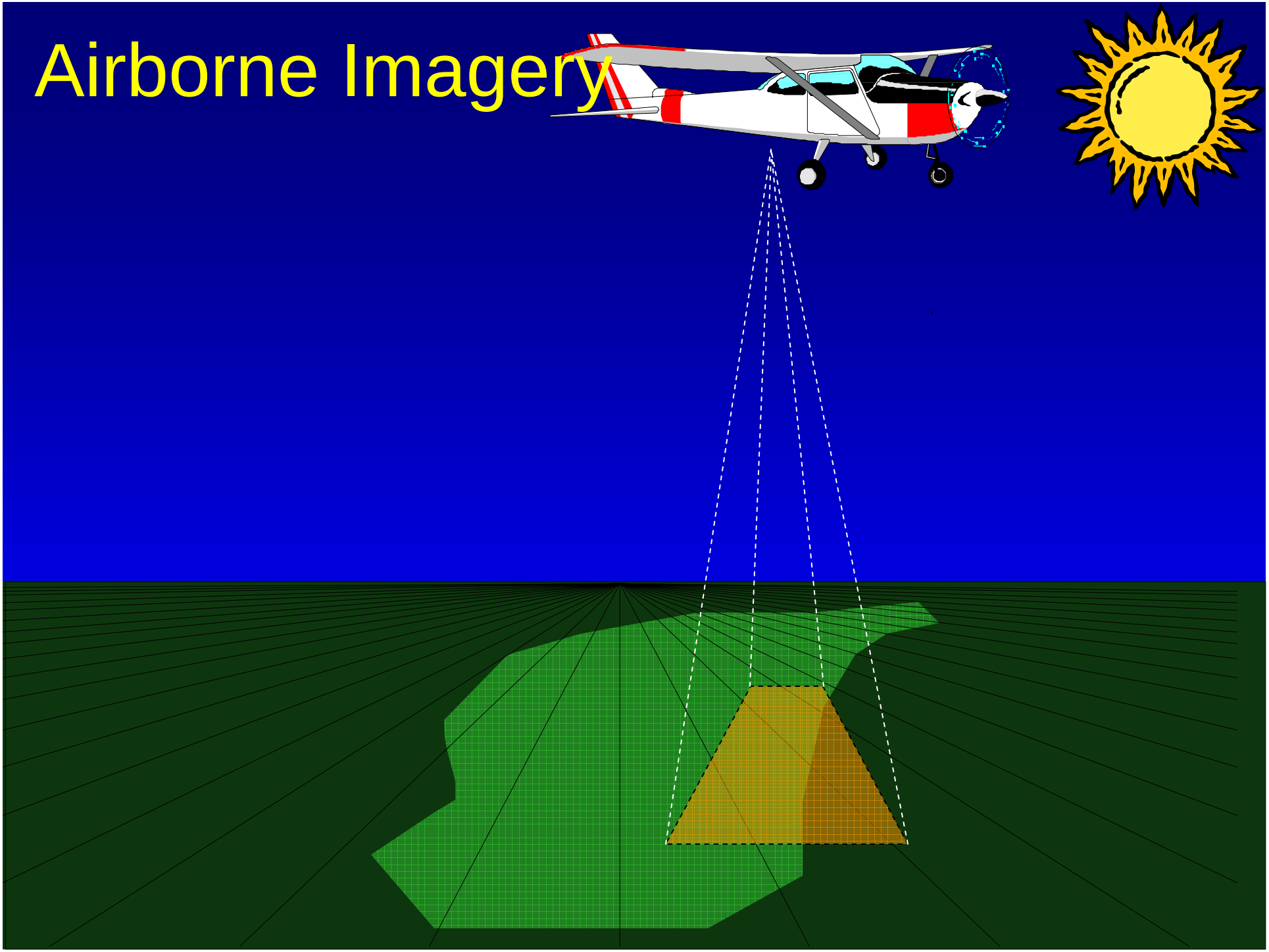
Thinner Canopy
Stressed Plants

Thicker Healthy
Canopy
Not Stressed

Multi-Spectral Remote Sensing



Airborne Imagery




Field-of-View
(Resolution)

Image Acquisition → Variable Rate

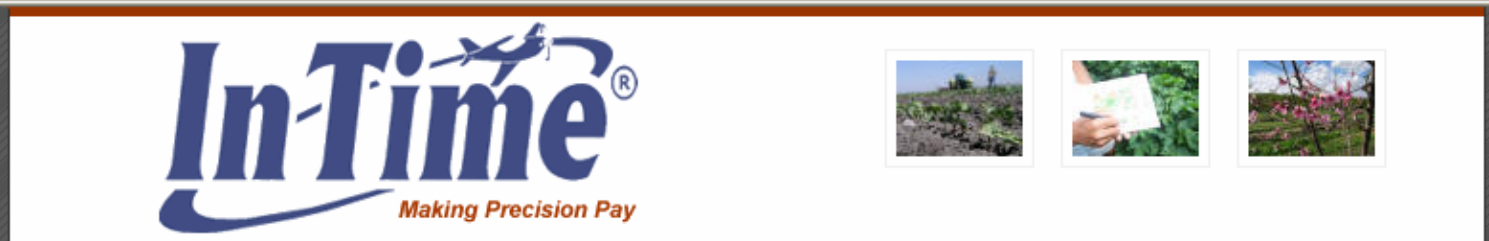
- An image is requested {date, field(s) }
- Acquisition of imagery from aircraft
- Image is processed to create a scouting map
- Geo-referenced image made available to consultant/producer via the internet

InTime :: Select a Tool - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites

Address http://www.gointime.com/StartMenu.jsp Go Links



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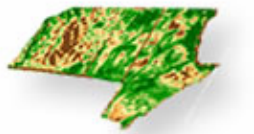
UT Milan **Blake Brown**

Client Toolbox

- **Toolbox Home**
- Imagery Status
- Data Acquisition
- Scout Maps
  - Create New Scout Map
  - Download Scout Maps
- Prescriptions
  - Create New Prescription
  - Download Prescriptions
- Settings
  - View Profiles
  - Edit Farm Profile
  - Change My Password
  - Edit My Profile
  - View/Edit Zones
- Log Out



Create New Scout Map

Download a Scout Map

Create New Prescription

Download a Prescription

Data Acquisition

Imagery Status

Error on page. Internet

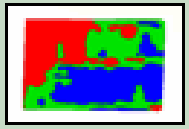
http://www.orderzone.johndeereagriservices.com - Aerial Imagery - Microsoft Internet Explorer

