Precision Agriculture

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John Nowatzki
Extension Ag Machine Systems Specialist

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STUDENT FOCUSED • LAND GRANT • RESEARCH UNIVERSITY

Precision Agriculture

- GPS Guidance and Auto-steer
- Section Control on Sprayers
- Row Control on Planters and Seeders
- Yield Monitoring
- Remote Sensing
- In-field Sensing
- Data Management
- Variable Rate Applications
- Telematics
- Robotics

Precision Agriculture

- Technology in Production Agriculture

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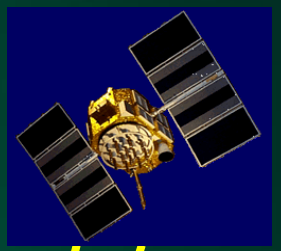
Technology in Production Agriculture

- Farmers are Adapting Technology



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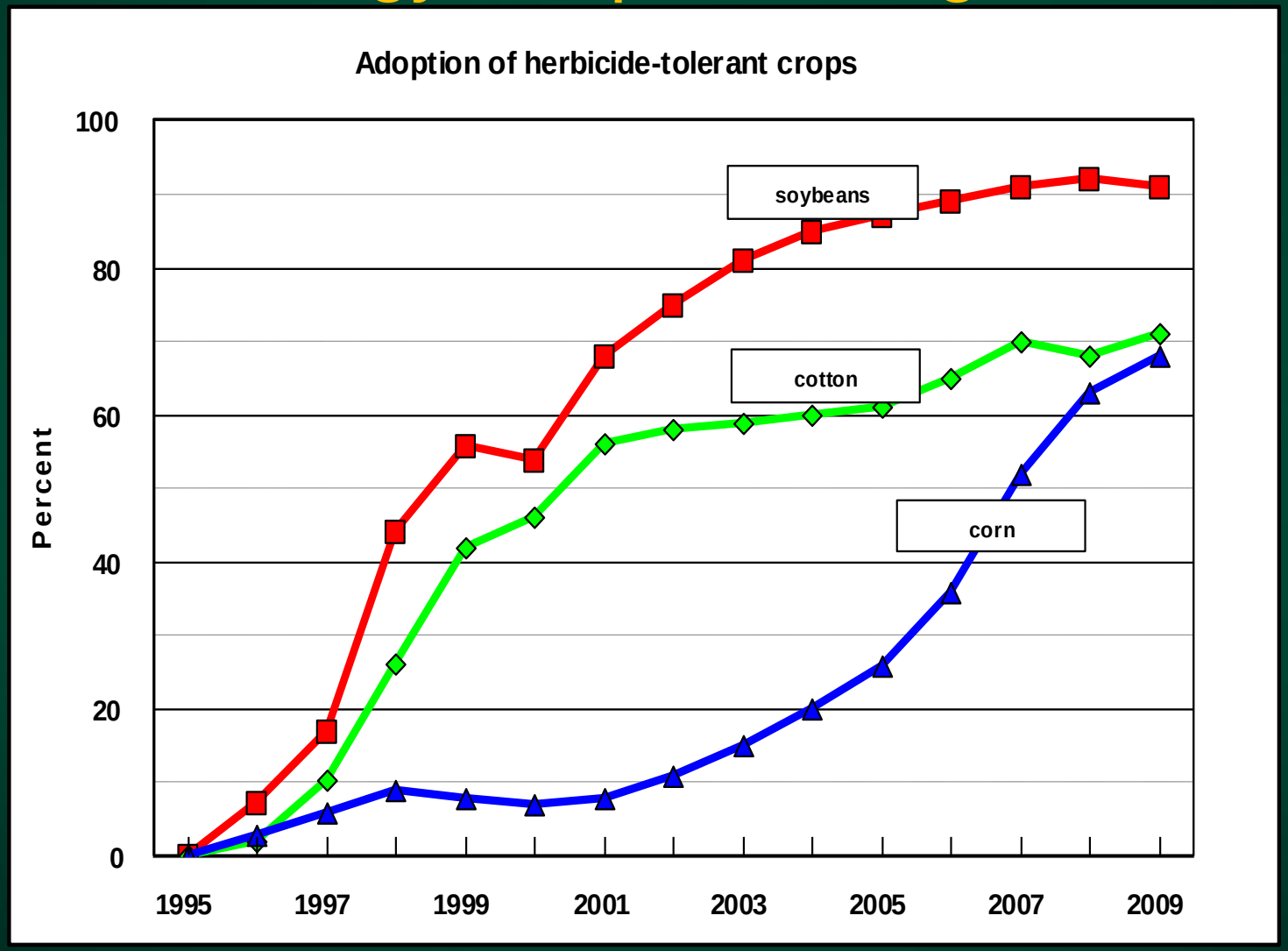
Technology Adoption in Agriculture

"duh" technologies

- Lightbars (GPS guidance)
  - Gains against overlap and marker alternatives are easily perceived
  - Do take a little more investment so less adopted by small farms until recently
- Tractor cabs
  - Hard to measure gain in $ but know it's there
- GPS-assisted steering
  - Larger investment than lightbars but still easy to perceive the advantage
  - Aspects like tractor cabs (reduces stress)

Dietrich Kastens
Kansas Agricultural Research Assn.

