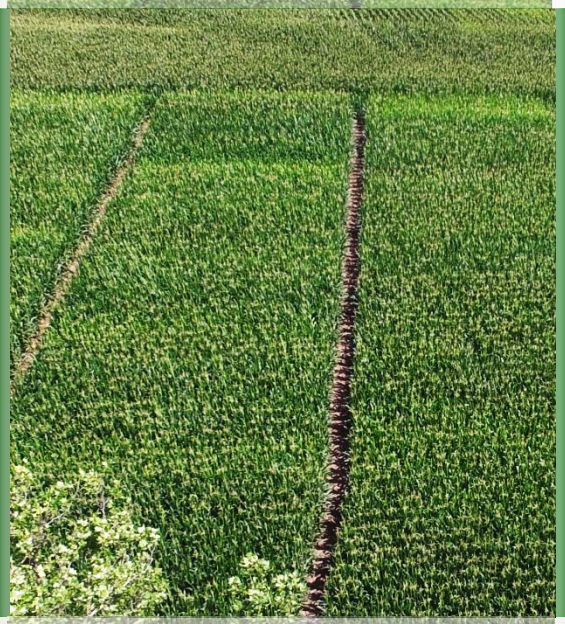
Proceedings of the 3rd Annual Nitrogen: Minnesota's' Grand Challenge & Compelling Opportunity Conference

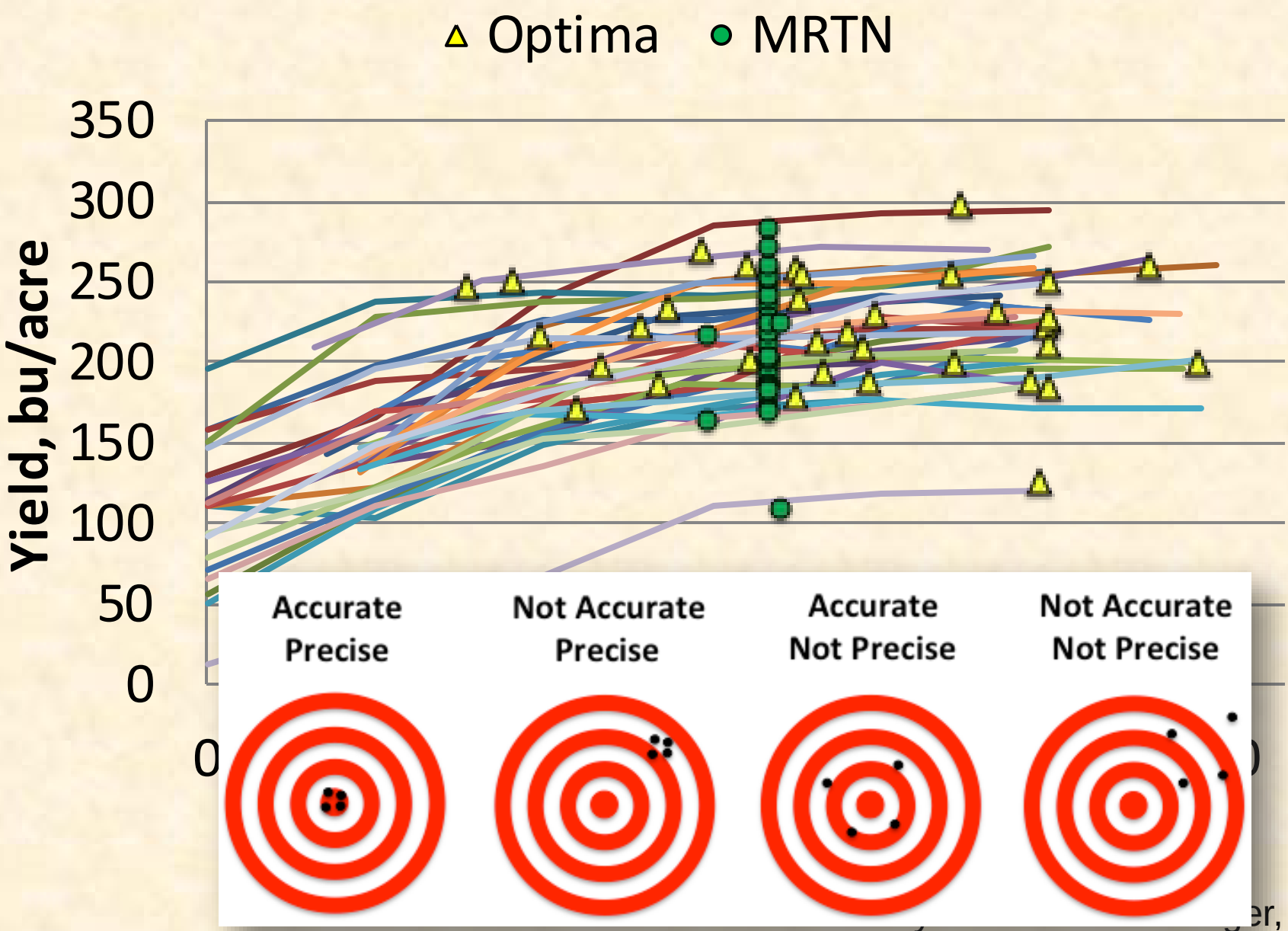


Upgrade Your Corn Nitrogen Management Using Precision Agriculture

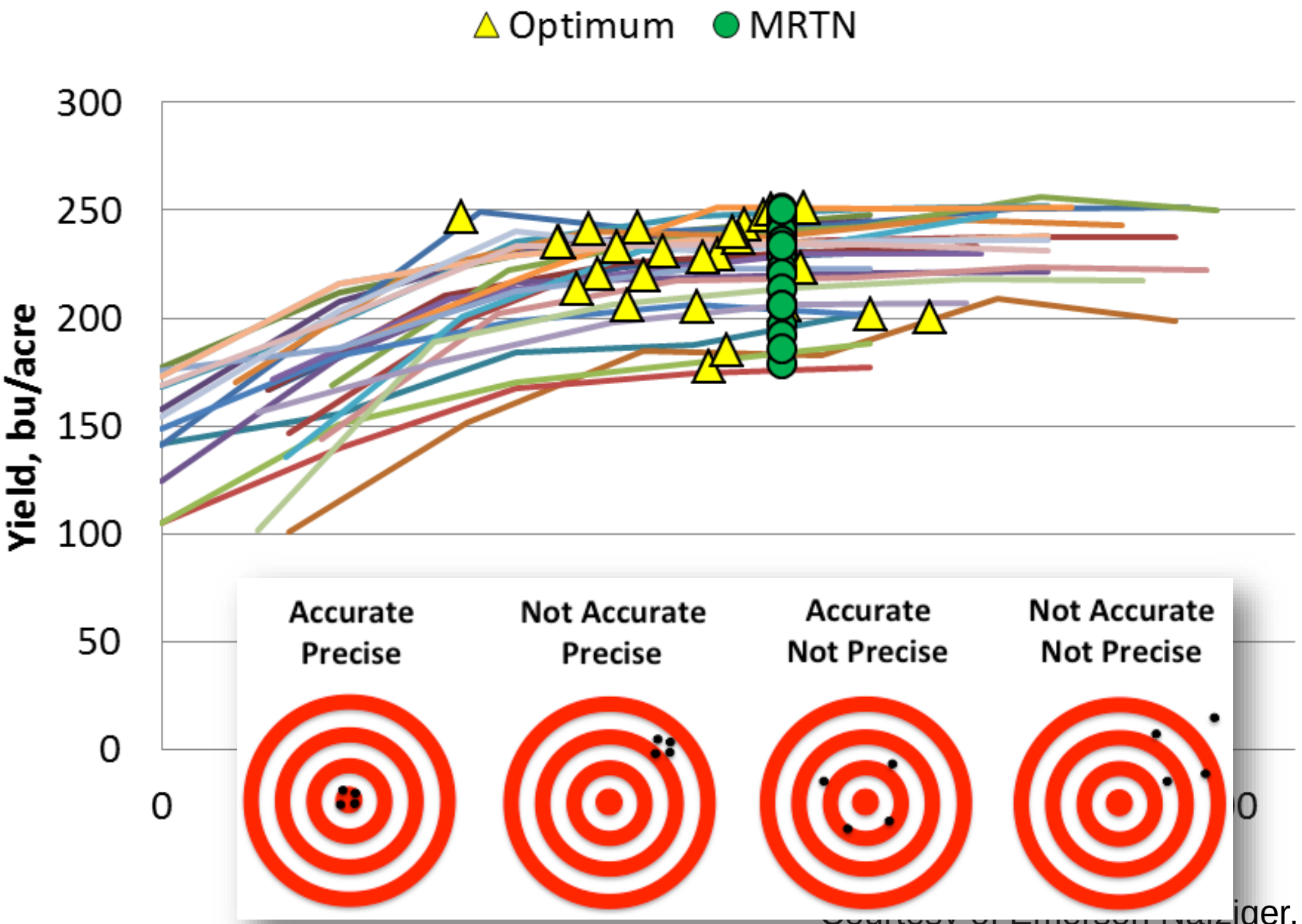
Newell R. Kitchen
USDA-ARS
Cropping Systems and Water Quality
Columbia, Missouri