JOHN DEERE AGRI SERVICES | Imagery

Order Imagery | Order Status | Zone Creation | Export Application

Order Imagery

Order Status

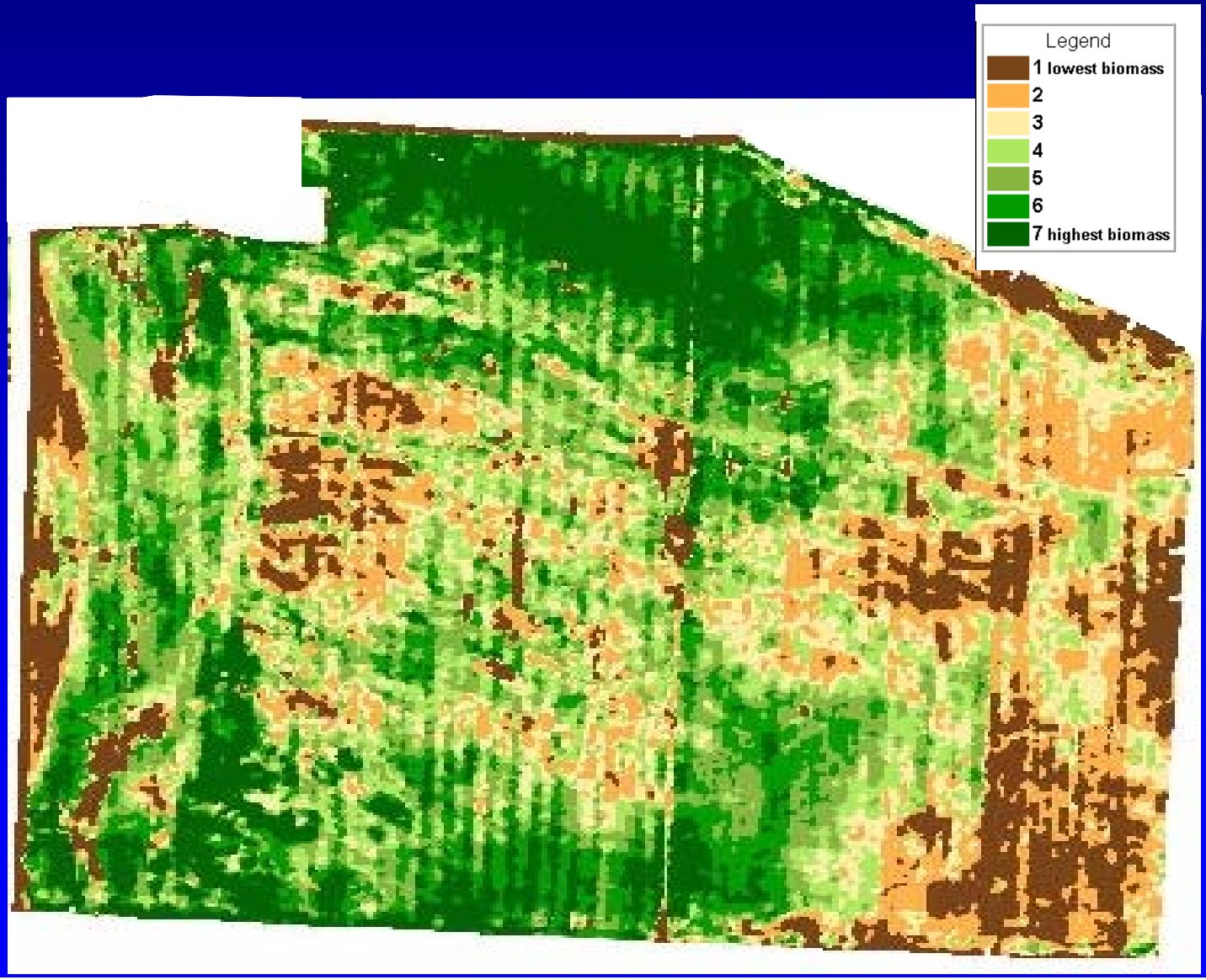


Zone Creation

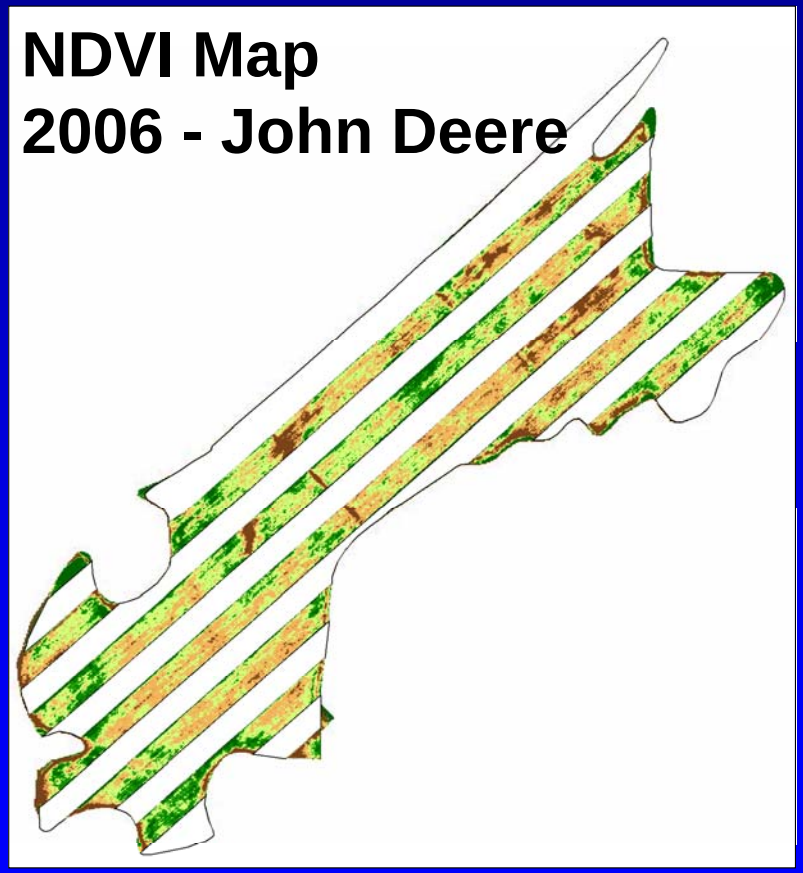
Export Application

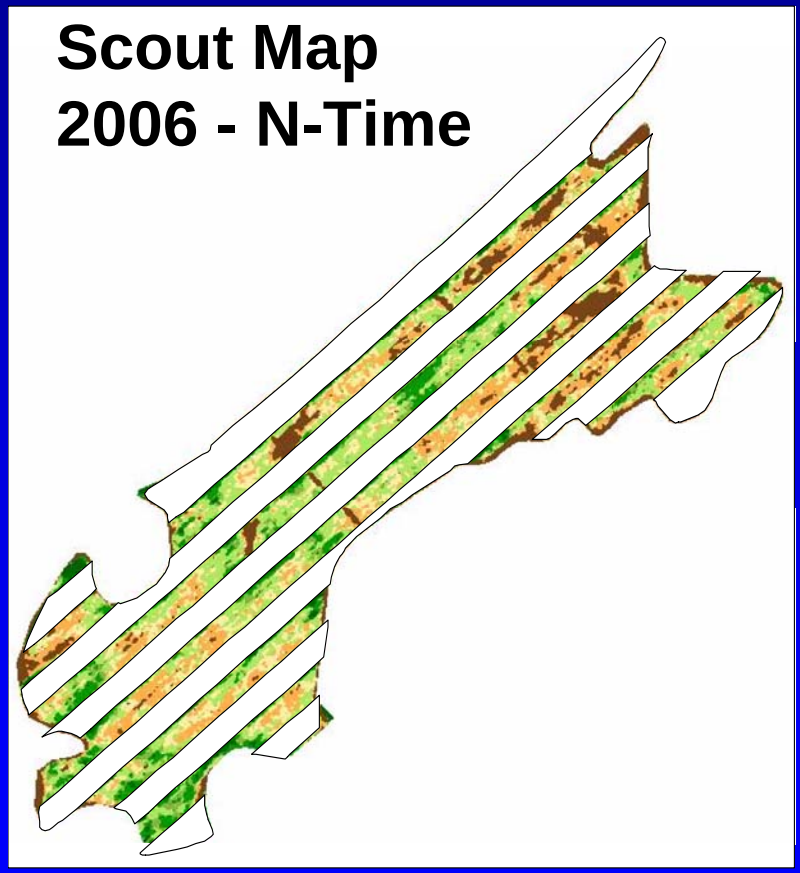
Done | Internet

Geo-referenced Scouting Map



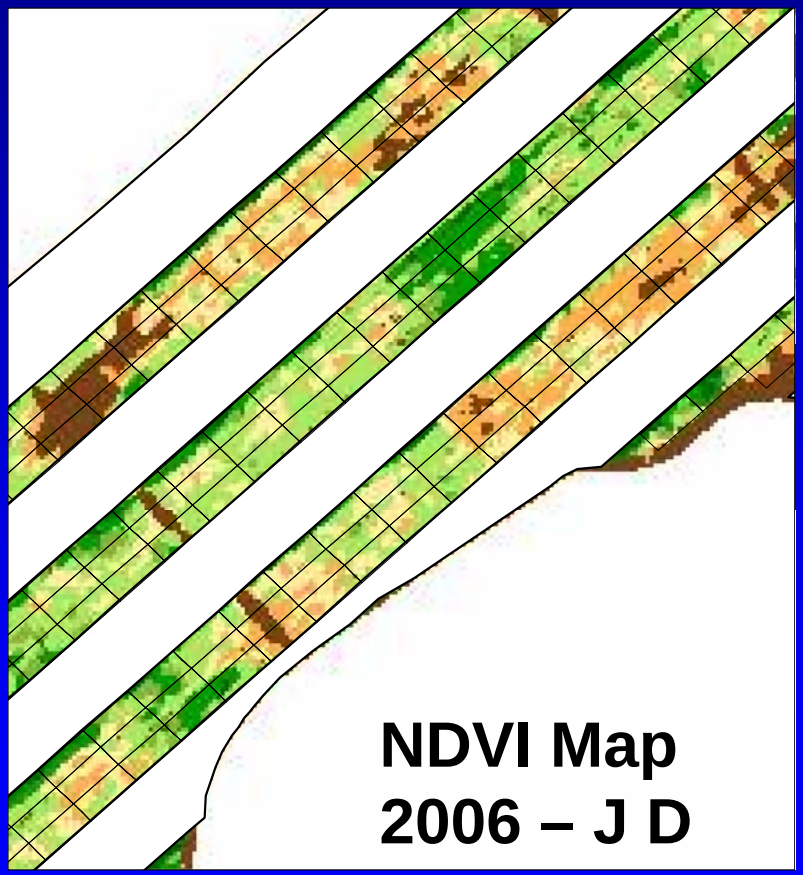
Scout Maps
July 5, 2006



