Finding Value in Conservation Targeting Using Precision Agriculture Technologies

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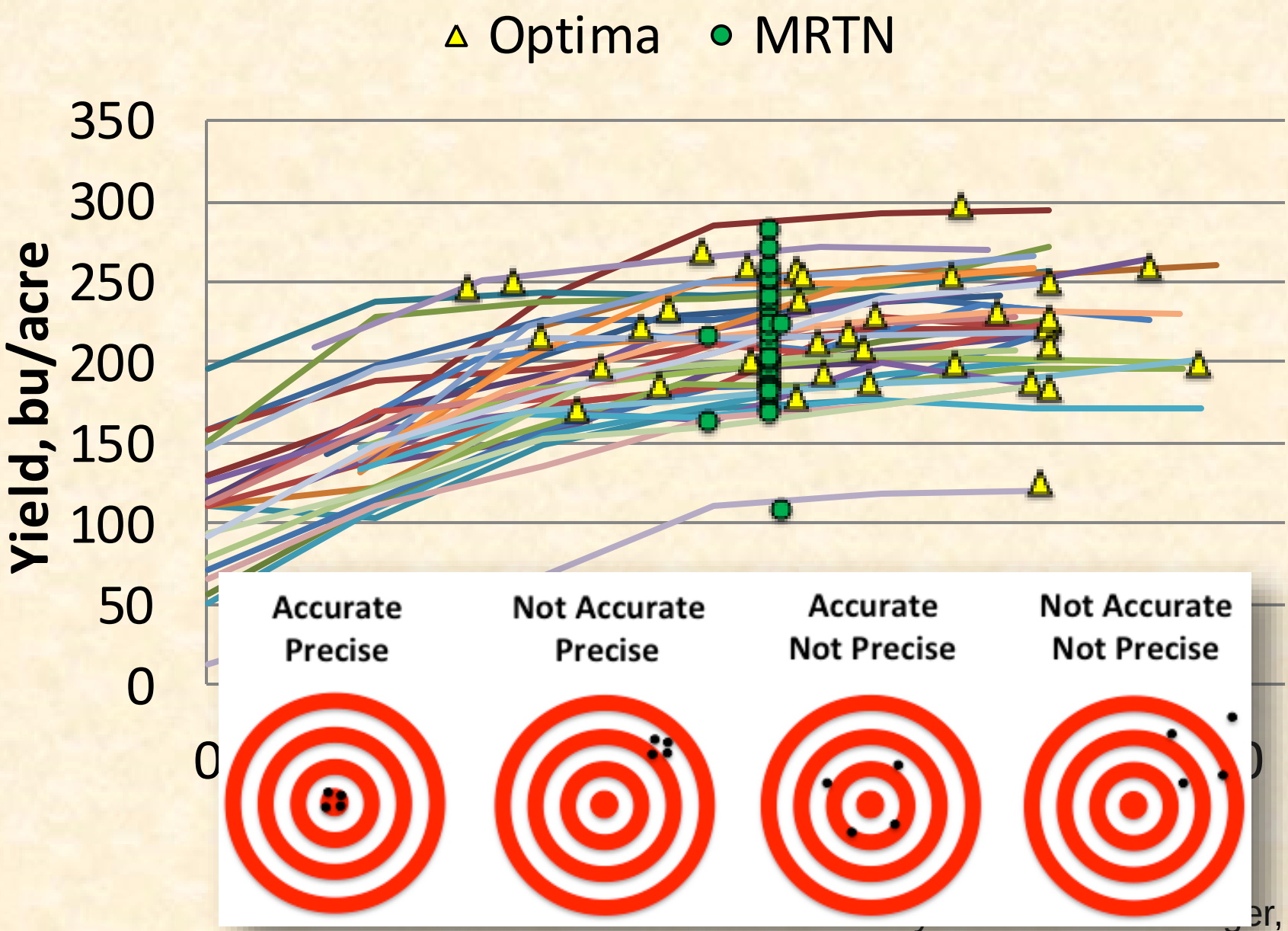
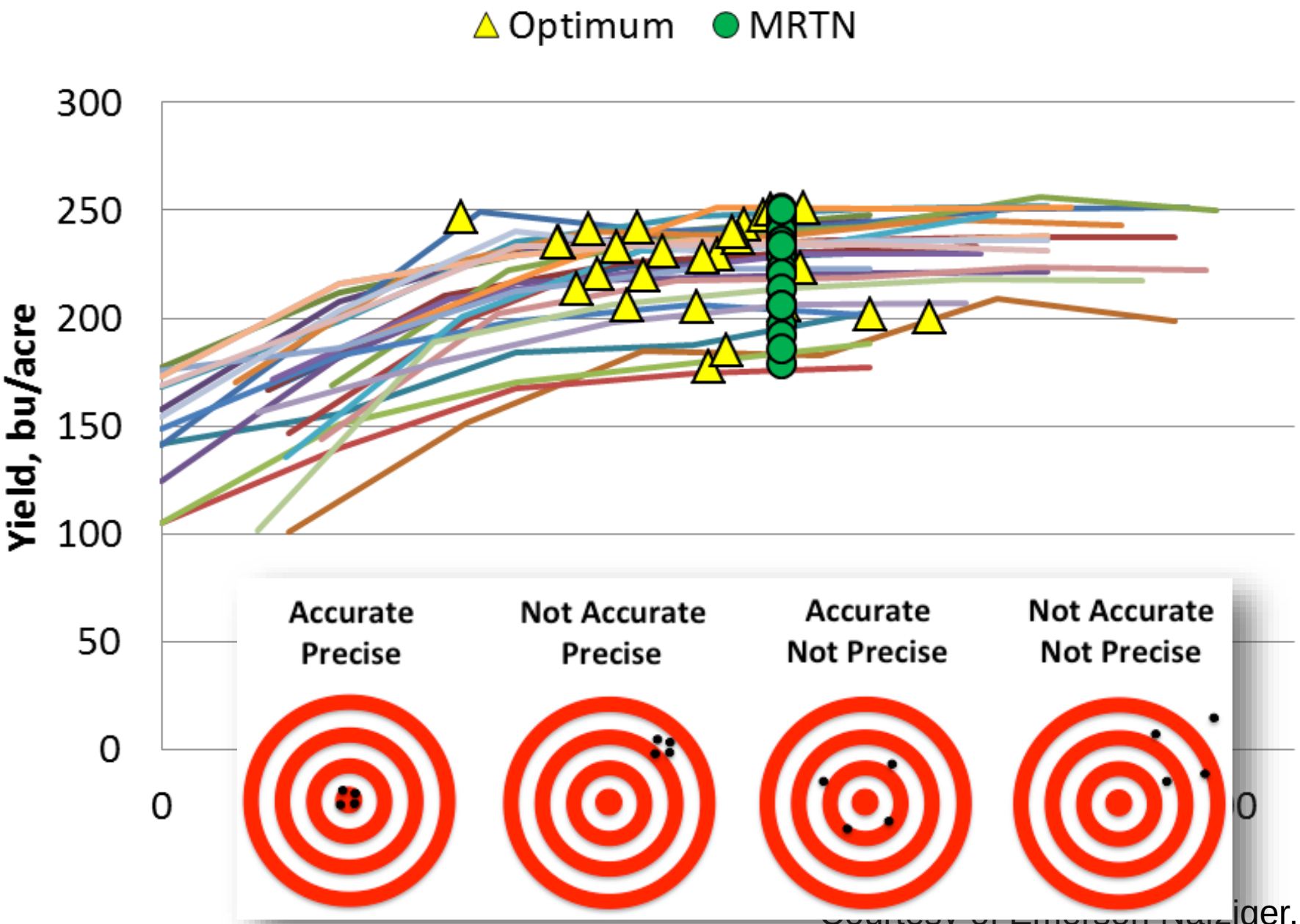
Michigan Chapter of the Soil and Water Conservation Society

Accurate Precise	Not Accurate Precise	Accurate Not Precise	Not Accurate Not Precise
			

35 on-farm trials Soy-Corn 2015

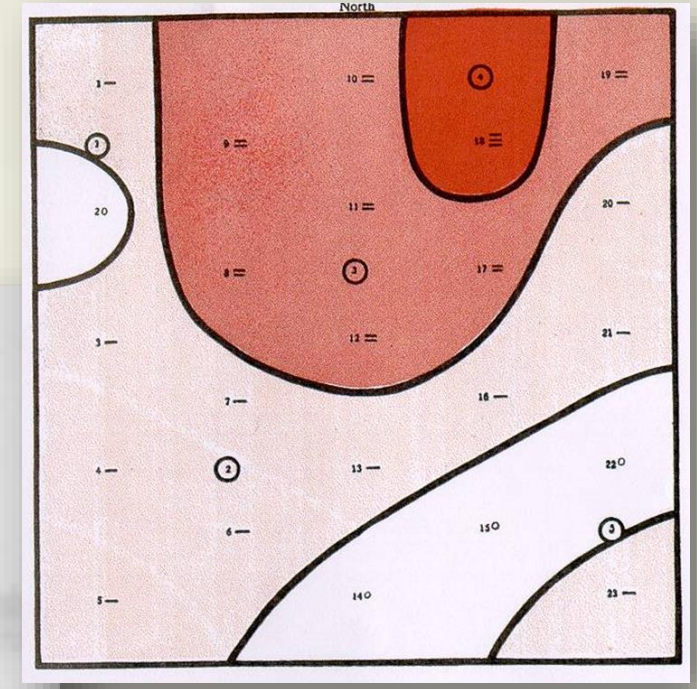


On-Farm N Rate Trials Soy-Corn 2016



Courtesy of Emerson Nafziger, UI

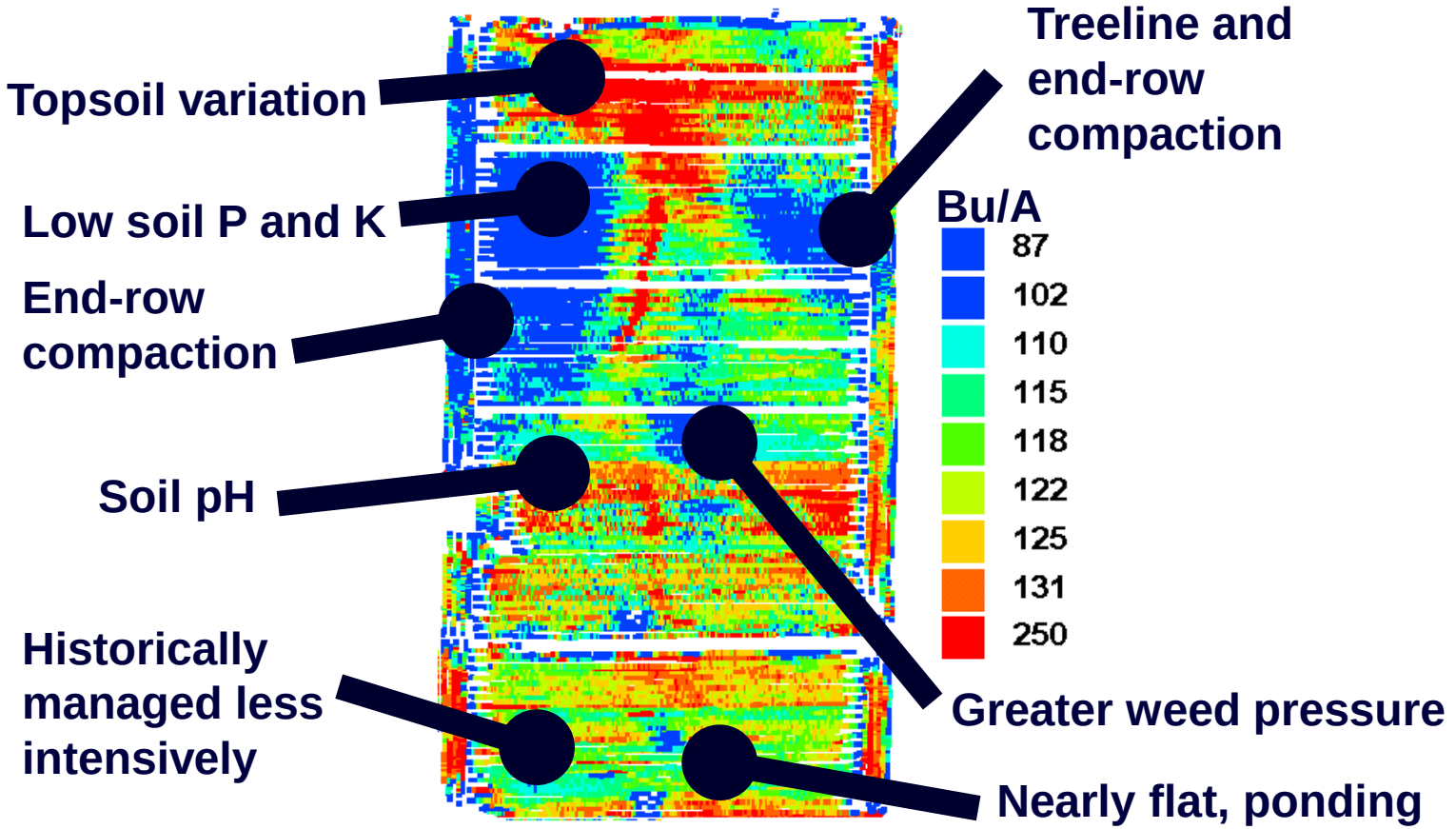
C.M. Linsley and F.C. Bauer. 1929. Test your soil for acidity. Univ. of Illinois. Agric. Exp. Station Circ. 246