Technology Adoption in Agriculture



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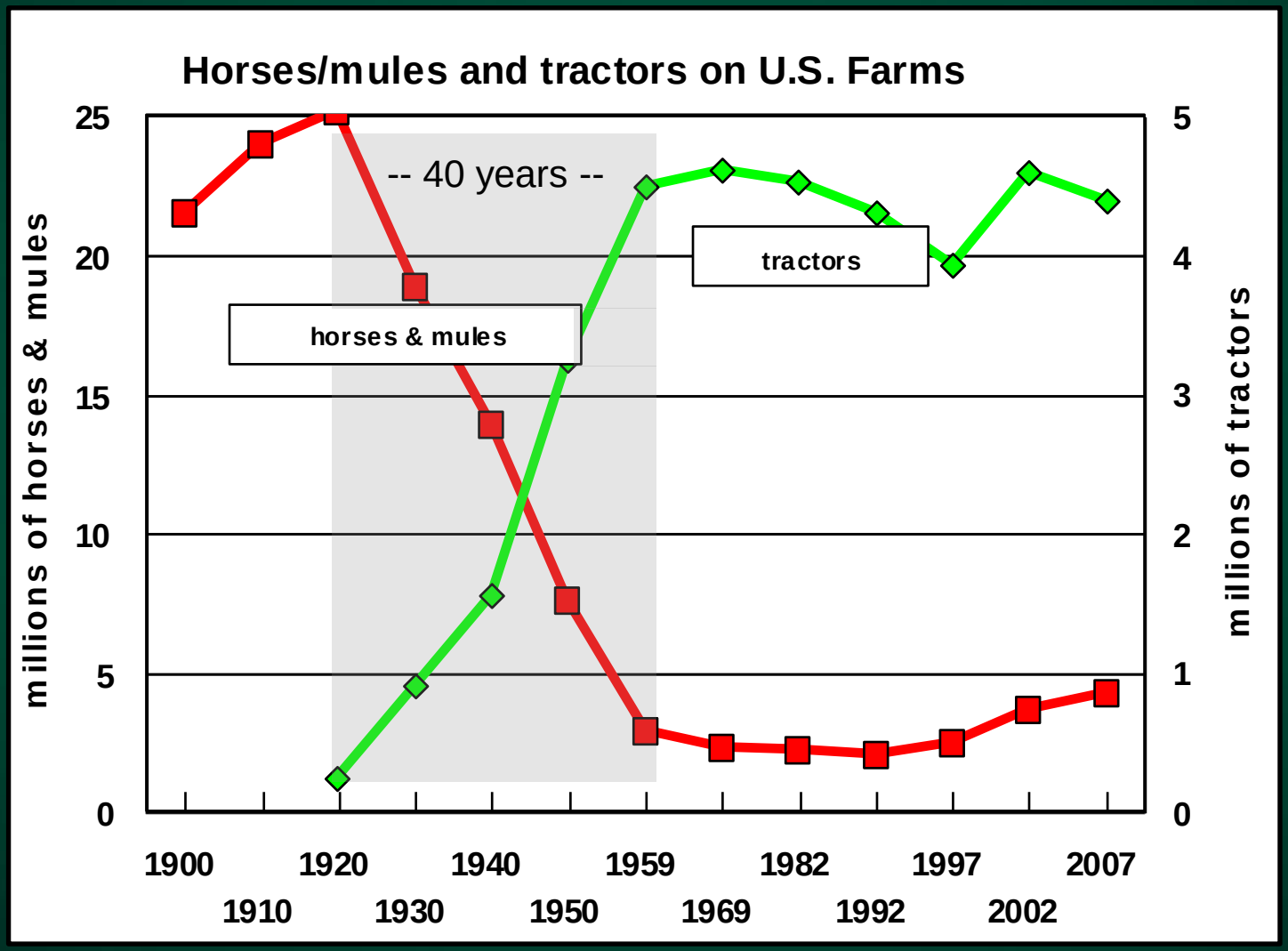
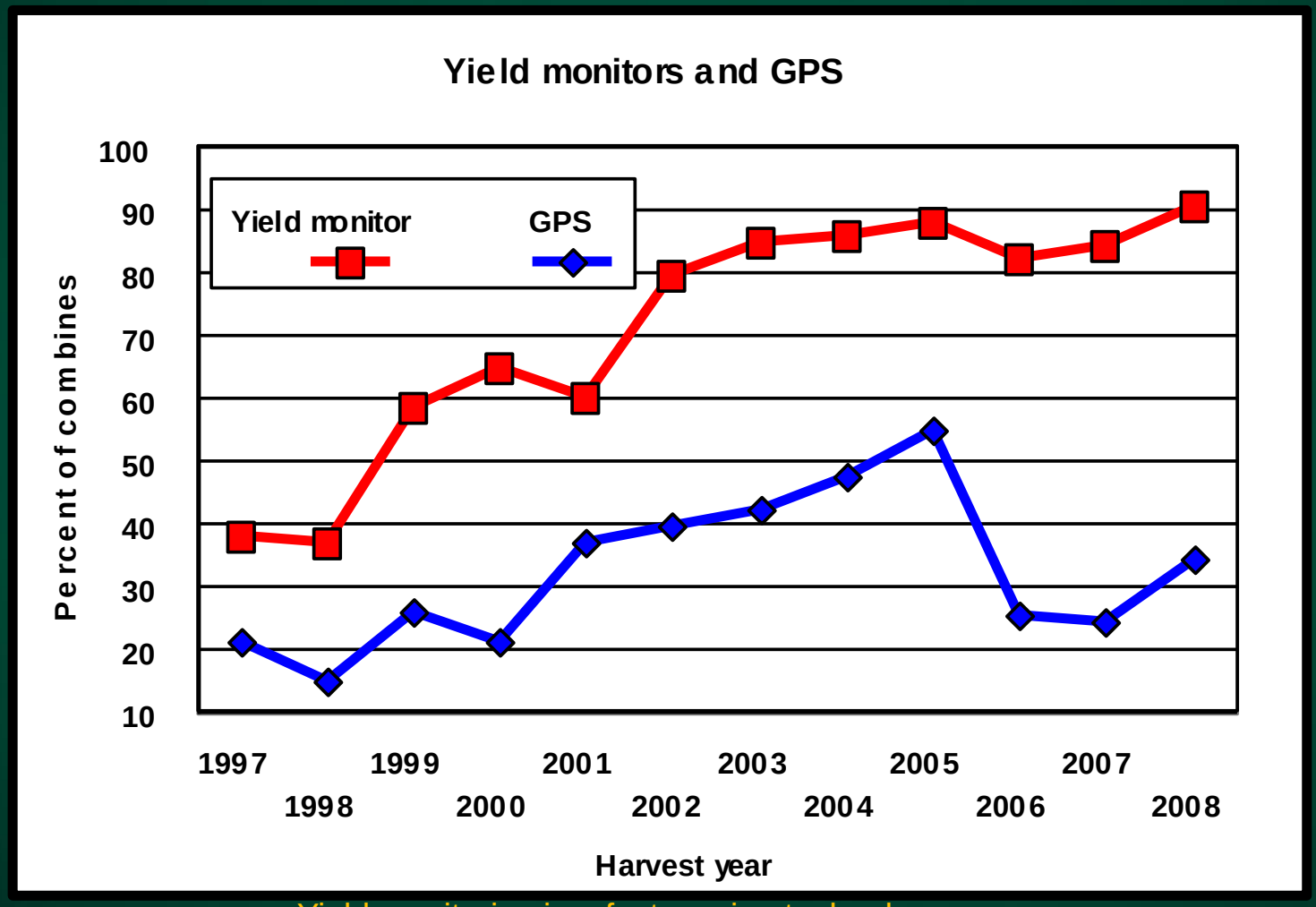
Slow Technology Adoption



Slow Technology Adoption



Yield monitoring is a fast moving technology
Yield mapping is a slow-moving technology