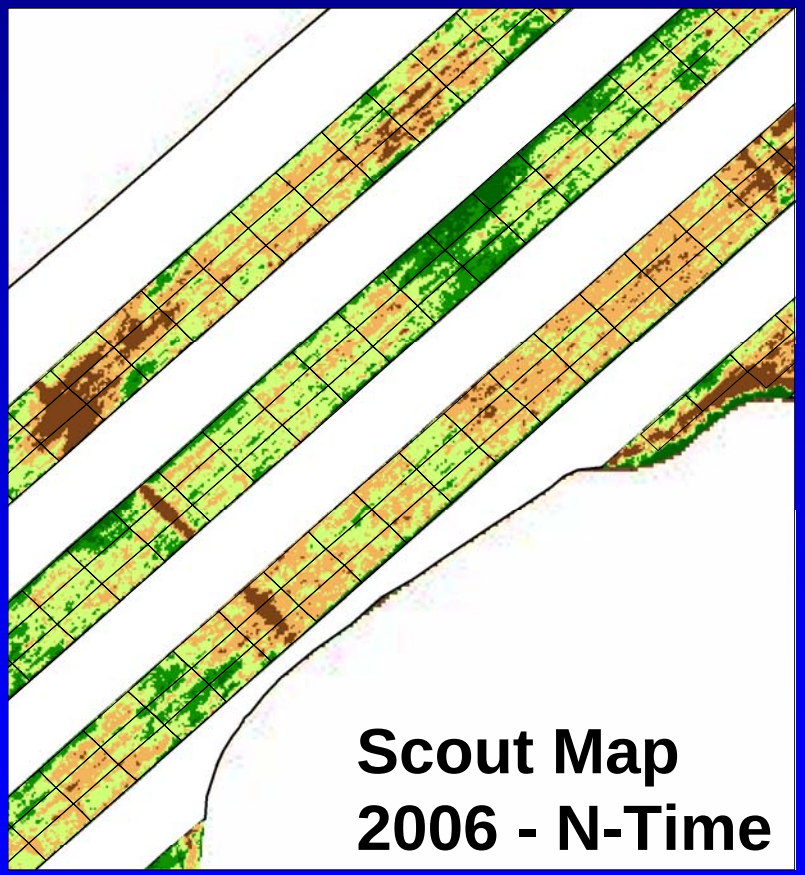


UT Milan Research & Education Center

Scout Maps
July 5, 2006

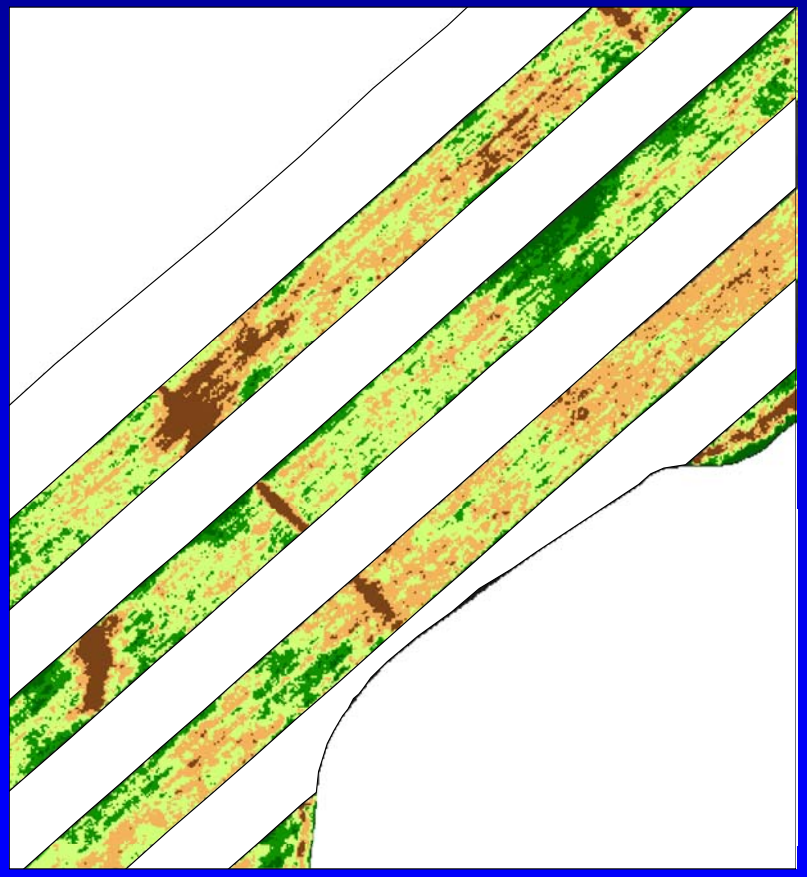


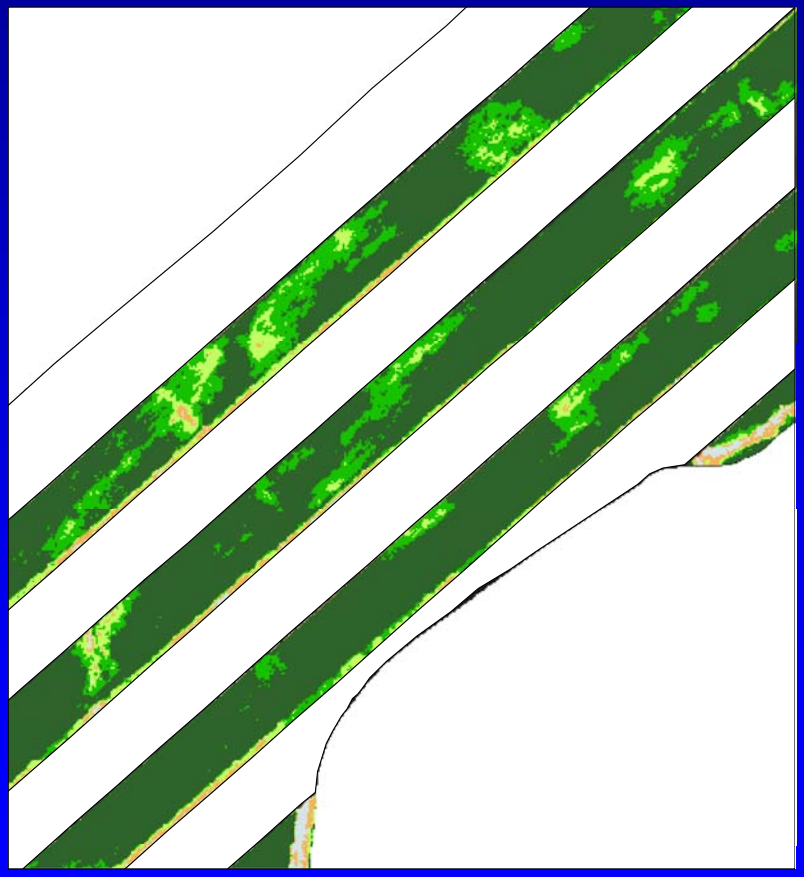
NDVI Map
2006 – J D



Scout Map
2006 - N-Time

Early vs. Late Season





Factors Impacting Scouting Maps

- Spatial Variability in:
  - The Crop (health)
  - Plant/Row Spacing
  - Crop Variety
  - Crop(s) within a Field (scene)

