Using Variable Rate Techniques For On-Farm Research

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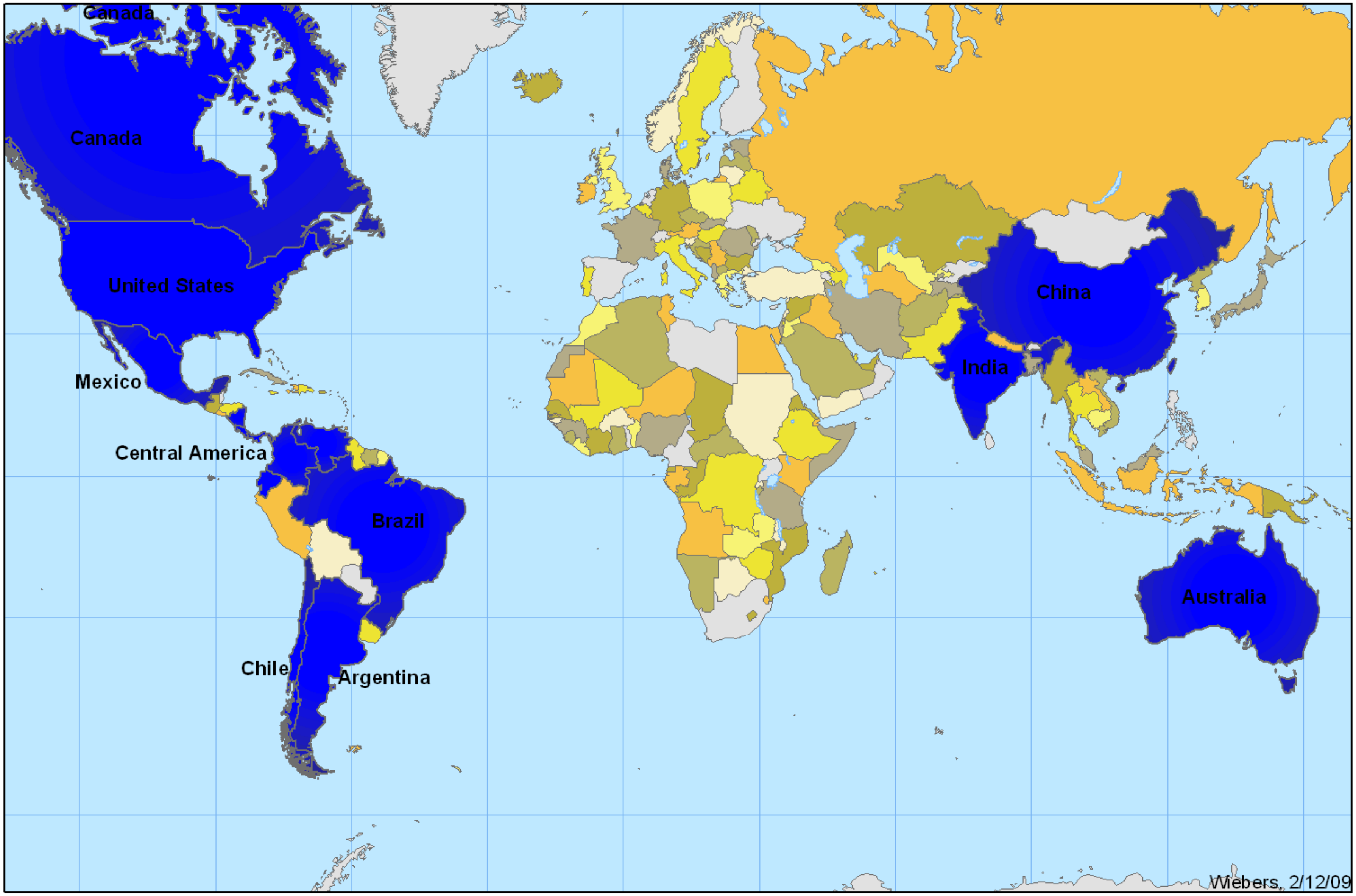
Mosaic Crop Nutrition
February 16 2009

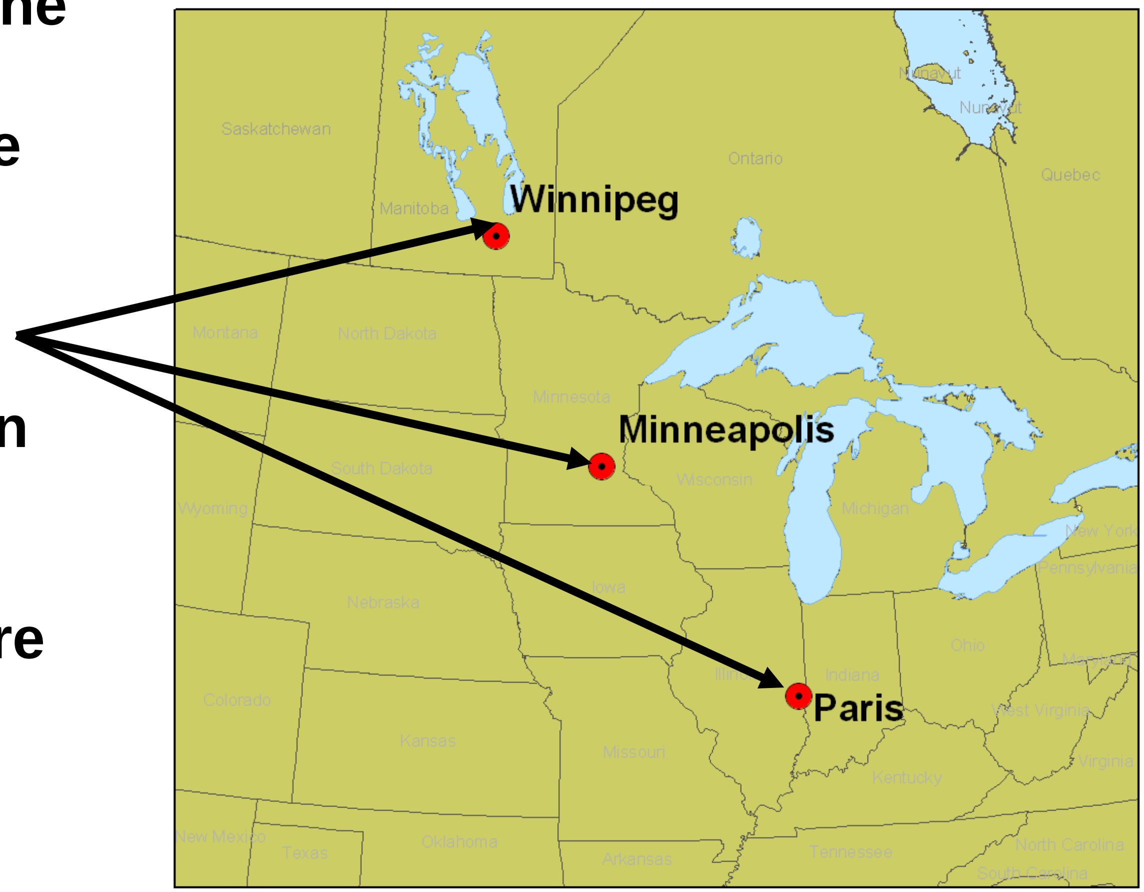
Mosaic Agronomy



Role of Agronomy Research

Mosaic recognizes the need for support of precision agriculture technologies

12 years with the company focused on
- **GIS**
- **Remote sensing**
- **Precision agriculture**



3 Questions to Answer

- What are the major steps in using precision ag for on-farm research?
- What do typical field scale designs look like?
- Does this approach really work in the real world?

A Literature Review of On-Farm Research

Source: Google Searches

- Purdue - Tips for Test Plots (2000)
- UNL – On Farm Research (1992, 1993)
- The Ohio State University (No Date)
- Kansas State University (1990)
- University of Illinois (1993?)
- Iowa State University (No Date)

- **Most publications are >10 years old**
- **Utilization of GPS technology is missing from the publications**

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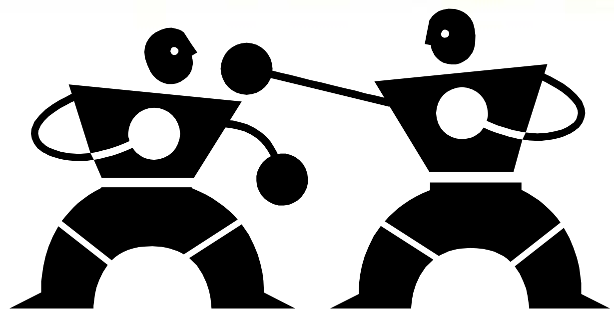
A Lot has Changed…

- Farmers recognize the value of technology
- New GPS systems have sub inch accuracy
- Rate controllers are more user friendly

Typical Midwestern On-Farm Research



Versus

Fungicide	→	No Fungicide
Standard N Rate	→	N Rate minus 50 lbs
Drought tolerant	→	Standard hybrid
No Tillage	→	Fall Chisel
Fall N application	→	Spring N application
Broadcast P &K	→	Banded P &K
Micronutrients (S/Zn)	→	No micronutrients

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The Importance of On-Farm Research

- Often, new products advertise yield increases in the range of 5-10%
- These responses can be real but can be hard to see visually
- Farmers & dealers like to see local results

Factors Influencing Corn Yield

		Average Effect (bu)
Easier to see	Weather	70+
	Nitrogen	70
	Hybrid	50
Harder to see	Previous Crop	25
	Population	20
	Tillage	15
	Chemicals	10
		Total: ~260

Don't forget P & K!

Data Source: Dr Fred E. Below, University of Illinois

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Steps in On-Farm Research

1. Define the question to answer
2. Planning & Implementation
3. In-Season Observations
4. Harvest
5. Analysis

Step 1: Define the Question

Example: What is the economic impact of changing from MAP to Microessentials SZ?

