

Precision Ag Technology ...it's all about the data

**Growing Michigan Agriculture
Conference**

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Assistant Professor

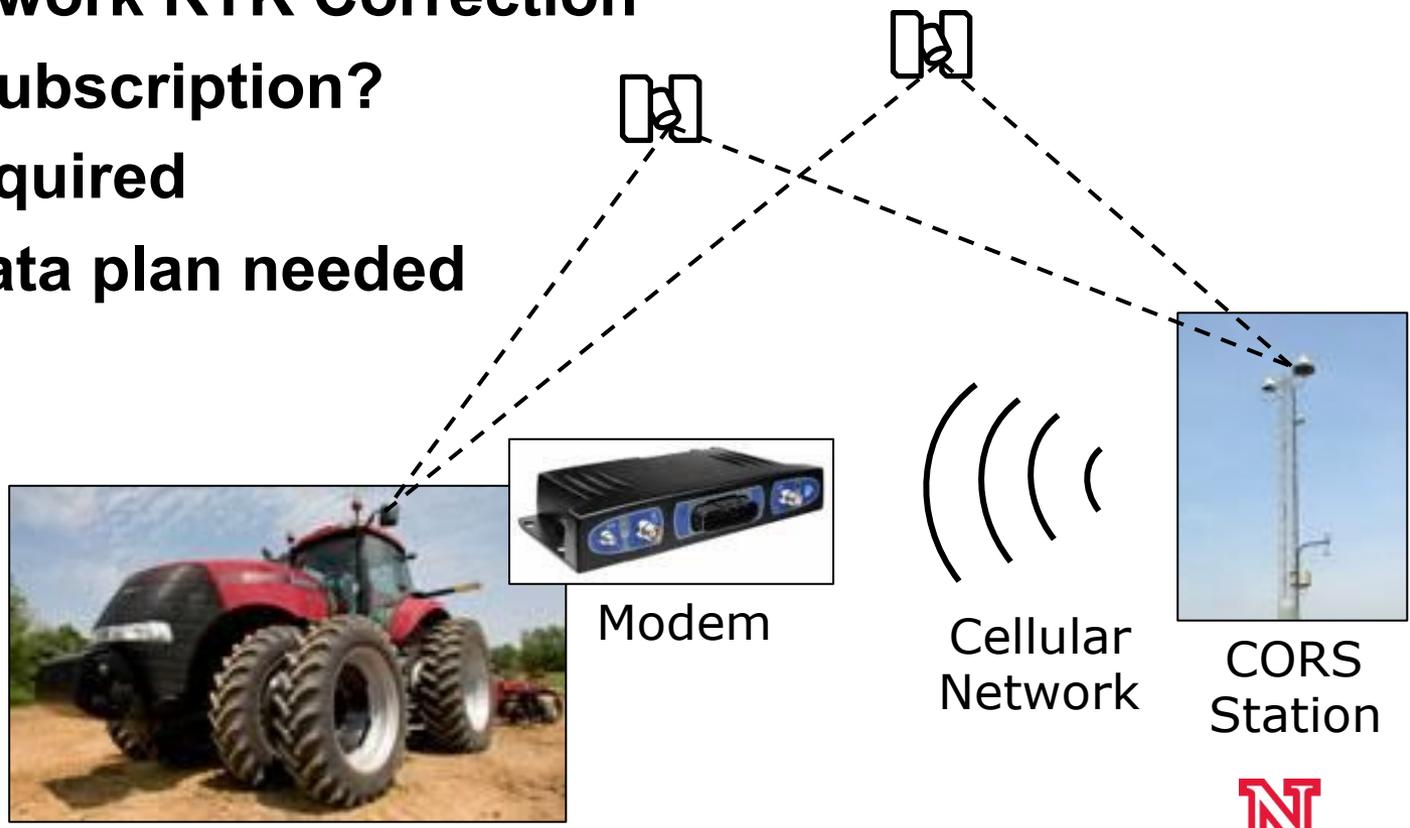
Department of Biological Systems Engineering

Presentation Outline

- **GPS and Network Technologies**
 - **Cellular**
 - **GPS + GLONASS**
 - **Satellite RTK**
- **Data Collection and Analysis**
- **Data Filtering and Processing**
- **Automated Data Processing**
- **Telematics/Analytics**

GPS and Network Technologies

- Continuously Operating Reference Stations
- CORS Network RTK Correction
- Network subscription?
- Modem required
- Cellular data plan needed



GPS and Network Technologies

■ MDOT CORS Network



GPS and Network Technologies

■ NDOR CORS Network



GPS and Network Technologies

■ Raven Slingshot Network



- Cellular RTK Delivery
- Multiple Networks:
 - MDOT
 - MyWayRTK
- Data Transfer:
 - Field to Office
 - Office to Field
- Cloud Data Storage
- Mobile Access

GPS + GLONASS Receivers

- The United States network: GPS
 - The Russian network: GLONASS
 - Each has about 30 satellites in orbit
 - Other networks? (China, EU)
-
- The benefits may include:
 - Improvements in accuracy
 - Faster initialization times



GPS Network



■ United States



NAVIGATION CENTER

The Navigation Center of Excellence

U.S. Department of Homeland Security
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GPS

- GPS General Information
- GPS Mapping Problems
- GPS Status and Outage Information
- NAWCA, Almanacs, & GPS Advisories
- GPS Service Information
- Subscribe to List Serve Mugs
- Space Wx & Precise Ephemeris Data
- Frequently Asked Questions (FAQ)
- GPS Augmentation Systems
- Reference Information
- GPS Modernization
- Report a GPS Problem