Image Acquisition → Variable Rate

- Producer scouts field with image (printed map or PDA+GPS)
- Decisions (crop consultants & producers)?
- Application map is created from scout map for producers variable rate controller or aircraft sprayer
- Application map is transferred from PC to Variable Rate Controller & application is made

http://jdas.agengine.com - Aerial Imagery - Microsoft Internet Explorer

JOHN DEERE AGRI SERVICES | Imagery

Location: JDAS Nitrogen Mgmt - Hoffman E

Order Imagery | Order Status | Zone Creation | Export Application

Mode: Single Field Analysis

Grower: Jim Grief

Farm: Grief Farms

Field: Kirkwood

Data Type: NDVI

Date: 2006-08-04

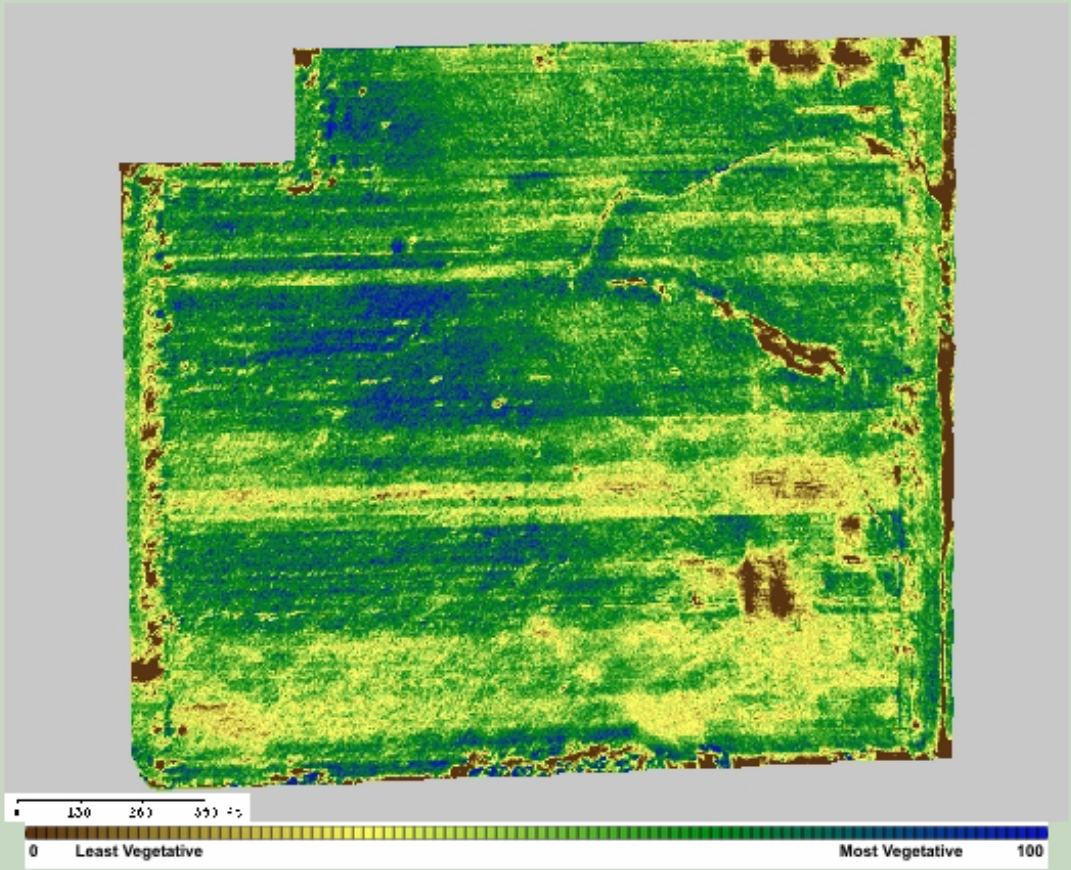
Zones: 4

Min Zone Size: 0.5

☐ Grid Correction

☐ Custom Break Points

Go



Save

Export

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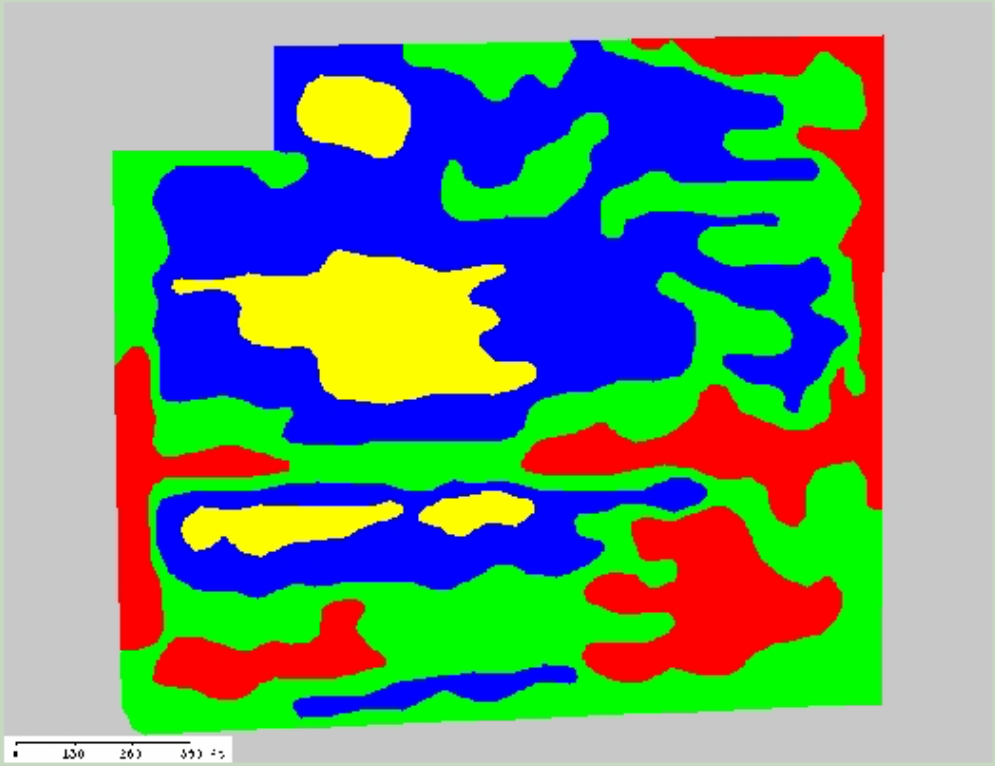
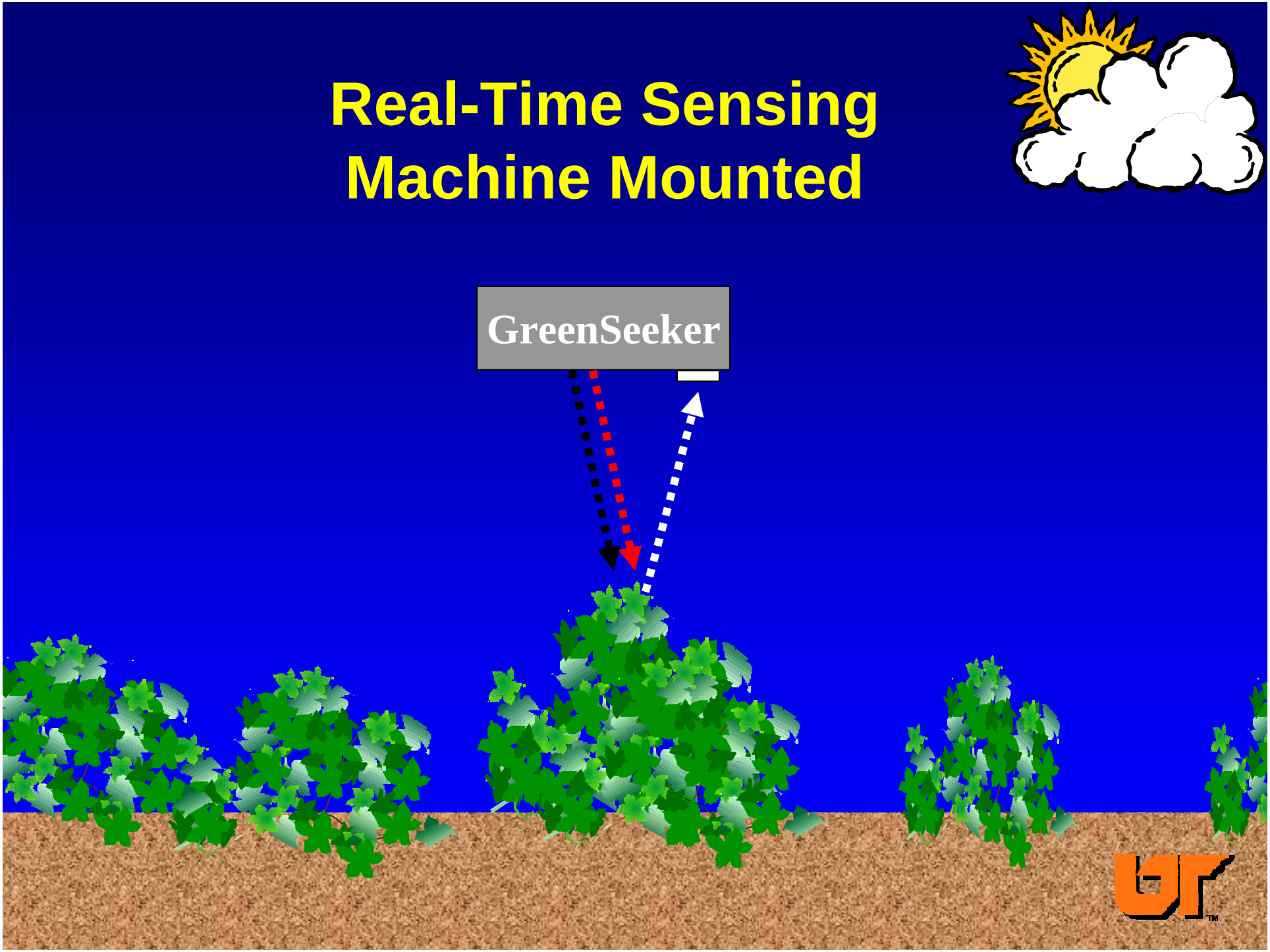