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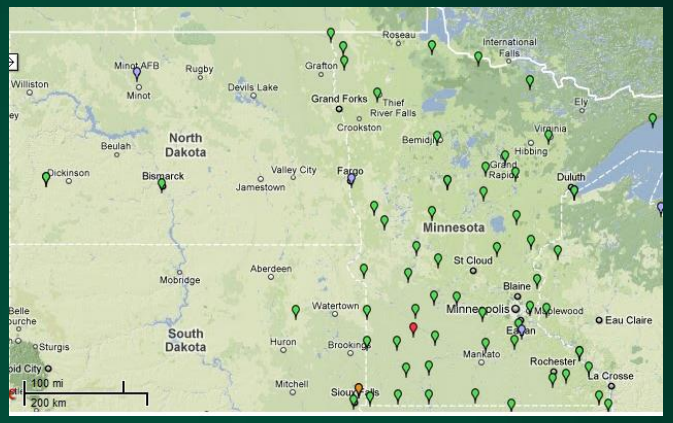
GPS Guidance



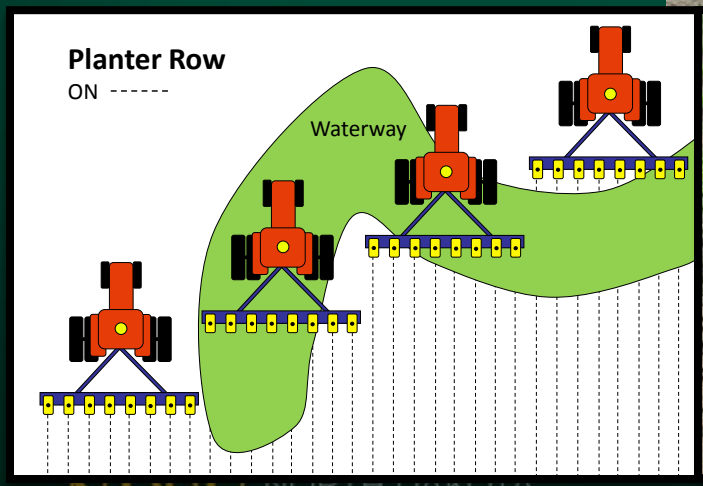
- GPS-assisted
- Auto-steer
- GPS Correction Options:
  - Free GPS Corrections
  - Commercial Options
  - Continuously Operating Reference Station (CORS) – Internet-based
  - RTK

Section and Row Control

- Planters
- Air Seeders

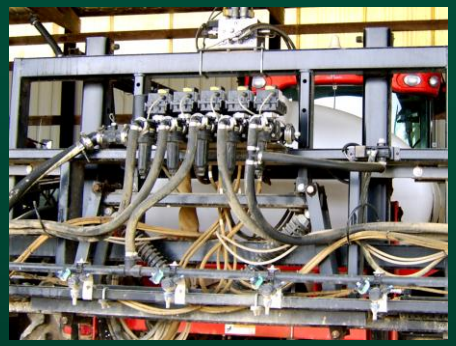
Electric

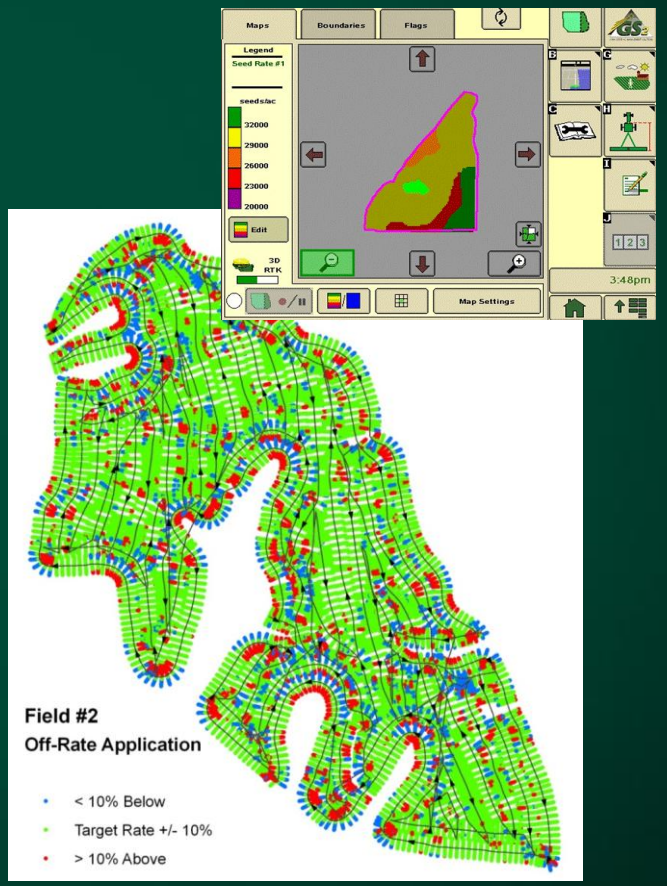
Pneumatic



Precision Spraying Technology

- Boom Height Control
- Section and Nozzle Control
- Nozzle Flow Control
- Droplet Size Control
- As-Applied Maps





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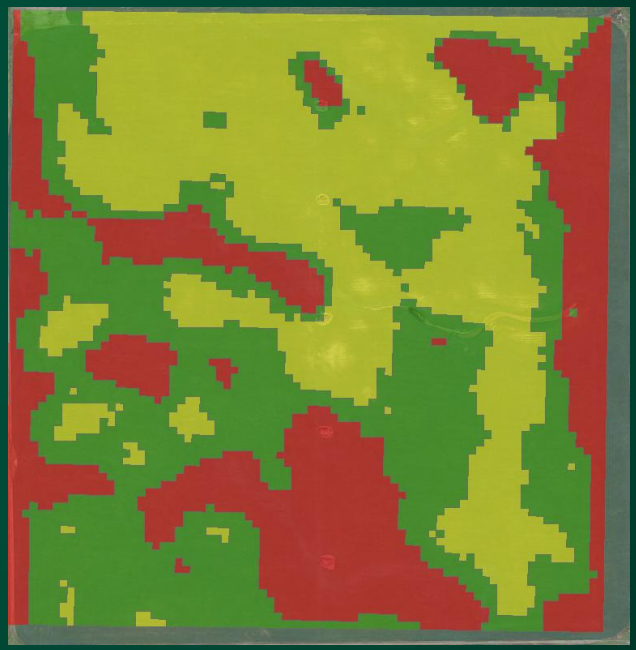
Variable Rate Fertilization

- Variable Rate Application
  - Fertilizer, Seed, Variety
- Delineate Uniform Areas
- More Precise Management
- GIS – Data Management



How to Get Needed Information?