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

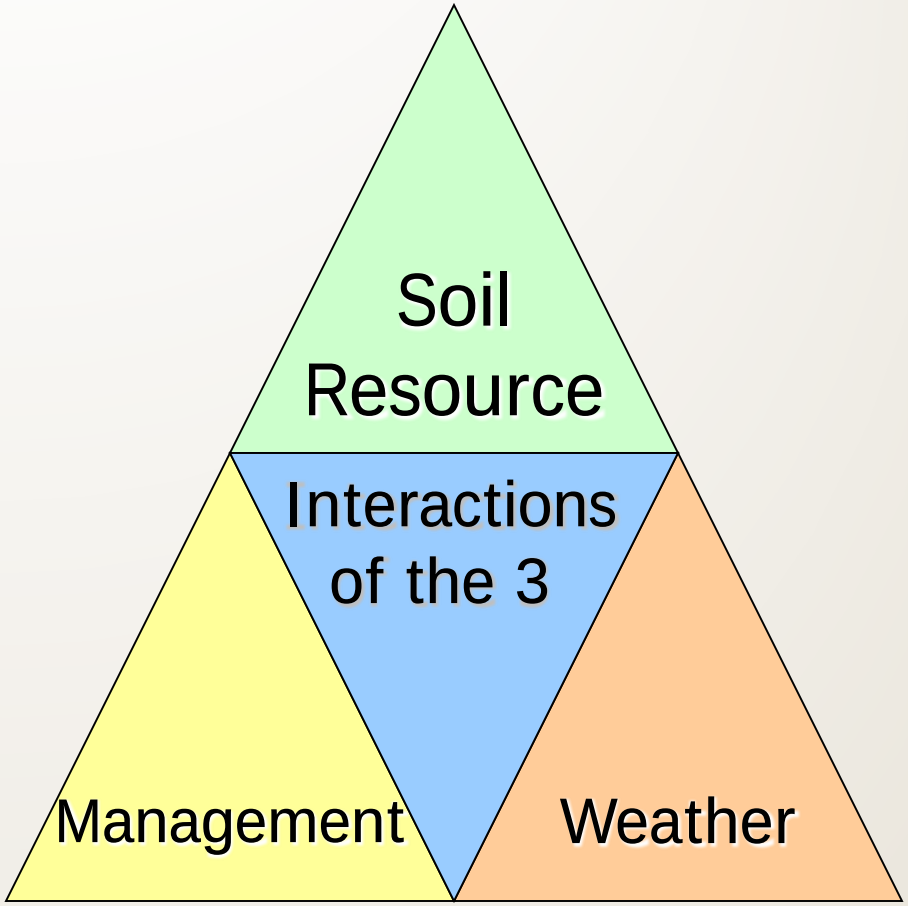
35 on-farm trials Soy-Corn 2015



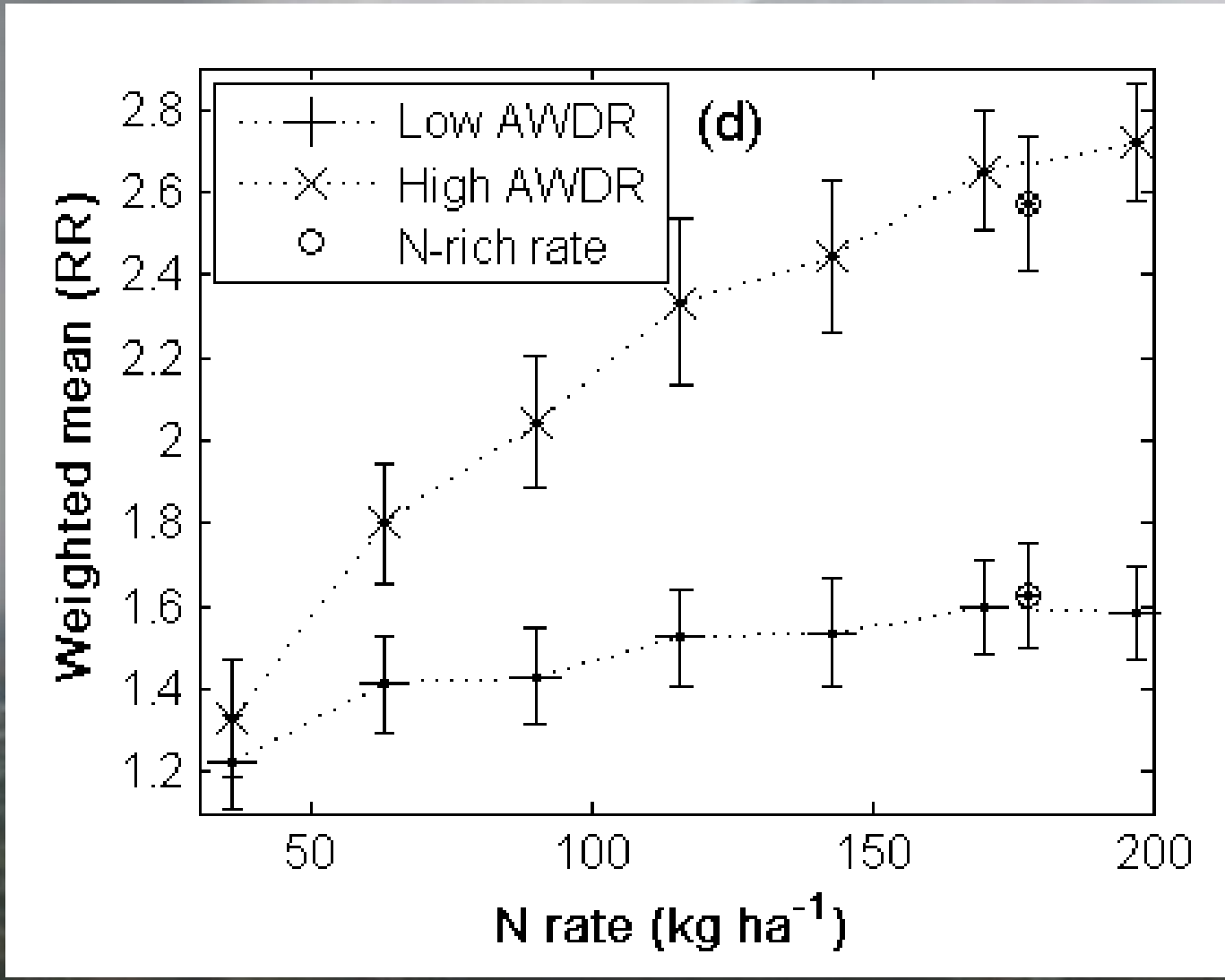
On-Farm N Rate Trials Soy-Corn 2016



Courtesy of Emerson Nafziger, UI

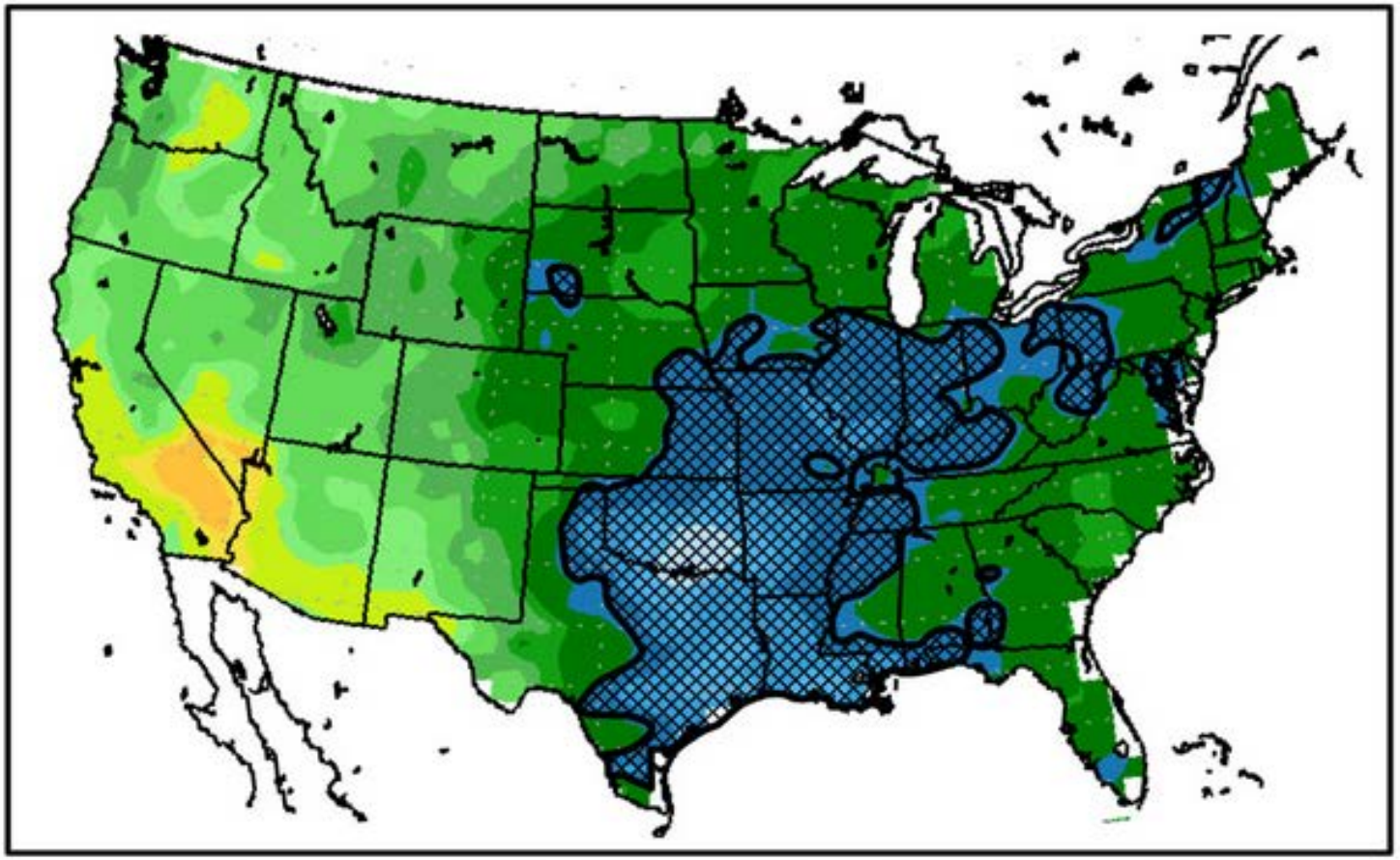

Soil
Resource
Interactions
of the 3
Management
Weather

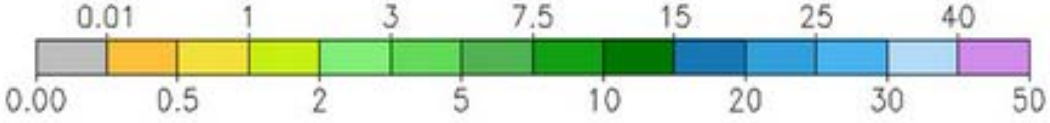
Abundant and Well-Distributed Rainfall



(Tremblay et al., 2012)