(12-40-0-10S-1Zn)

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Step 2: Develop the plan

- Talk to the farmer or dealer
- Use fields with good crop history and soil tests
- Use previous GPS data to identify field management
- Know the width of both the applicator and combine
- Limit the study to a single variable

Step 2: Develop the plan

- Use a mapping package to generate the plot design
- Balance nutrients (N-P-K) across treatments
- Confirm with the farmer / dealer
- Load the prescription into the rate controller
- Spread the product

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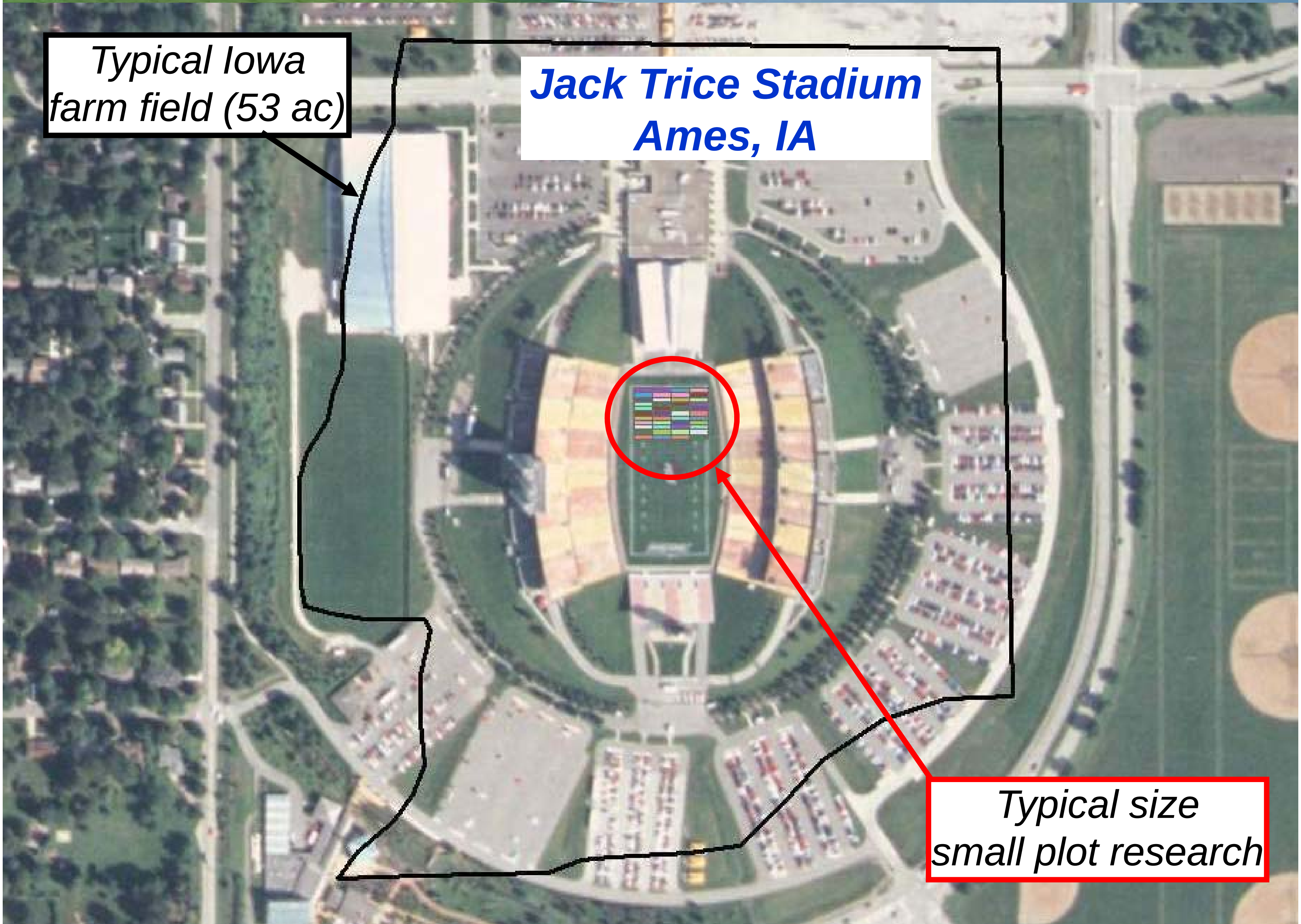
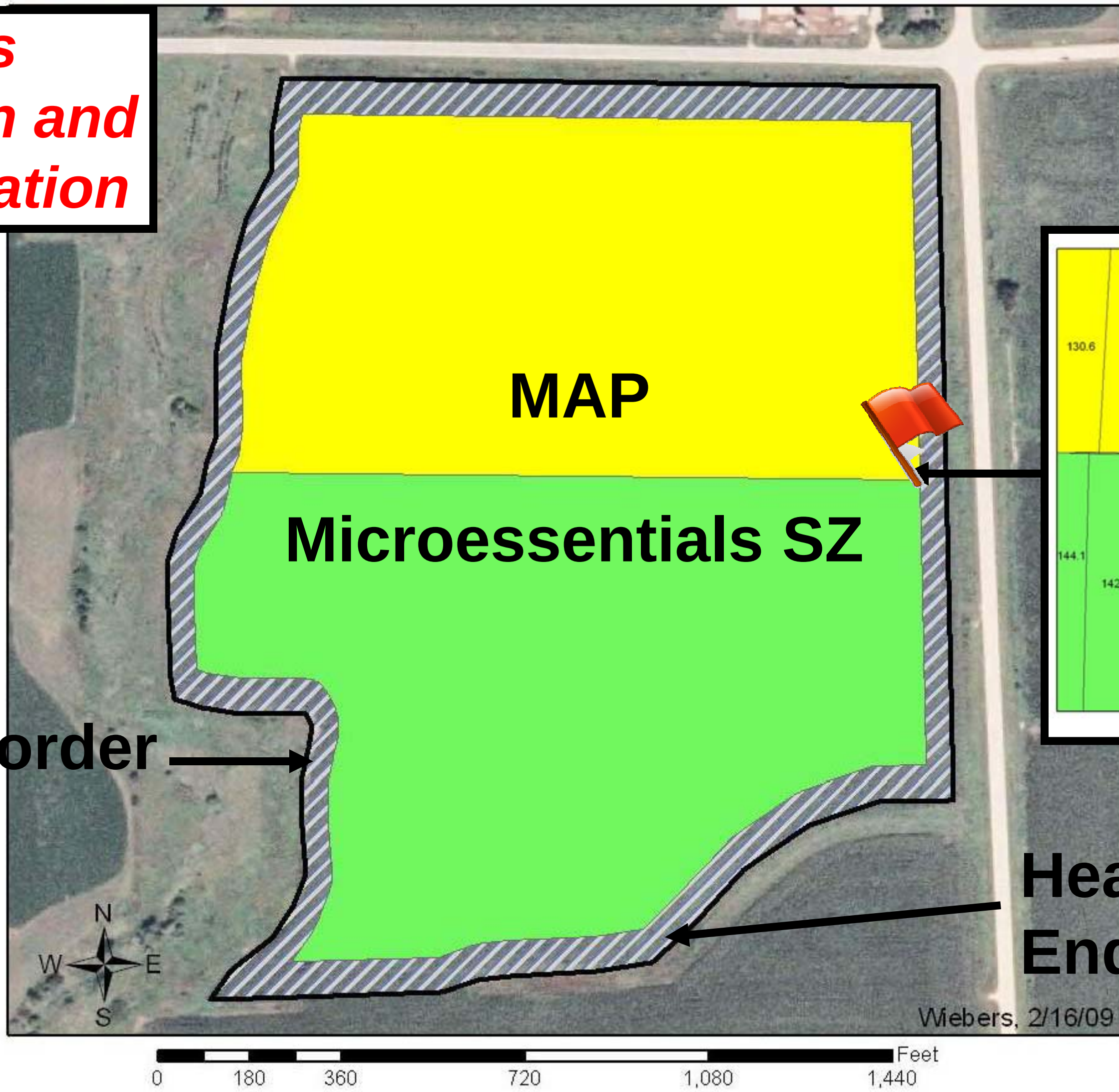
Sample Protocol Designs

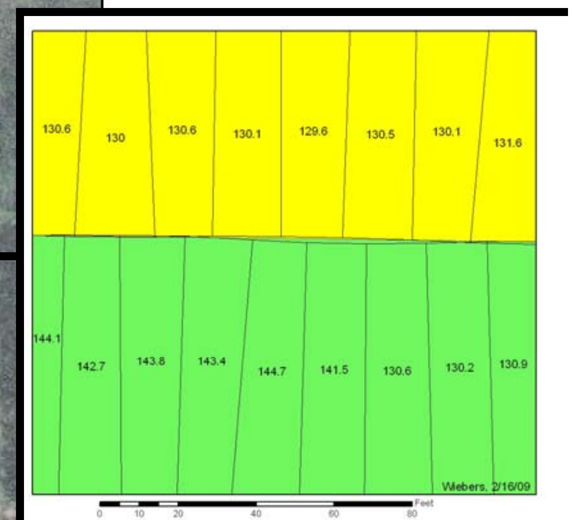

Typical Iowa
farm field (53 ac)
Jack Trice Stadium
Ames, IA
Typical size
small plot research

Example - Split field

Needs replication and randomization

53 acre field





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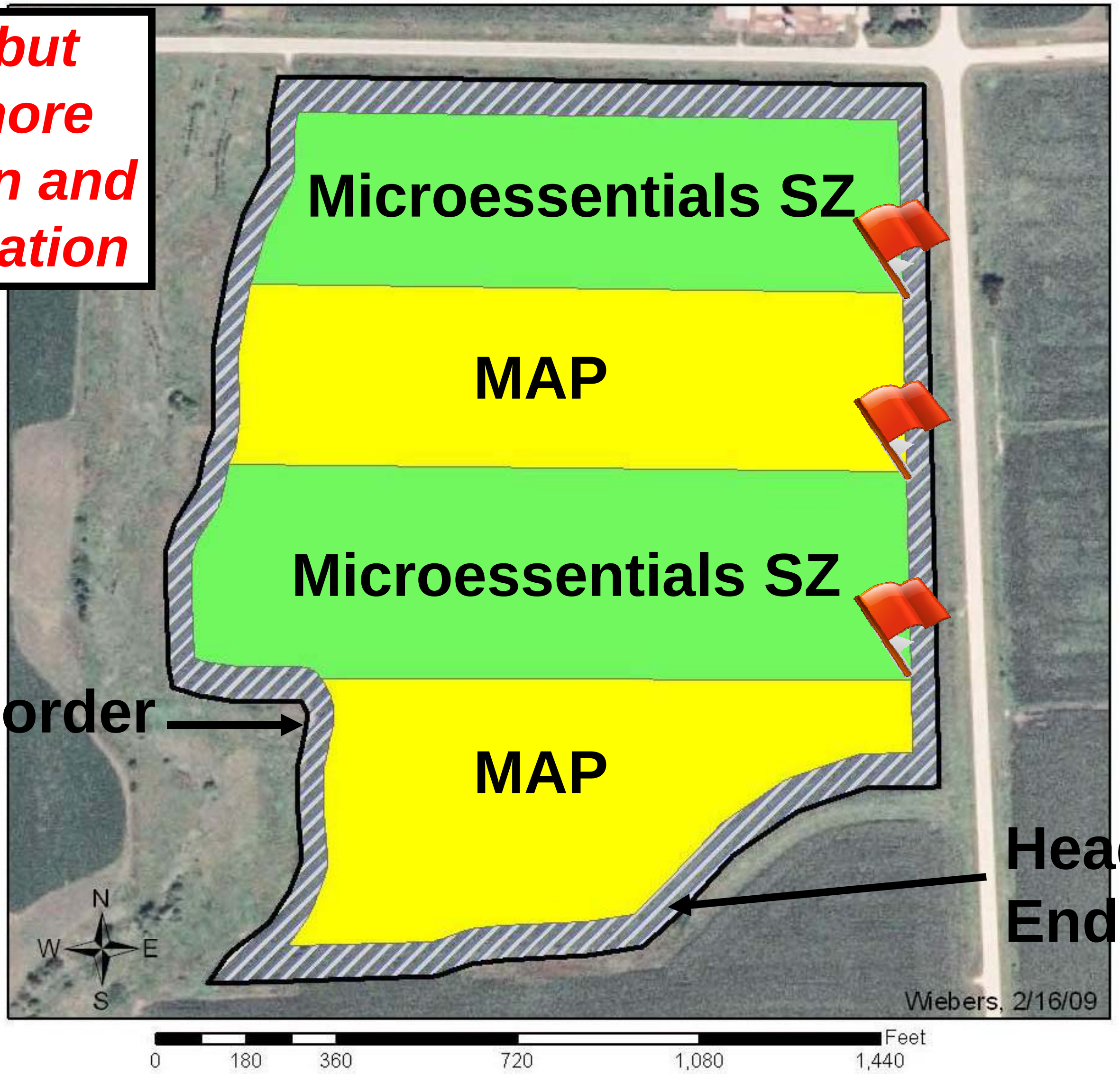
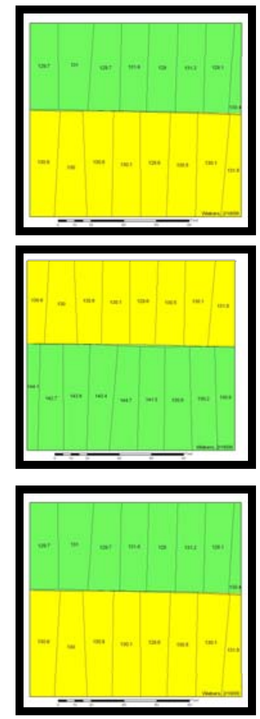
Example - Quartered field