Yield Monitoring and Data Management

- Yield Monitors with GPS
- GIS Programs

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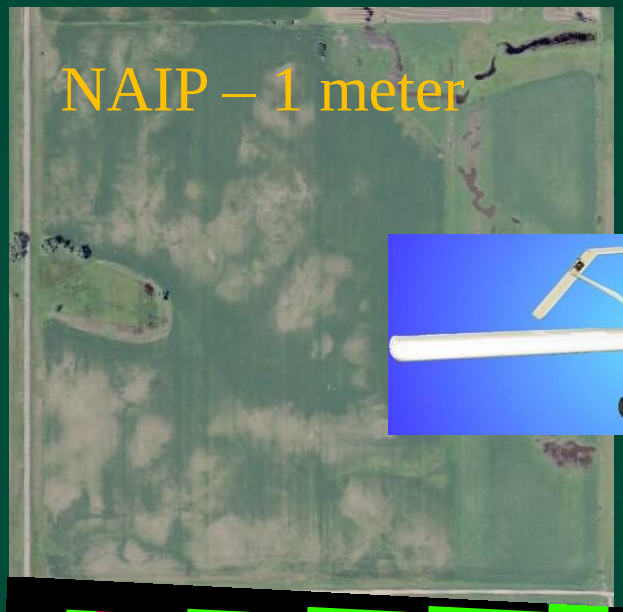
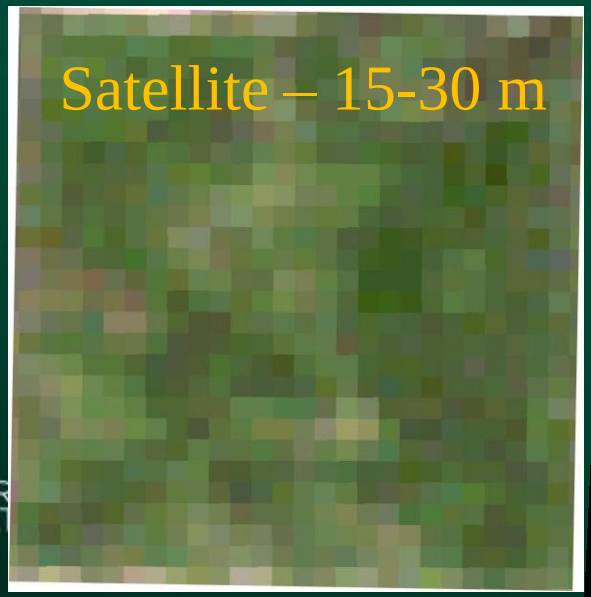
Remote and In-field Sensing

- Satellite Imagery
- Aerial Photography
- Electrical Conductivity (EC)
- In-field Infrared
- Chlorophyll Meters
- Crop Height Monitoring

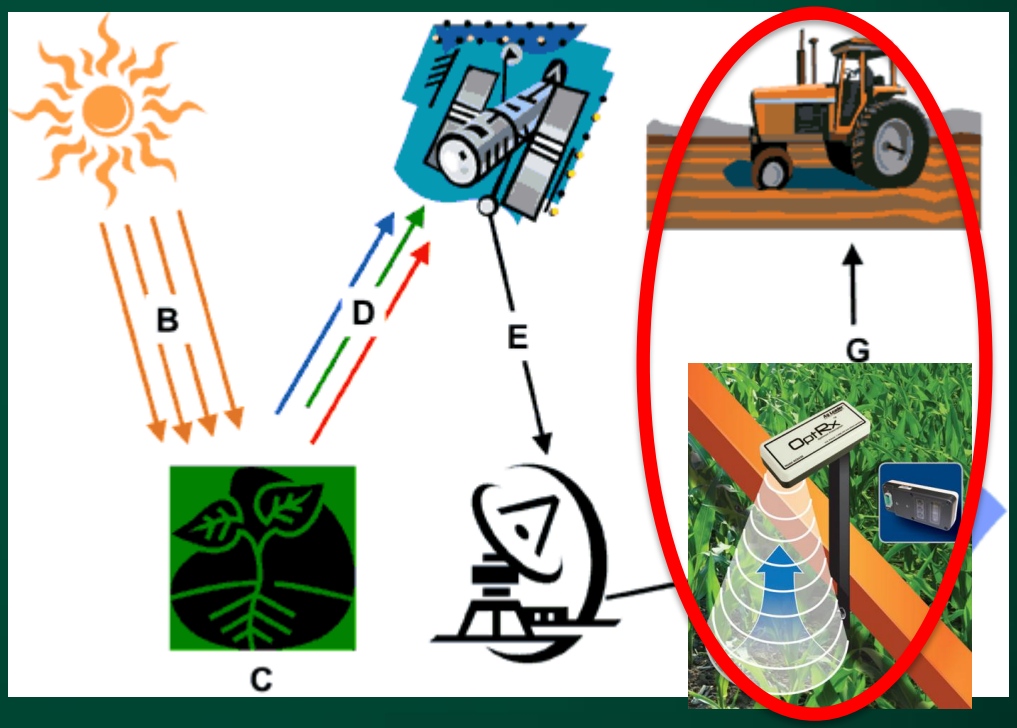
Remote Sensing : Suitability and Accuracy





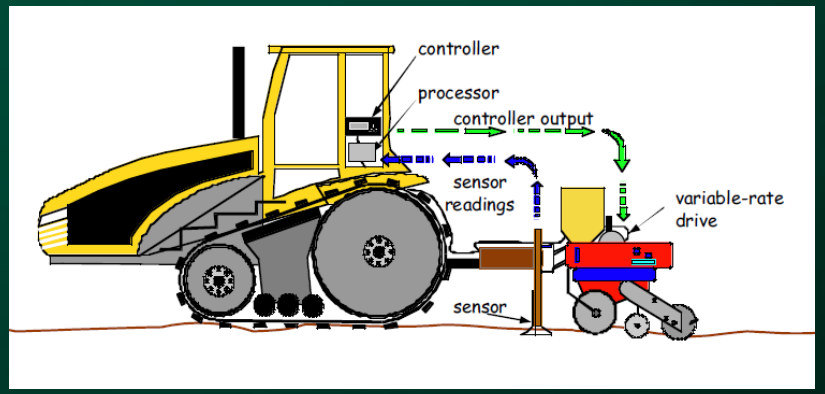
In-field Sensors vs. Remote Sensors

- Sensors on Equipment
- Internal Light Source
- Real-time



Sensor Field Operation

- Rate Determination:
  - NDVI Value
  - Compare NDVI to Optimum Area
  - Growing Degree Days
  - Potential Yield
- Activate Rate Controller



Available Crop Sensors

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

Research Results

- NDSU Oakes - Wheat
  - Summary
    - 40% N Applied at Planting
    - Remainder Early Season
  - Results
    - Reduced Lodging
    - Significant Yield Increase
    - Increased Protein
    - No Increase in Nitrogen

Research Results

- Indian Head Research Farm - Wheat and Canola
  - Reduced N Use
  - No Effect on Yield
- Pioneer - Corn
  - Reduced N Fertilizer
  - No Significant Effect on Yield
  - Potential Issue: no rain after in-season application

Implications in Precision Agriculture

- Real-time Plant Fertilizer Requirements
  - Maximize Yield
  - Increased Use Efficiency - Reduce Total Application
- Early Yield Prediction
- Precision Desiccant Application
- Issues:
  - Additional Application Costs
  - Another Pass of Field
  - Weather Issues Could Prevent Second Application