Accumulated Precipitation (in)
April 1, 2015 to June 30, 2015

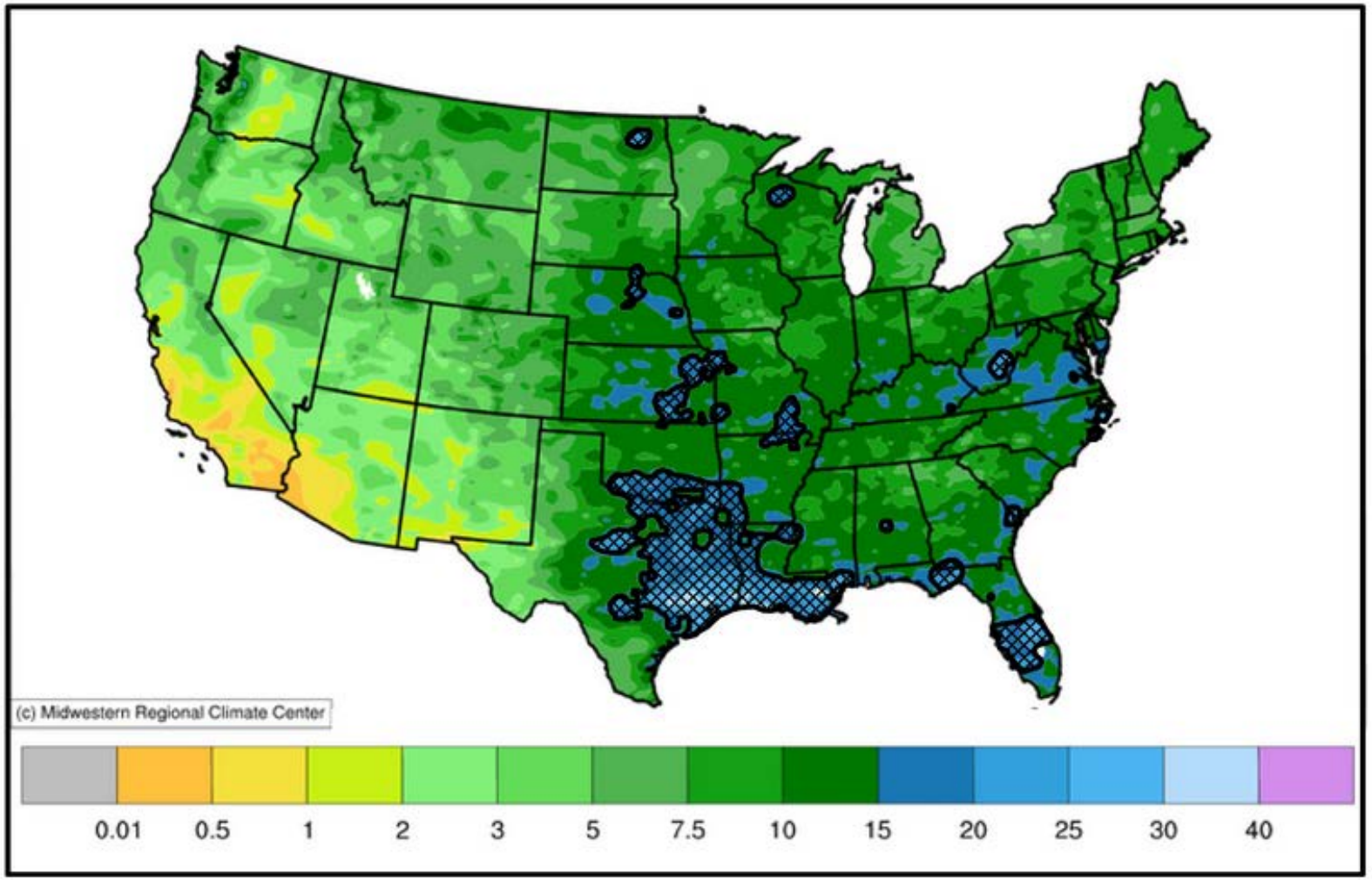




Midwestern Regional Climate Center

cli-MATE: MRCC Application Tools Environment

Accumulated Precipitation (in)
April 1, 2016 to Jul 3, 2016



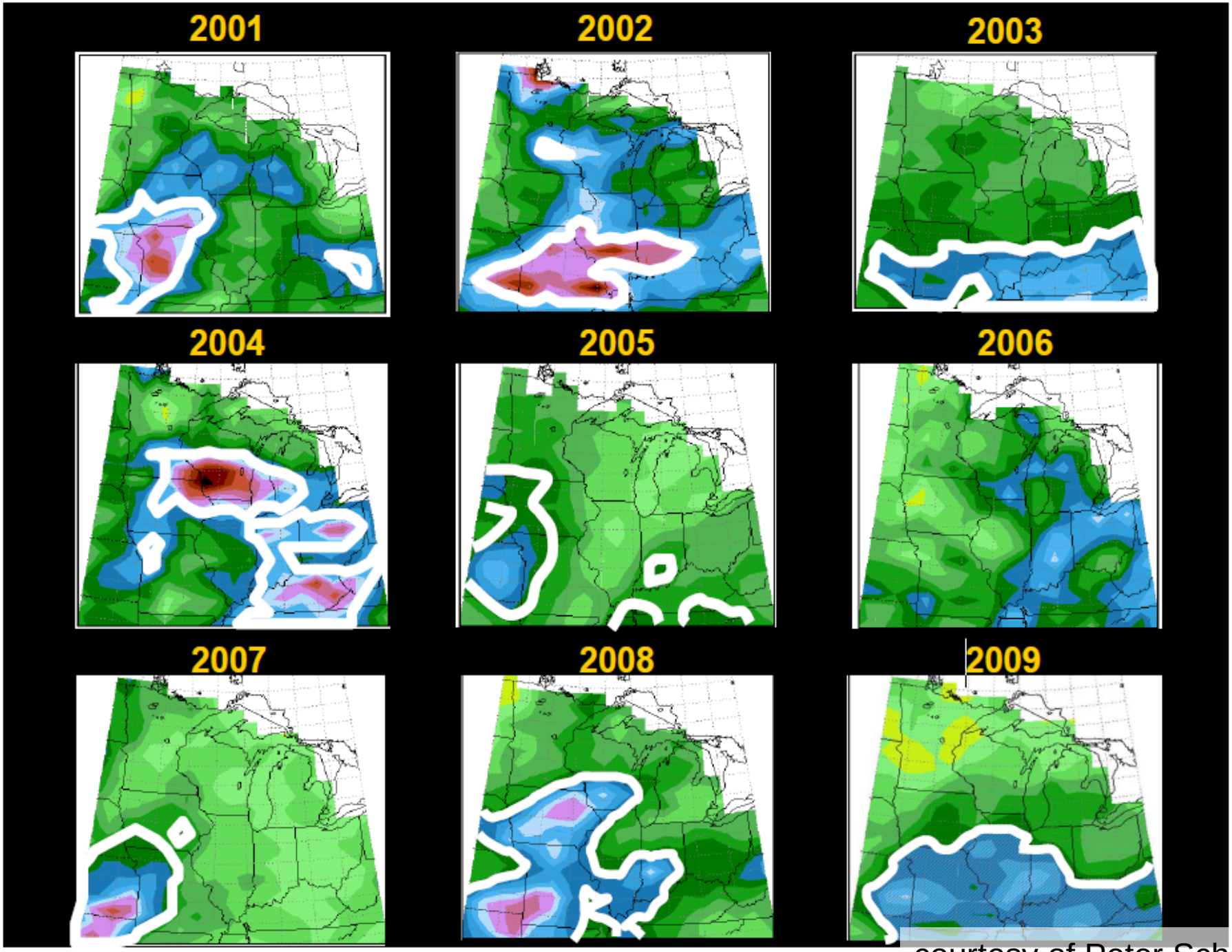
Midwestern Regional Climate Center

cli-MATE: MRCC Application Tools Environment

West central Missouri

early August 2009, south of Marshall

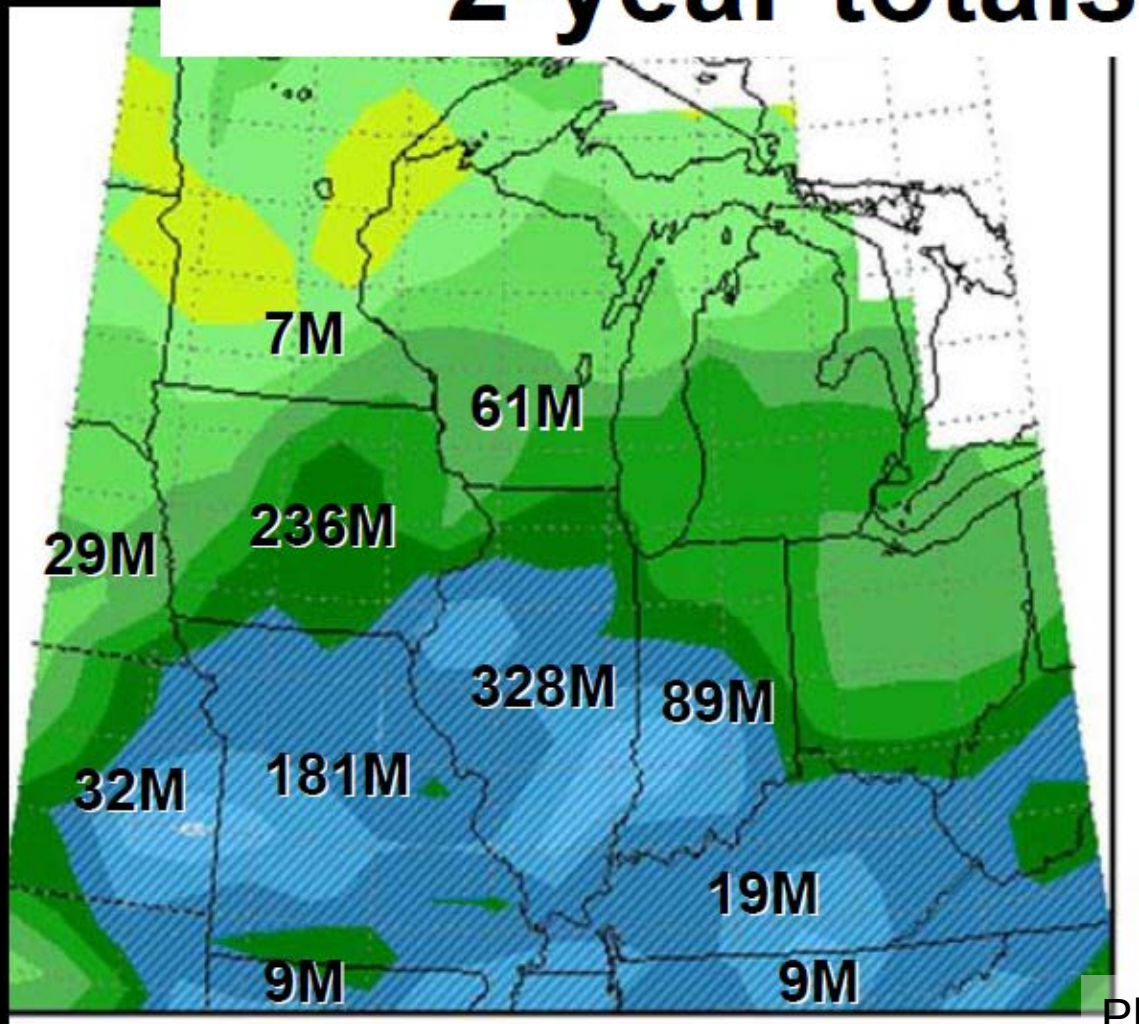
Photo courtesy of Peter Scharf



courtesy of Peter Scharf

Bushels lost due to N deficiency:

2-year totals

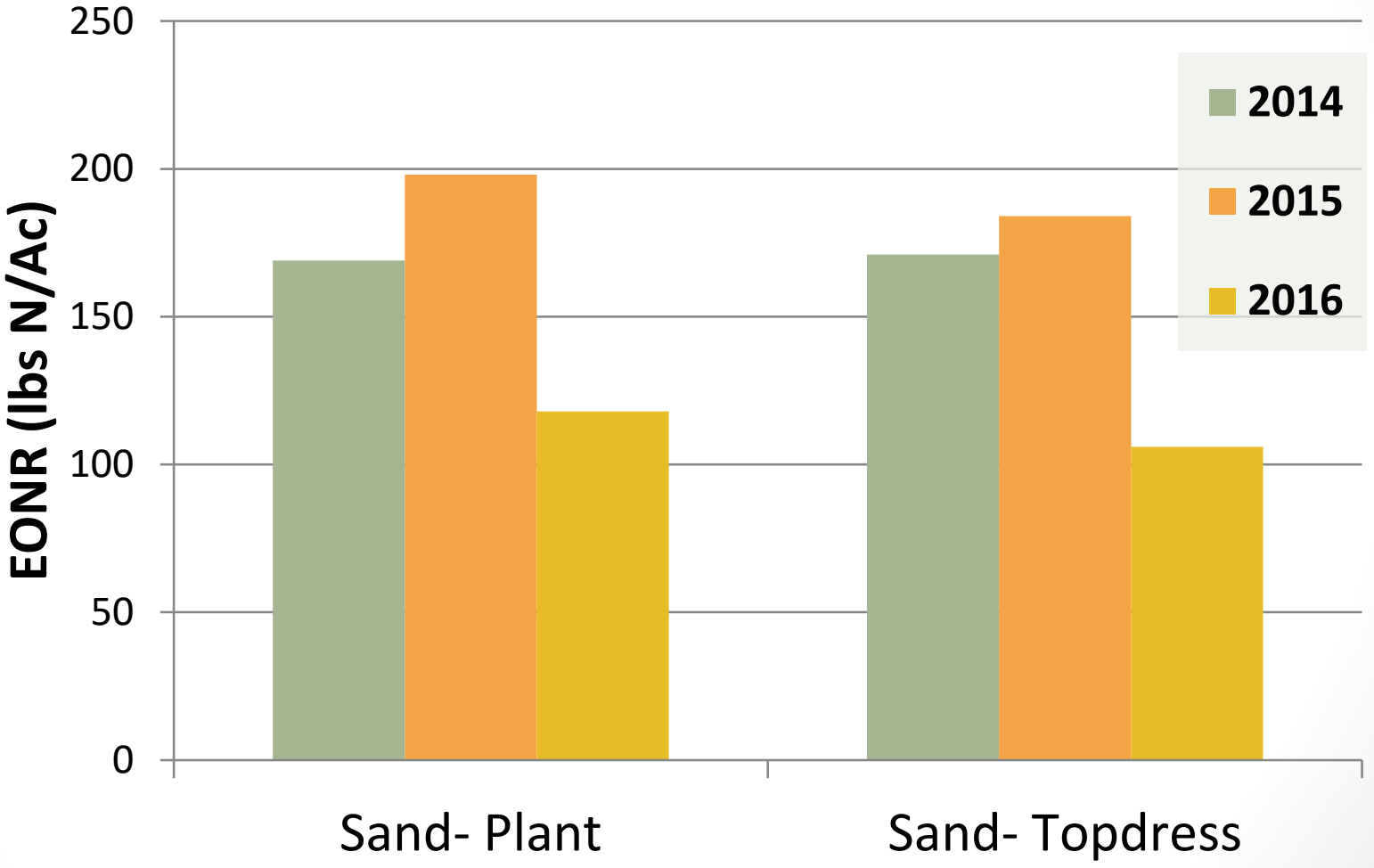


Total 11 states:

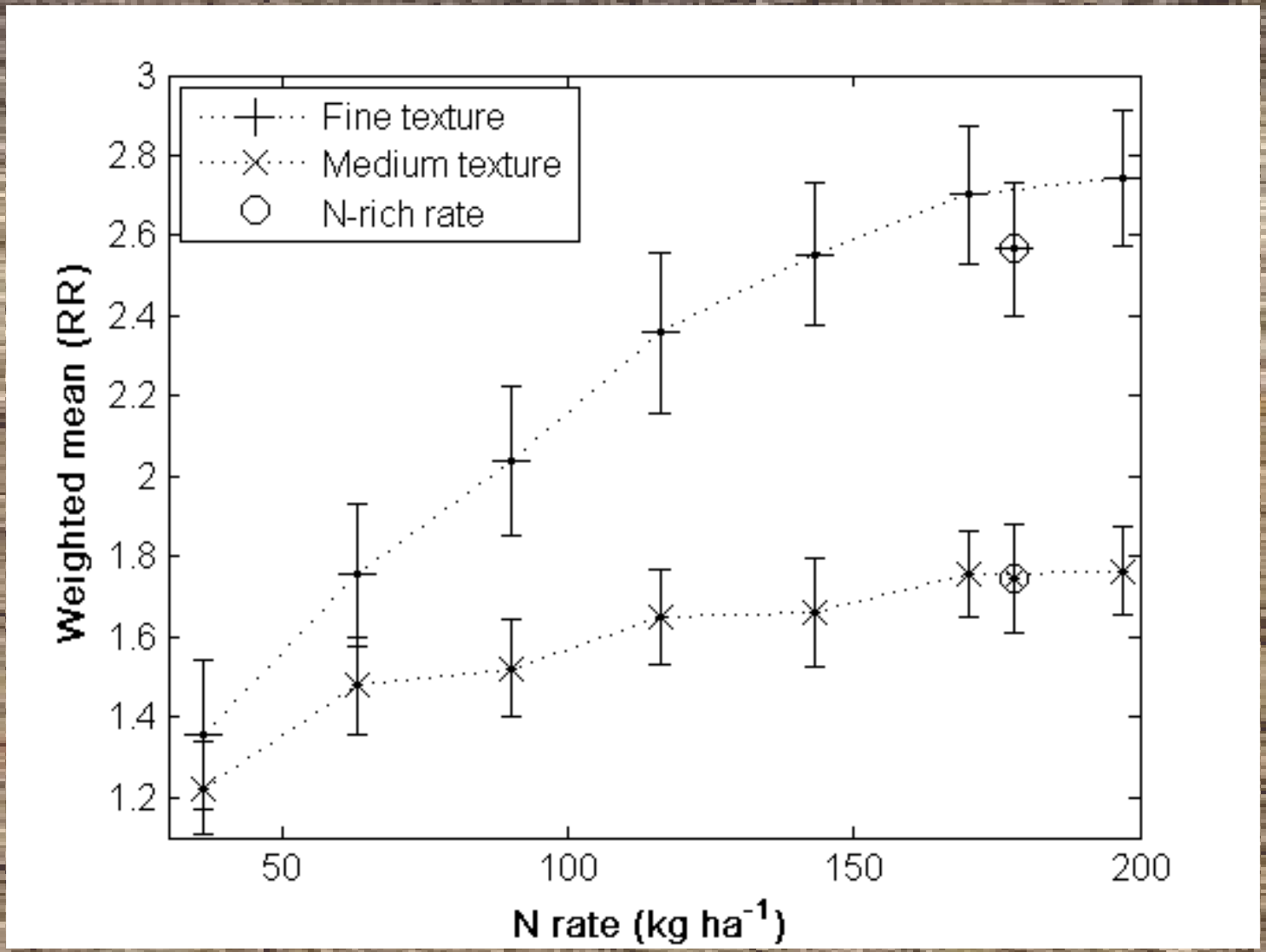
1 billion bushels

Photo courtesy of Peter Scharf

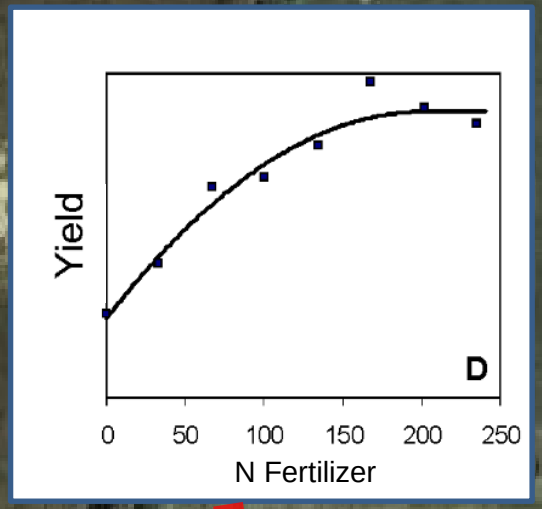
EONR for Indiana Sand Sites

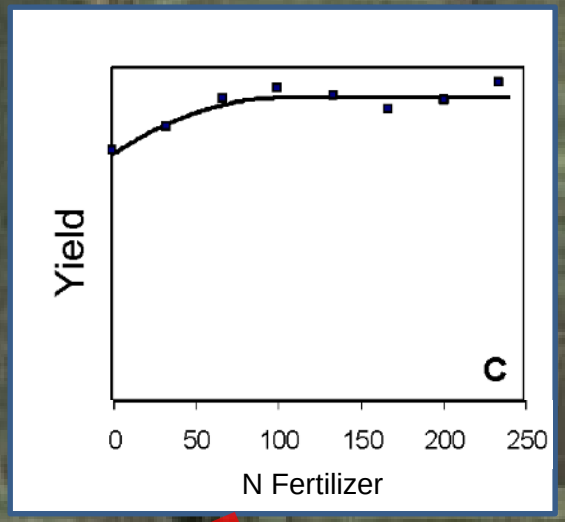


The Soil Factor



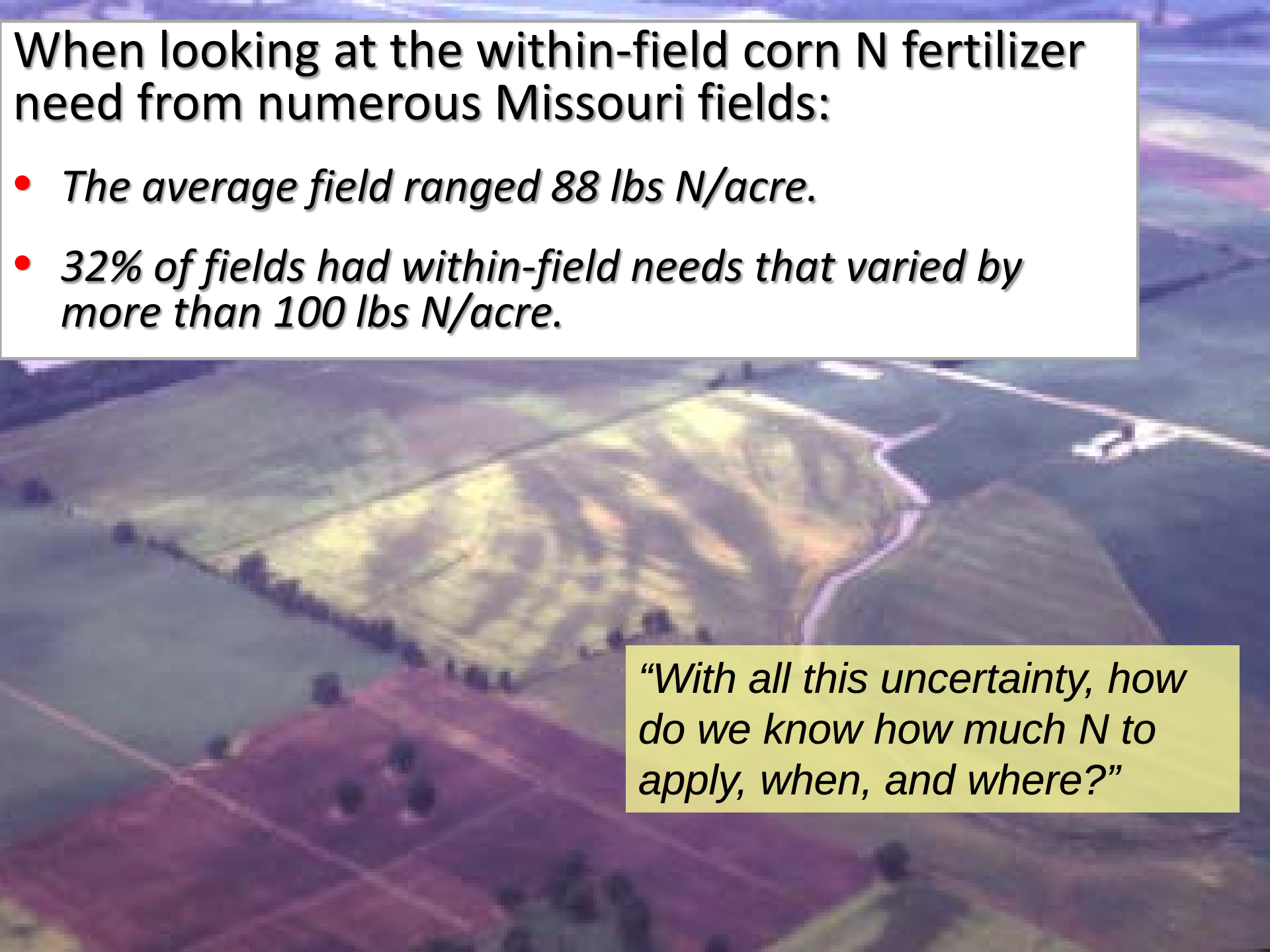
(Tremblay et al., 2012)





180 lbs

40 lbs



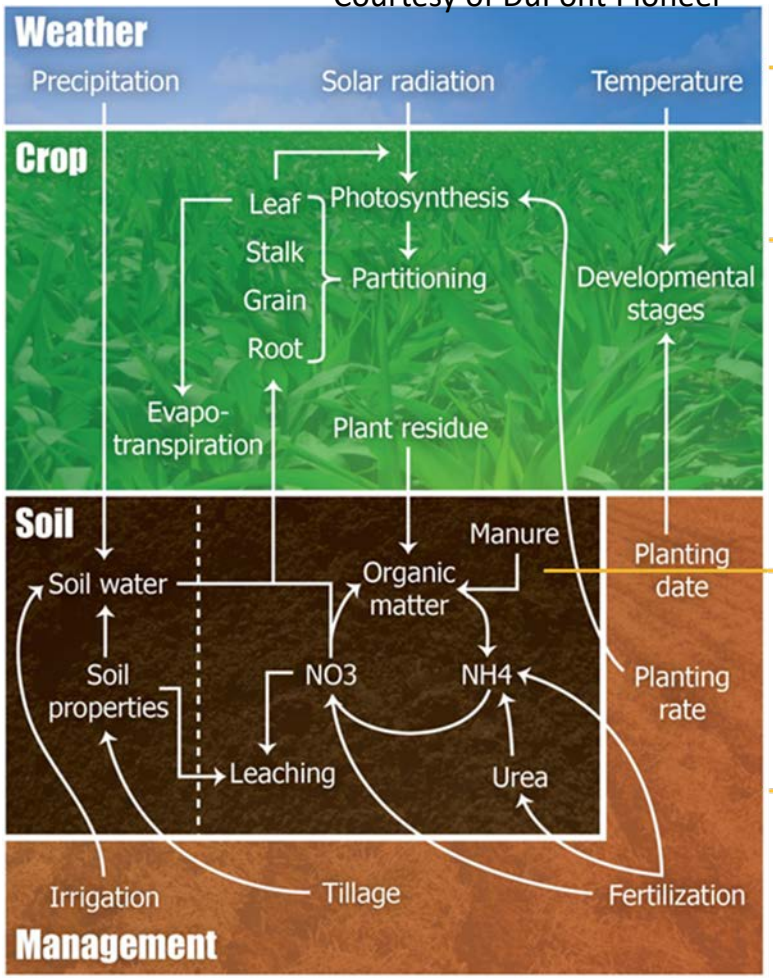
When looking at the within-field corn N fertilizer need from numerous Missouri fields:

- *The average field ranged 88 lbs N/acre.*
- *32% of fields had within-field needs that varied by more than 100 lbs N/acre.*

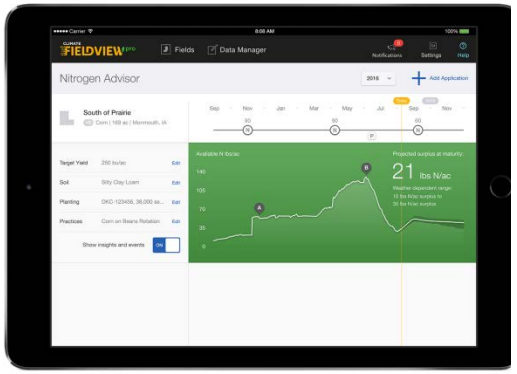
"With all this uncertainty, how do we know how much N to apply, when, and where?"