Good, but prefer more replication and randomization



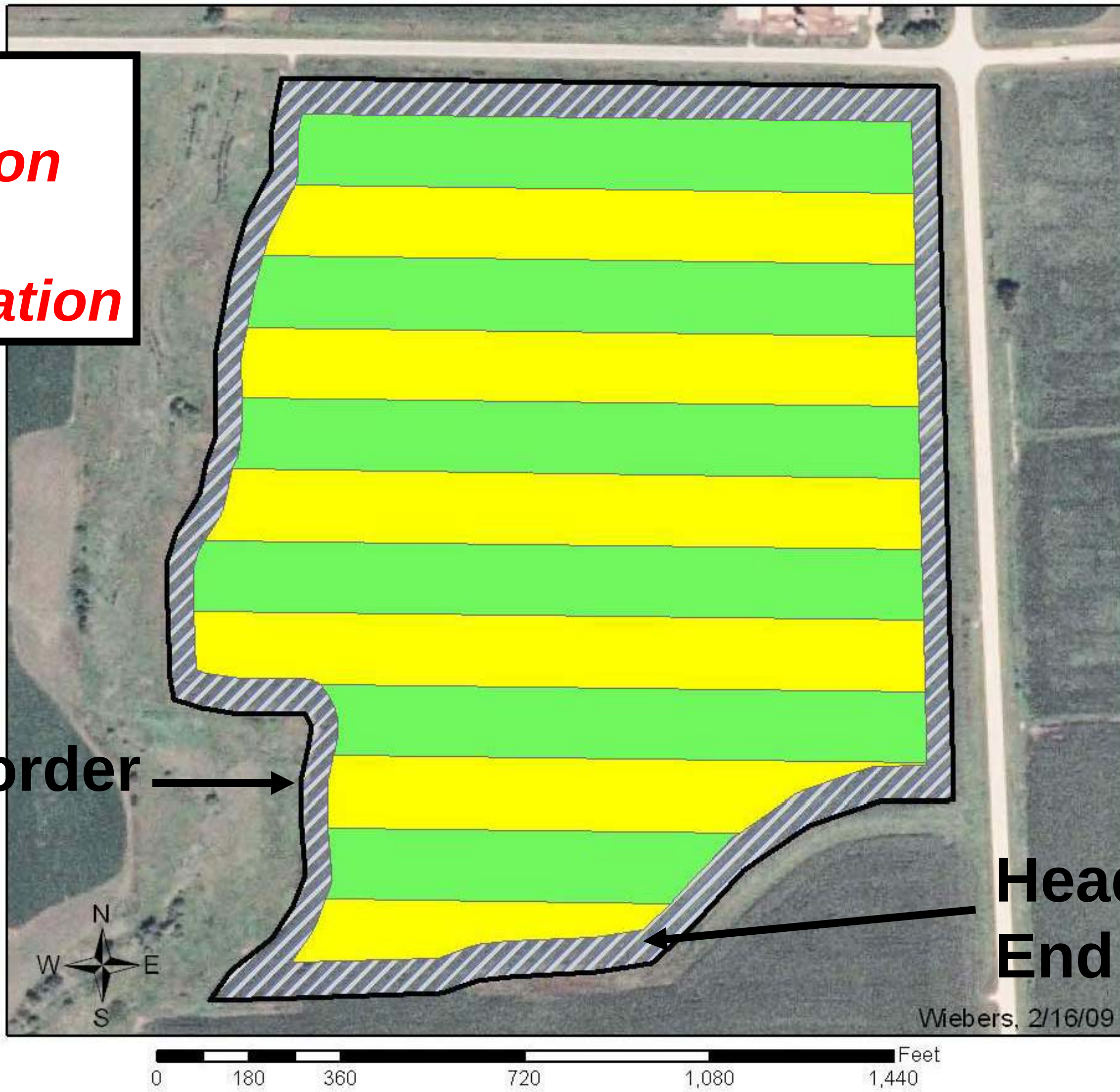
53 acre field



Example – 140 foot (2x machine width)

Good replication Needs Randomization

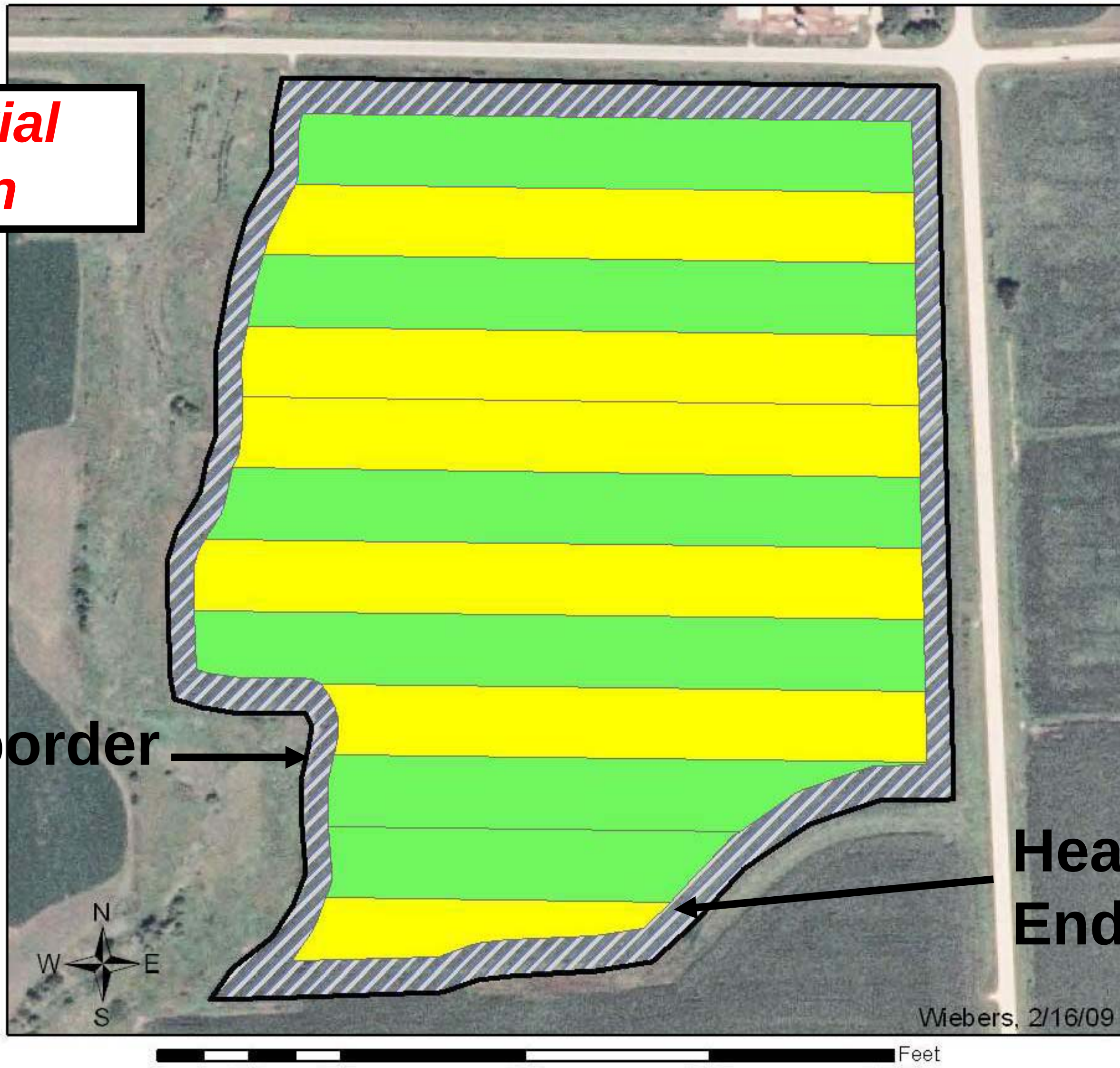
53 acre field



Example – 140 foot (2x machine width)