Primary Mission Areas:

- Global Positioning System

GPS CONSTELLATION STATUS FOR 07/25/2012

PLANE	SLOT	SVN	PRN	BLOCK	TYPE	CLOCK	OUTAGE	DATE	NANU	TYPE	NANU-SUBJECT
A	1	29	9	SA		CS					
A	2	52	31	IRAM		RB					
A	3	26	6	SA		CS					
A	4	48	7	IRAM		RB	27 JUN 2012	FCSTCANG	2012044	SVN48 (PRN7)	FORECAST OUTAGE CANCELED
A	6	27	27	SA		CS					
B	1	56	18	IR		RB					
B	2	62	25	SP		RB					
B	3	44	28	IR		RB					
B	4	58	12	IRAM		RB					
B	5	35	30	SA		RB					
C	1	57	29	IRAM		RB					
C	2	33	3	SA		CS					

GLONASS Network



■ **Russia**

**FEDERAL SPACE AGENCY
INFORMATION-ANALYTICAL CENTRE**

UTC+4: 22:38:11

GLONASS S/C: GLONASS GPS: News: Archive: Search: Feedback: About IAC

GLONASS constellation status, 21.07.2013

Total satellites in constellation	24 (24)
Operational	21 (21)
In commissioning phase	1 (1)
In maintenance	1 (1)
Spares	1 (1)
In flight tests phase	1 (1)

GLONASS status

Satellite-based RTK correction

- **Trimble CenterPoint RTX**
- **Horizontal accuracy of ± 1.5 inches**
- **Susceptible to typical GPS errors**
- **Standard initialization (up to 30 minutes)**
 - **Satellite or cellular network delivery**
- **One-minute initialization**
 - **Satellite network delivery**

Satellite-based RTK correction

- RTK One-minute initialization (in blue)



Data Collection and Analysis

- Farm Management Software (FMS)
- Many FMS packages are available:
 - Apex
 - SMS
 - Farmworks
 - SST
 - SGIS
 - MapShots