Crop Growth Modeling

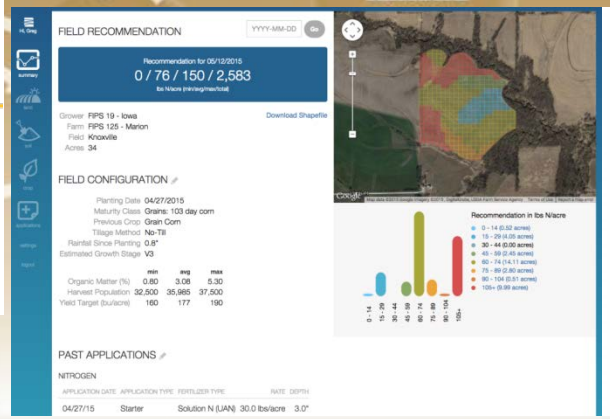
Courtesy of DuPont Pioneer



encirca℠



CLIMATE FIELD VIEW™

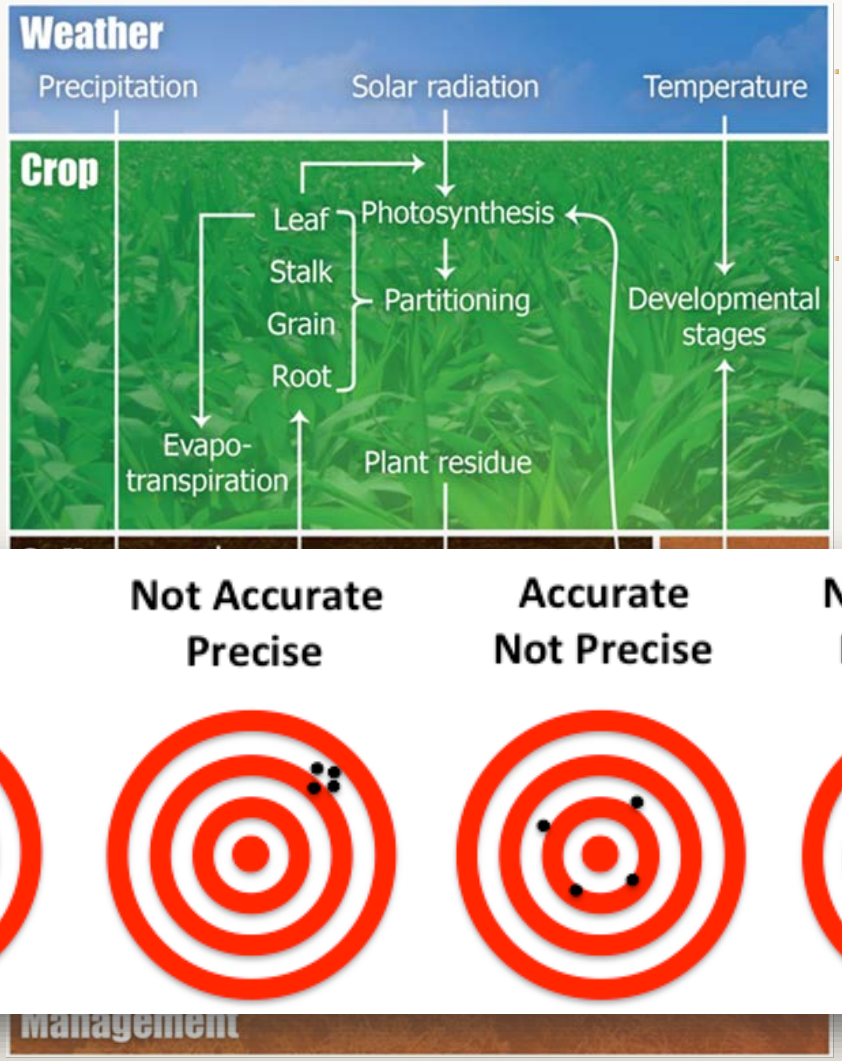


adapt-N

Crop Simulation Models (G x E x M)

E

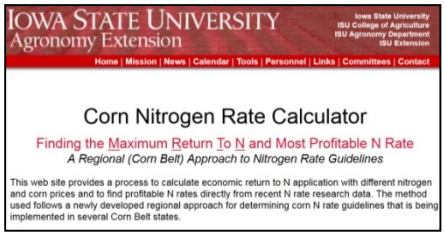
G



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

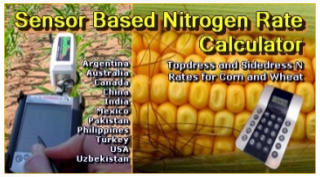
Encira

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

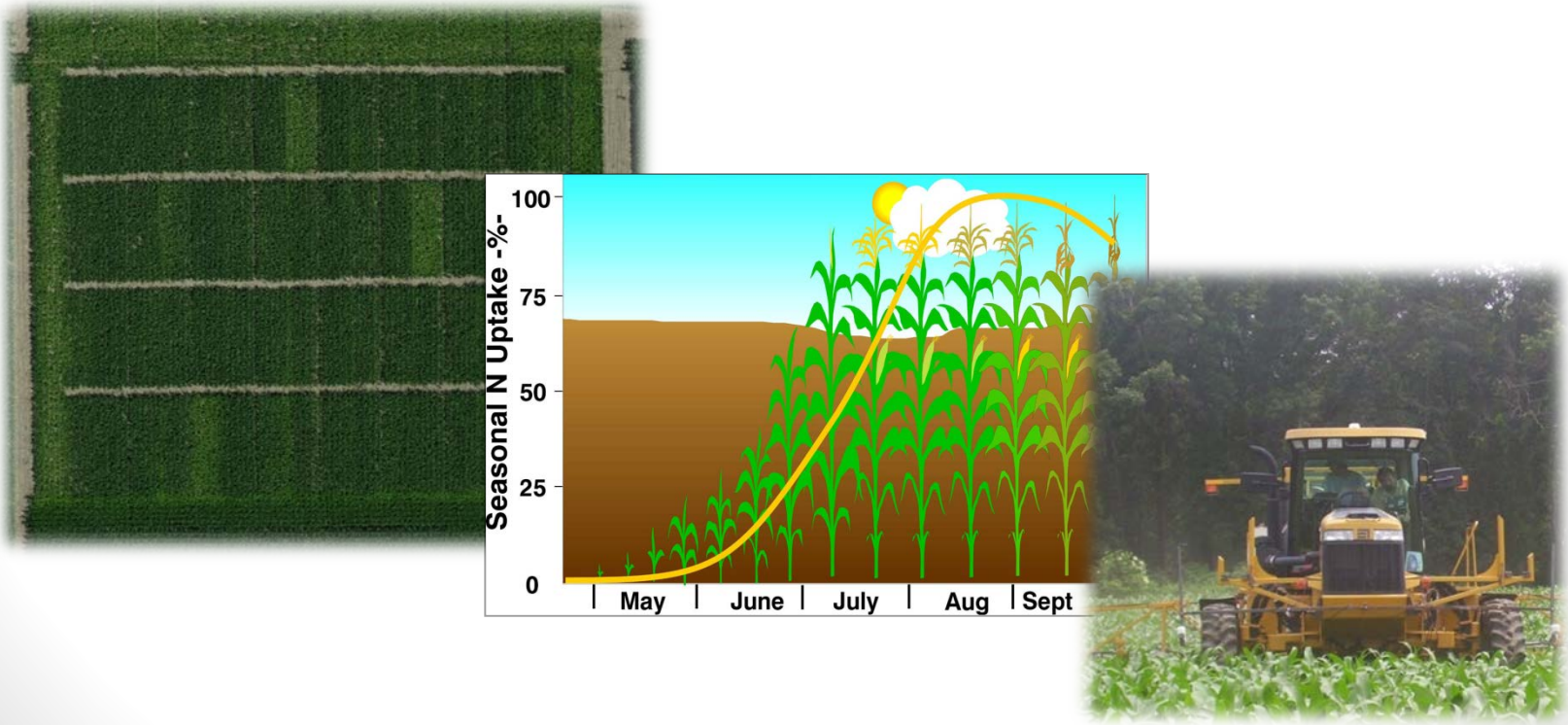
University

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

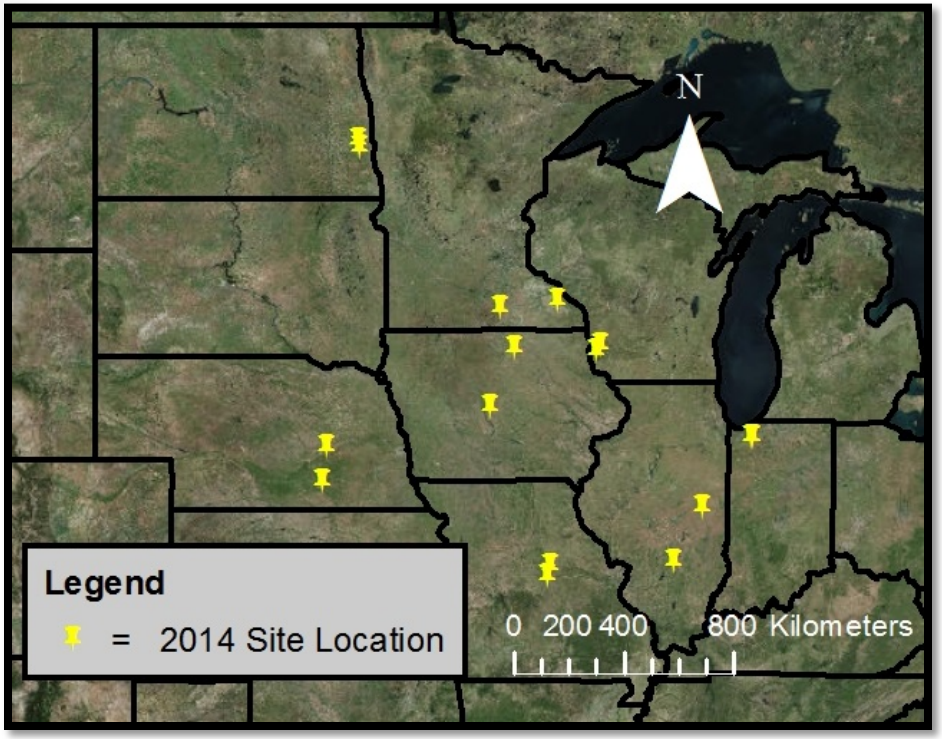
What is needed?