53 acre field

Good trial design



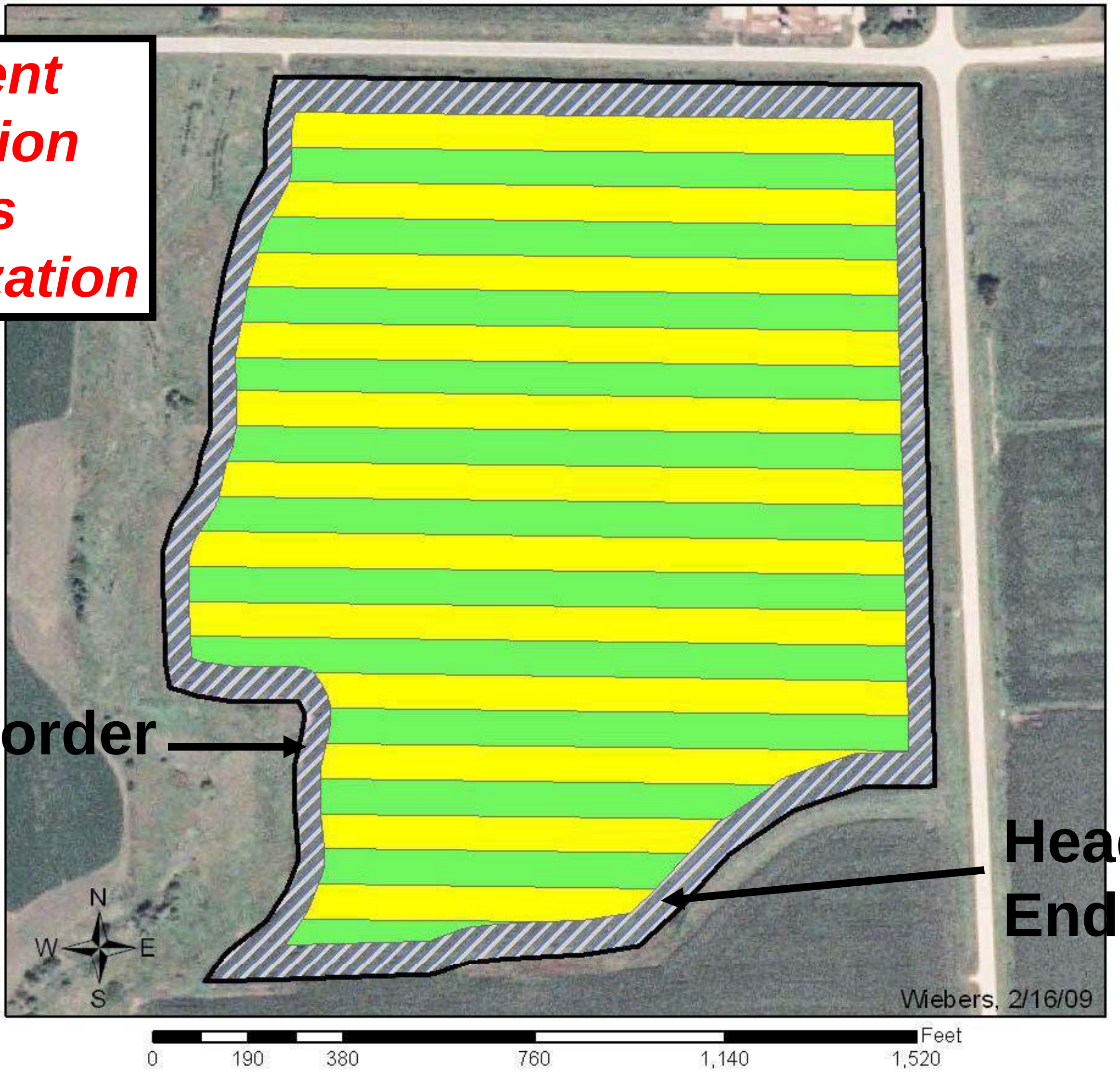
Field border

Headlands & End rows

Example – 70 foot (machine width)

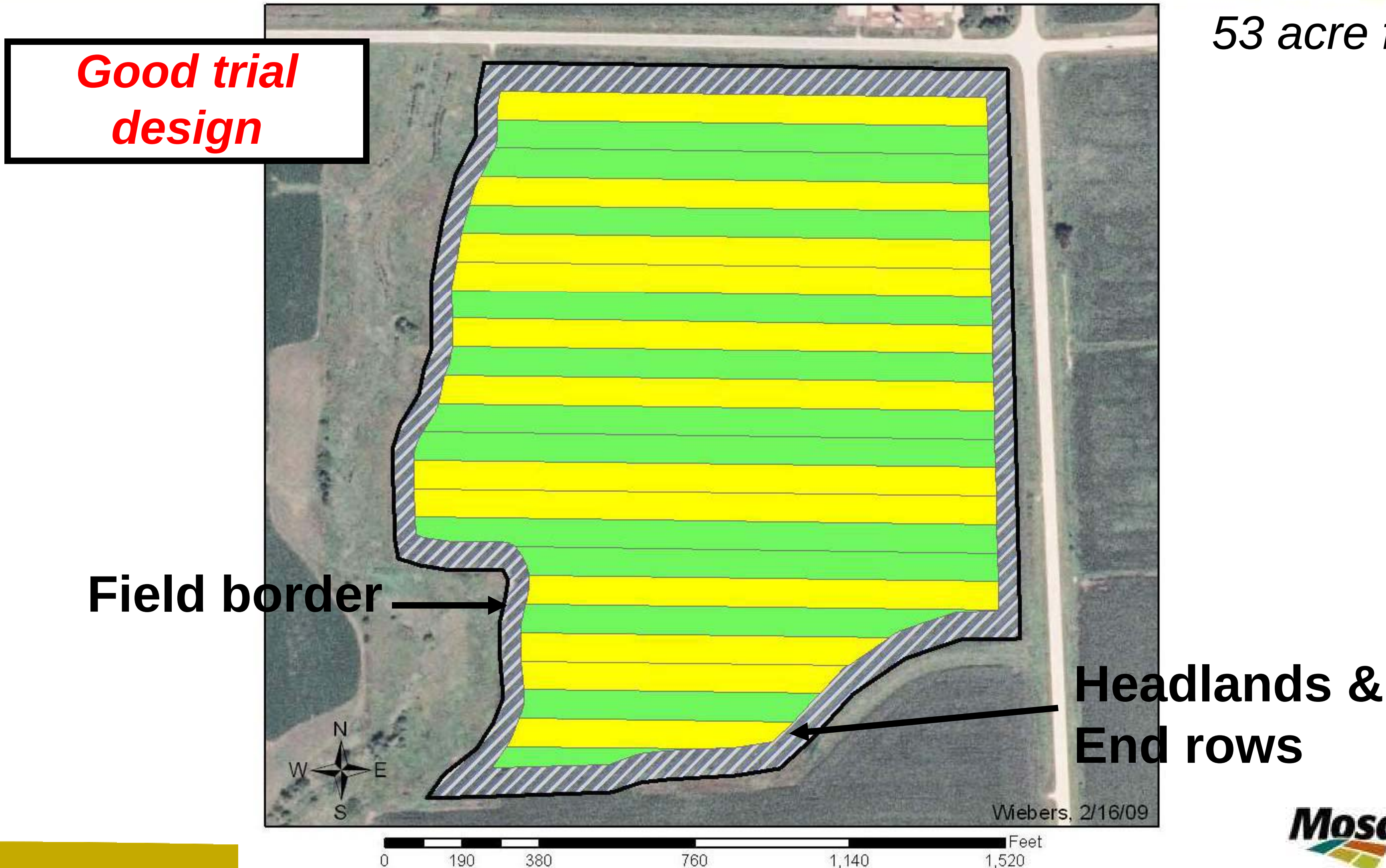
53 acre field

Excellent replication Lacks Randomization



Example – 70 foot (machine width)

53 acre field



Step 2: Protocol summary

- Most practical: use a multiple of the implement width (2x)
- Use at least 4 replications
- Exclude headlands and end rows
- Add randomization if possible
- Get the GPS as-applied data

Step 3: In-Season Observations

- Control factors that could influence yield (weeds, insects)
- An aerial photo is a cost-effective way to monitor the field
  - Can be used after harvest as a yield data filtering tool

Step 3: In-Season Observations

Red = Low vigor
Yellow – Average
Green – High vigor

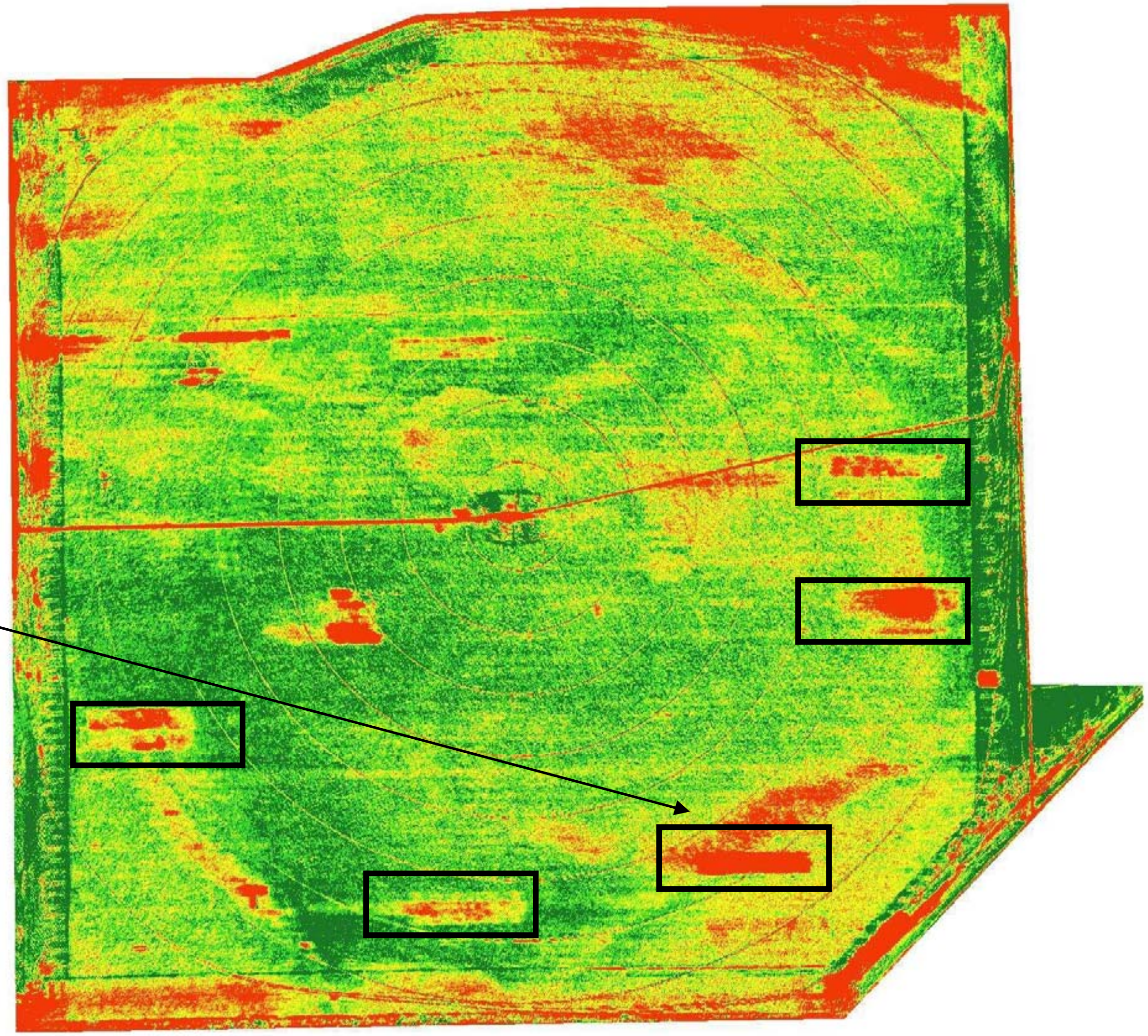


Image source: Crop Assure

In-Season Monitoring

Red = Low vigor
Yellow – Average
Green – High vigor

Crop loss – Water damage

Applicator damage (side-dress)