Unmanned Aircraft

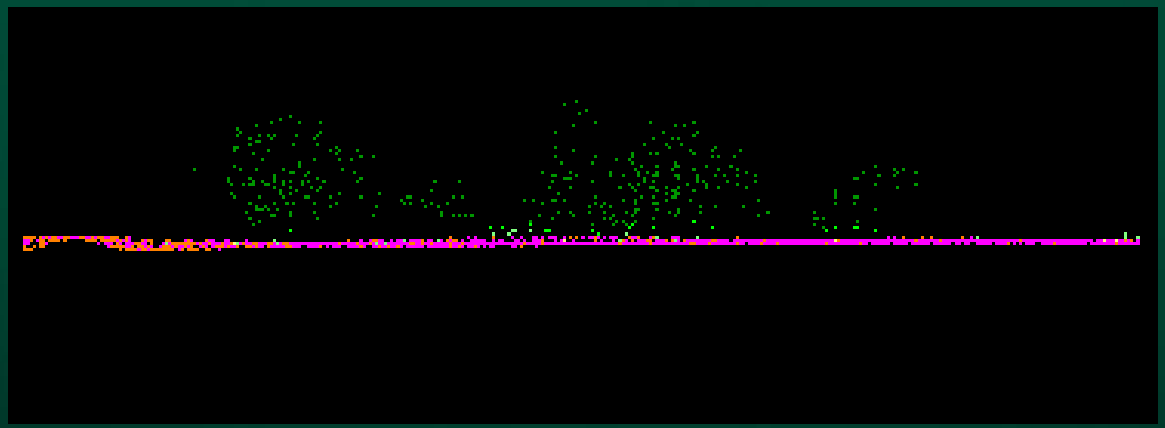
- Inventory of Nursery Tree Crops
- Crop Stress
- Livestock Observation
- Monitoring Rangeland Condition

- Issues:
  - Issues of Operating in Airspace
  - Time
  - Image Processing Complexities
  - Difficulty of Operation

measures the time delay between transmission of a pulse and detection of the reflected signal

LiDAR Technology

- **Li**ght **D**etection **A**nd **R**anging
  - Optical Remote Sensing using Lasers
  - Measuring Distance to Ground from Airplane



Agriculture Applications

- Tile and Surface Drainage
- Topographic Layer for Precision Agriculture
- Road Construction
- Community Development

Red River Basin LiDAR Data

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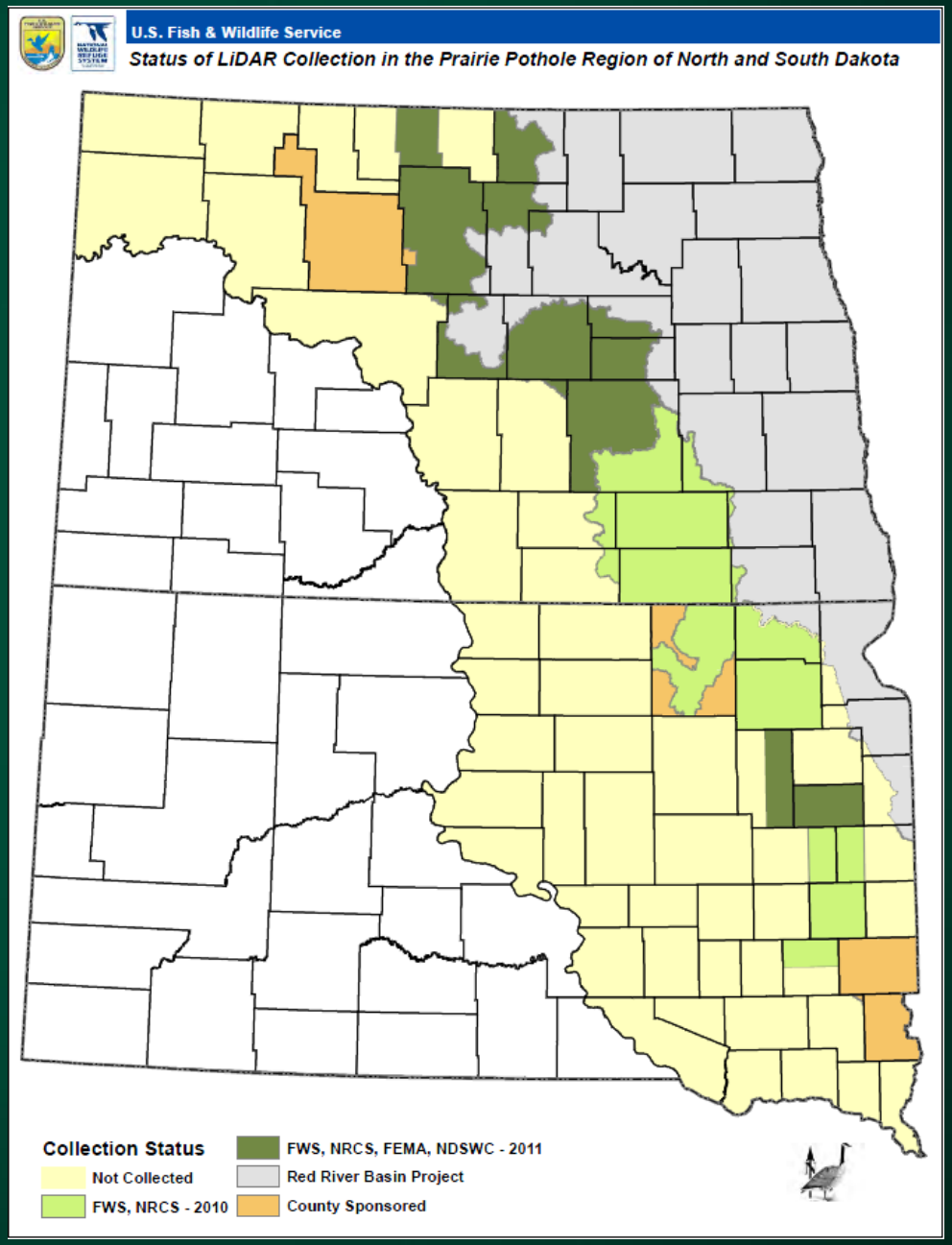
James River Basin LiDAR Data