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

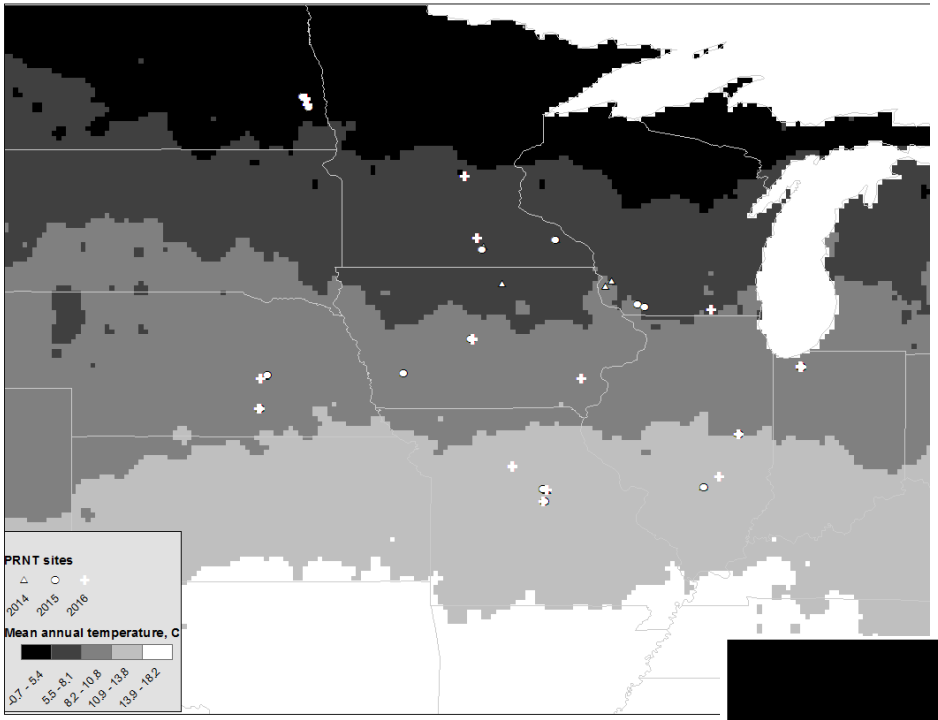
Soil

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

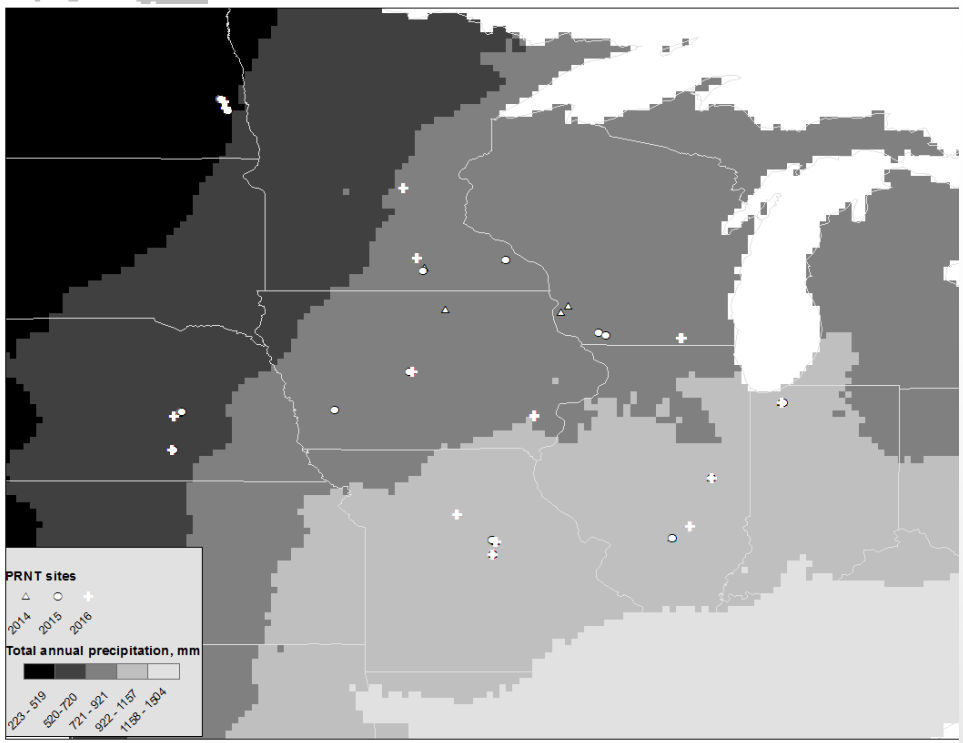
Crop

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

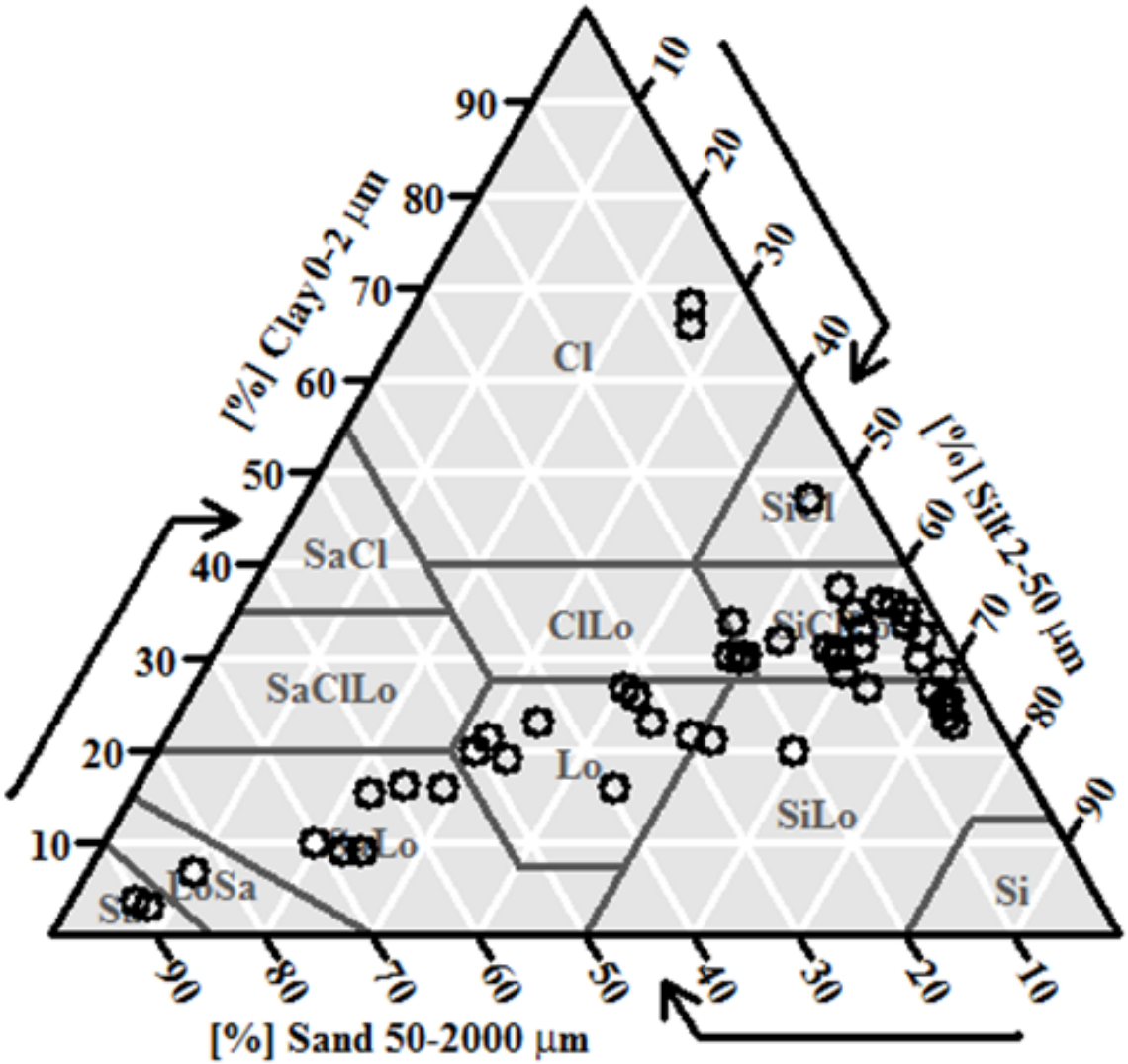
Temperature



Precipitation



49 Research Sites over 8 States

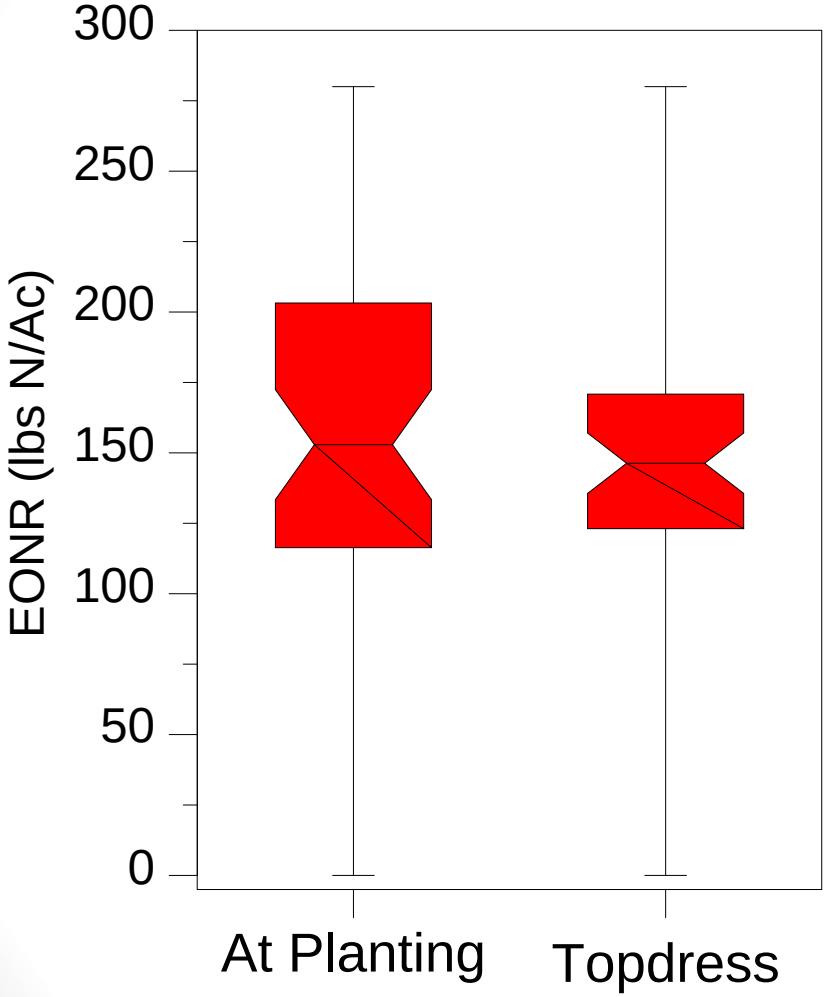


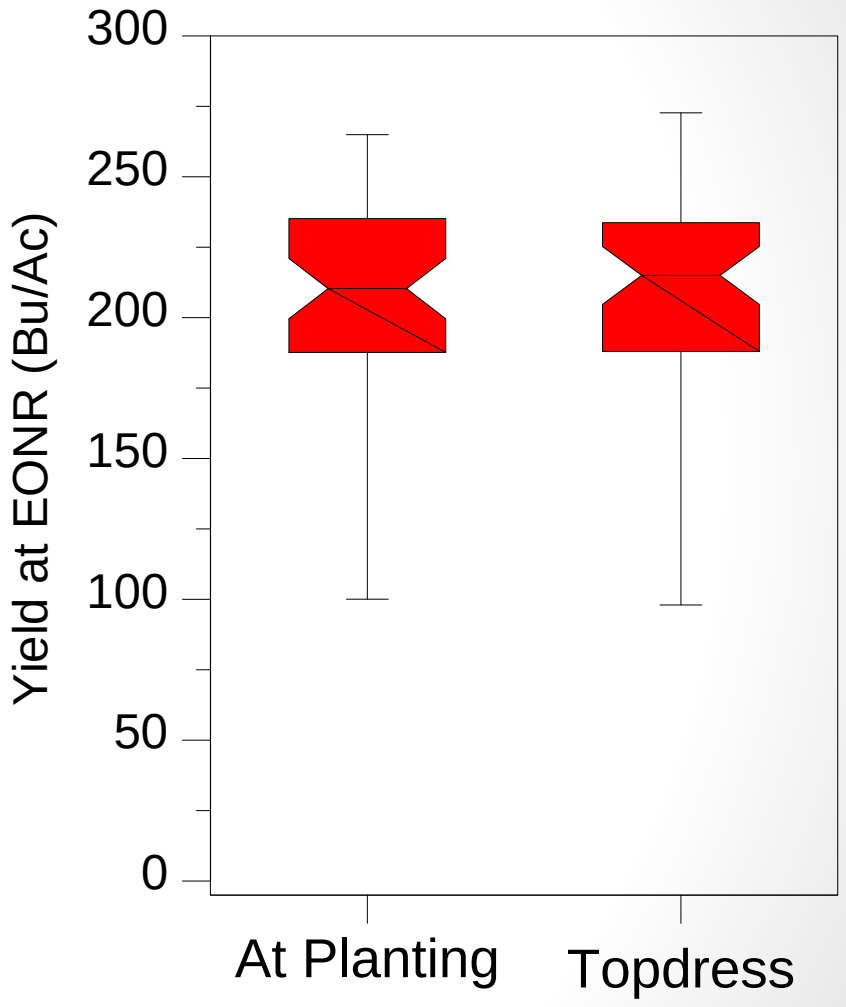
What Tools were Evaluated?