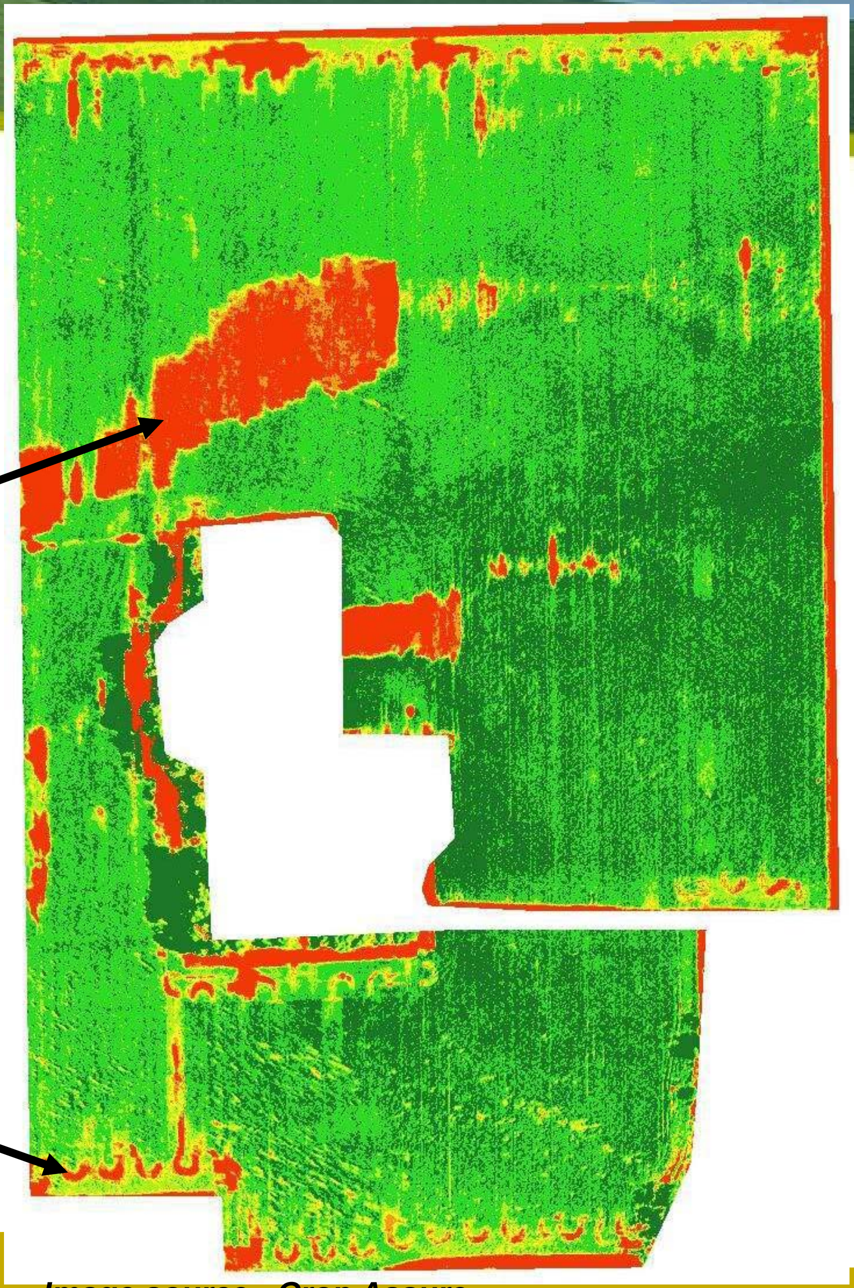


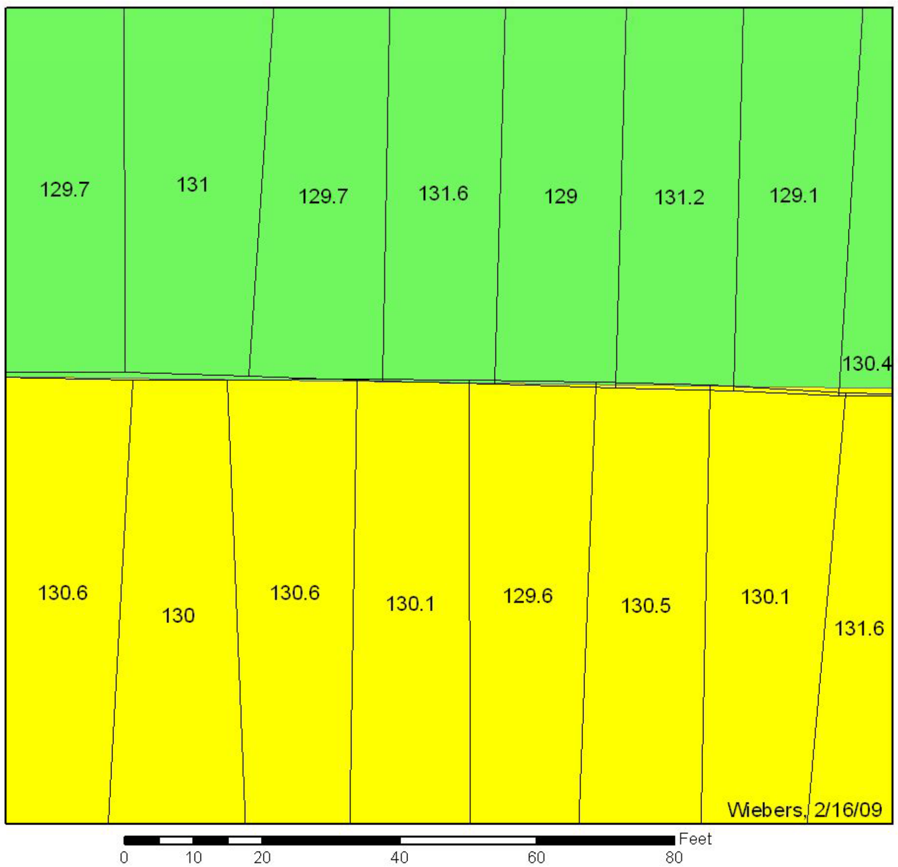
Image source: Crop Assure

Step 4: Collect the yield data

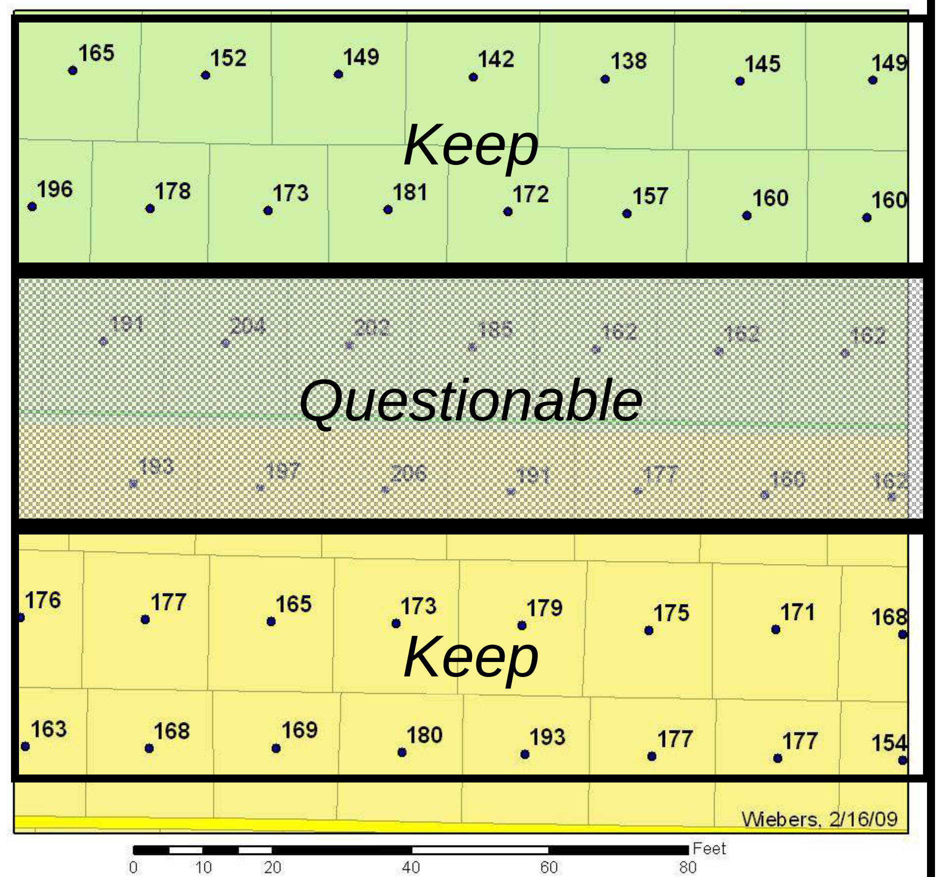
- Don’t harvest the research fields first
- Calibrate the yield monitor
- Use one combine only
- Get the raw yield data

Step 5: Analysis

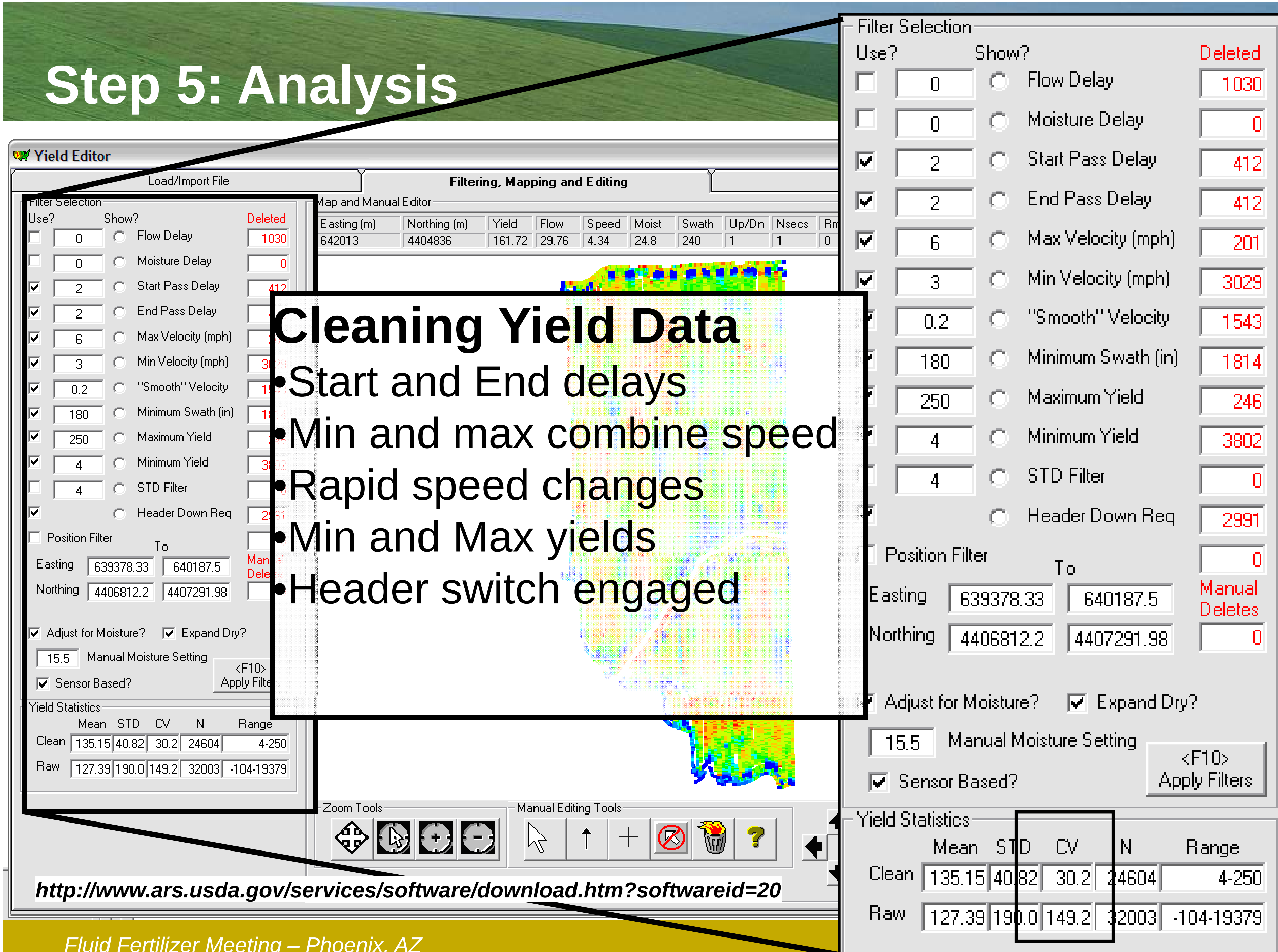
As-applied



Yield



Step 5: Analysis



Cleaning Yield Data

- Start and End delays
- Min and max combine speed
- Rapid speed changes
- Min and Max yields
- Header switch engaged