- Not Yet Available
- Likely from ND Water Commission



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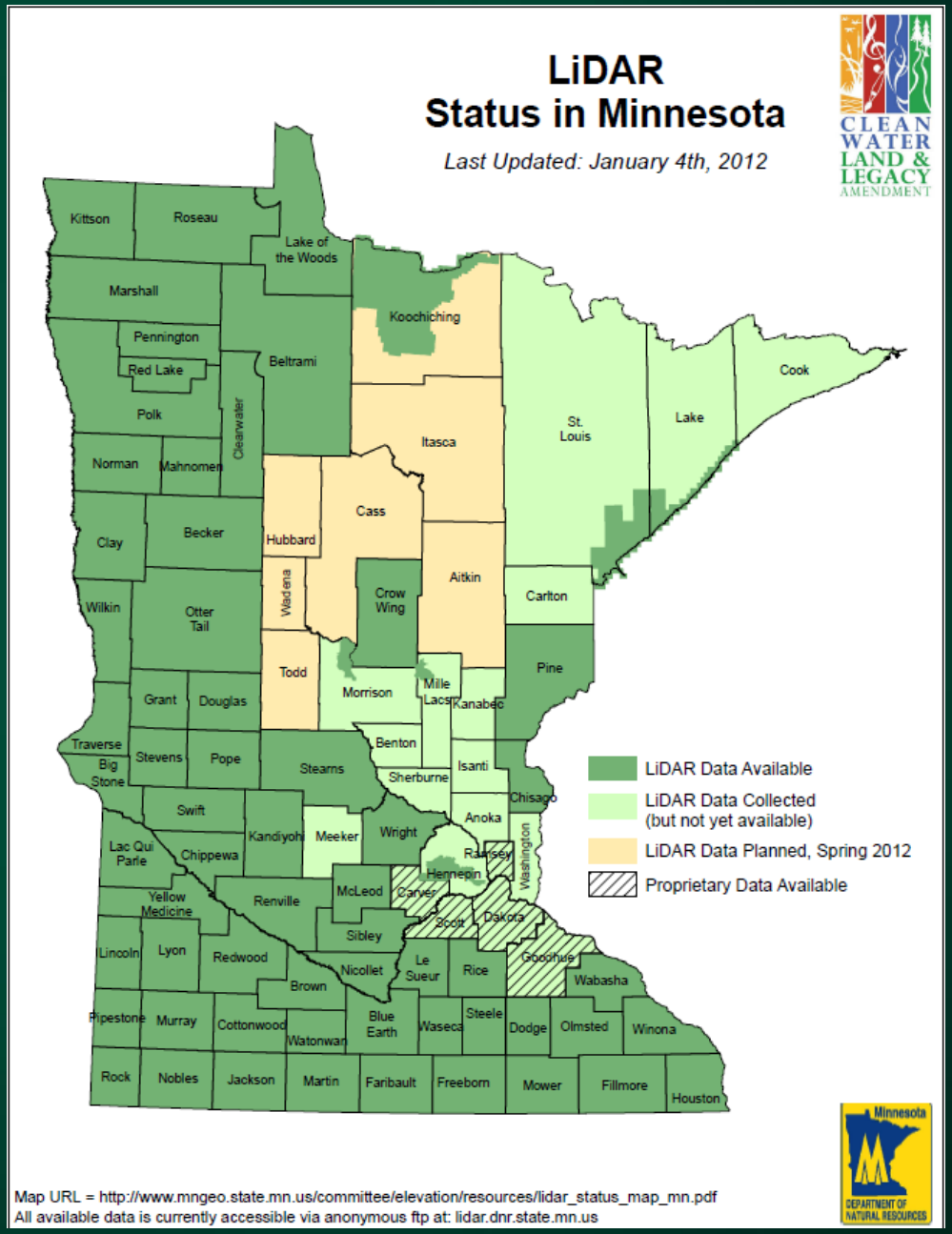
Minnesota LiDAR Data