- Farmer's Historical Practice
- Generic Yield Goal - *(1.2 * YG)*
- State Recommendation Yield Goal
- Maximum Return to Nitrogen *(MRTN)*
- Pre-plant Soil Nitrogen Test *(PPNT)*
- Side-dress Soil Nitrogen Test *(PSNT)*
- Maize-N
- Canopy Reflectance - *different algorithms*

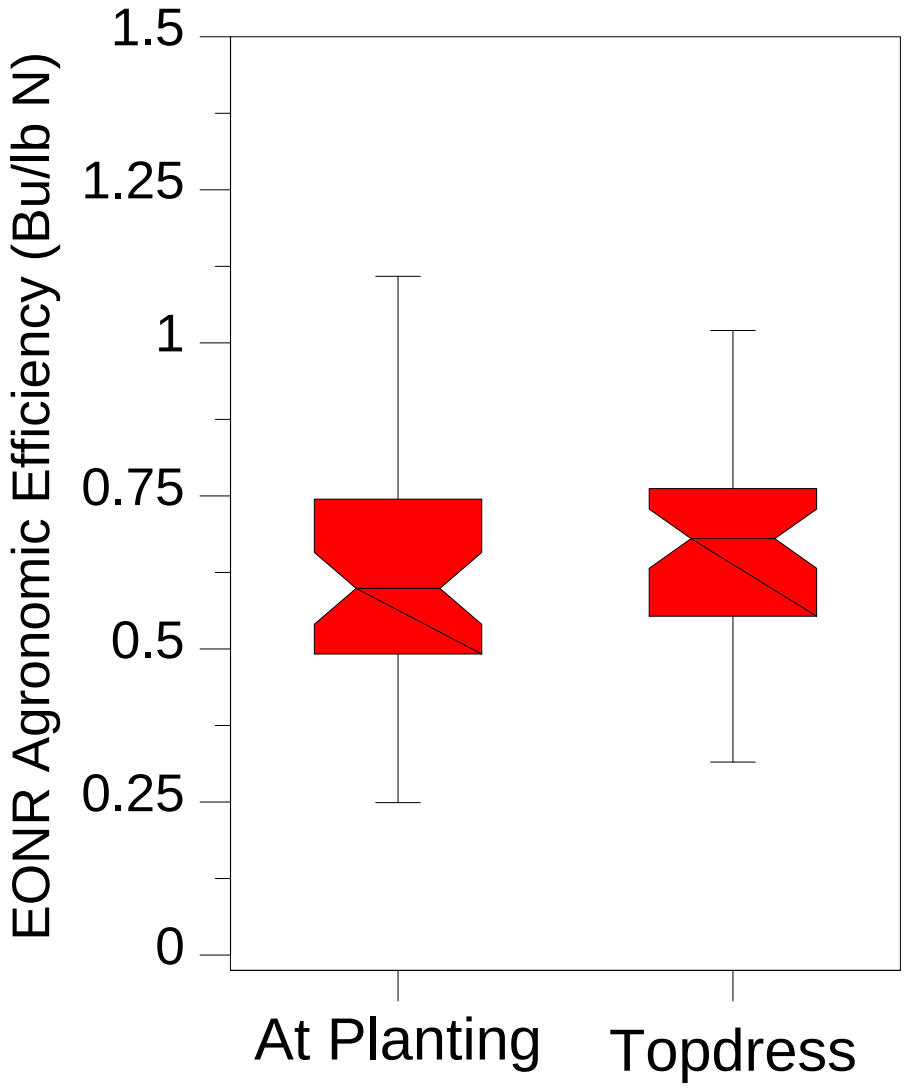
EONR and Yield at EONR

(49 PRNT sites)

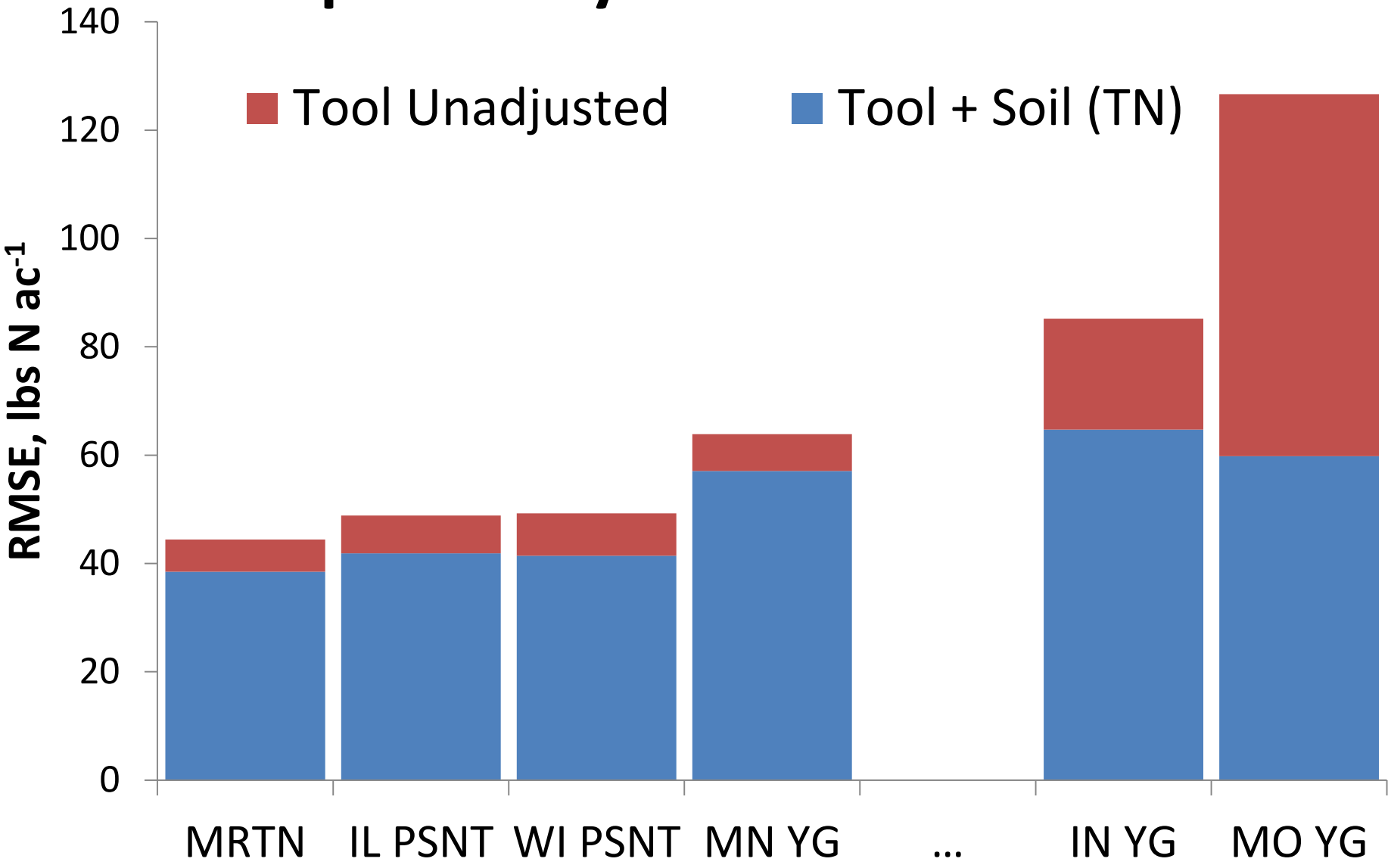




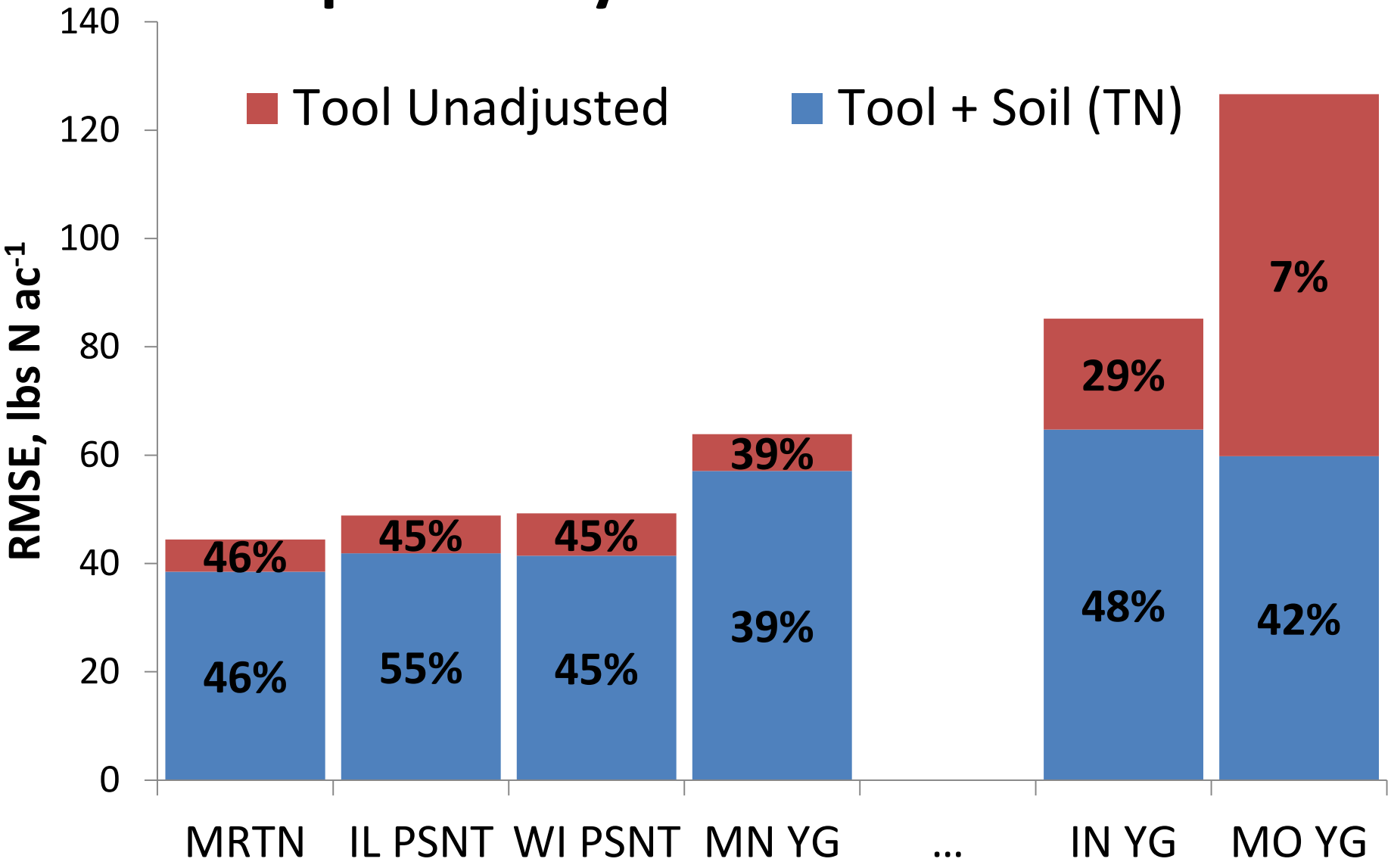
EONR Agronomic Efficiency
(46/49 PRNT sites)