http://www.ars.usda.gov/services/software/download.htm?softwareid=20

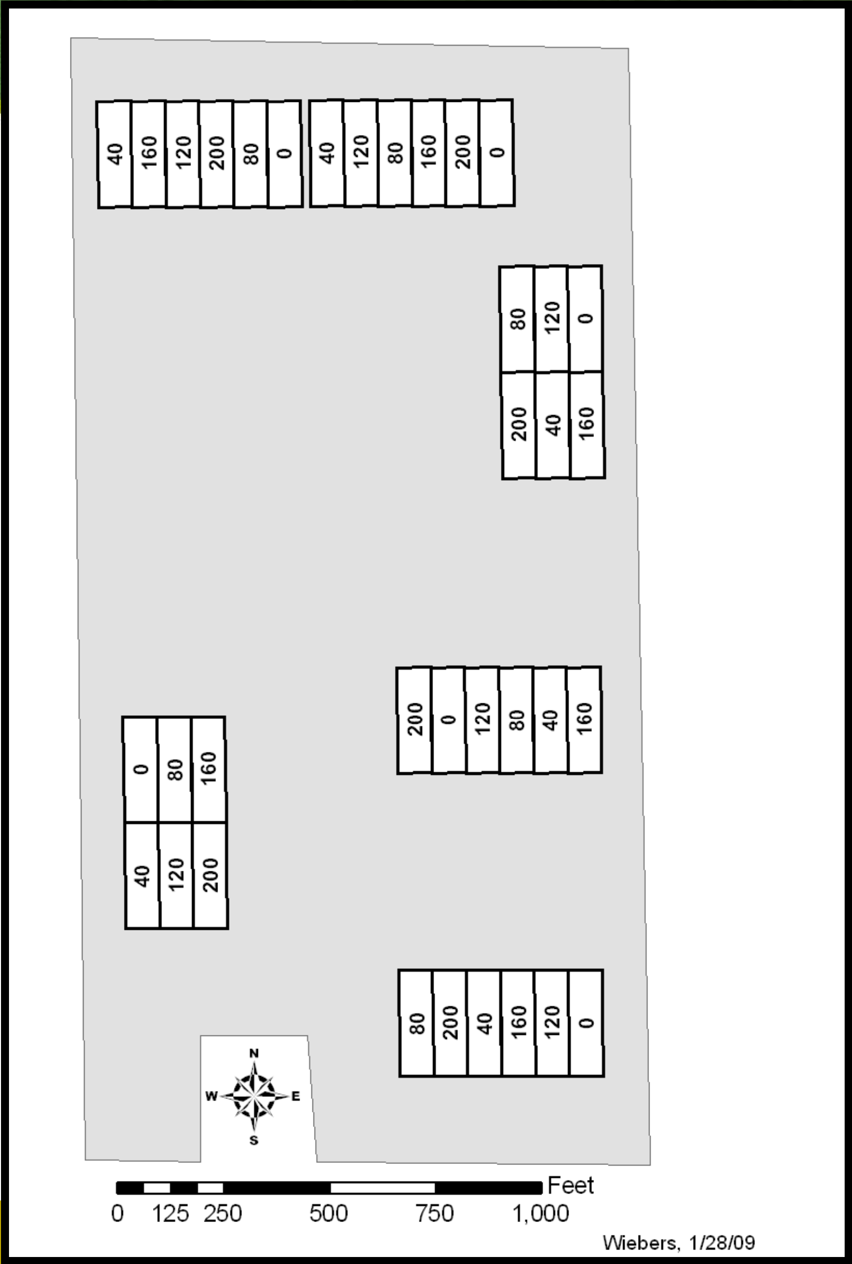
Step 5: Analysis - Summary

- GIS and mapping packages can help clean, analyze and summarize the data in each treatment
  - ArcView, SSToolbox, AgLeader SMS, Farmworks, MapShots
- Determine if the differences are statistically significant
- Communicate the results to growers and dealers

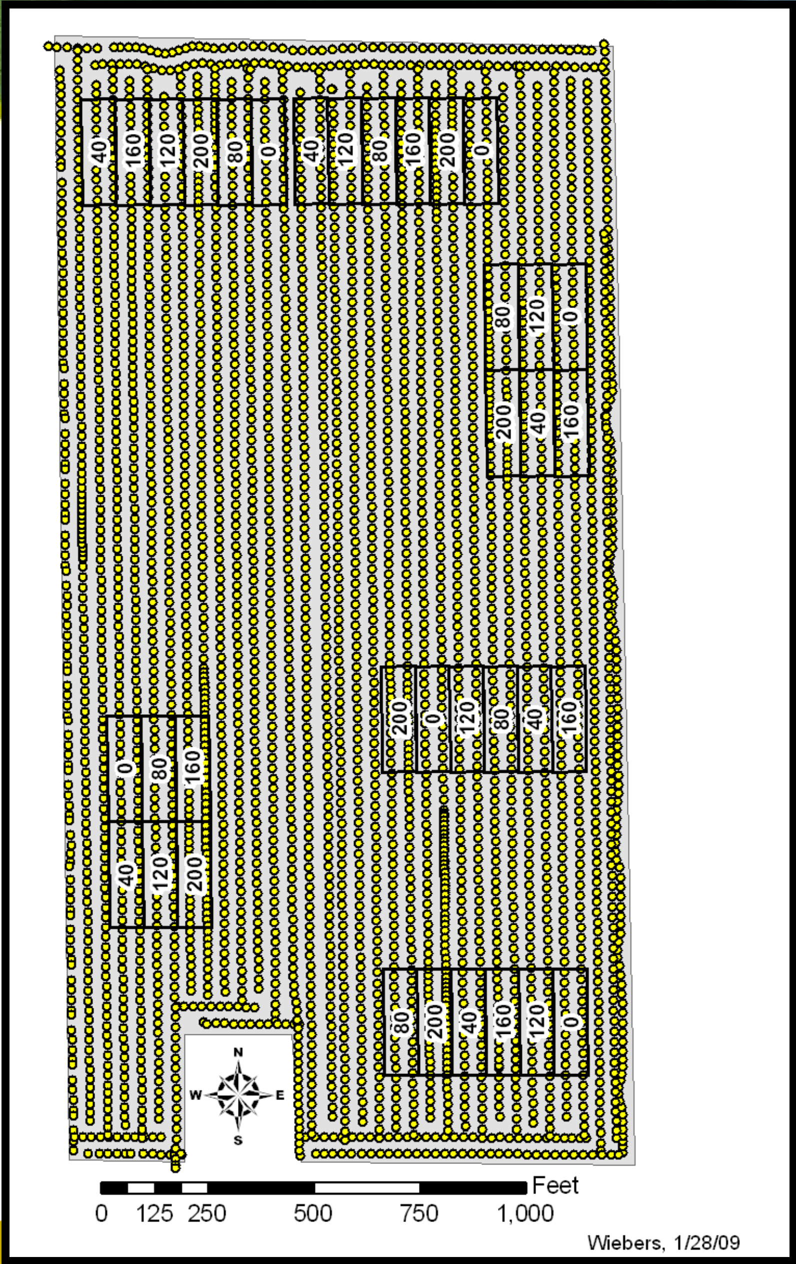
Example of a Nitrogen Study using this Approach