ftp://lidar.dnr.state.mn.us/



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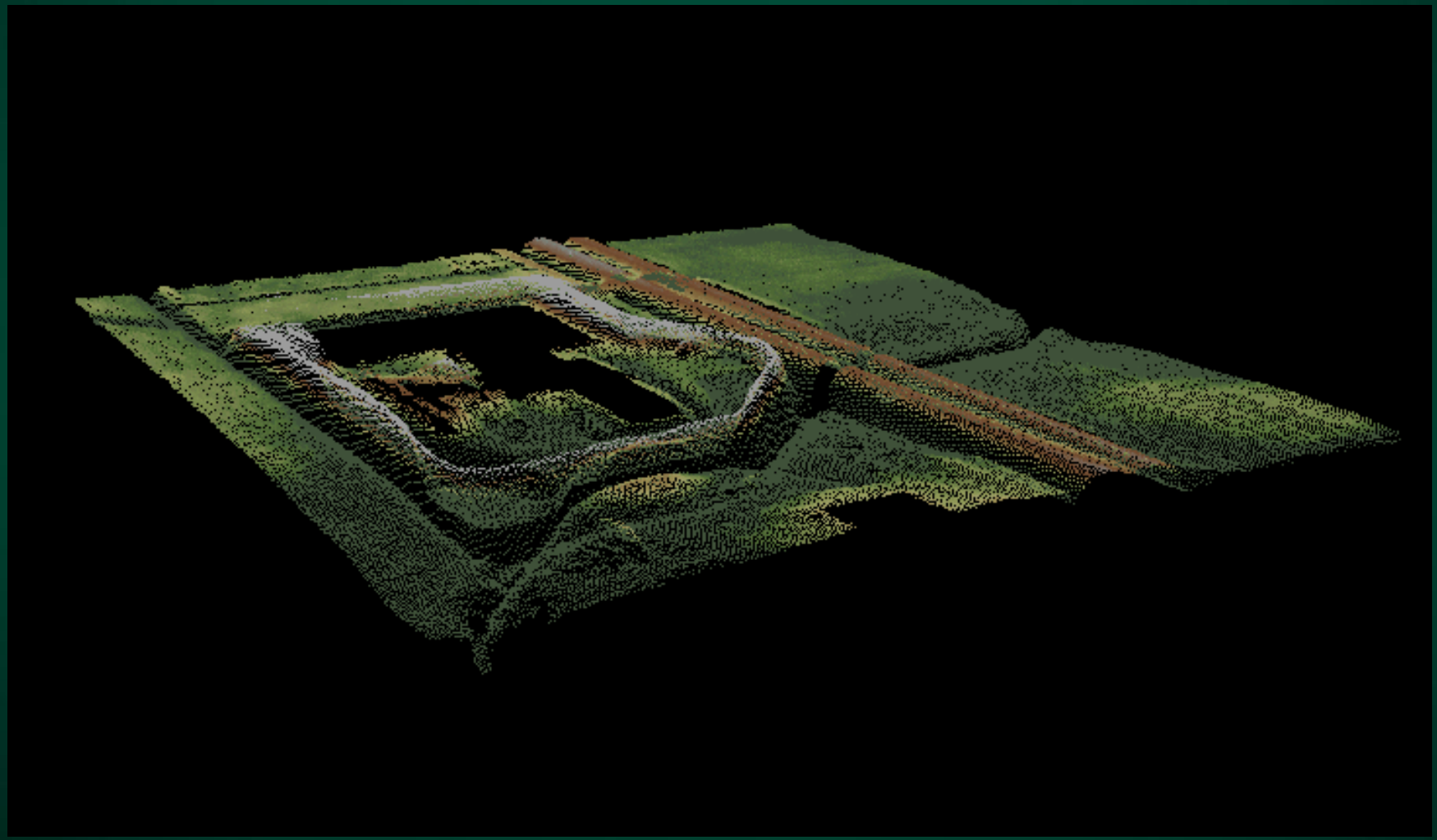
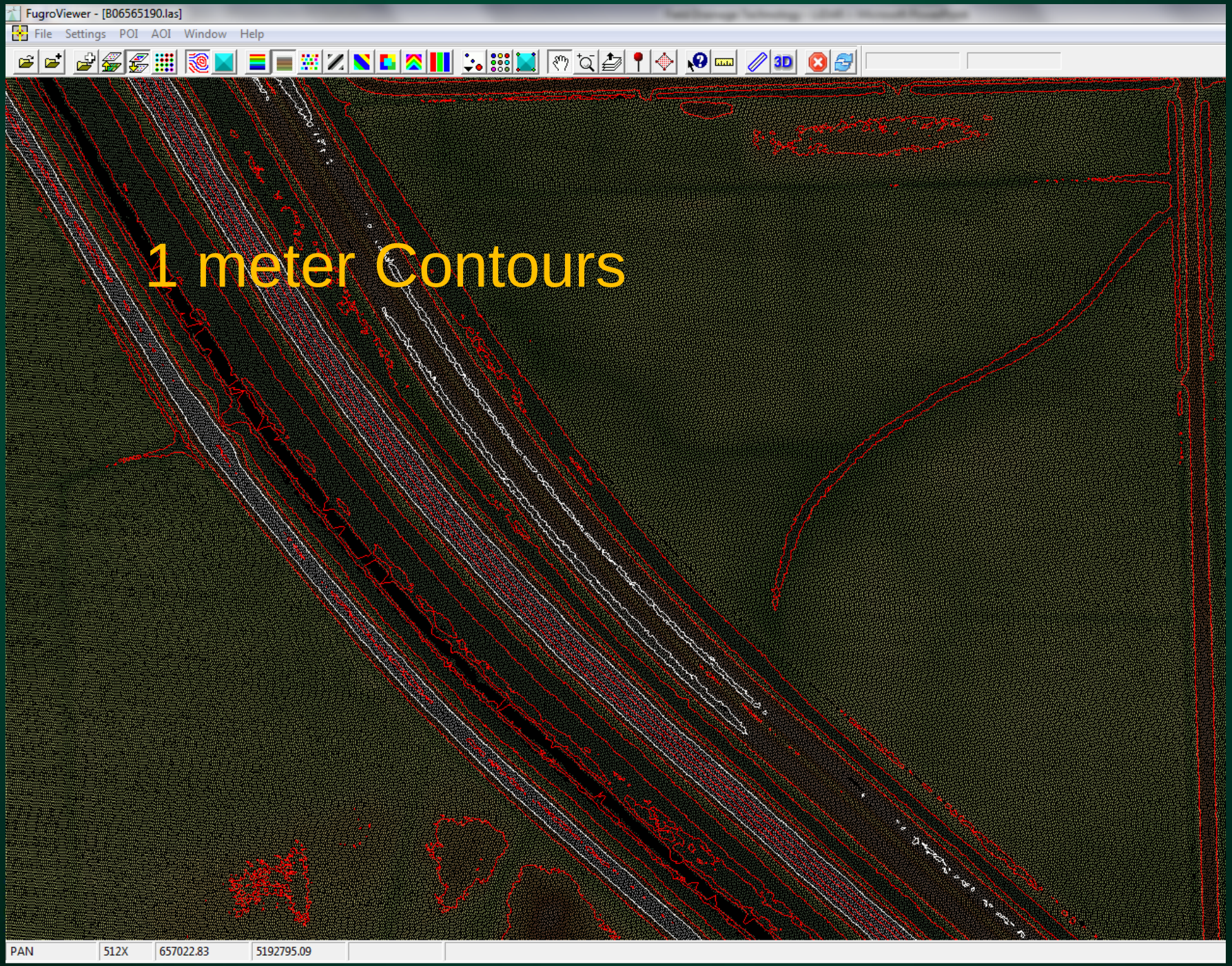
3D View in Fugro Viewer