Phases of Modern Precision Nutrient Management

- **Adaption** (1990s):
  - How much, when, where, and what product
  - Mostly Spatial
  - Only 1 or 2 factors at a time
  - Insure optimal yield
- ***Integration & Economics*** *(*2000s to now):
  - Smart sampling / Smart sensing / Smart decision making
  - Integrated information
  - Optimize economic yield
- **Convergence & Accountability** (now to future):
  - Consumer driven and Producer driven
  - Efficiency
  - Conservation (soil, water, air, input resources)
  - Resiliency
  - Convergence of diverse and complex information to actions

Causes of Variability Often Are Complex



Corn Grain Yield
Centralia, MO

Fundamental Theorem of Precision Ag production

Yield = Genetics x Environment x Management

$$Y = f(G_{st} \times E_{st} \times M_{st})$$

Assumptions:

- We have a response model known everywhere at the exact timing for the management opportunity.
- We have a reasonable response model for management
- We can mange at a specific location and resolution (i.e., engineering and technology)

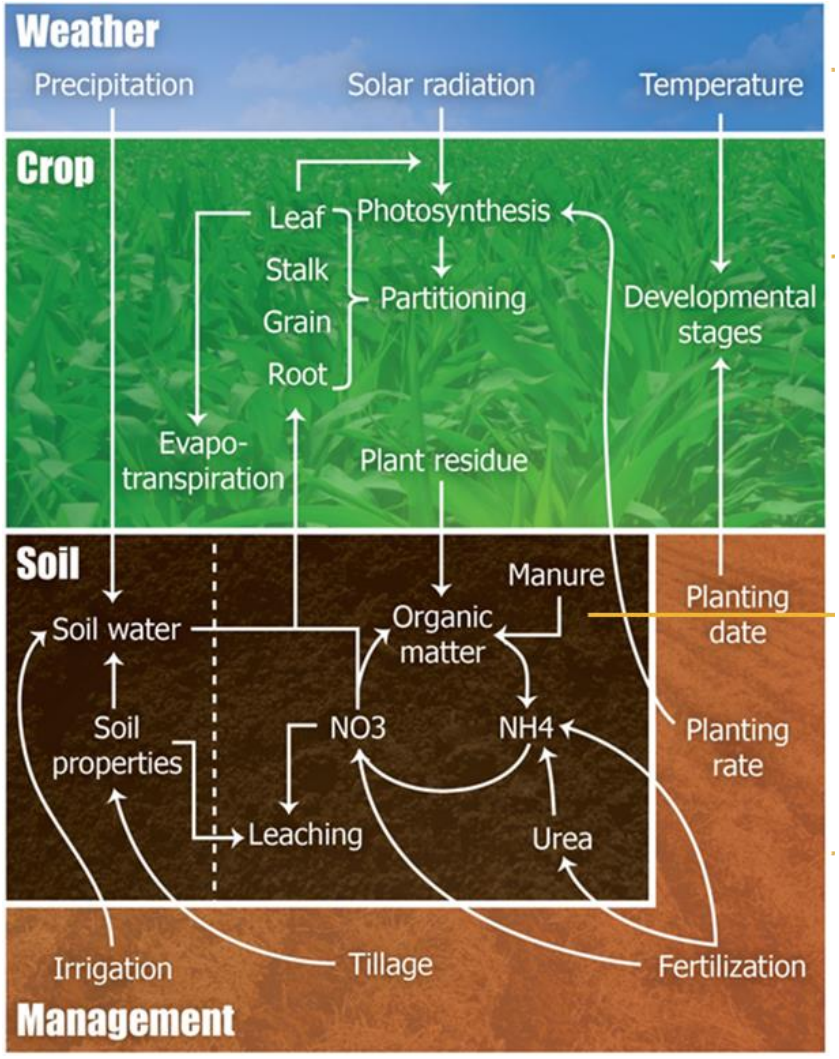
Crop Simulation Models

E_{st}

G_{st}

E_{st}

M_{st}



Courtesy of DuPont Pioneer

Premise: Precision agriculture enables a sustainable framework for managing soils for improved production and conservation.

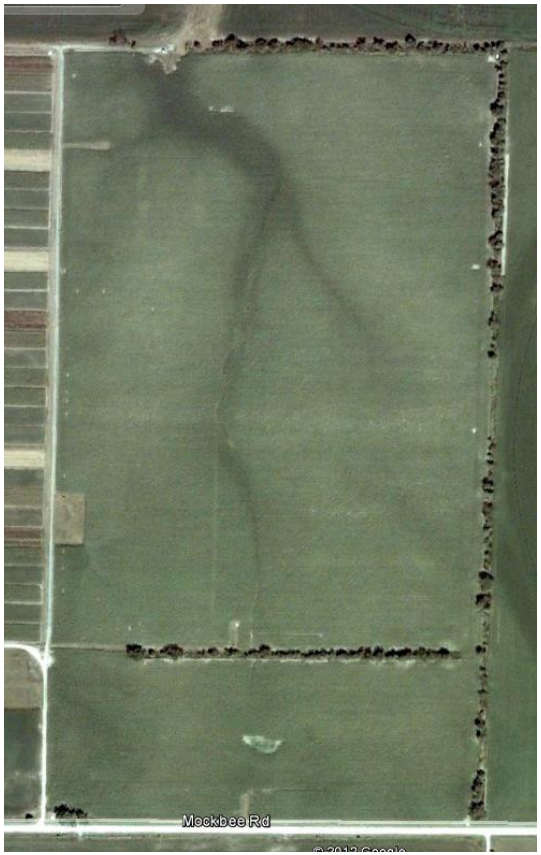
1. Characterizing the soil resource
2. Quantifying its productive and economic capacity
3. Assessing the environmental implications of agriculture produ practices
4. Targeting management that stops soil erosion and degradation, and promotes soil restoration