Paris, Illinois 2007

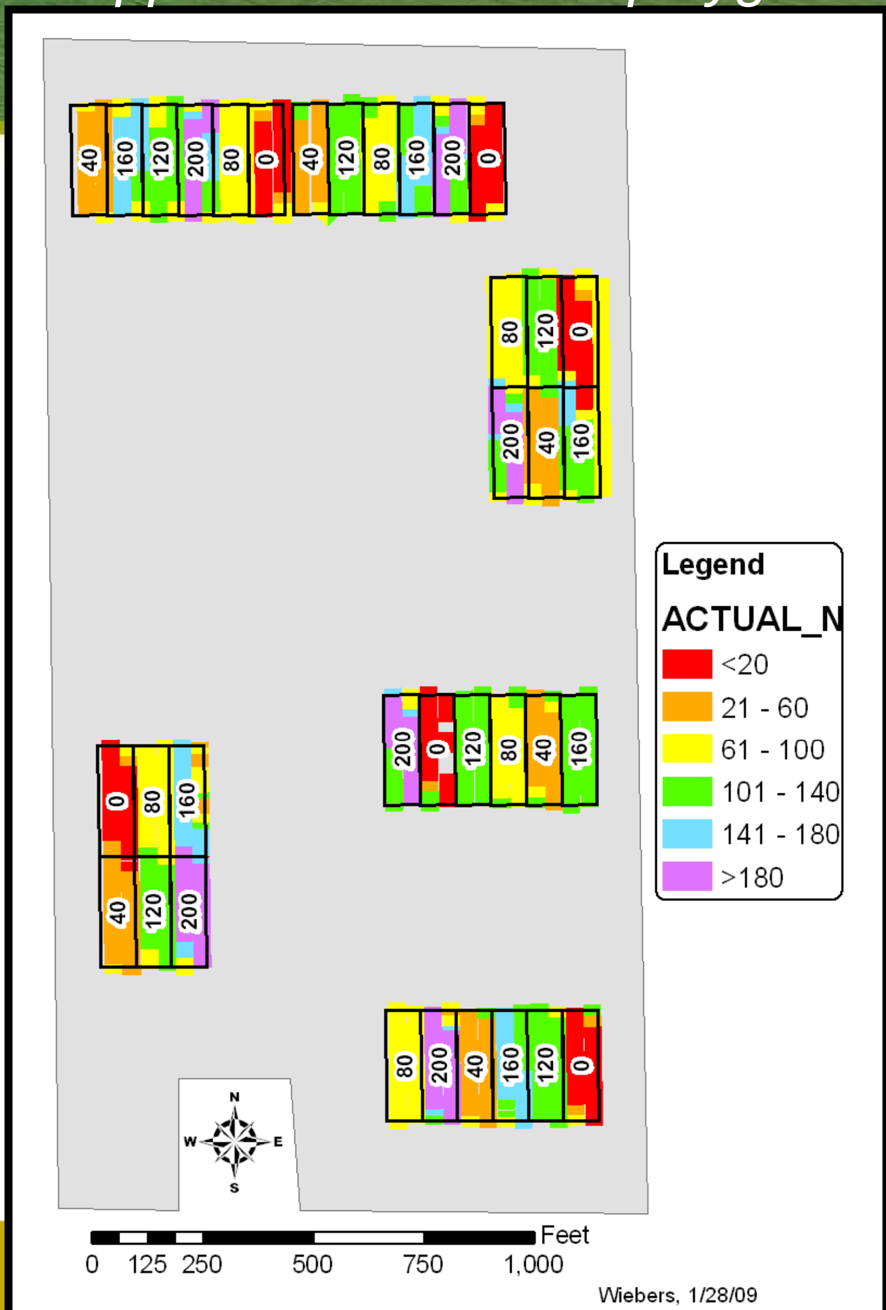
Experiment Design



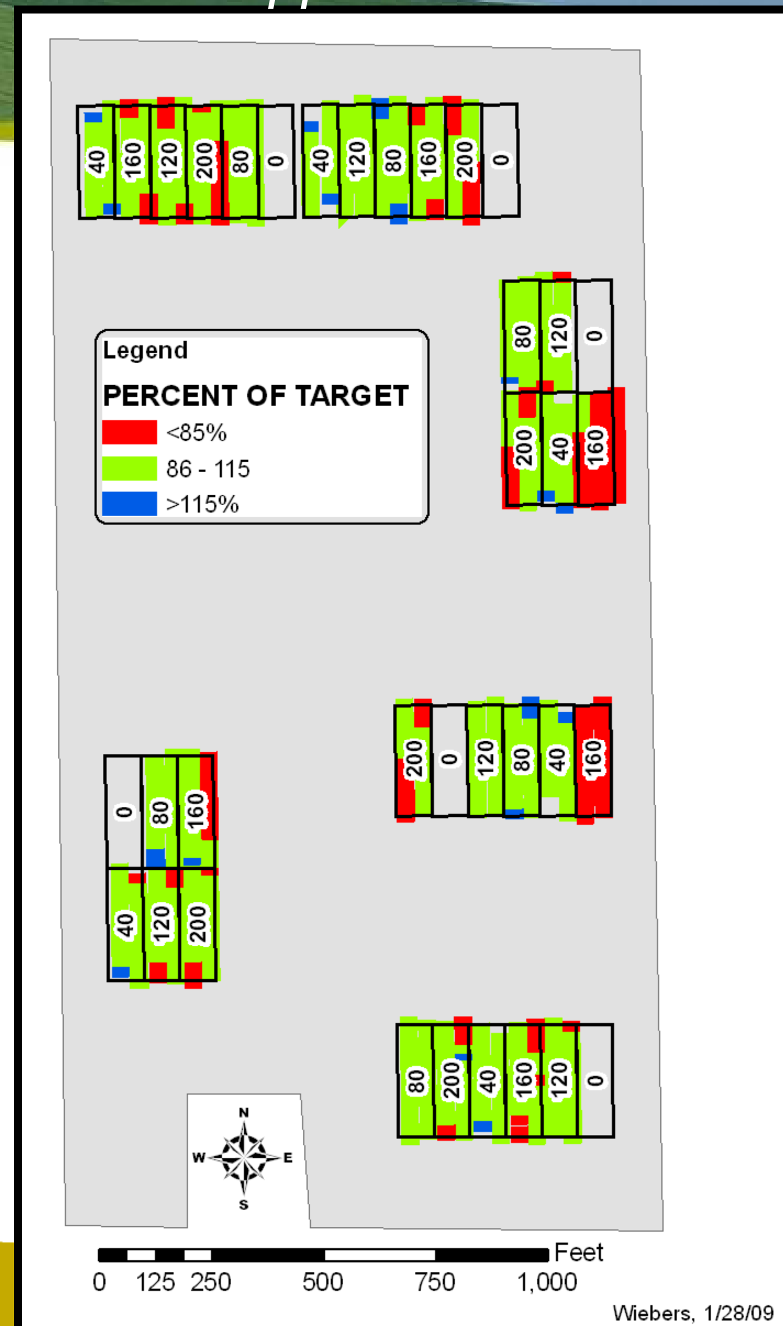
As-applied points (PF3000)



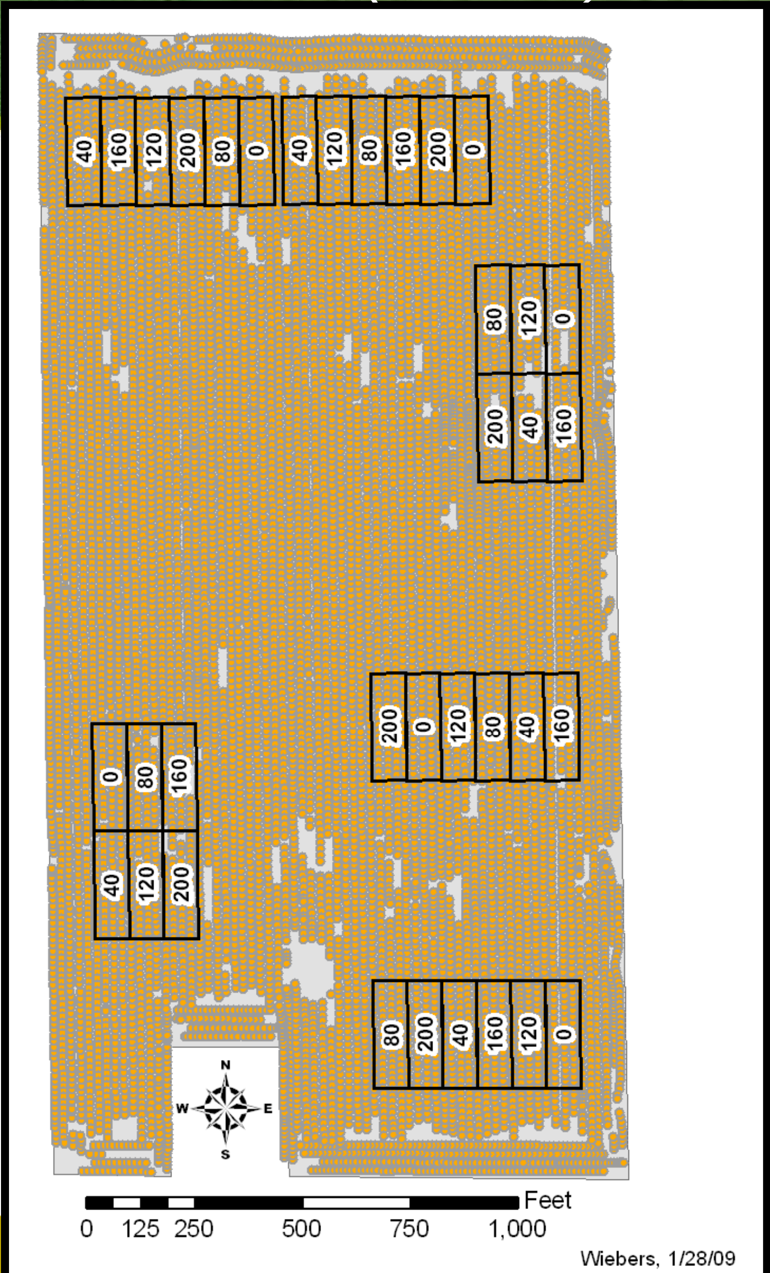
As-applied converted to polygons



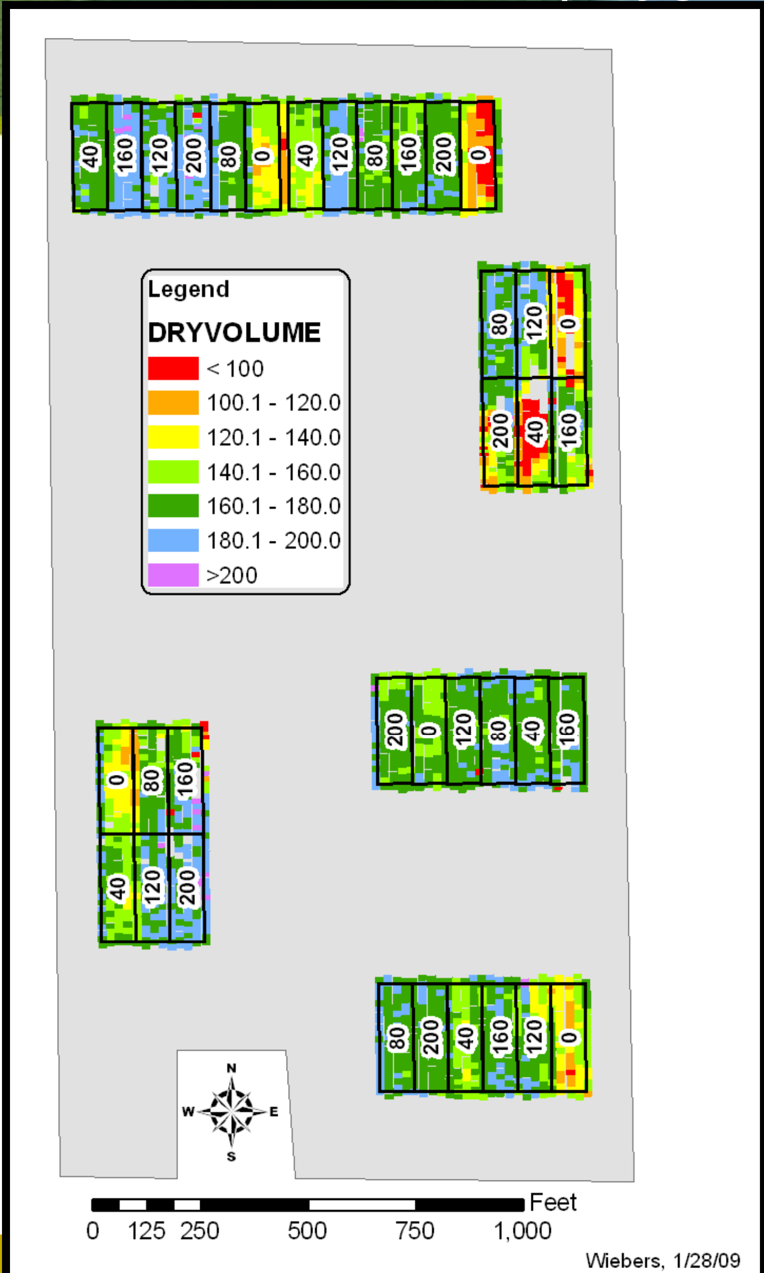
As-applied Scorecard



Yield data (PF3000)