Zone	Acres	Range
1	10.2 Ac.	1.0 - 46.0
2	20.5 Ac.	46.0 - 59.0
3	20.4 Ac.	59.0 - 71.0
4	5.4 Ac.	71.0 - 100.0

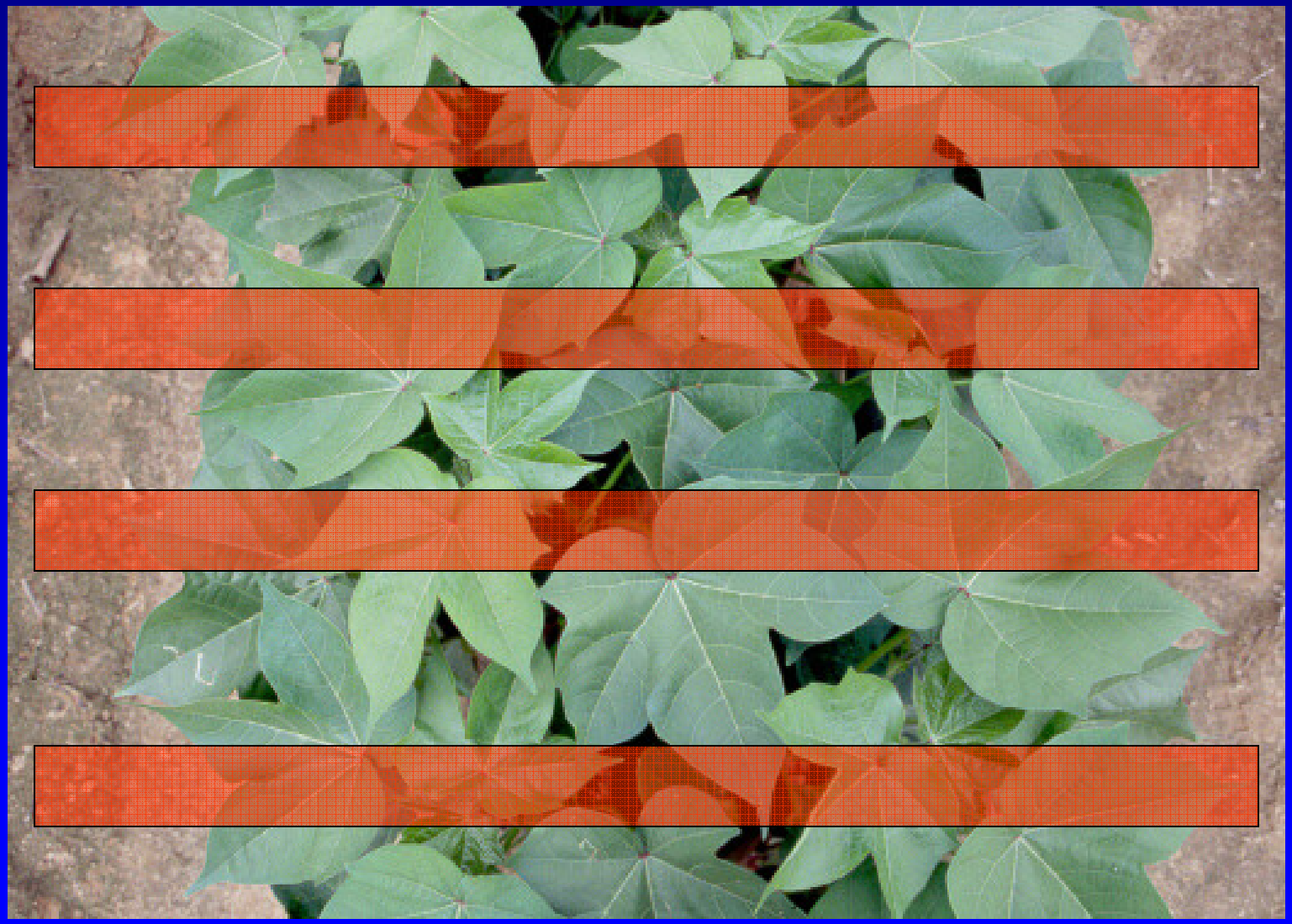
Save

Export

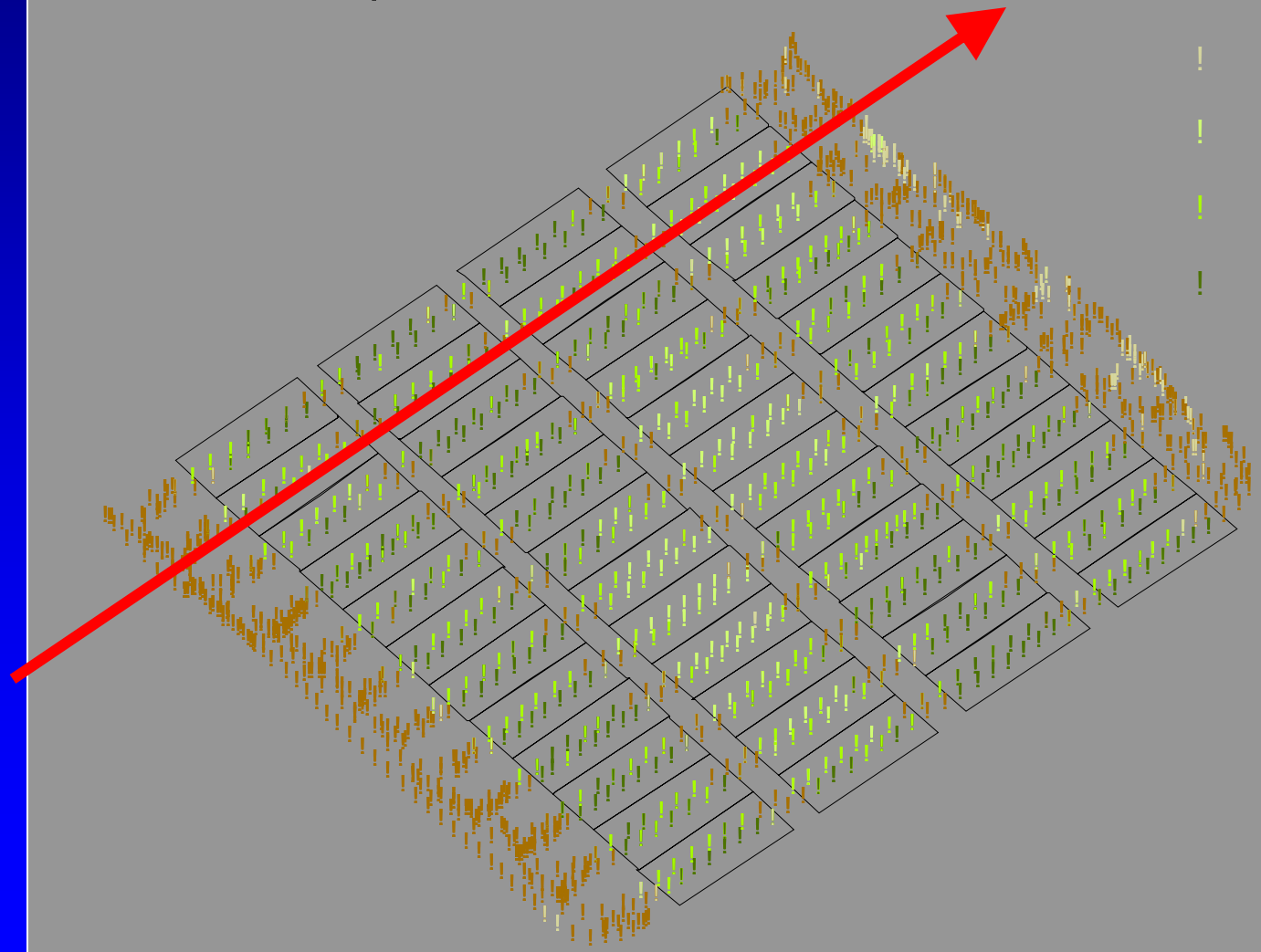
Real-Time Sensing Machine Mounted