88-acre Research Field in Centralia, Missouri

1991-2003

Corn-Soybean Mulch-Till

Production

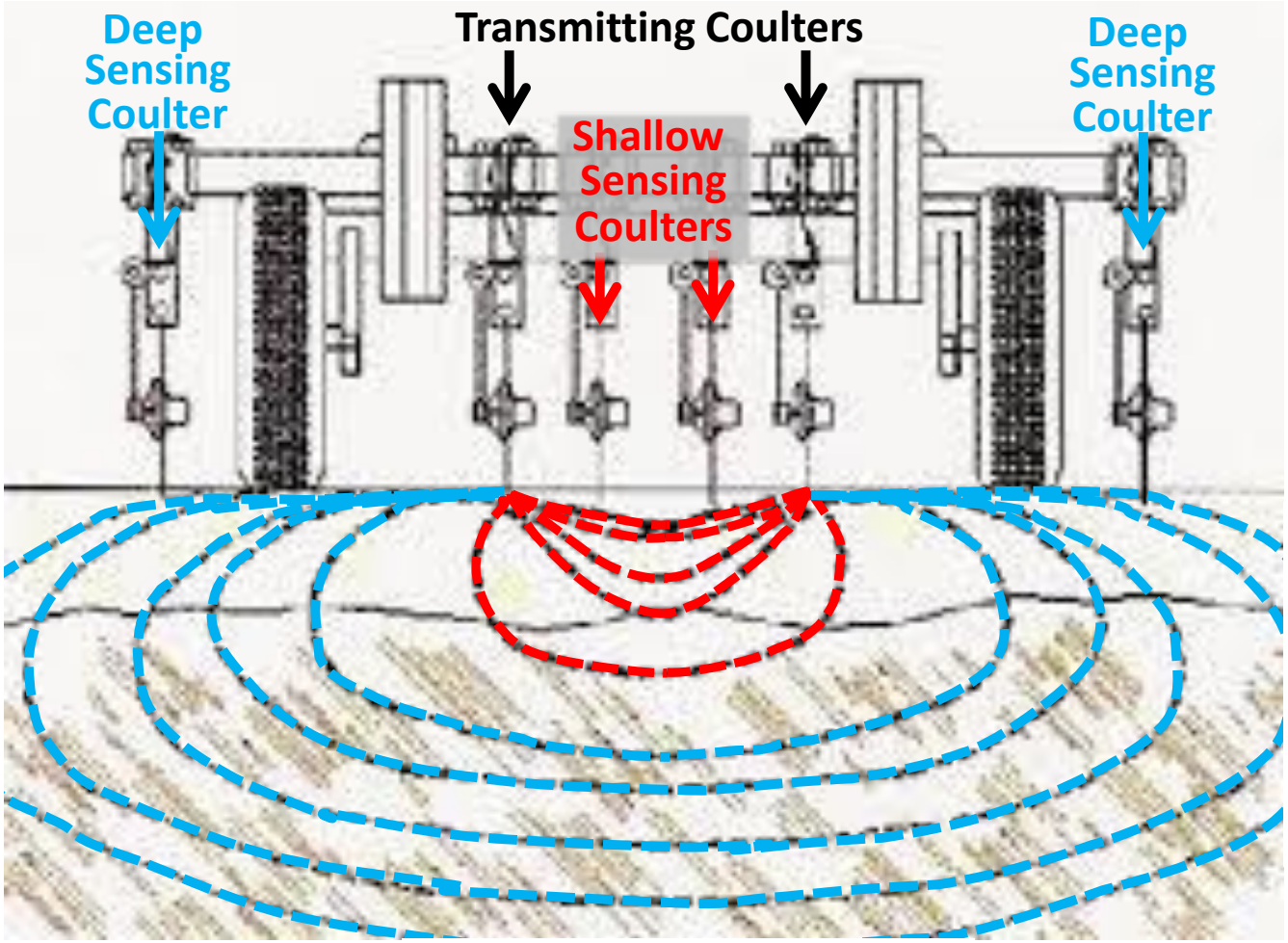


Surface Water Quality

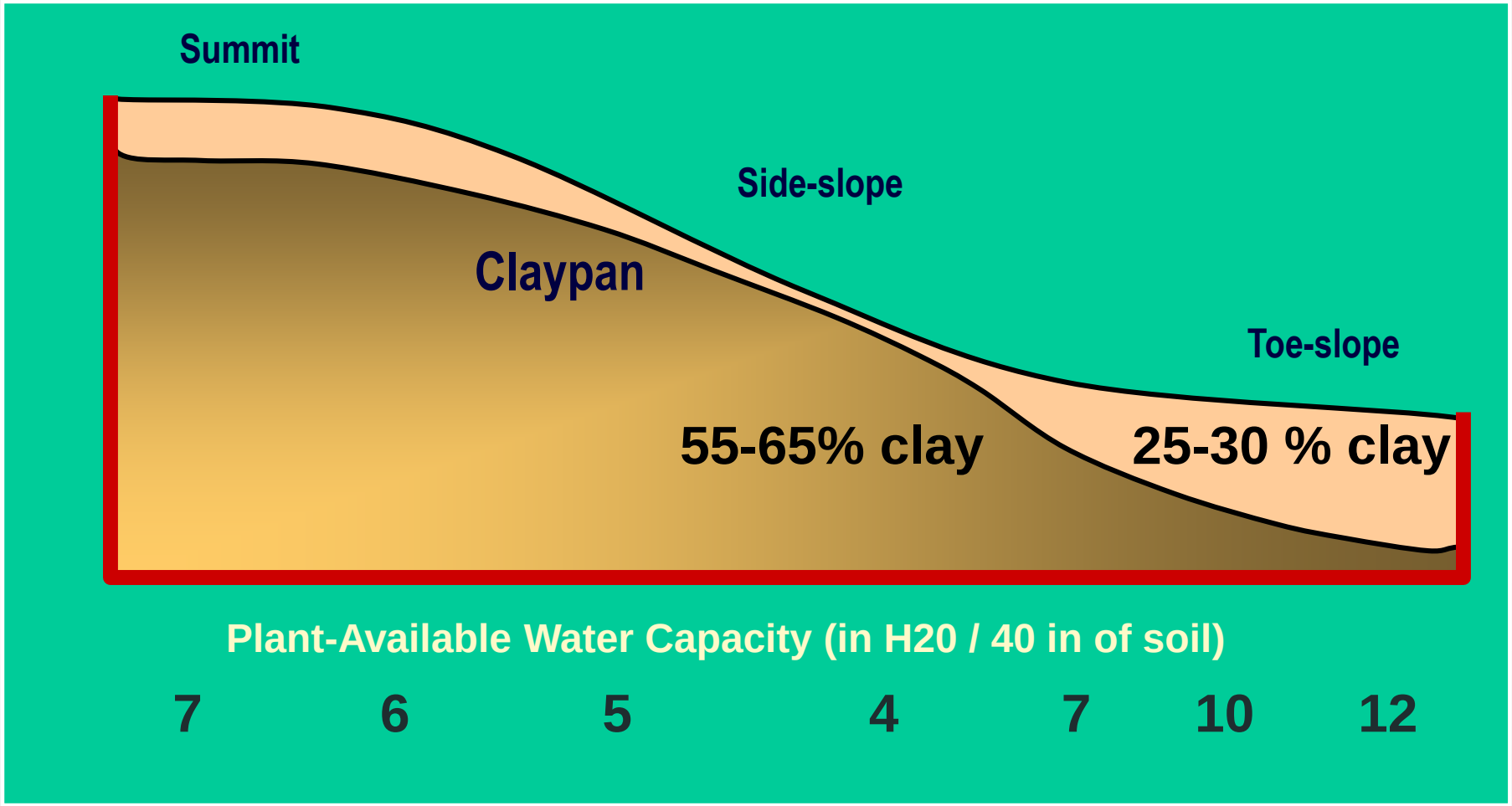
Soil Quality

Ground Water Quality

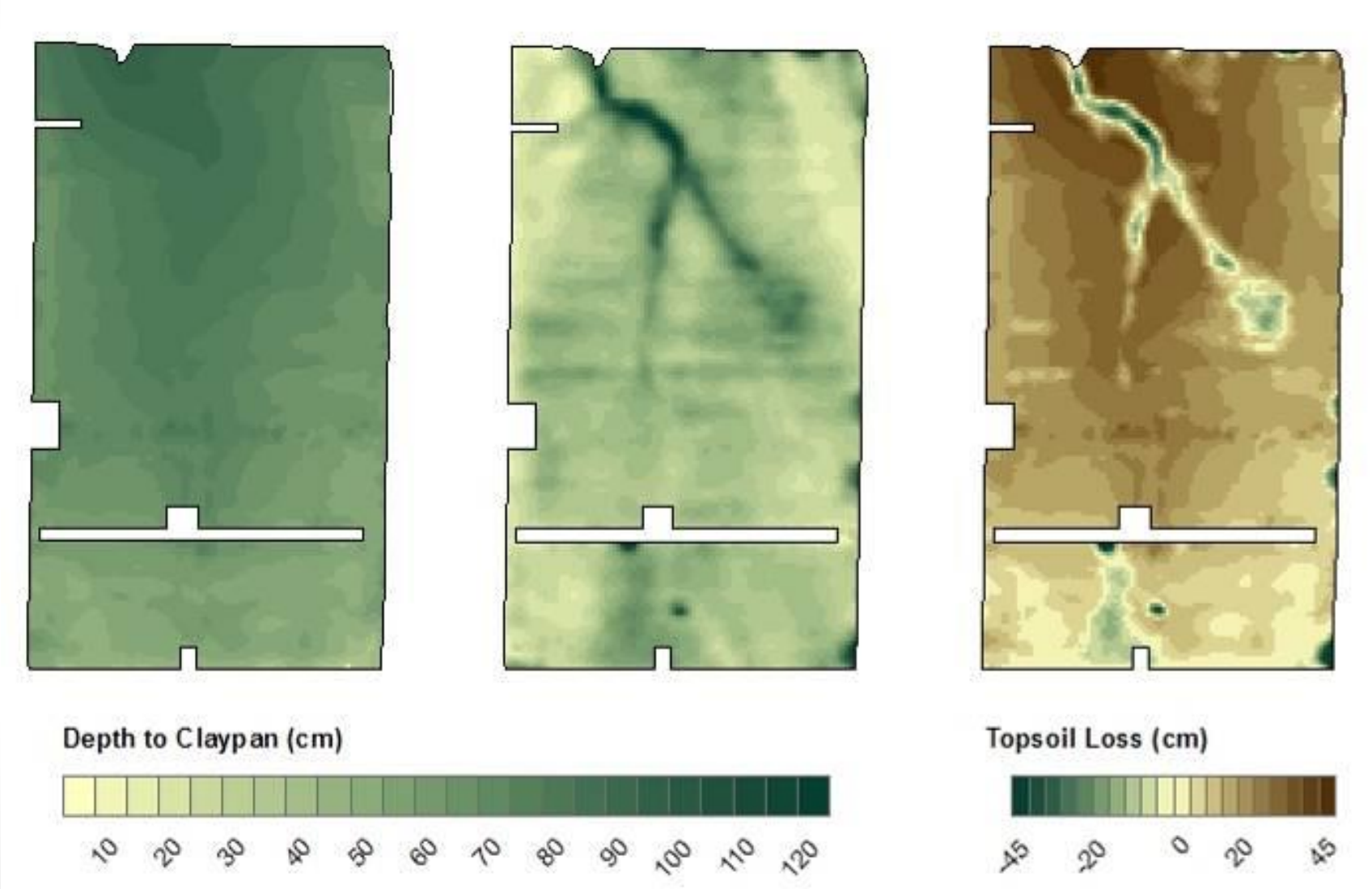
Veris 3100/3150


Deep
Sensing
Coulter
Transmitting Coulters
Shallow
Sensing
Coulters
Deep
Sensing
Coulter

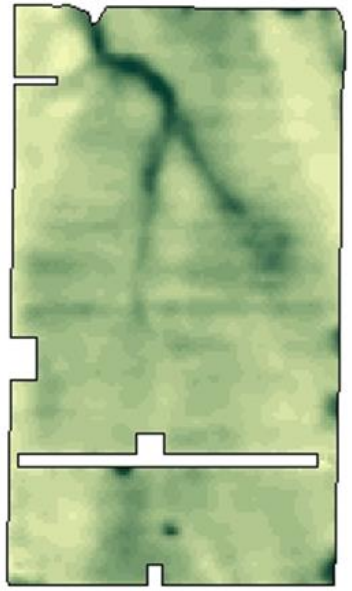
Claypan Soil Landscape Affects Production



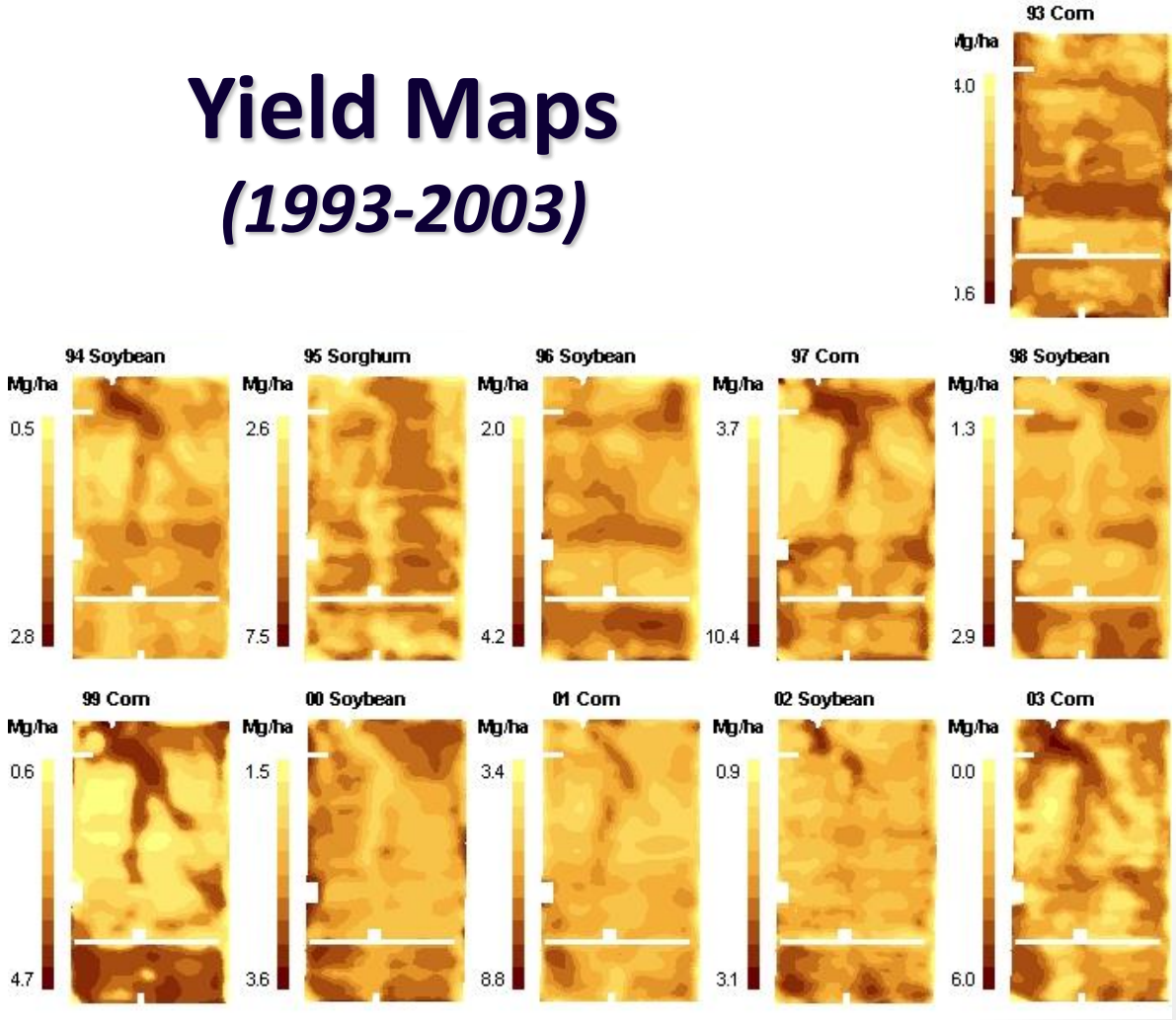
120 Years of Erosion



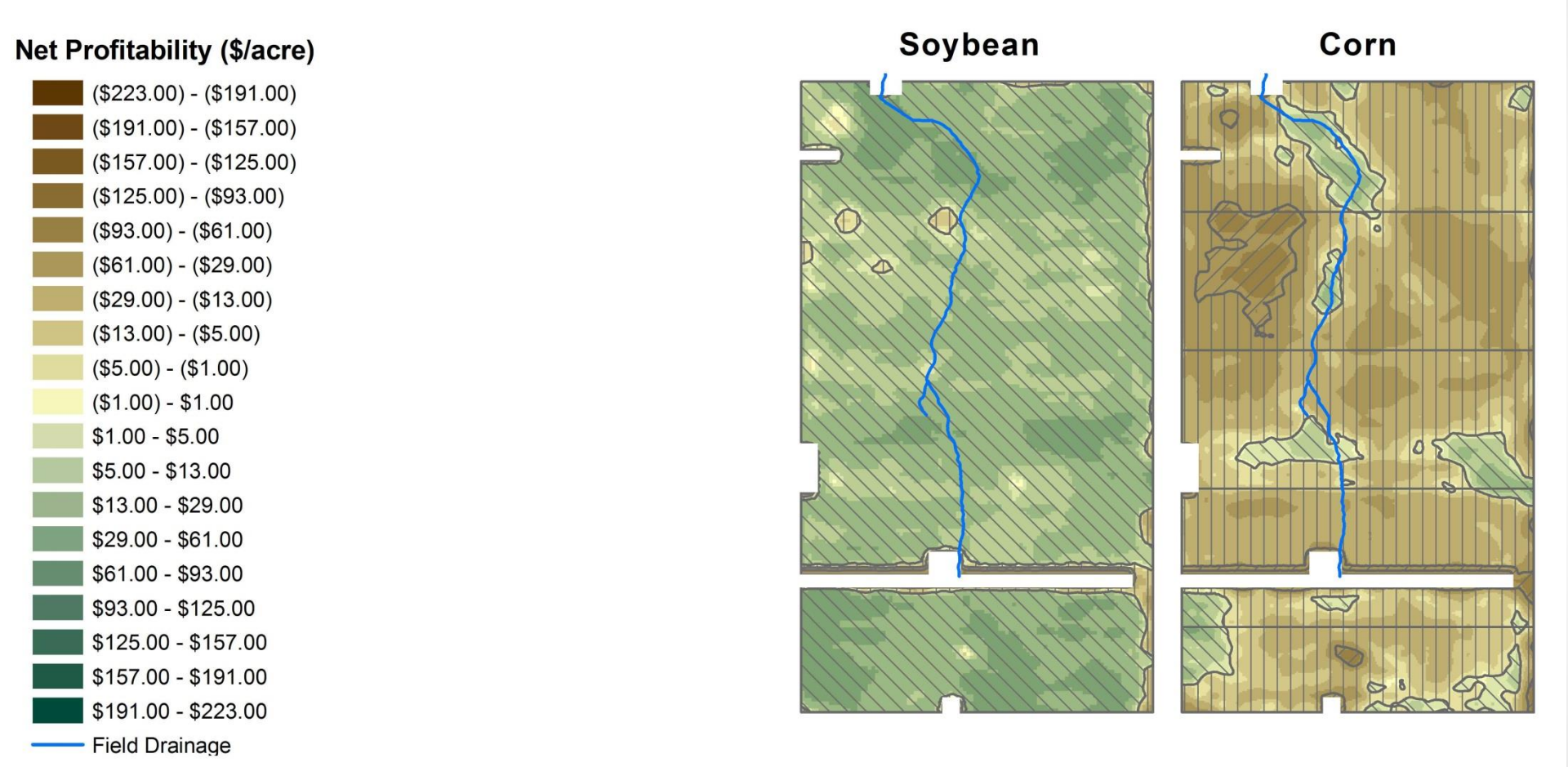
Lost Topsoil Creates Yield Variability.