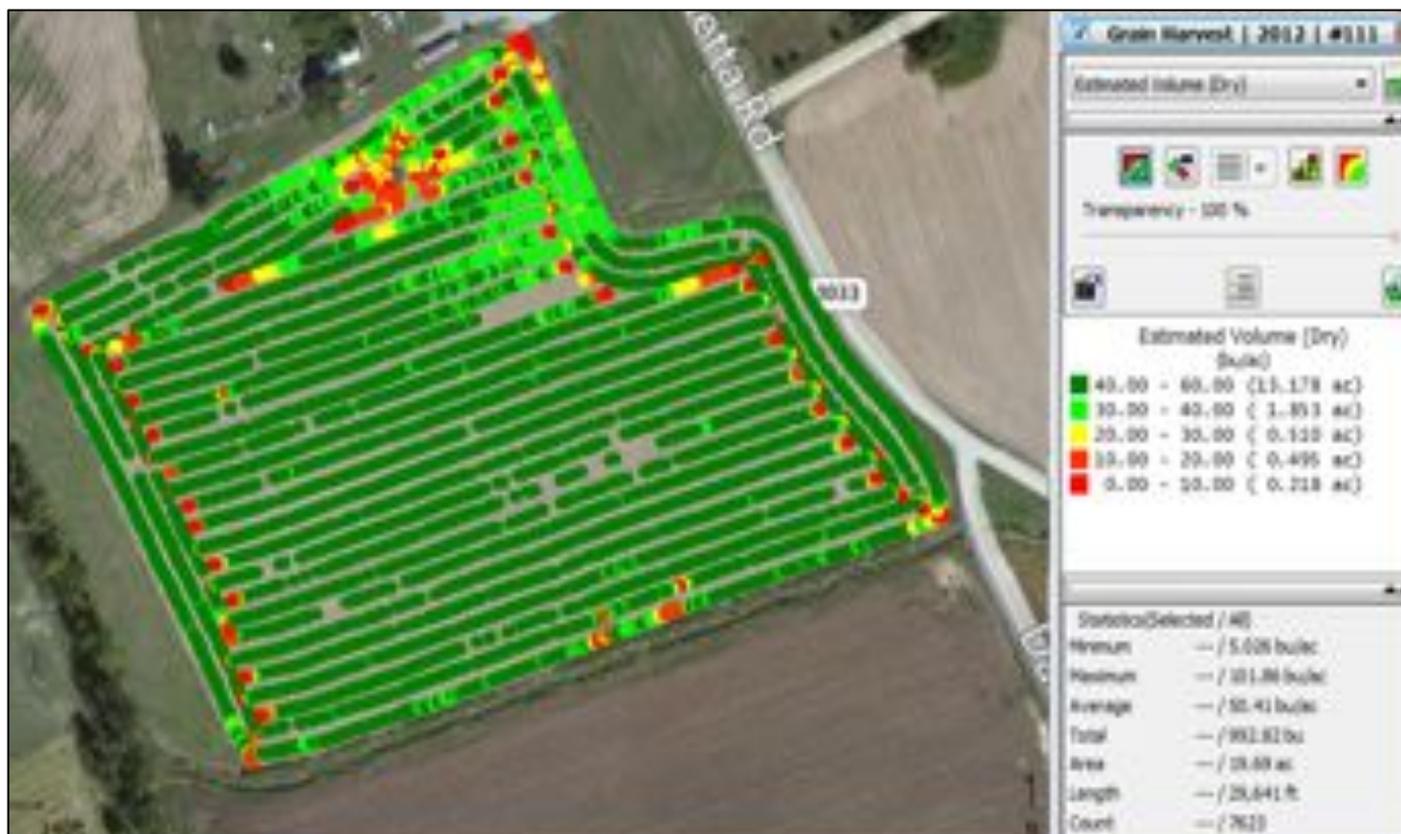


Data Collection and Analysis

- Today FMS is more user friendly
- Handle data from multiple manufacturers
- Store and analyze field data
- FMS can perform many functions:
 - Comparison analysis (soil type, topography)
 - Prescription (Rx) map development
 - Batch data processing
 - Yield data normalization

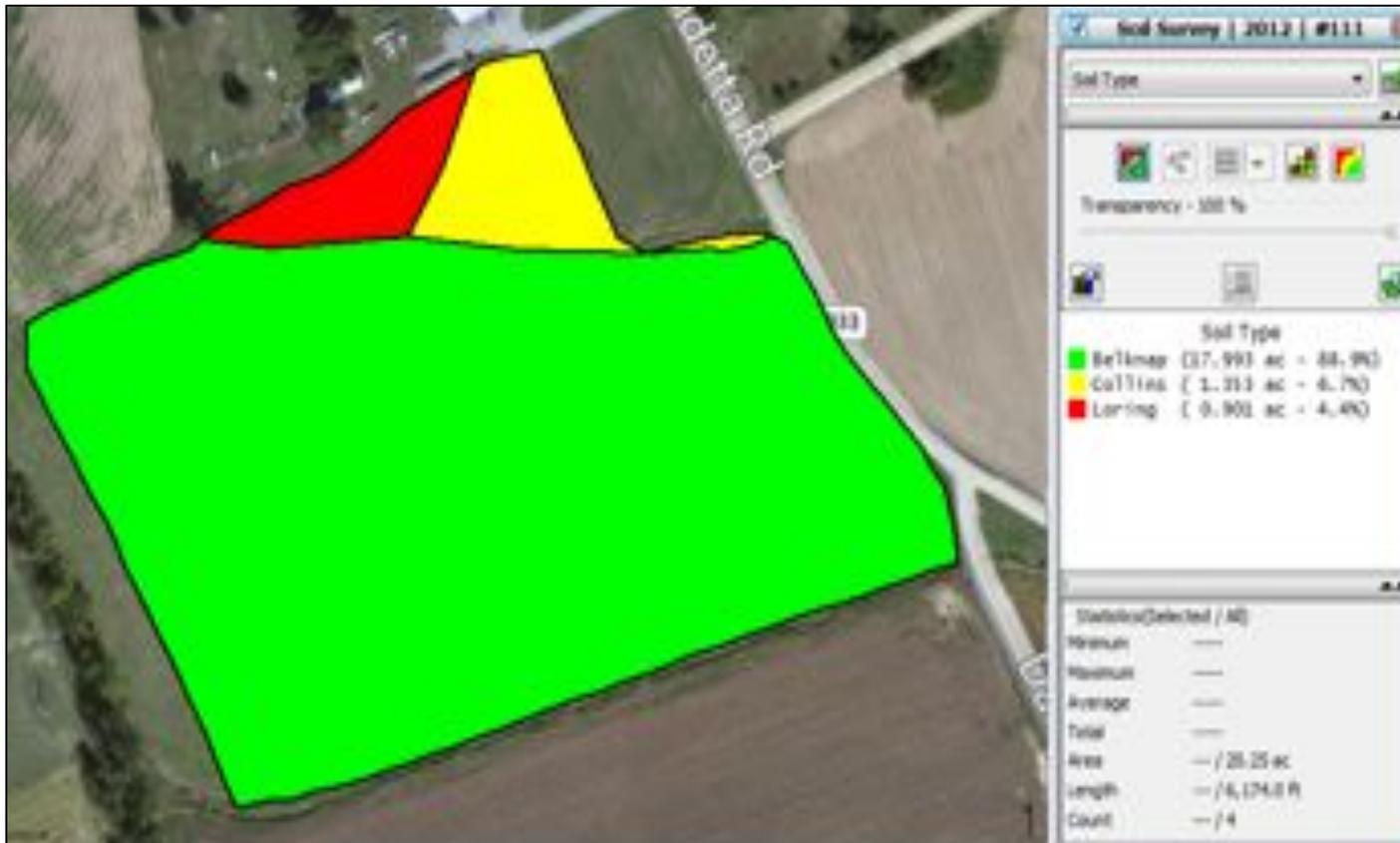
Data Collection and Analysis

- Comparing Yield to Soil Type
- Soybean harvest data:



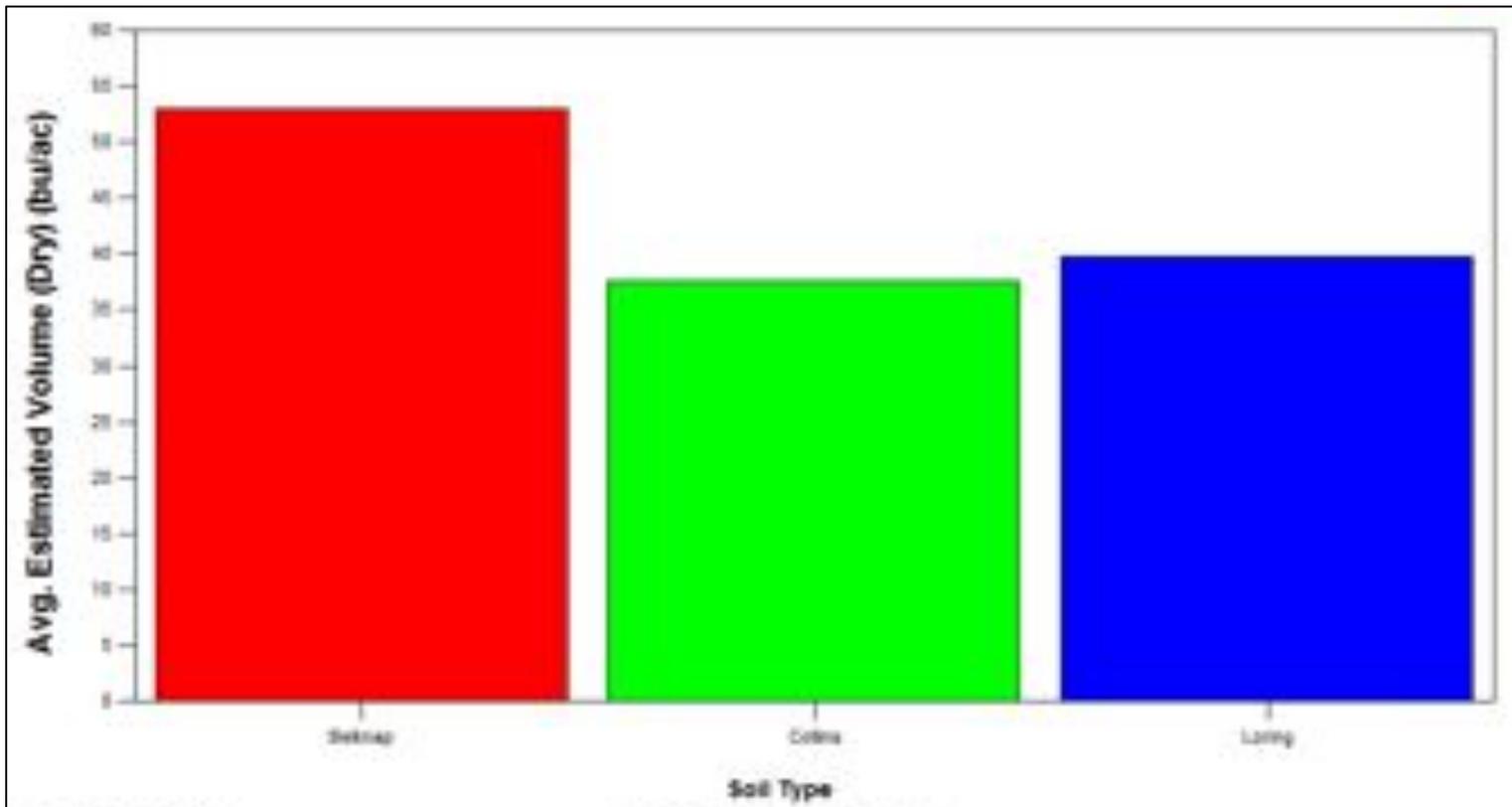
Data Collection and Analysis

- Comparing Yield to Soil Type
- Soil survey data:



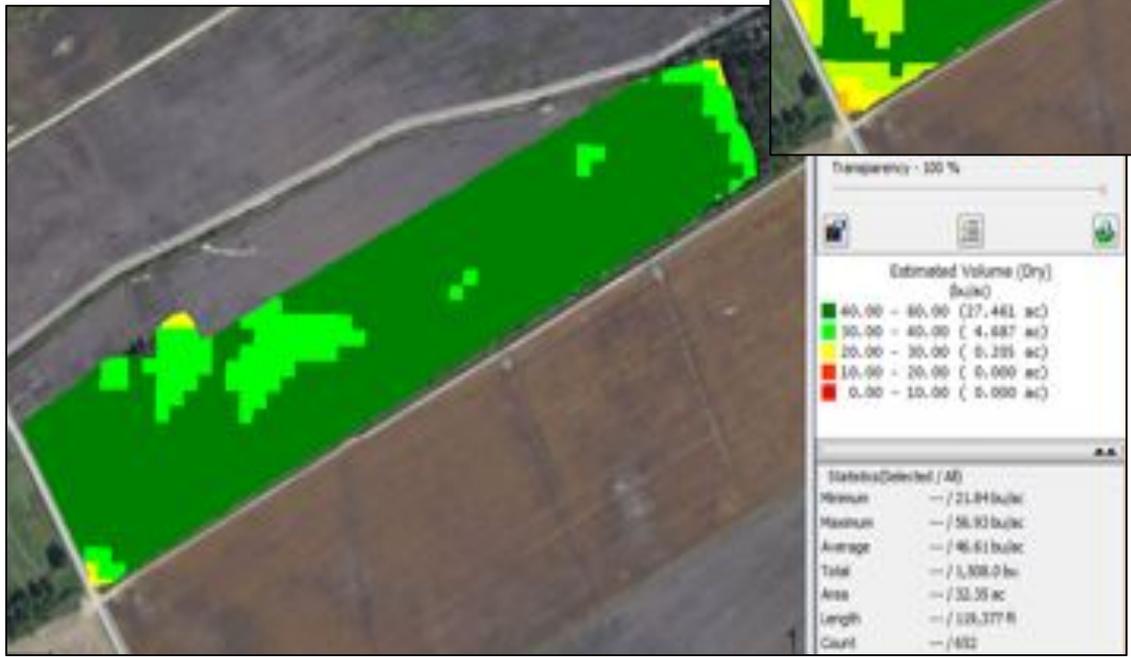
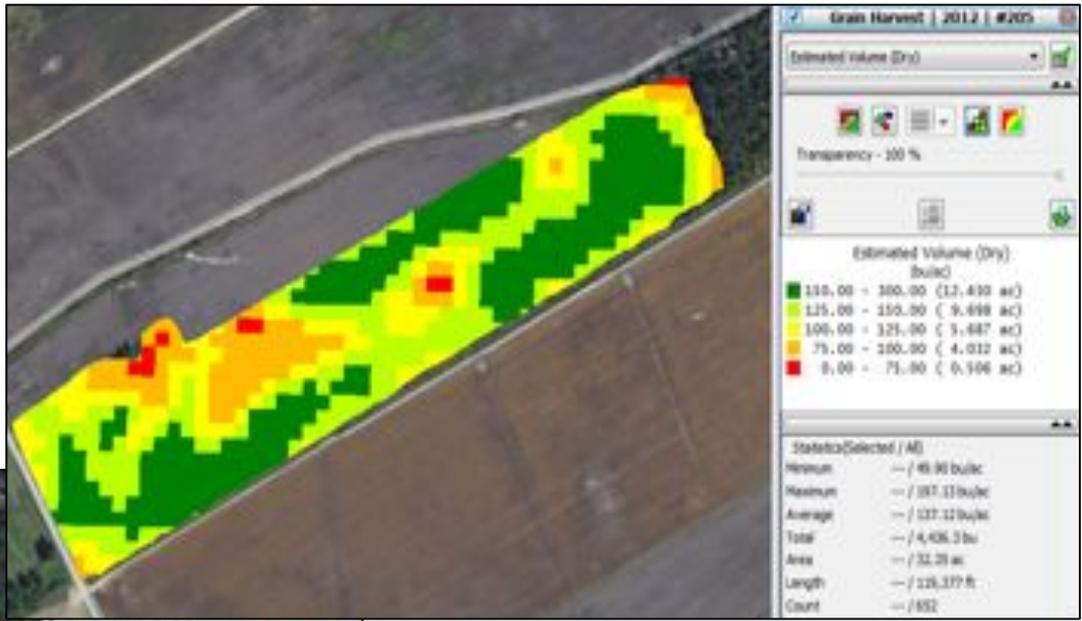
Data Collection and Analysis