Field-of-View (Resolution)



Long-term N-Rate Experiment
UT Milan Experiment Station



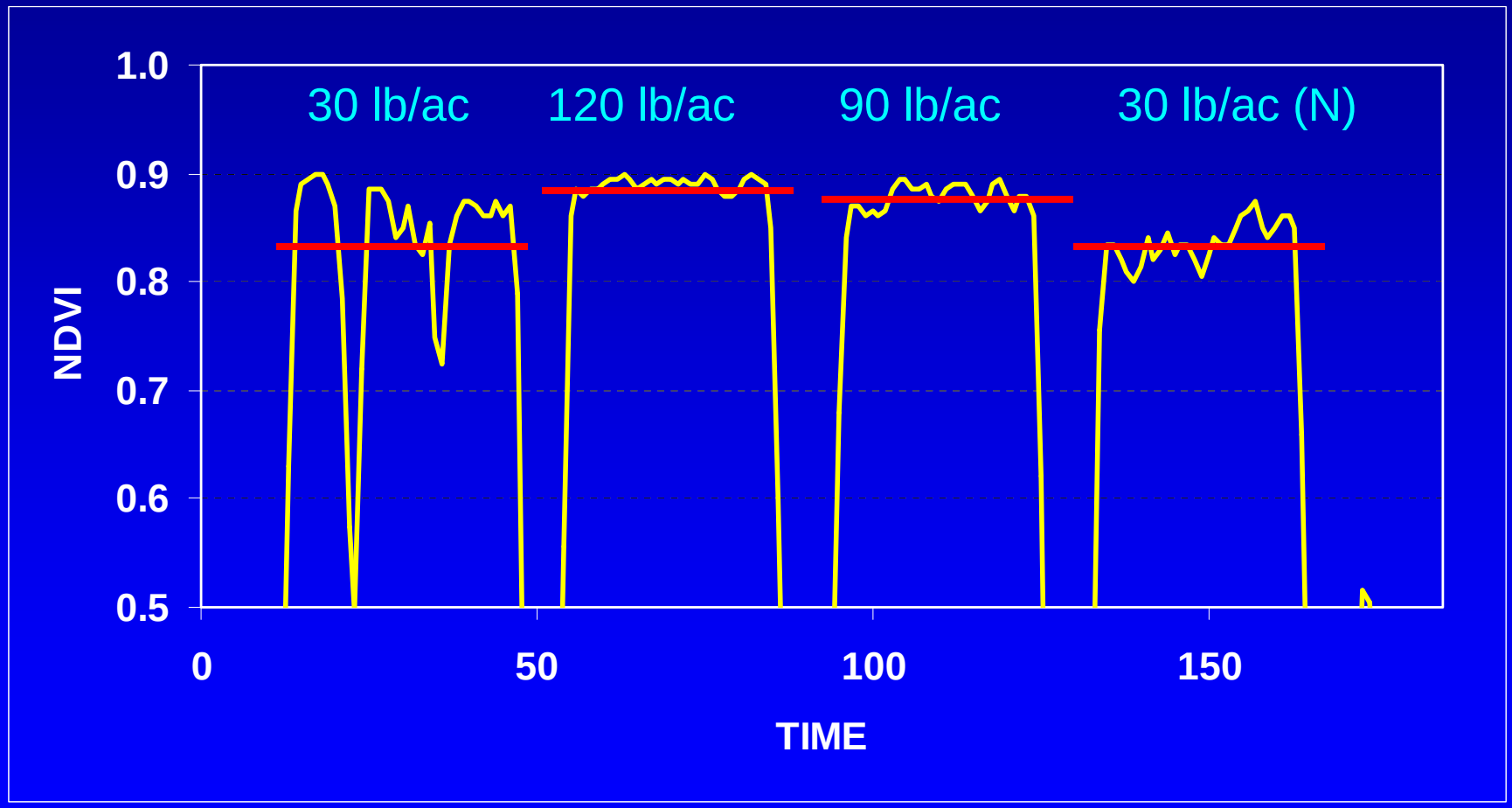
Legend

NDVI

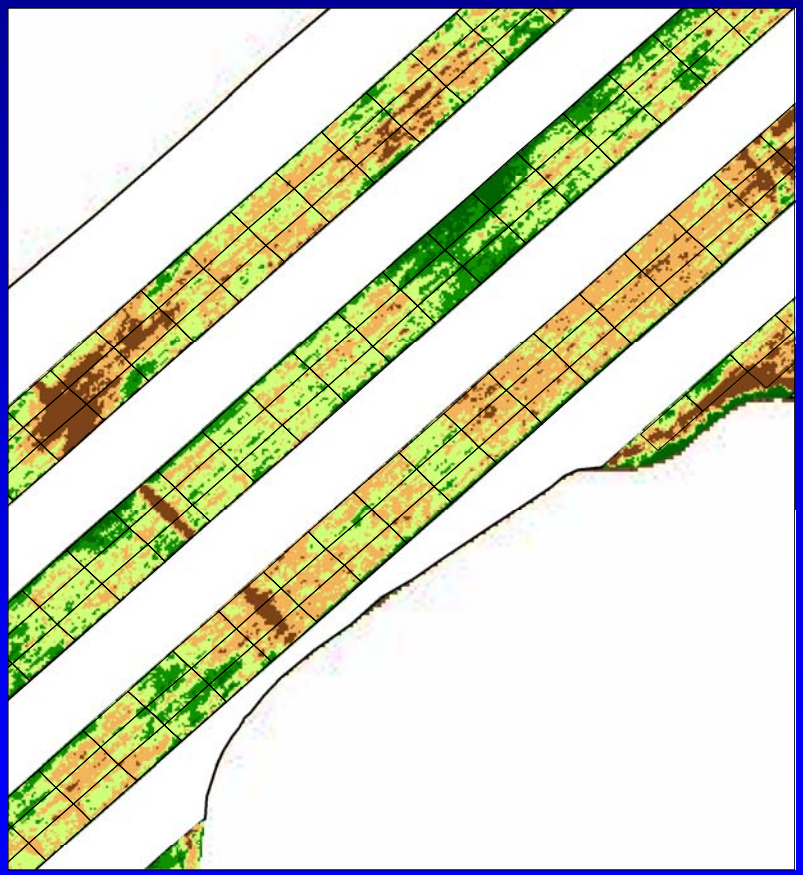
- 0.130 - 0.636
- 0.637 - 0.773
- 0.774 - 0.843
- 0.844 - 0.884
- 0.885 - 0.919