Yield Maps
(1993-2003)

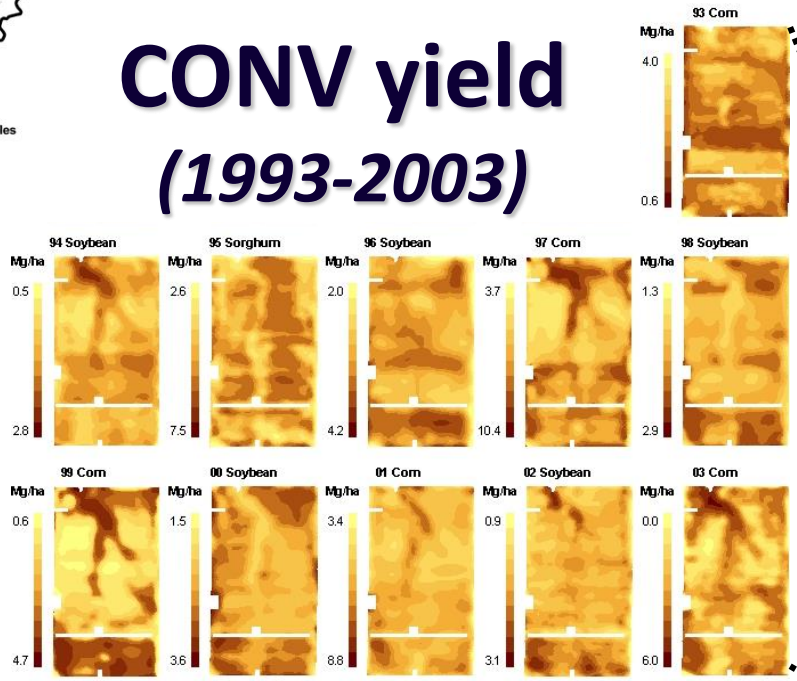


Combining10-Years of Profit Map



PA System Development

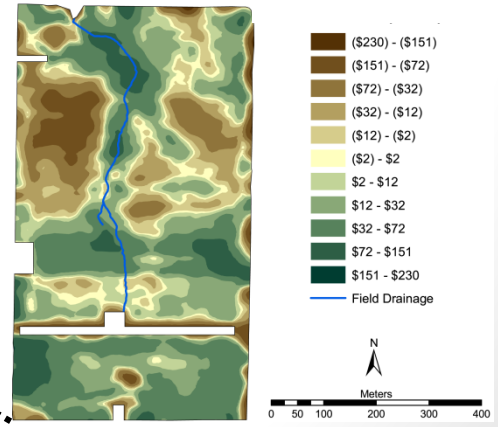
CONV yield (1993-2003)



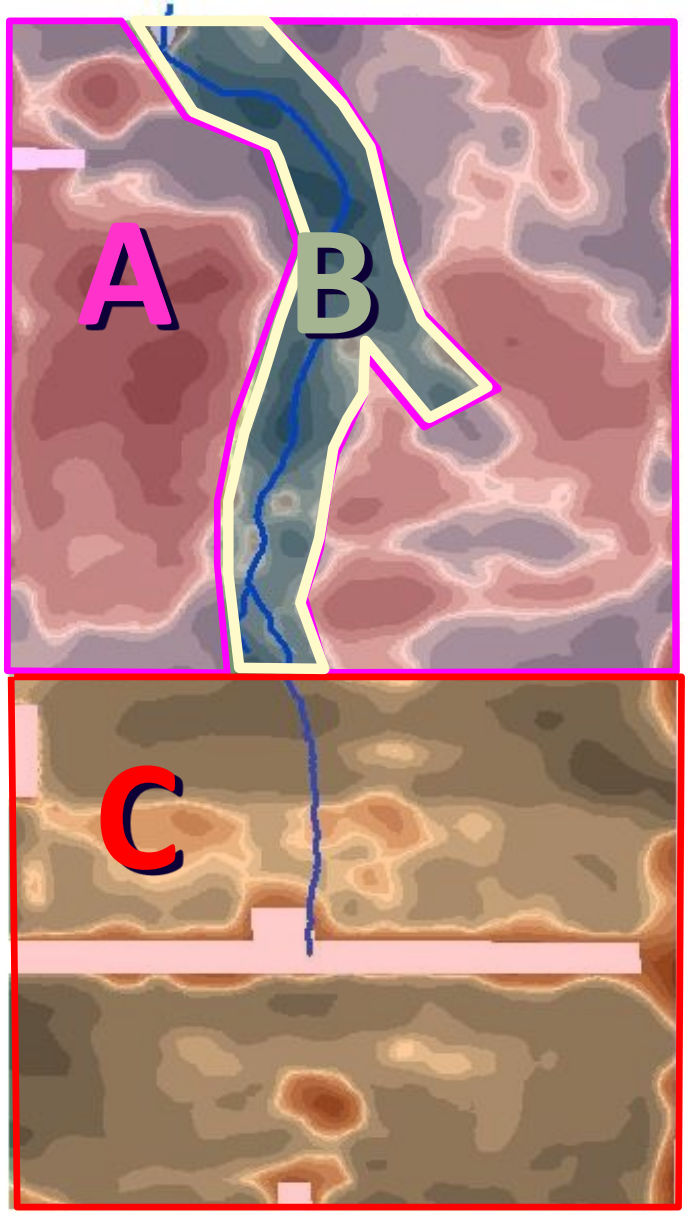
Priorities of PA

- Ground Water Quality
- Soil Quality (sustainability)
- Surface Water Quality
- Production (profitability)

Net Profit

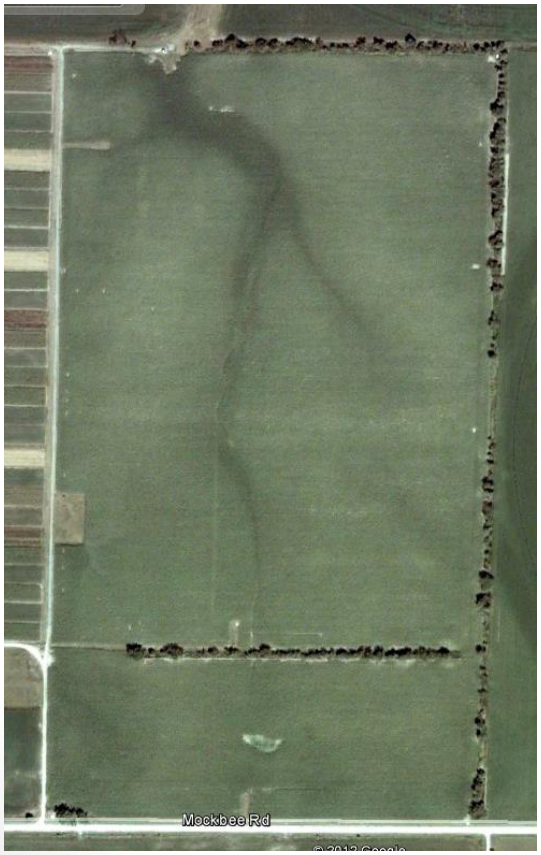


- **Whole Field:**
  - no-till and cover crops
  - grade to remove ponding problems
  - variable rate N, P, K, and lime
- **Area A.** 2-year rotation of wheat--soybean
  - wheat replaced corn
  - no soil active herbicides
- **Area B.** Waterway grass hedge
- **Area C.** 2-year rotation of corn-soybean



Pre-PAS era compared to PAS era

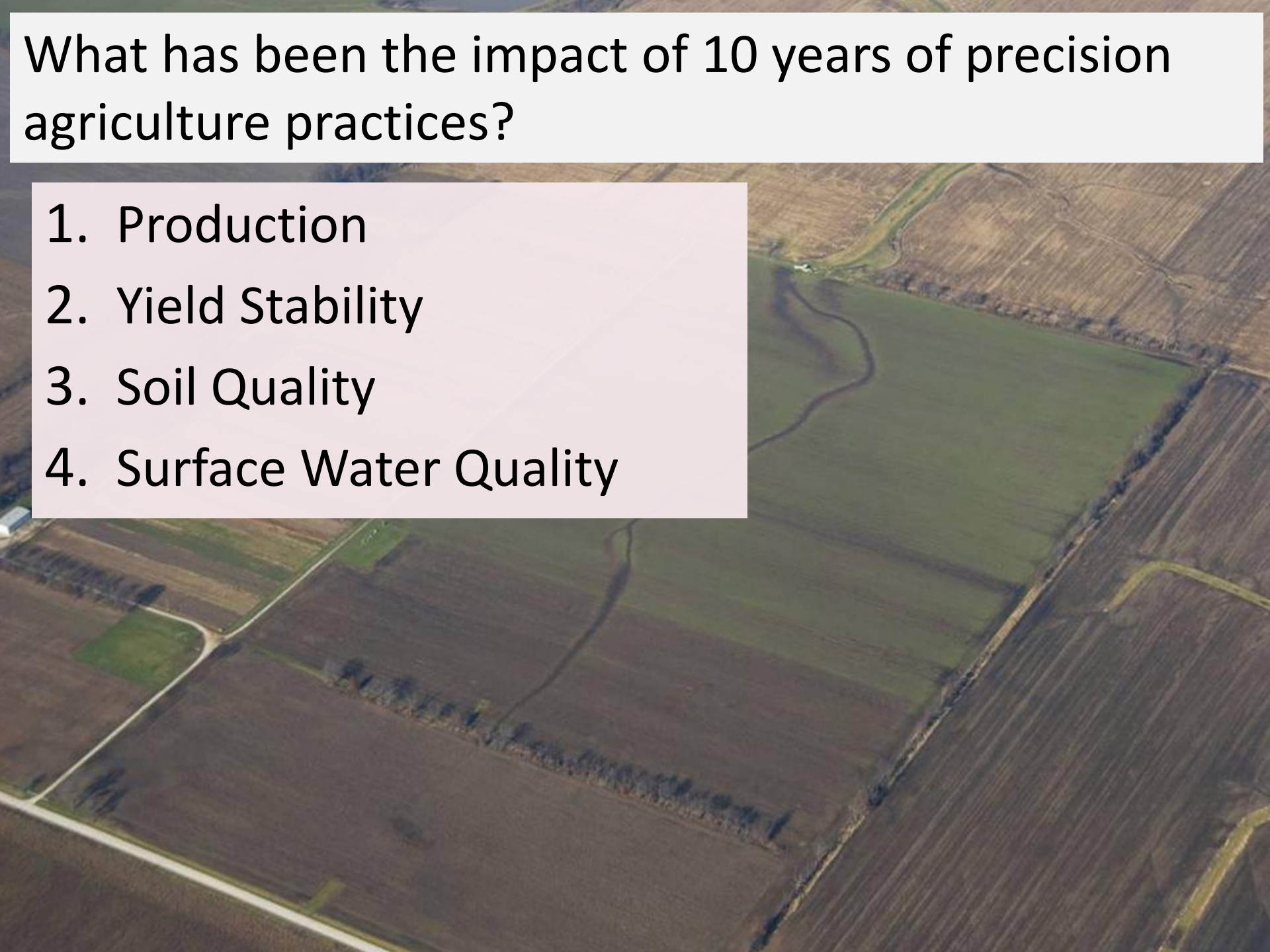
1991-2003
Corn-Soybean Mulch-Till



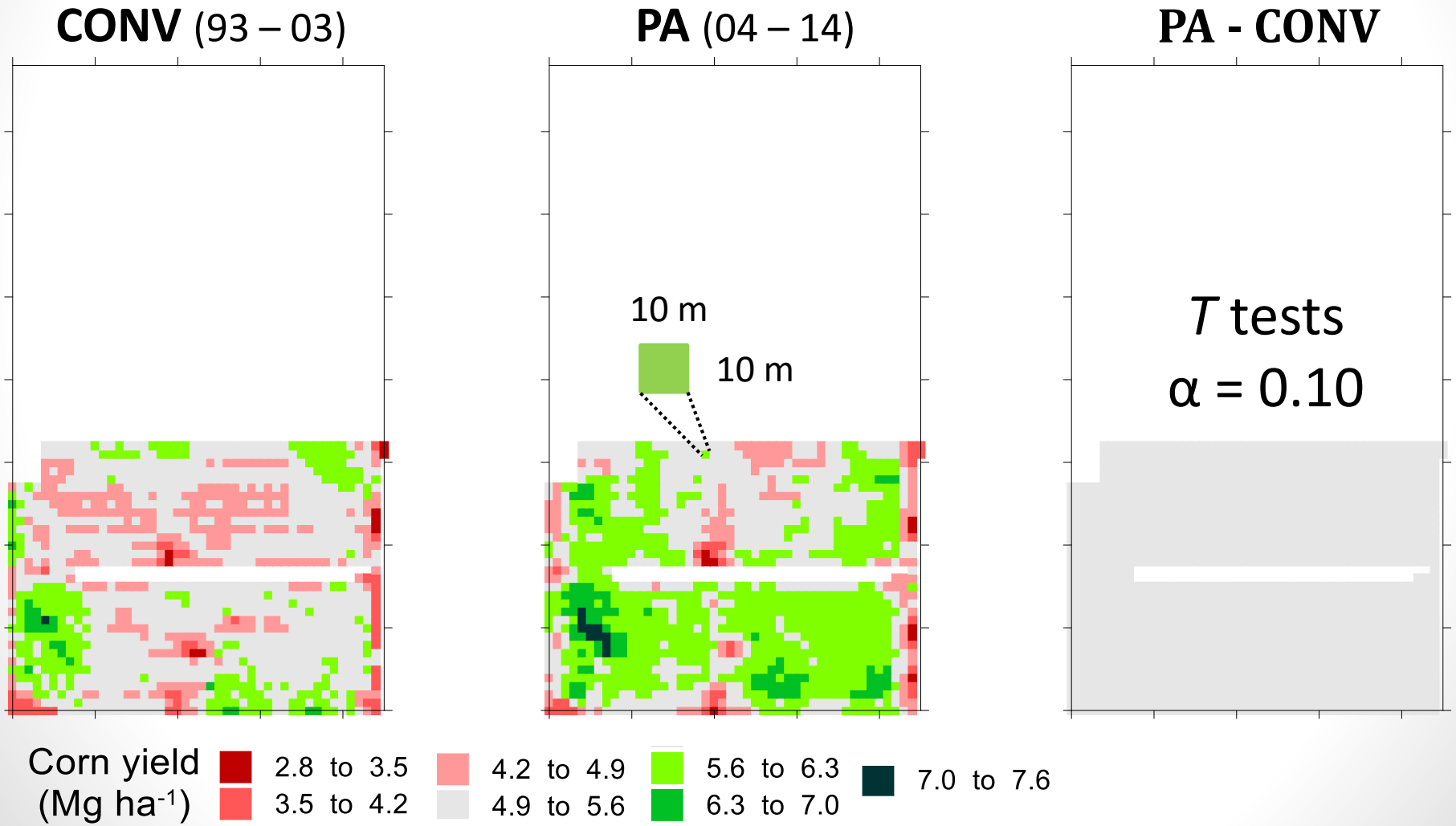
2004-present
Soybean-Wheat (N) Soybean-Corn (S)
No-Till + Cover Crop

What has been the impact of 10 years of precision agriculture practices?