- **Comparing Analysis Results:**



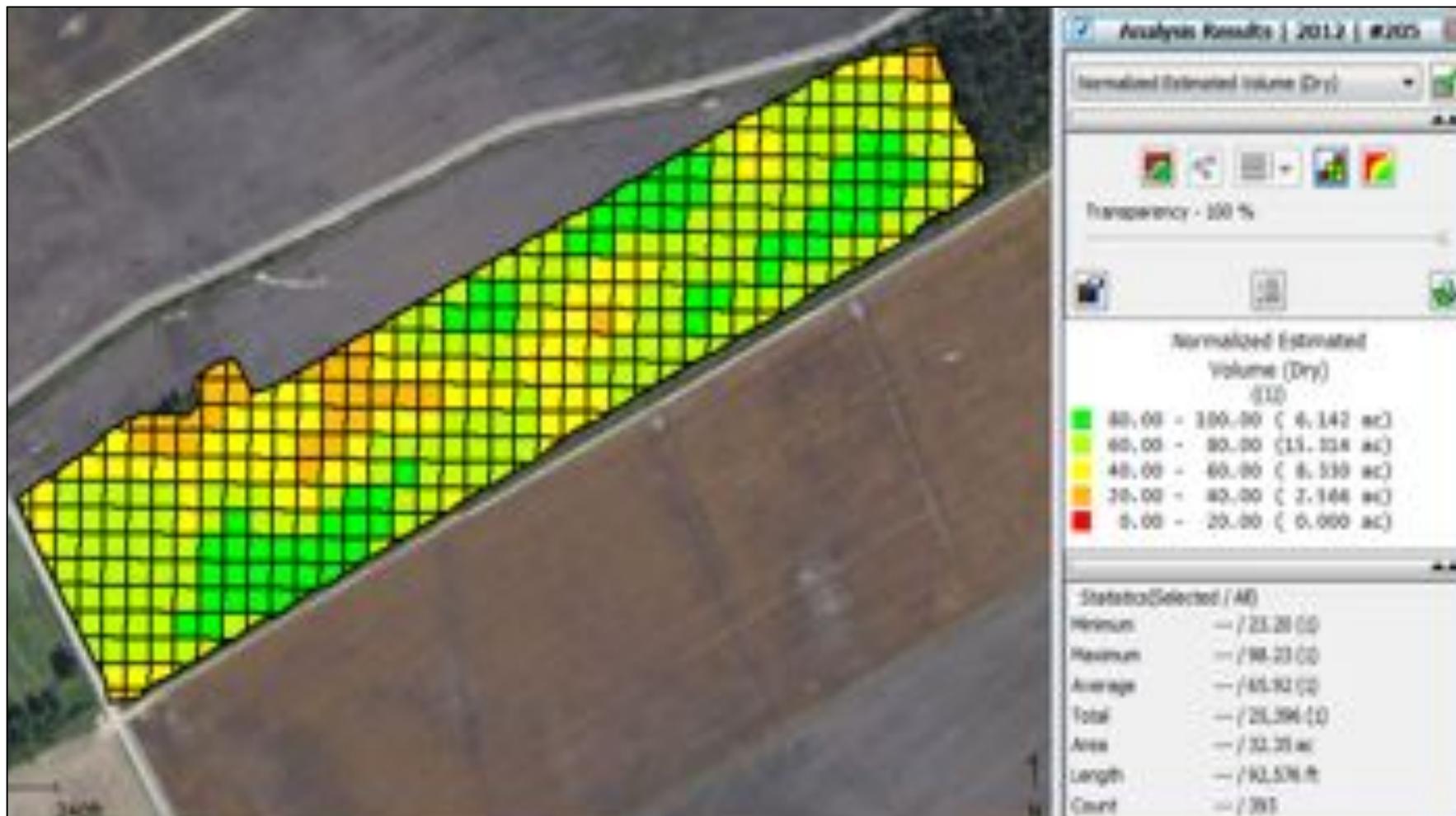
Yield Data Normalization

- Corn (right)
- Soybean (below)



Yield Data Normalization

- Multi-year analysis using different crops:



Yield Data Normalization

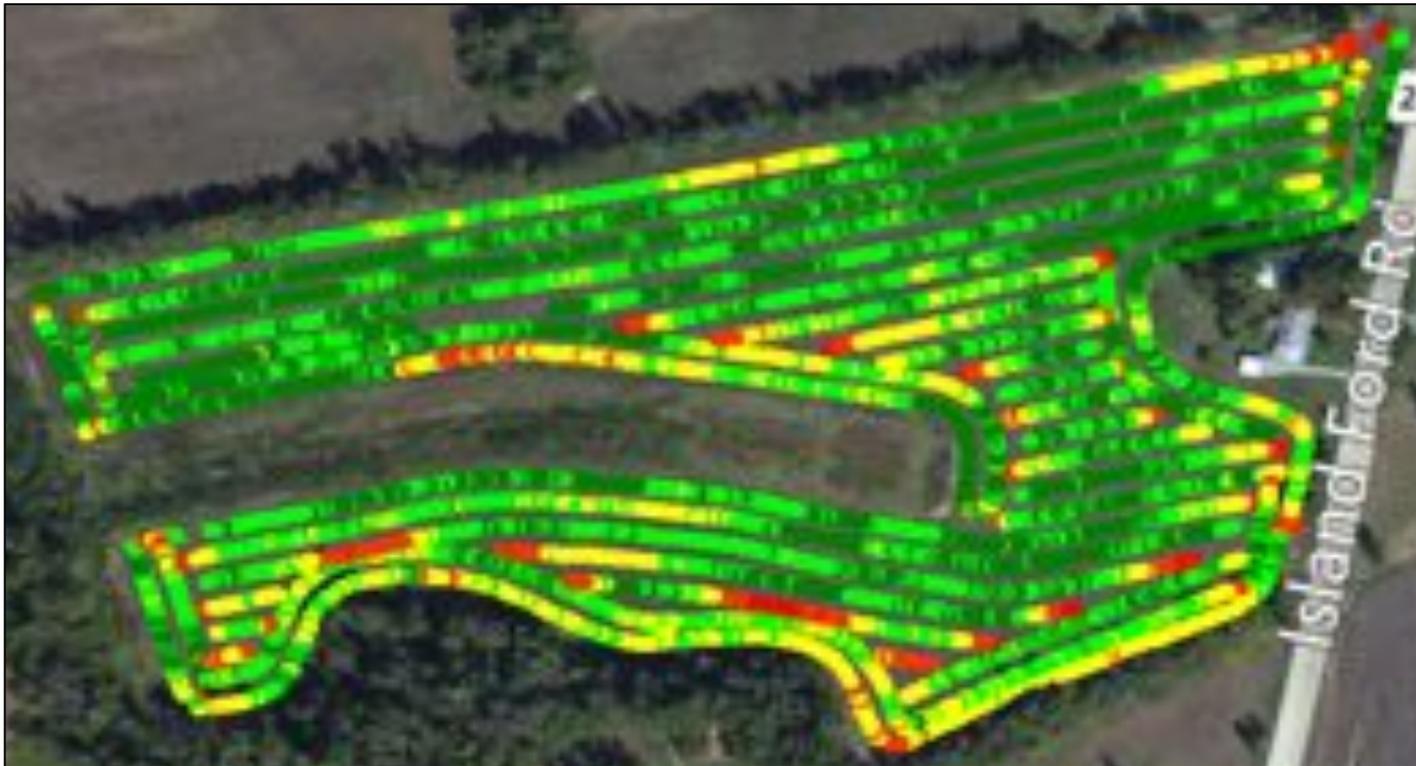
- Provides a yield range in % (not bu/ac)
- Allows for comparison with different crops
- Still need to consider the “year” (wet or dry)
- Baseline yield data (3-5 years) is good starting point
- May be useful for:
 - Identifying management zones
 - Locating test plots
 - Evaluating management changes
- Next step...yield “stability” maps