2.5 Square Miles – West Fargo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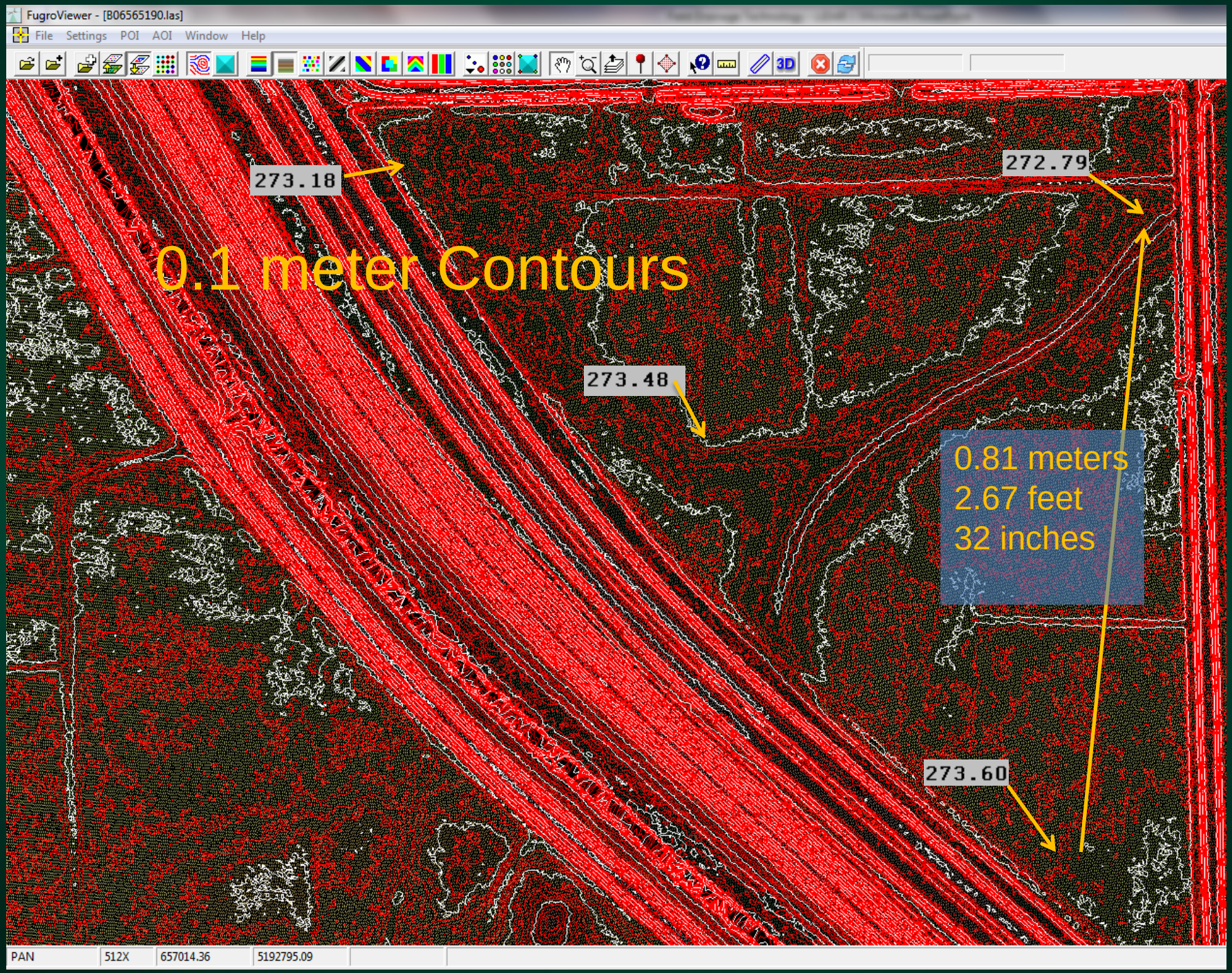
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272.79
0.1 meter Contours
273.48
0.81 meters
2.67 feet
32 inches
273.60
PAN
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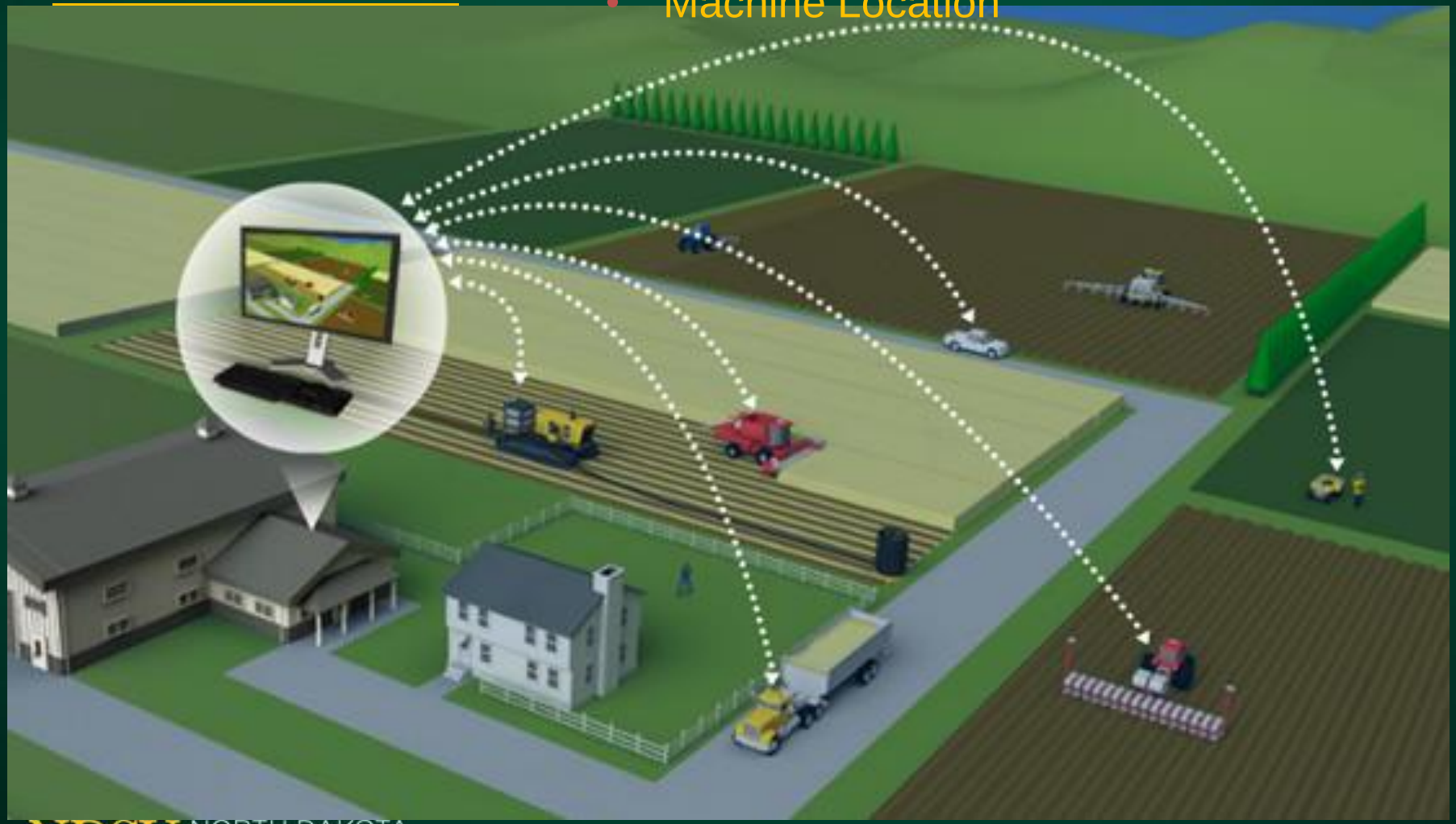
Telematics

- On-the-go Transfer of Data
- Remote Diagnostics , Error Codes
- Combine Threshing Efficiency
- Machine Location



Robotics in Agriculture

- Chemical Applications in Orchards
- Mechanical Weeding
- Autonomous Tractors

Spirit

Summary: Precision Ag Technologies

- GPS Guidance and Auto-steer
- Section Control on Sprayers
- Row Control on Planters and Seeders
- Yield Monitoring
- Remote Sensing
- In-field Sensing
- LiDAR
- Variable Rate Applications
- Telematics
- Robotics
- Data Management

Why Precision Agriculture?

- Maximize Profits
  - Less Overlap
  - Reduce Inputs
  - Increase Yields
- Reduce Stress
- Protect Environment
- Feed 7 Billion People

Current World Population:

7,044,864,008

1804	**1 billion**
1850	1.2 billion
1900	1.6 billion
1927	**2 billion**
1950	2.55 billion
1955	2.8 billion
1960	**3 billion**
1965	3.3 billion
1970	3.7 billion
1975	**4 billion**
1980	4.5 billion
1985	4.85 billion
1987	**5 billion**
1990	5.3 billion
1995	5.7 billion
1999	**6 billion**
2000	6.1 billion
2005	6.45 billion
2010	6.8 billion
2011	**7 billion**

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Questions - Comments

Office 701-231-8213 Cell 701-261-9842

John.Nowatzki@ndsu.edu

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