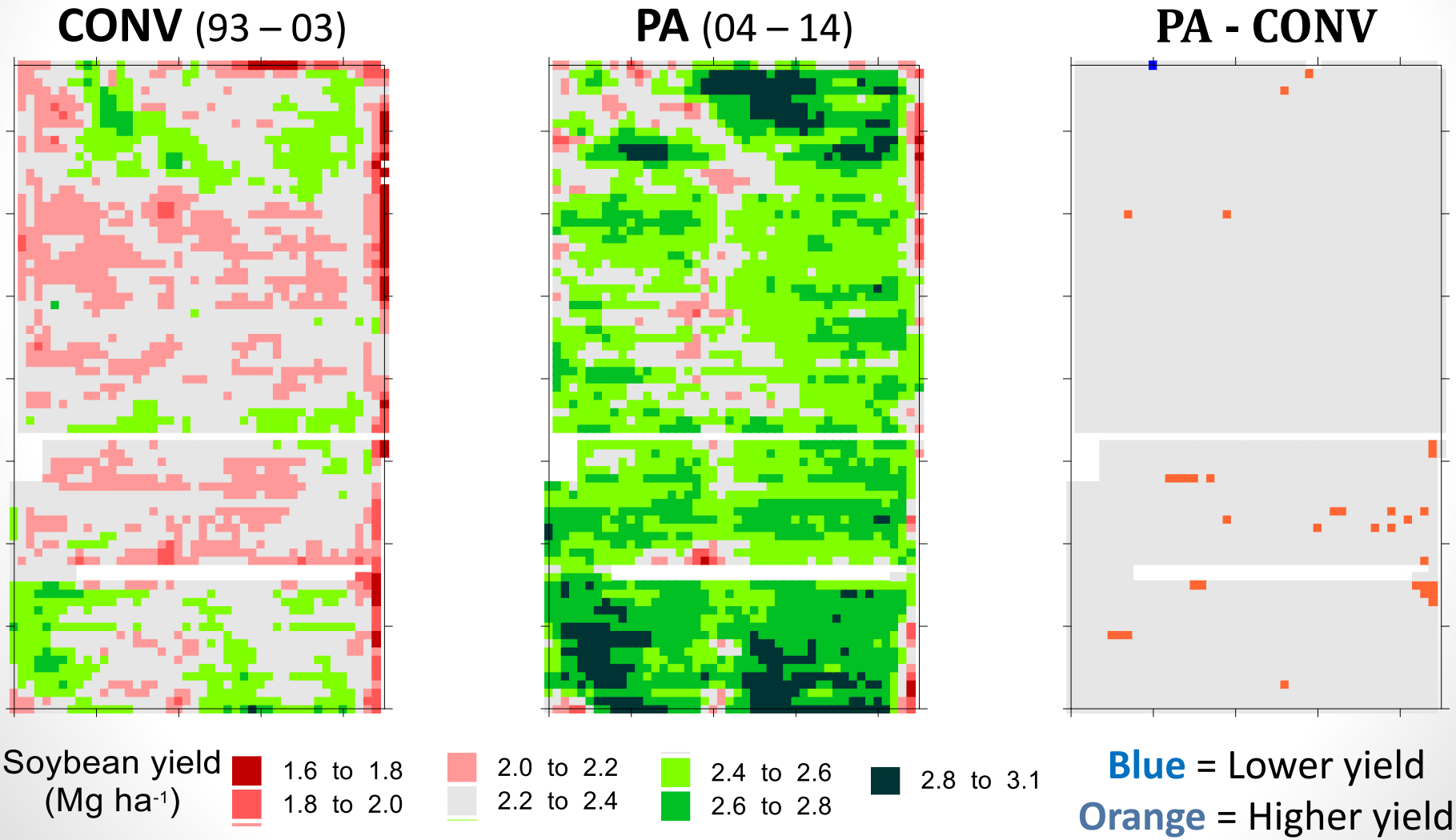
1. Production
2. Yield Stability
3. Soil Quality
4. Surface Water Quality



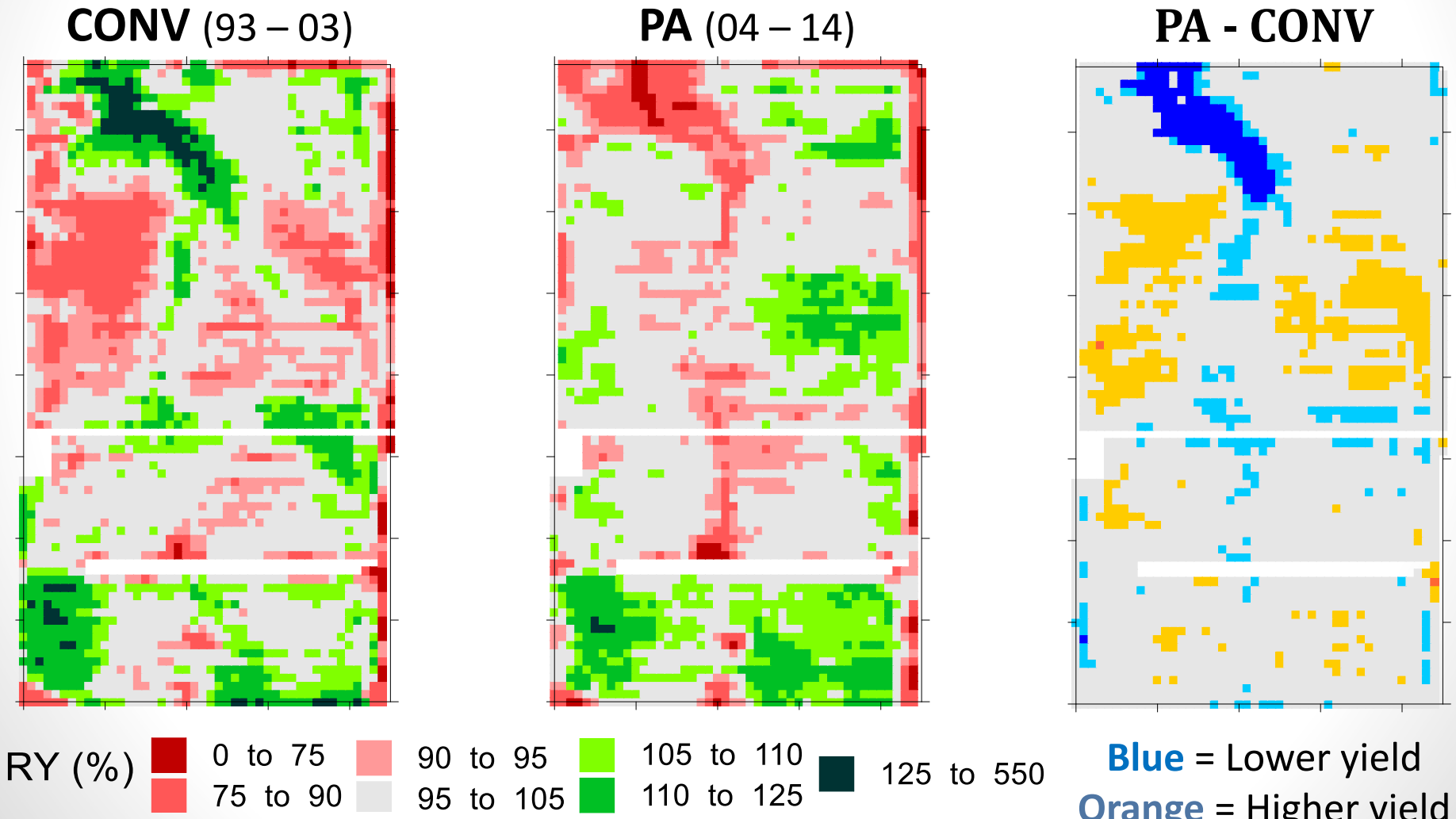
No corn yield change within the field



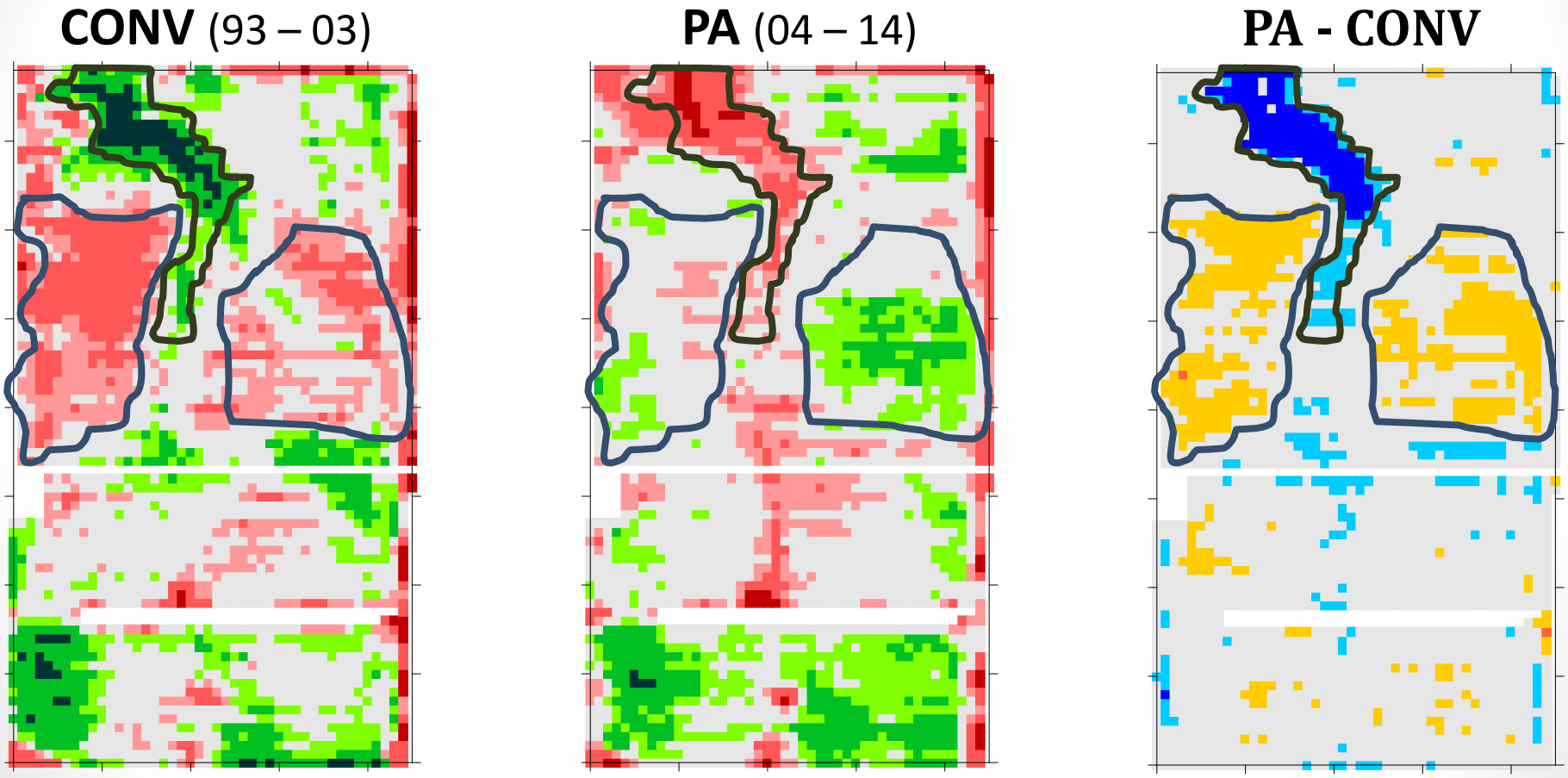
Few areas had greater soybean yield



RY used to compare all crops



North part of field affected the most



Soil Quality

Soil Management Assessment Framework (SMAF)

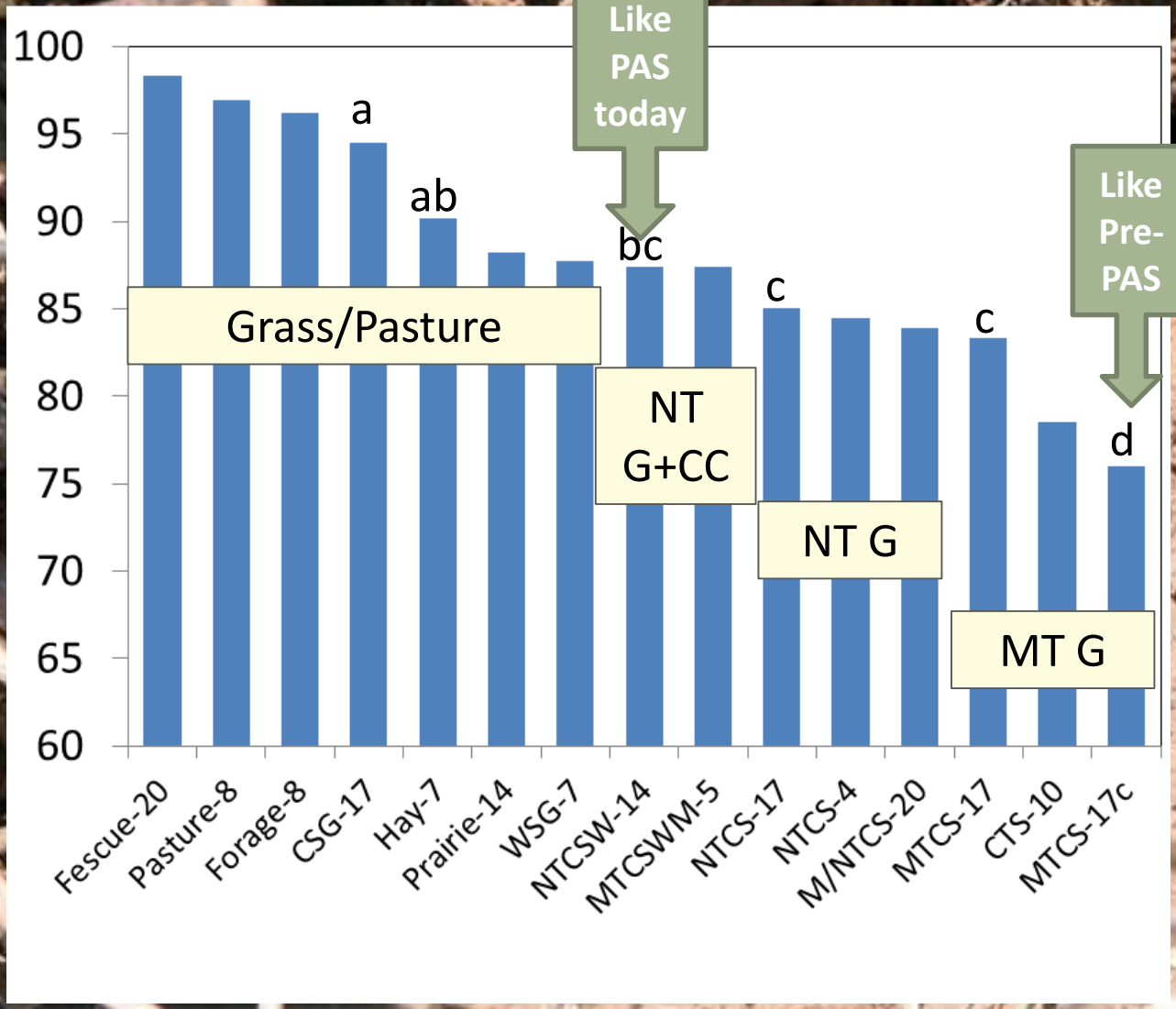
Physical Score
- bulk density
- water-filled pore space
- water-stable aggregates