NDVI

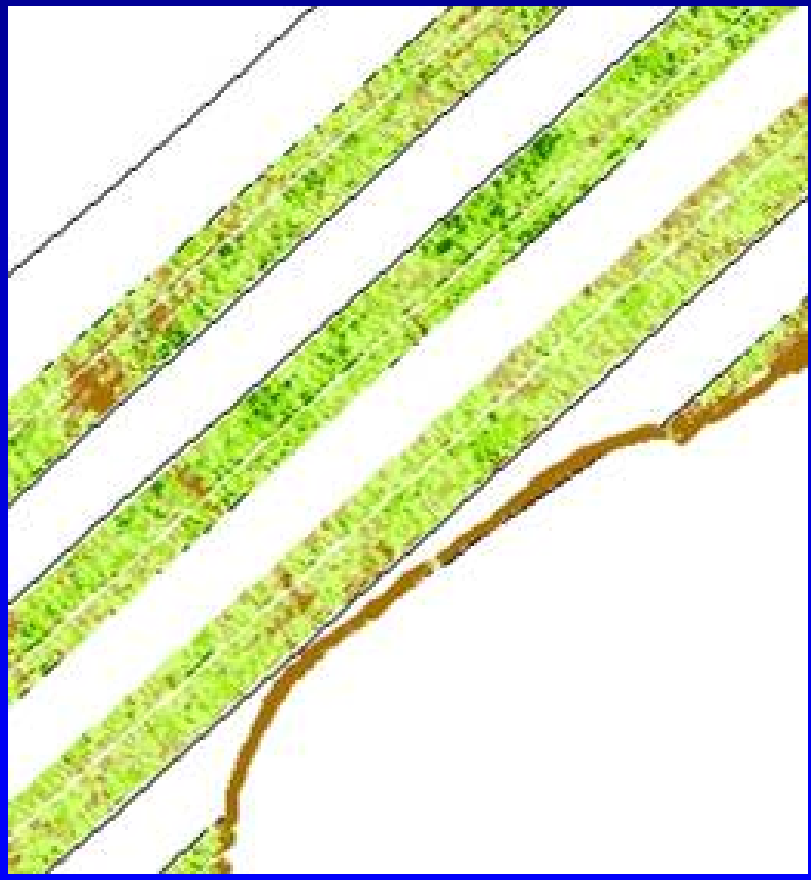
5 reading/sec



NDVI Map from Aircraft (JD)



NDVI Map from GreenSeeker



Airborne Sensing vs. Ground-Based

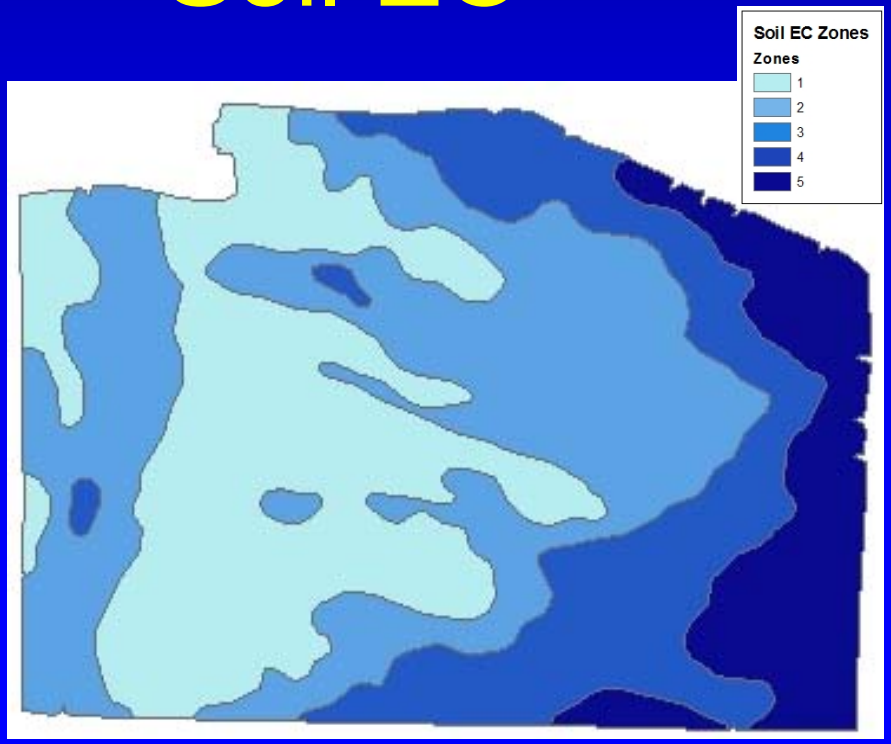
- ✓ Capital Investment
- ✓ Commitment to an Application
- ✓ Weather
- ✓ Producer/Consultant Involvement
- ✓ Spatial Resolution

Future

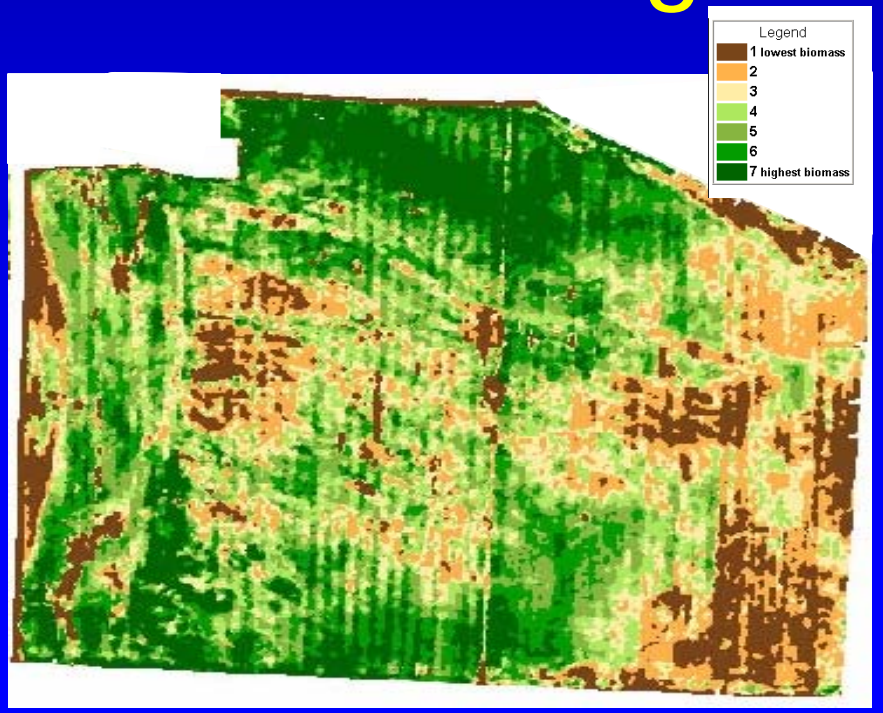
- Difference Maps
  - What has changed from the previous image?
- Integration of real-time sensing with map-based (historic) information
  - Yield maps (yield potential)
  - Soil maps (E.C.)

Crop reflectance may correlate with:
yield, available nitrogen, plant population, growth stage, soil properties, moisture stress, etc.