Automated Data Processing

- Automated processing is our goal (saves time)
 - Data analysis or Rx map development
 - Accurate data is critical
 - Good data in = Good data out
 - Bad data in = _____
- Processing yield data is a good idea:
 - Improves total harvested grain estimates? No
 - Improves accuracy of information gained? Yes
- Yield Editor software, USDA (free download)

Data Filtering and Processing

- Raw yield data contains errors:



Data Filtering and Processing

■ Yield Editor Software (USDA):

The screenshot displays the Yield Editor Software interface, which is divided into several functional areas:

- Filter Selection:** A list of filters with checkboxes for 'Use?' and 'Show?'. The 'Maximum Yield' filter is checked and set to 250. Other filters include Flow Delay, Moisture Delay, Start Pass Delay, End Pass Delay, Max Velocity (mph), Min Velocity (mph), "Smooth" Velocity, Minimum Swath (m), Minimum Yield, STD Filter, Header Down Req, Overlap (Auto), and Local STD (Auto).
- Position Filter:** A section for defining geographic coordinates with 'From' and 'To' fields. The 'From' coordinates are Easting: 461114.73, Northing: 4143827.79. The 'To' coordinates are Easting: 461554.11, Northing: 4144072.04.
- Map and Manual Editor:** A central map area showing a field layout with colored lines representing different yield zones. A legend at the bottom right indicates 'Display Legend?' and 'Symbol Size (m)'. The symbol size is currently set to 1.25.
- Yield Statistics:** A table at the bottom left showing summary statistics for 'Clean' and 'Raw' data.

	Mean	STD	CV	N	Range
Clean	40.10	11.50	28.7	5304	7-156
Raw	40.10	11.50	28.7	5304	7-156

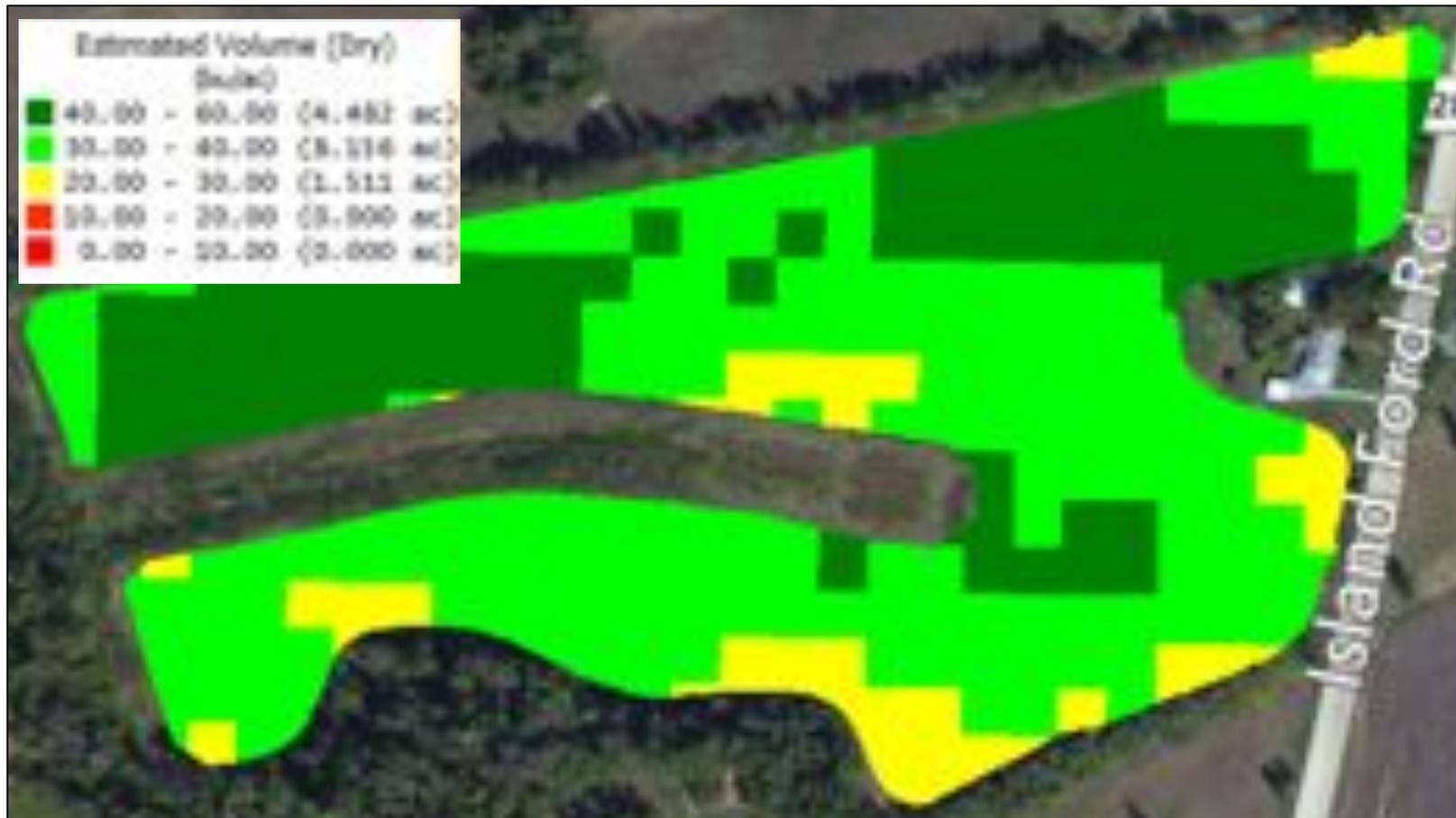
Data Filtering and Processing

- Processing (Yield Editor) can remove errors:



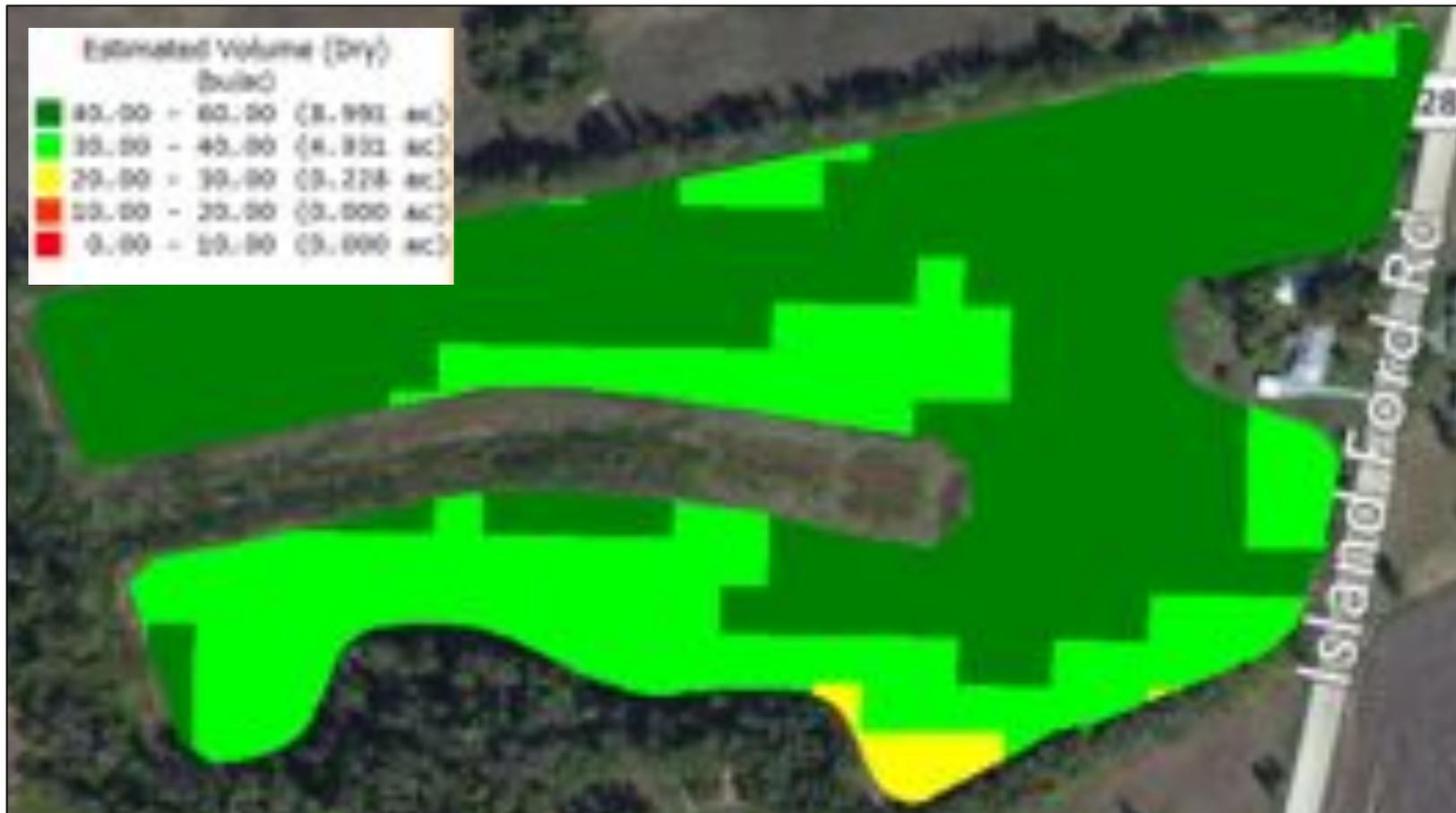
Data Filtering and Processing

- Interpolating with raw points to create a grid:



Data Filtering and Processing

- Interpolating with the filtered data:



Raw versus Cleaned Grid Data



Contour (zone) maps?



Telematics and Analytics

- **Telemetry:**
 - Data transmission from source to central
 - Storage, processing and analysis at central
 - Transmission back to source, remote control
 - Mobile-central or source-to-source transmission
- **Analytics:**
 - Finding or detecting patterns in data
 - Computer programming and statistical analysis
 - Data visualization and communication
 - Provides information for decision-making

Telematics and Analytics

- Telemetry has numerous Ag applications:
 - Weather data
 - Soil moisture status
 - Grain bin monitoring
 - Machine performance
 - Irrigation systems



Telematics and Analytics

- **Analytics follow the data:**
 - **Industrial/Marketing**
 - **Healthcare**
 - **Social Media**
- **Ag systems are starting to generate large datasets**
 - **May range from 0.25 to 2.5 MB/operation/acre**
 - **What data do we really want/need?**
- **BIGDATA**
 - **New U.S. R&D Initiative**
 - **How to manage/utilize HUGE datasets**

Thank You!

- Questions/Comments?
- Feel free to contact me:

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or visit: **www.precisionagriculture.unl.edu**