Biological Score
- organic C
- B-glucosidase
- microbial C
- mineralizable N

Chemical Score
- pH
- electrical conductivity

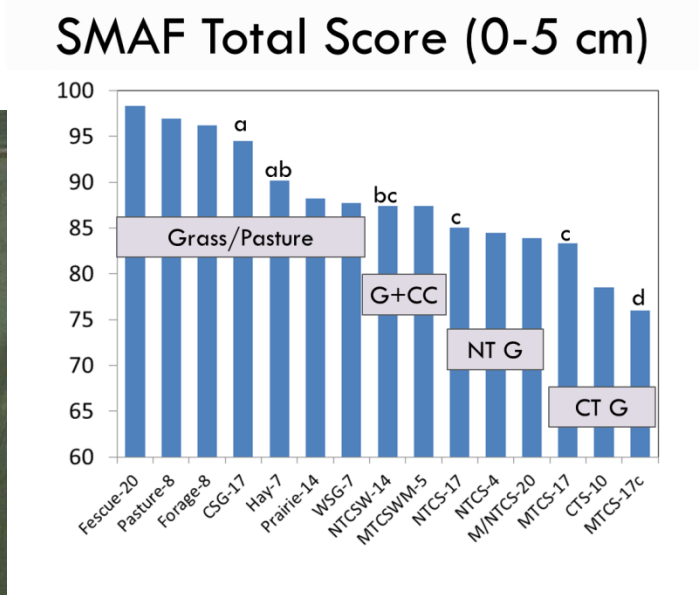
Nutrient Score
- extractable P
- extractable K

SMAF Total Score (0-5 cm)



Long-Term Research Field

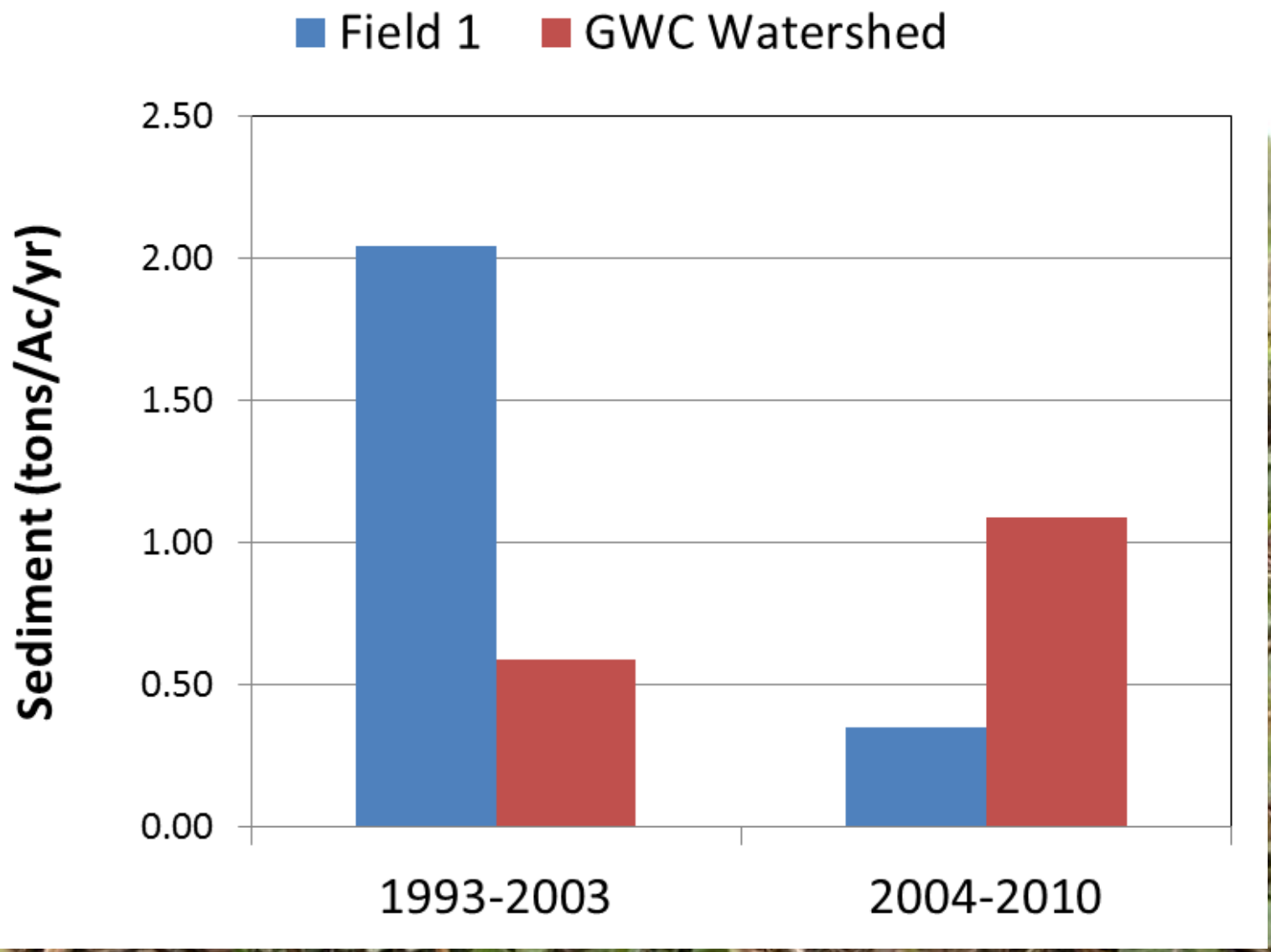
1991-2003
Corn-Soybean Mulch-Till



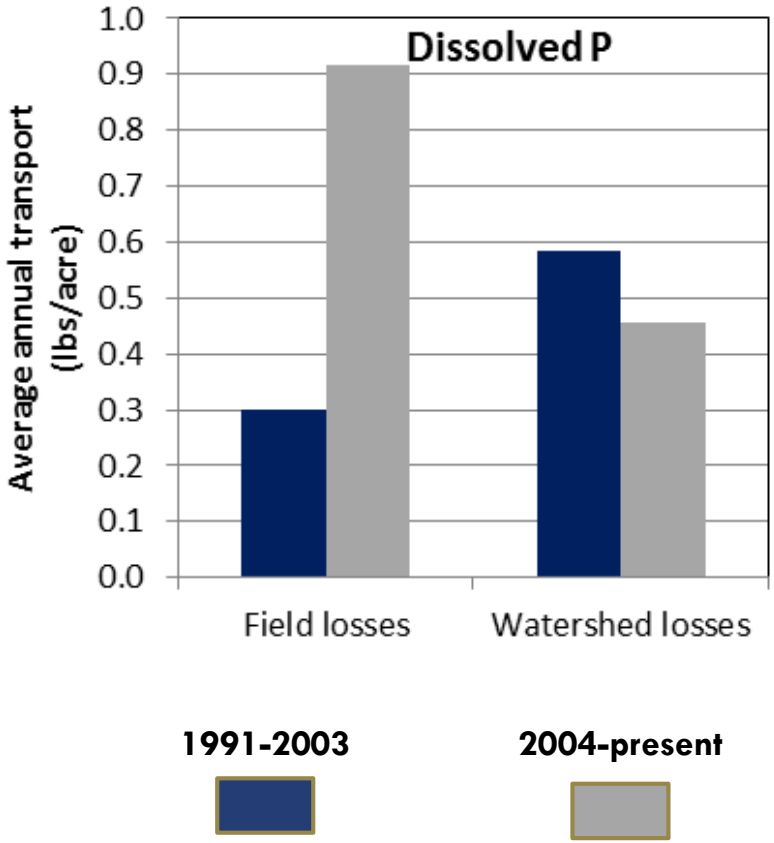
2004-present
Soybean-Wheat (N)
Soybean-Corn (S)
No-Till + Cover Crop

Water Quality: Erosion Sediment Loss

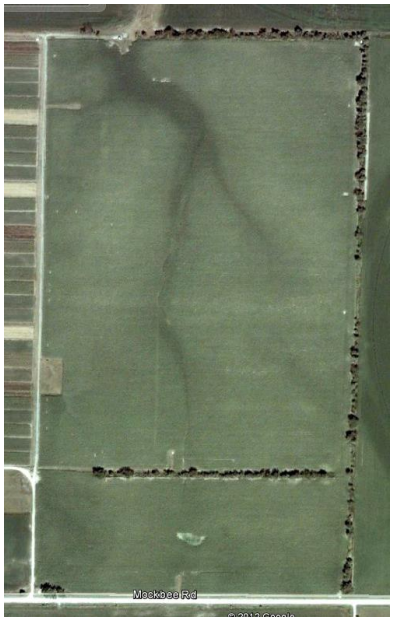
Average Annual Sediment Loss



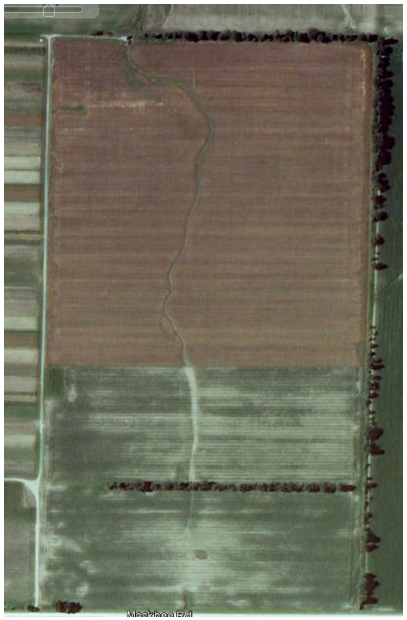
Impact of PA, CC, and No-till on Nutrient Loss



1991-2003
Mulch-Till



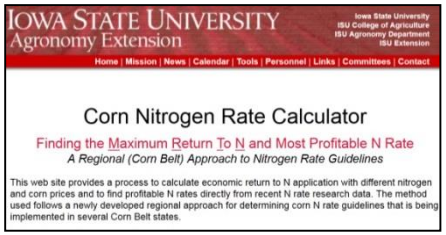
2004-present
No-Till + Cover Crop



What decision tools perform best for making corn N fertilizer rate recommendations?

Where do they work best? **When** do they work best?