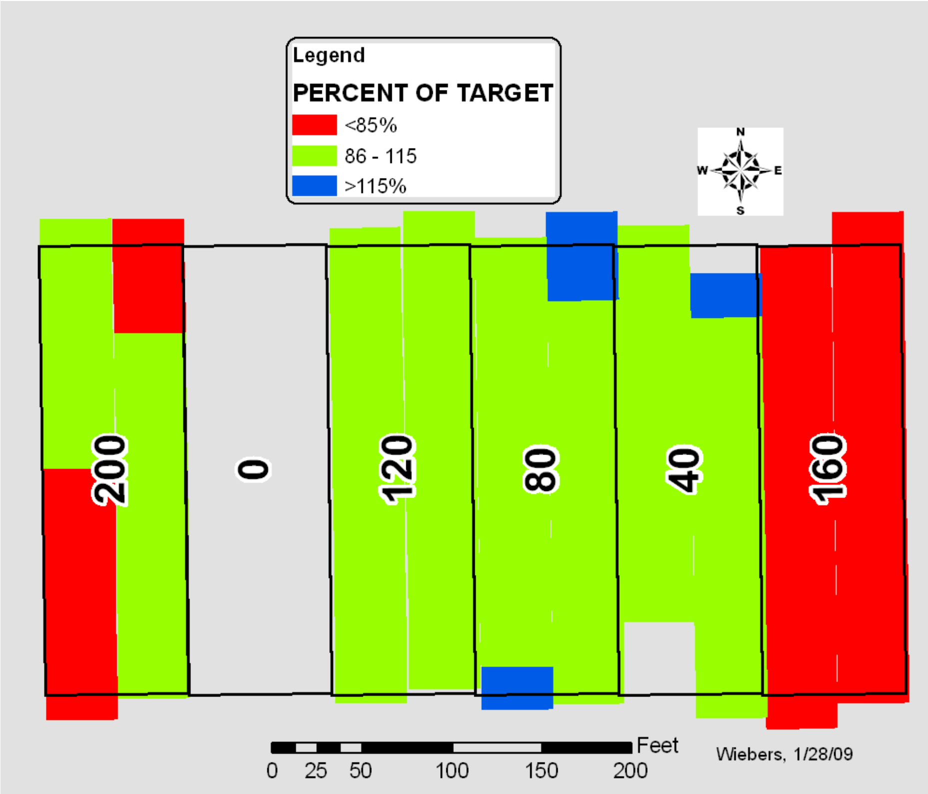


Yield data converted to polygons

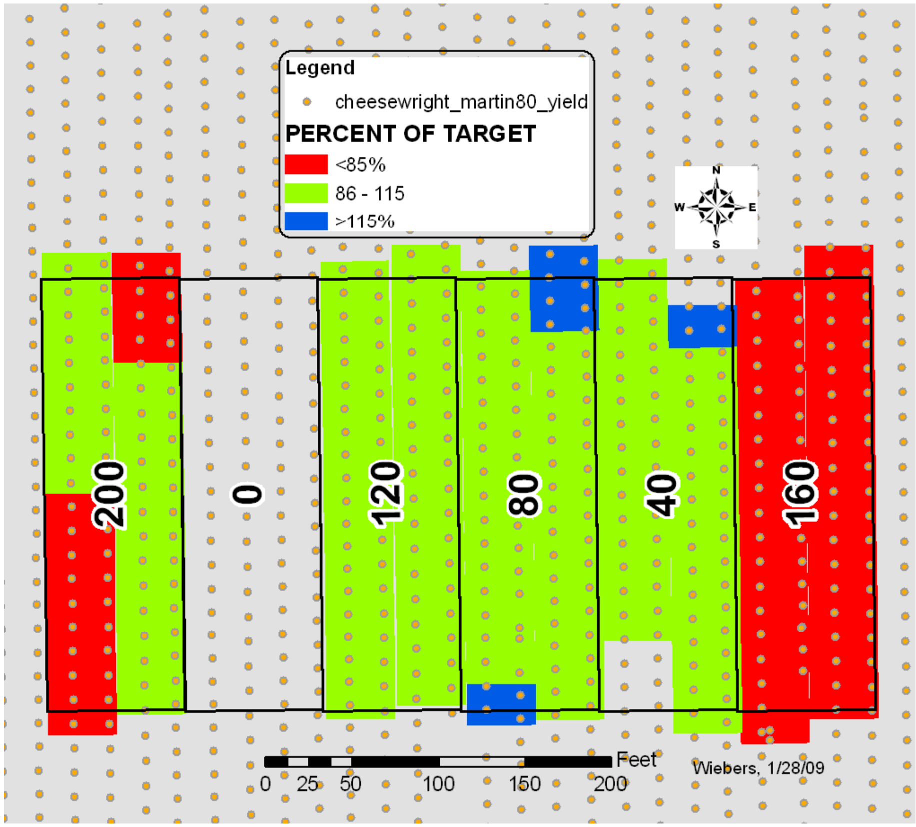


Data analysis

As-applied -% of Target Rate



As-applied with yield overlay



Step 5: Analysis

- CV (Coefficient of Variation) is one measure of variability
  - STDEV / MEAN

Mosaic On-Farm Research

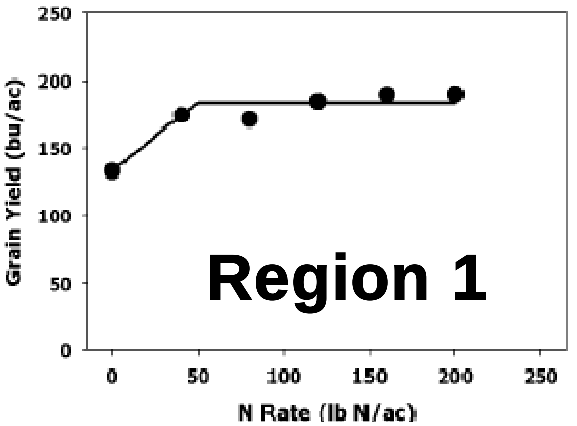
Field	CV	N Source
Dale E	3.49	NH_3
Ellis JLFQ	3.88	UAN
Obowa	5.2	Urea
Hovel	13.5	Urea

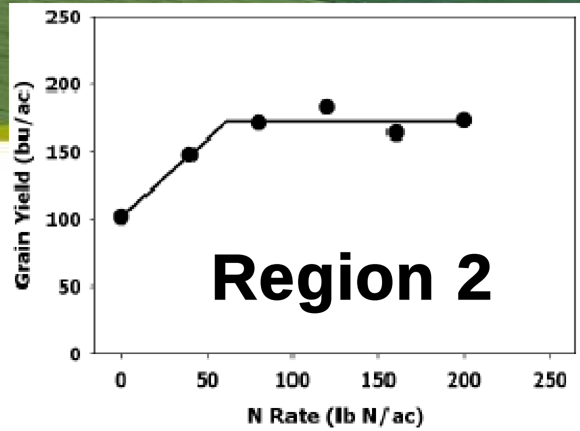
Small plot trials, U of IL

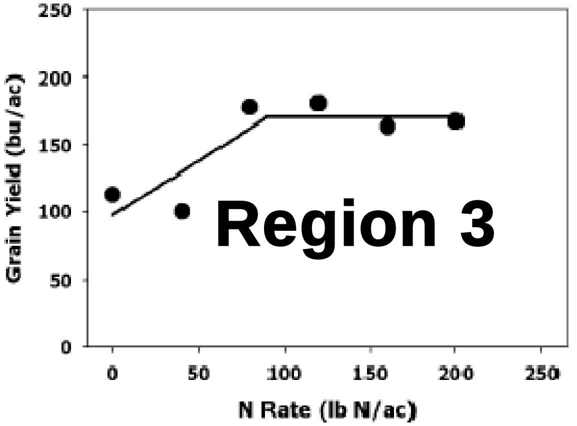
Field	CV
Small Plot UI	8.16
Small Plot UI	8.26
Small Plot UI	12.3
Small Plot UI	7.87

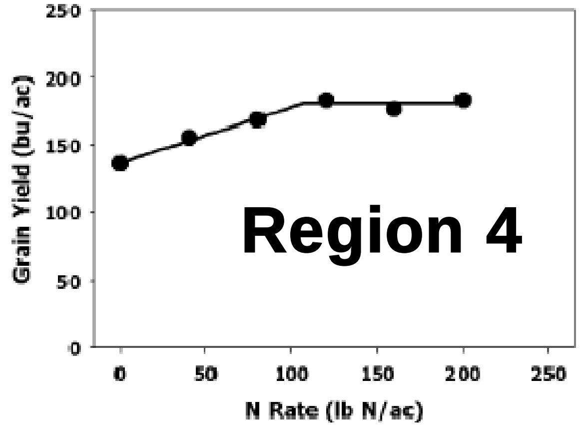
Source: Matias Ruffo, PhD

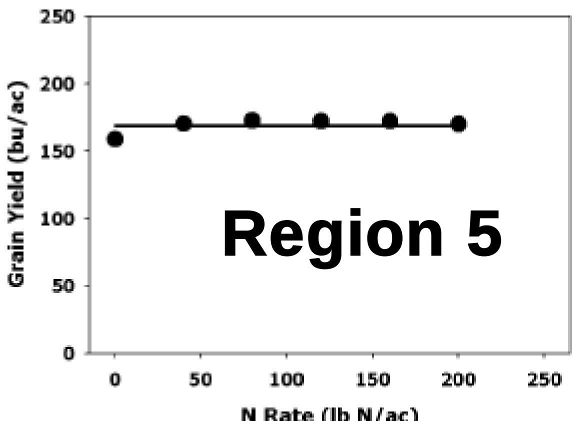
Yield Response Curves

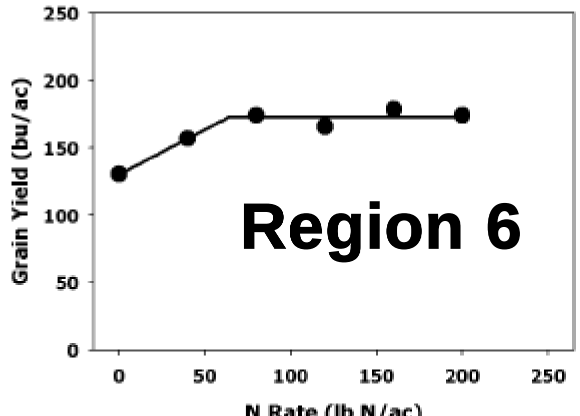


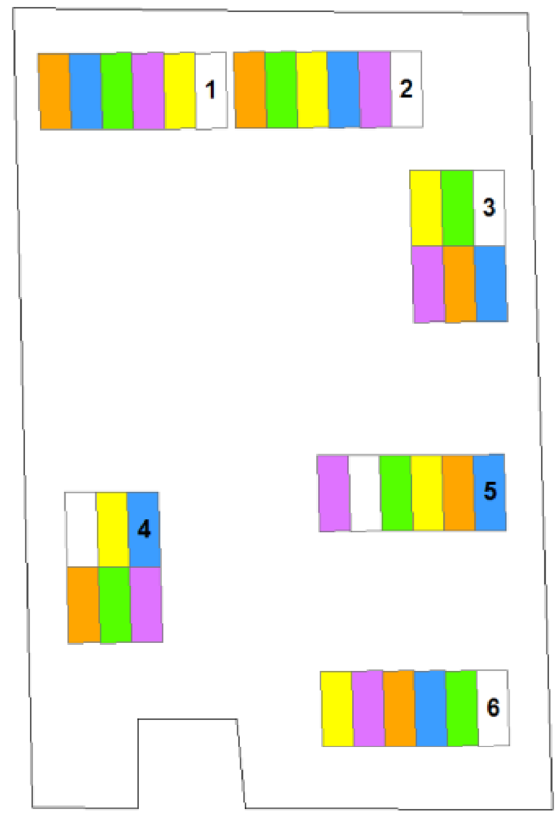












Summary

- Progressive farmers and dealers have very precise GPS systems
- On-farm trials with new technology can produce results statistically similar to small plots