Soil EC

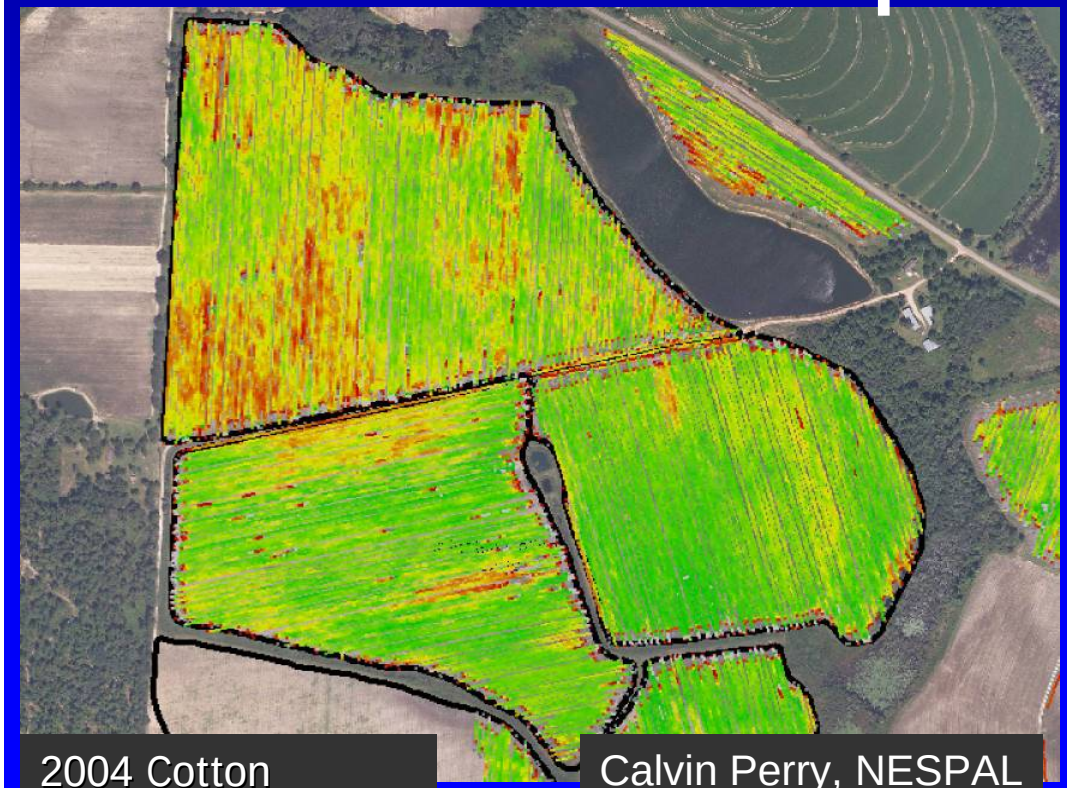


NDVI Image



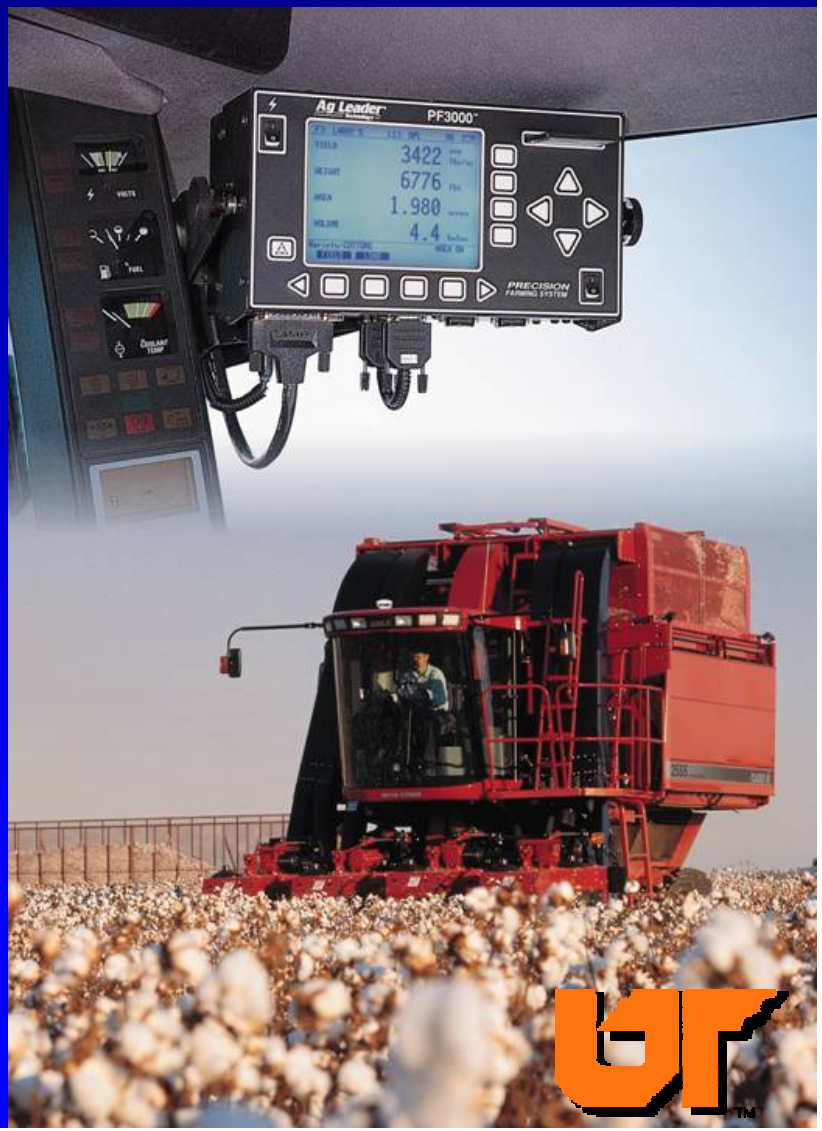
Did we make the correct decision?

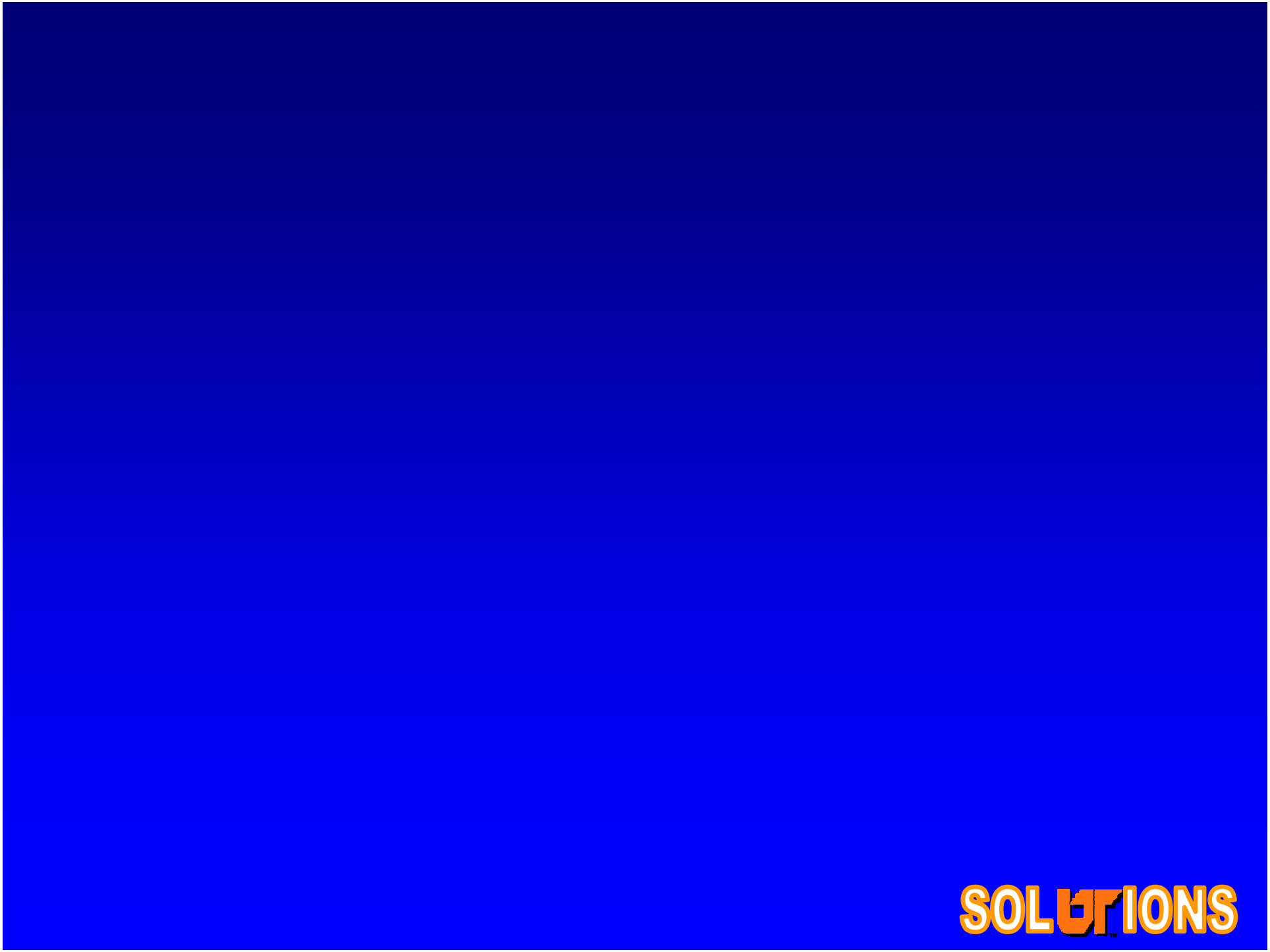
Cotton Yield Map



2004 Cotton
Colquitt Co. Georgia

Calvin Perry, NESPAL
Tifton, GA

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