Empirical-Based Models



Crop Growth Models

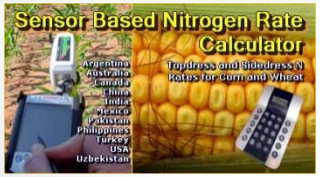
Encira

Maize-N

Climate: Nitrogen Advisor

Adapt-N

Proximal Canopy Sensing



Remote Imagery

Soil Tests

PPNT Pre-Plant Soil Nitrate Test

SDNT Side-Dress Soil Nitrate Test

Performance and Refinement of In-season Corn Nitrogen Fertilization Tools

Data from *Performance and Refinement of In-season Corn Nitrogen Fertilization Tools*

DUPONT PIONEER

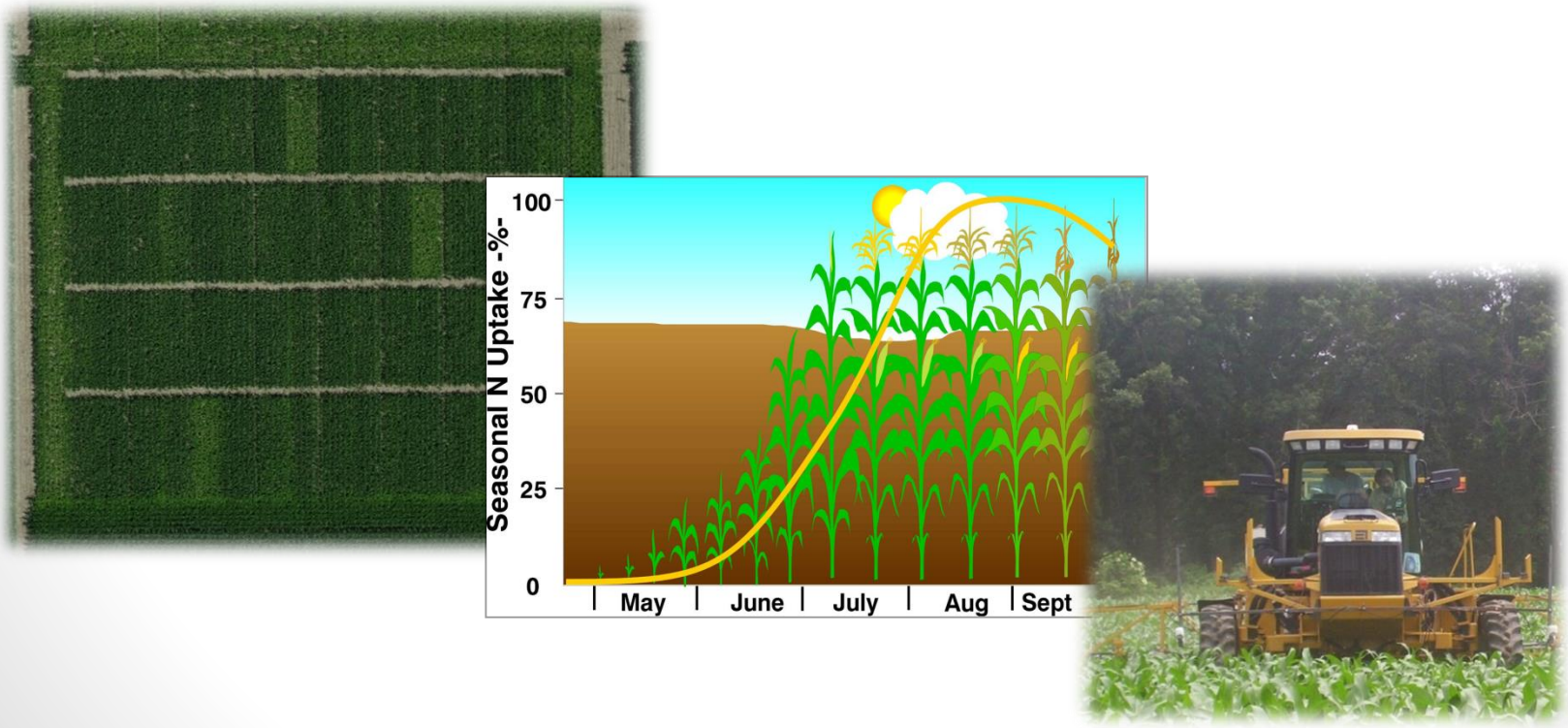
University

Evaluate DuPont Pioneer proprietary products and decision aids

Evaluate public-domain decision aid tools, develop agronomic science for improved crop N management, train new scientists, and publish results

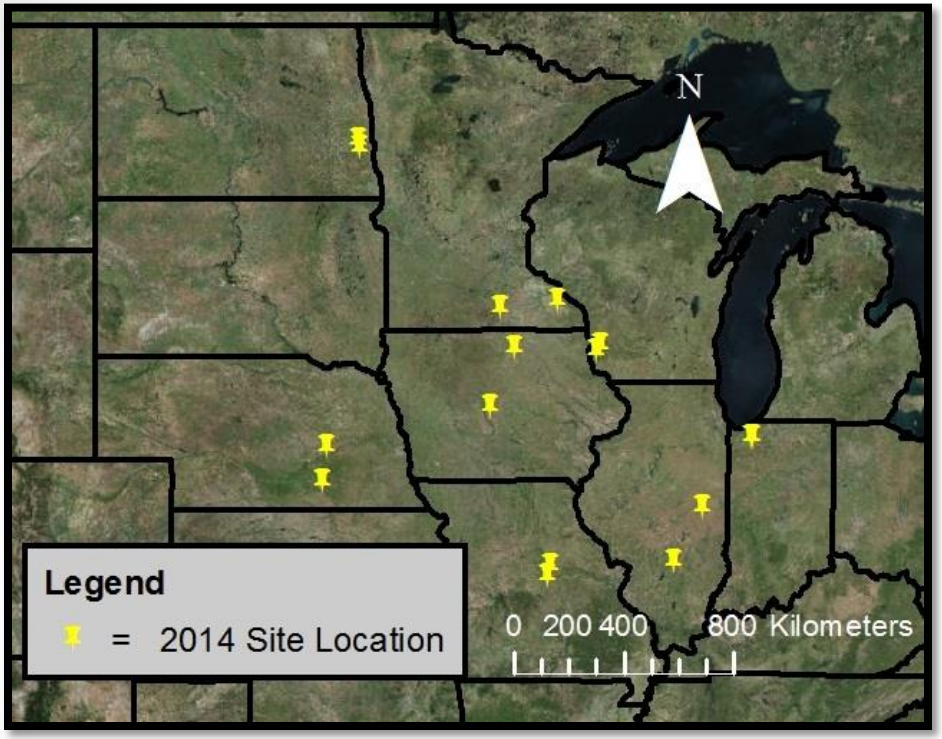
What is needed?

Datasets over a wide range of soil and weather scenarios that allow for calibration and/or validation of decision-support tools used in making corn N fertilizer recommendations.



Standarized Design

16 Locations/Year Total 49



N Treatments (lbs/acre)

Planting	Split (plt+V9)
0	40+40
40	40+80
80	40+120
120	40+160
160	40+200
200	40+240
240	80+80
280	80+160

Measurements

Climate

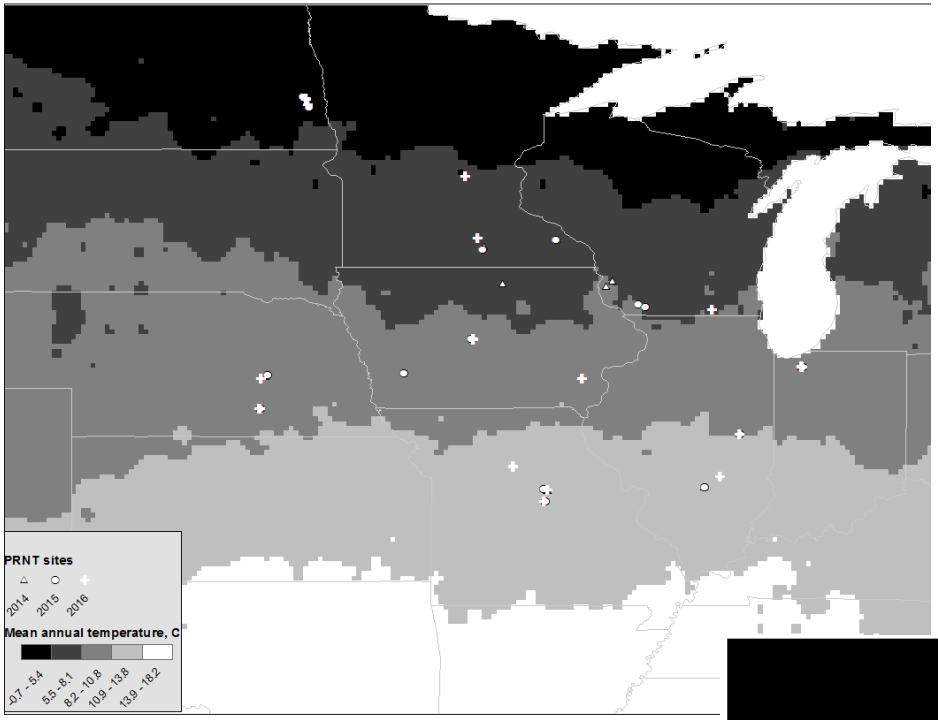
- Precipitation
- Temperature
- Solar radiation

Soil

- EC mapping (Veris™)
- Soil sampling (3x)
- Soil moisture (TRT 3+16)

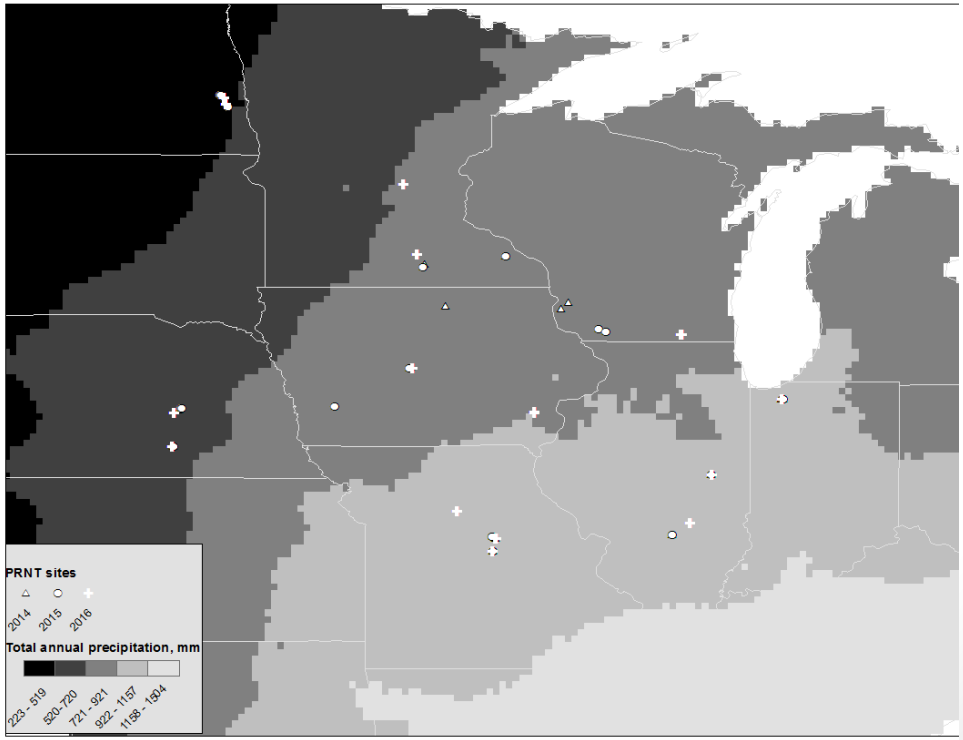
Crop

- Plant N (VT & R6)
- Canopy reflectance (V9)
- Grain yield and moisture

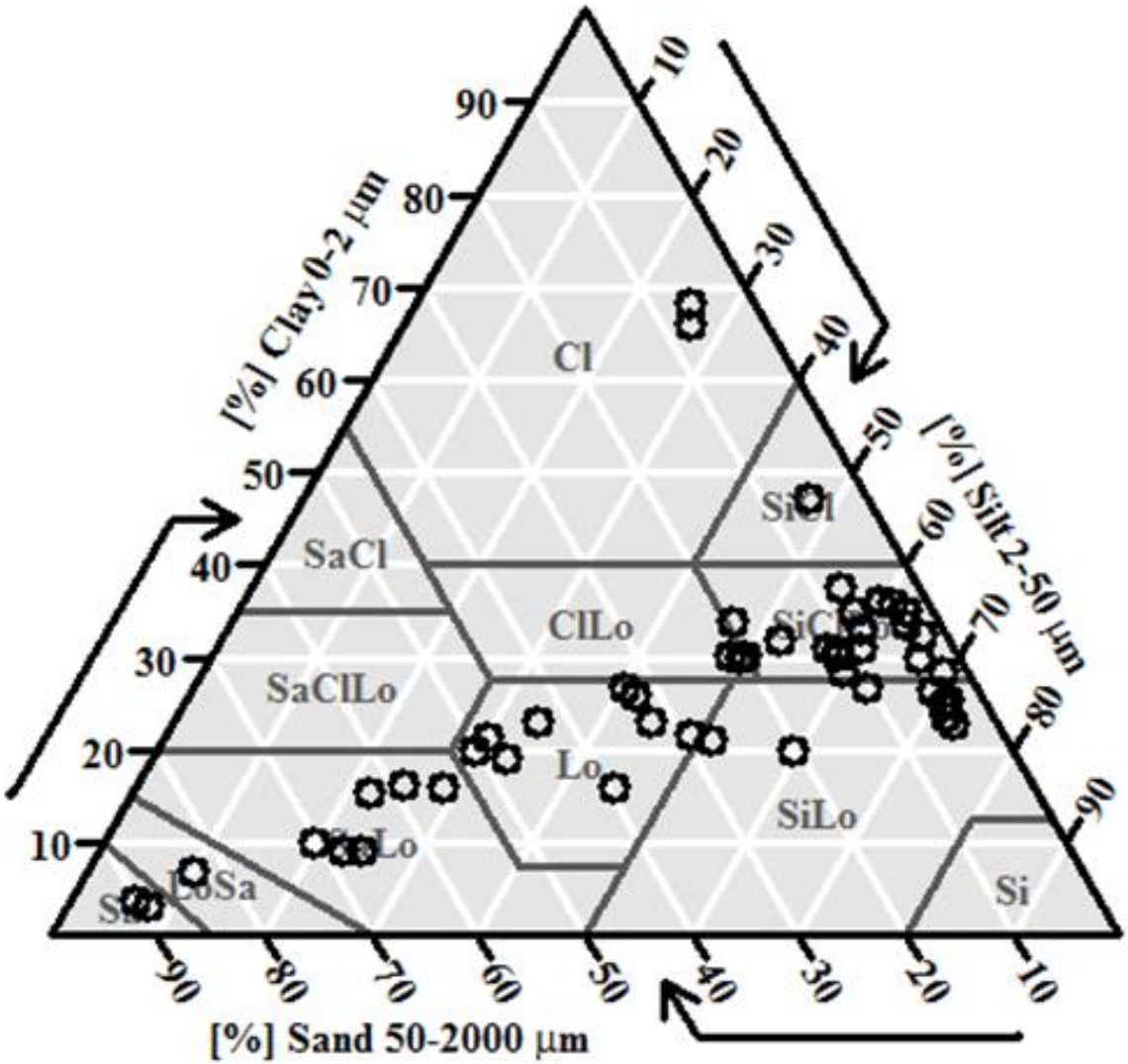


Temperature

Precipitation

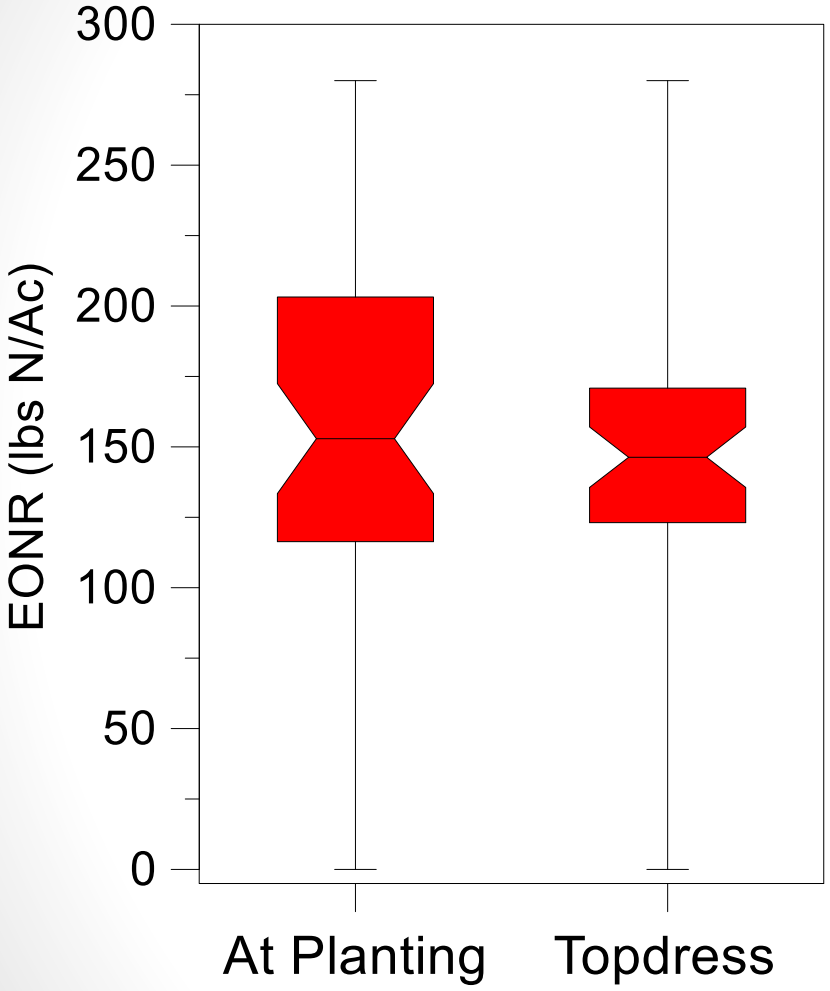


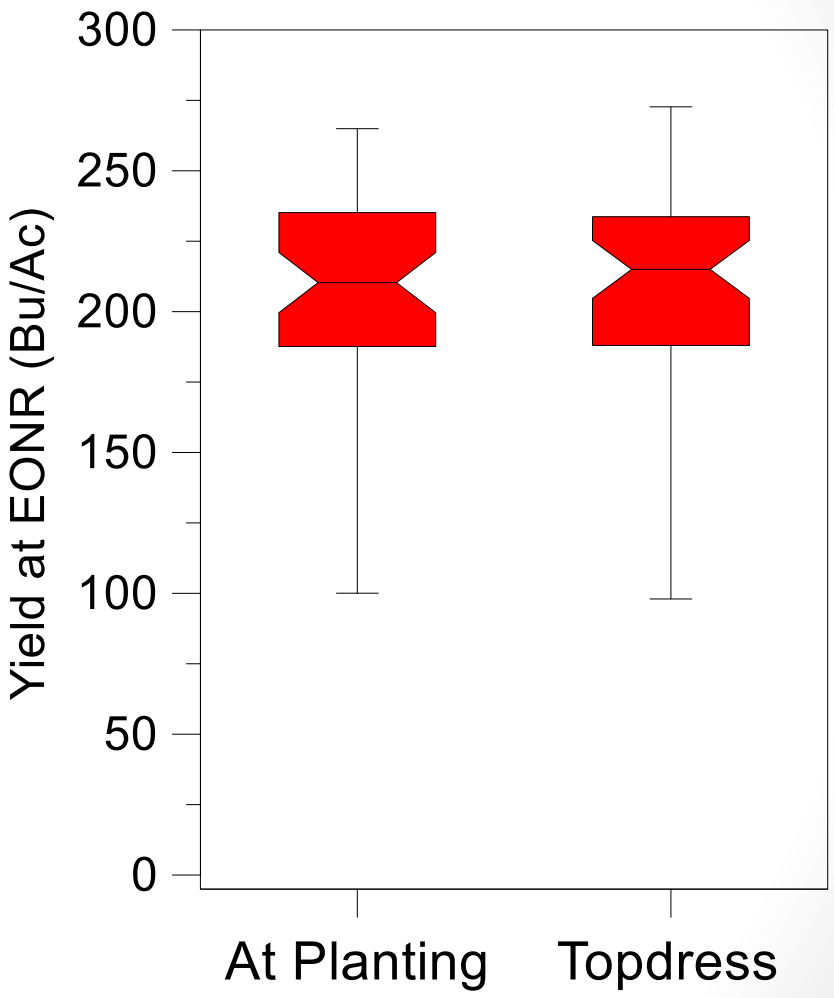
49 Research Sites over 8 States



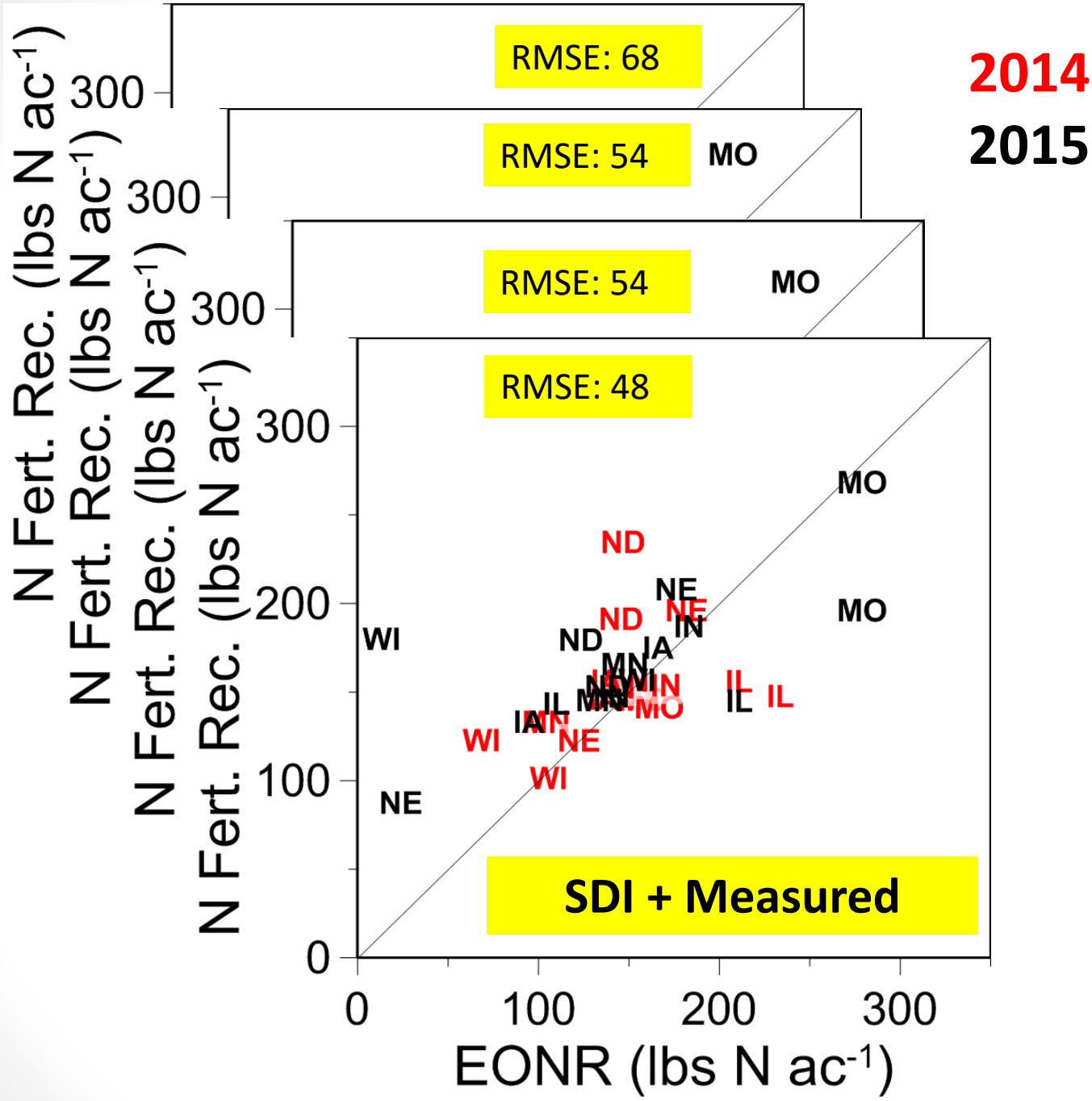
EONR and Yield at EONR

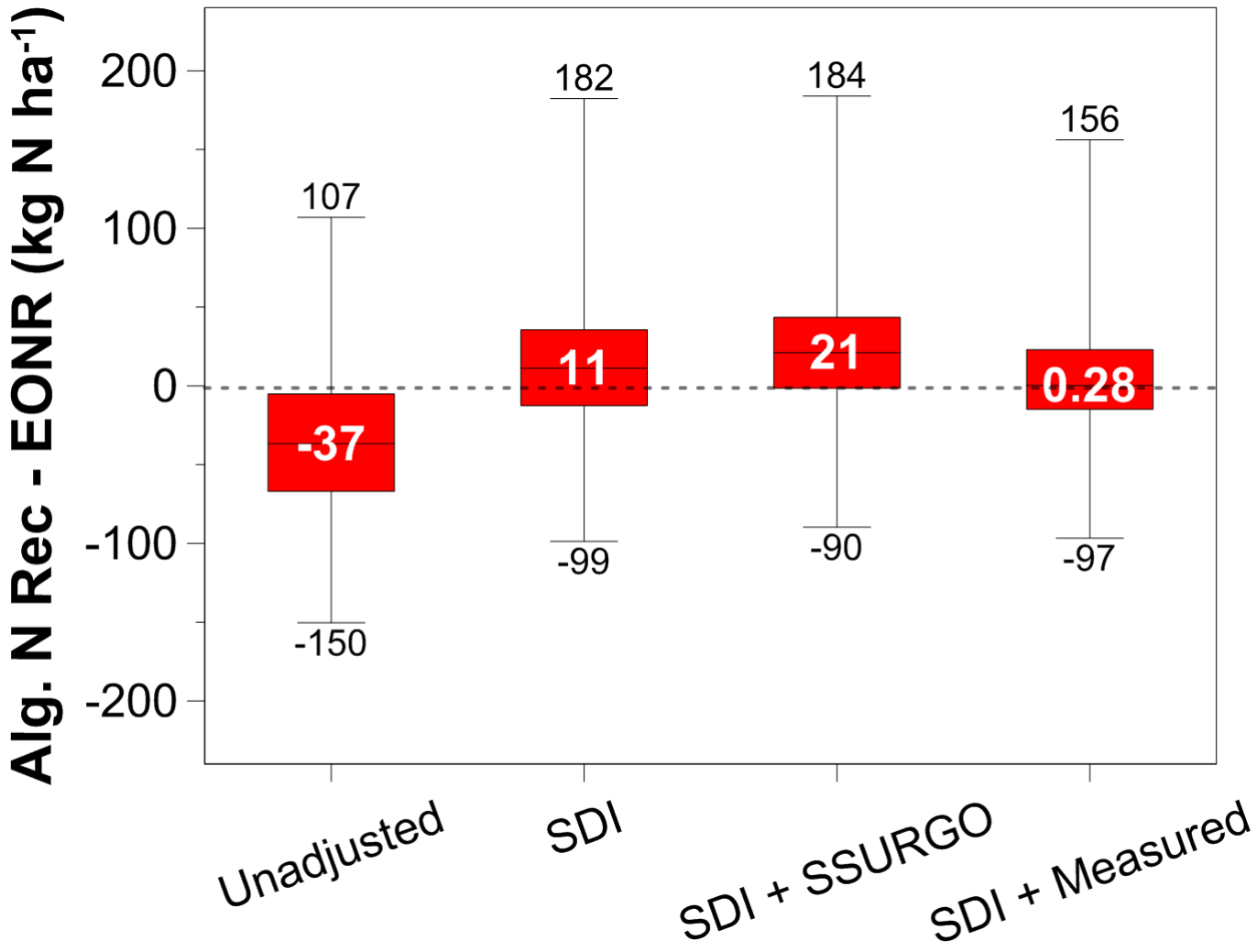
(49 PRNT sites)






HAGIE


RMSE: 68
RMSE: 54
MO
RMSE: 54
MO
RMSE: 48
2014
2015
N Fert. Rec. (lbs N ac-1)
N Fert. Rec. (lbs N ac-1)
N Fert. Rec. (lbs N ac-1)
N Fert. Rec. (lbs N ac-1)
300
300
300
300
200
100
0
0
100
200
300
EONR (lbs N ac-1)
MO
MO
ND
NE
ND
NE
IN
WI
ND
IA
MN
IL
IL
IL
IA
IN
MO
WI
NE
WI
NE
SDI + Measured


Alg. N Rec - EONR (kg N ha-1)
200
100
0
-100
-200
107
182
184
156
-37
11
21
0.28
-150
-99
-90
-97
Unadjusted
SDI
SDI + SSURGO
SDI + Measured


Questions?