At Side-Dress N Tools Improved by Soil Information

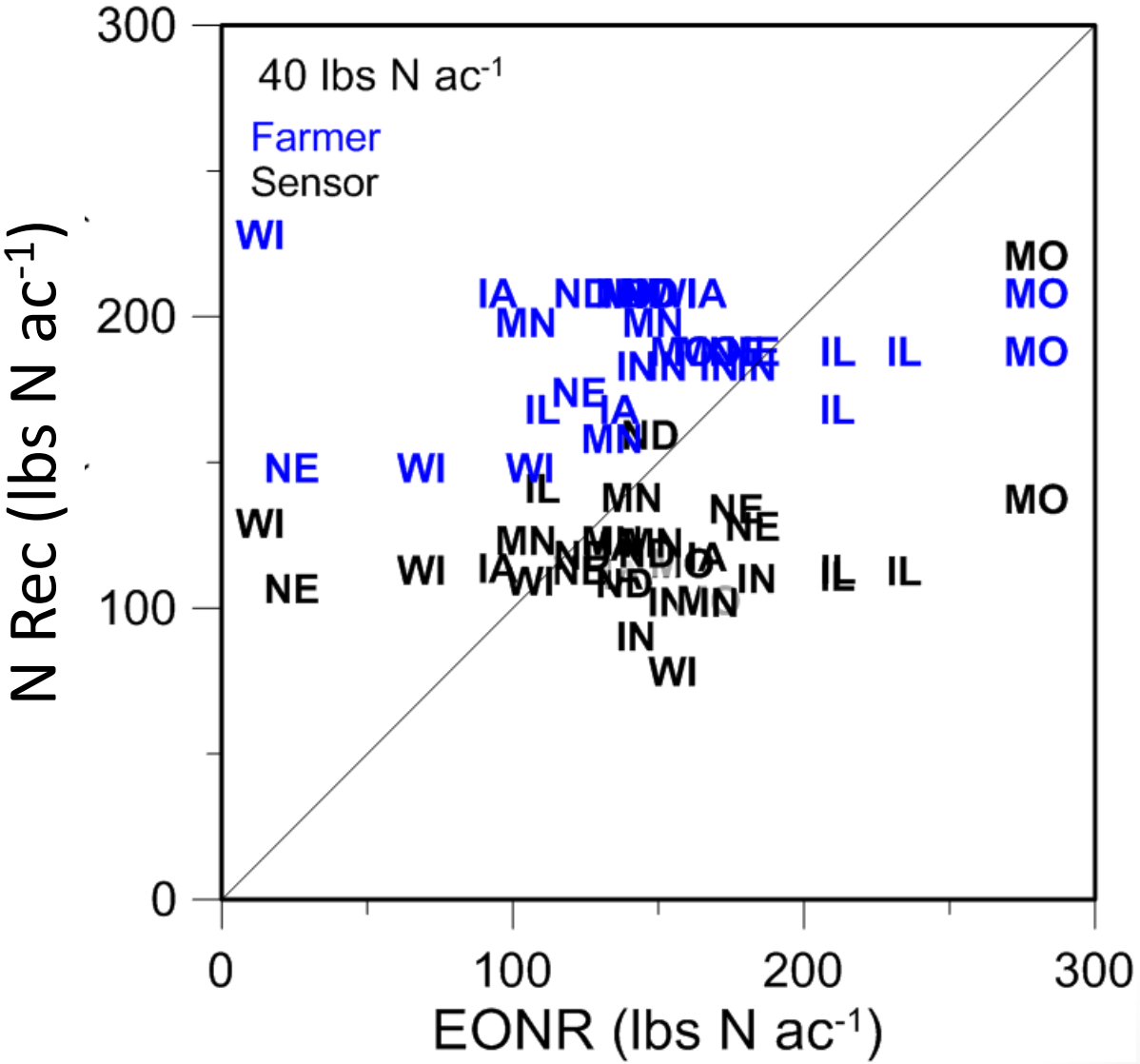


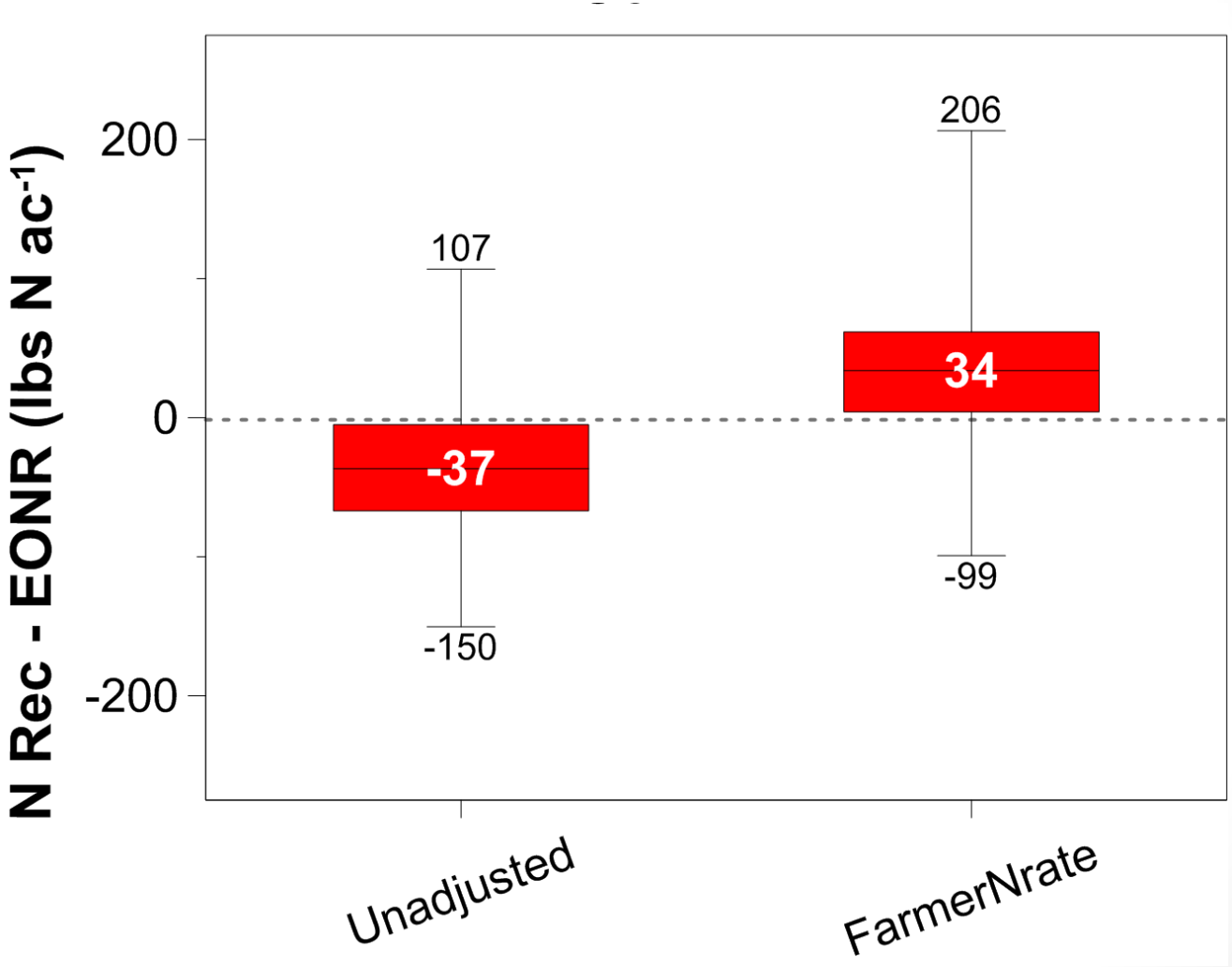
At Side-Dress N Tools Improved by Soil Information

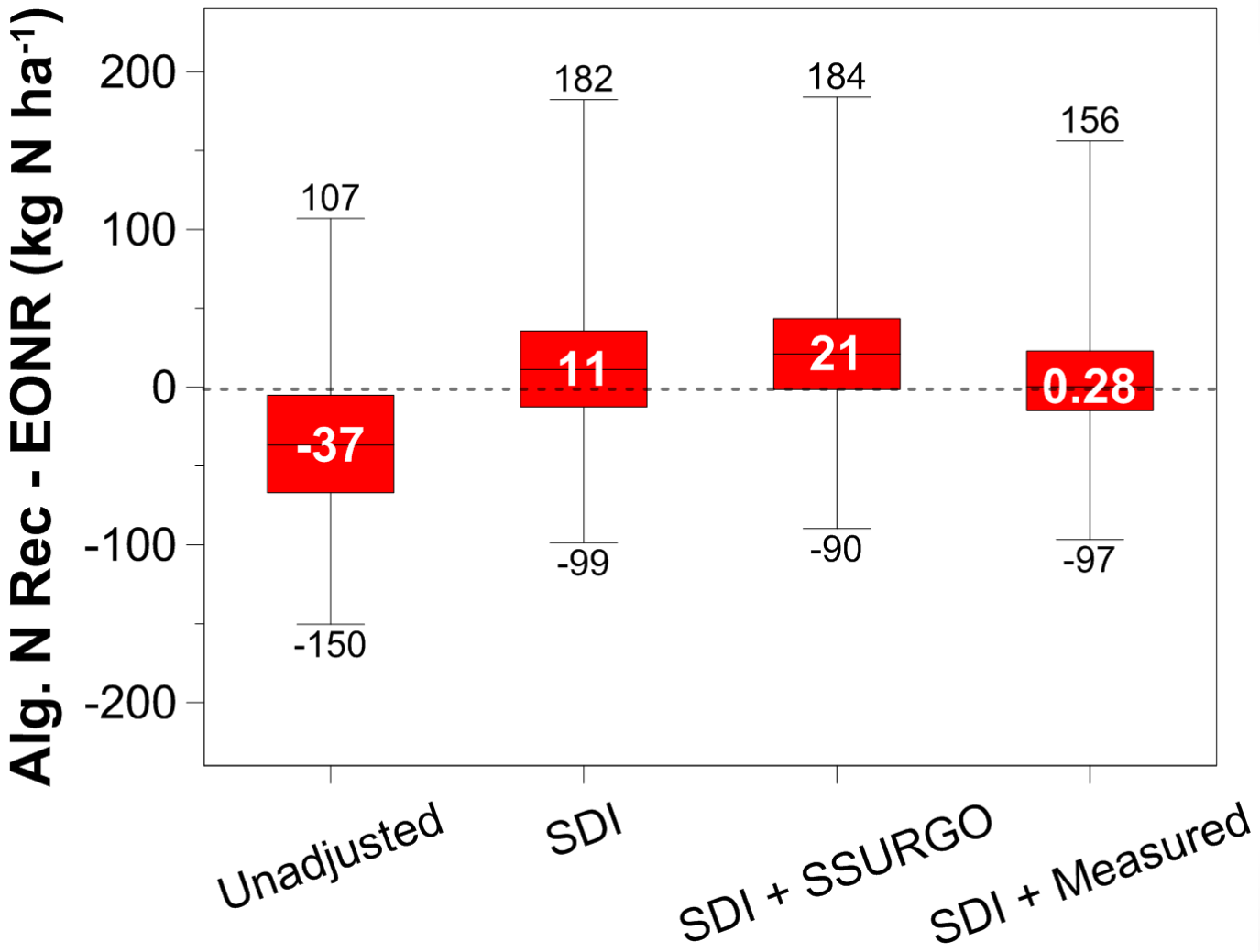


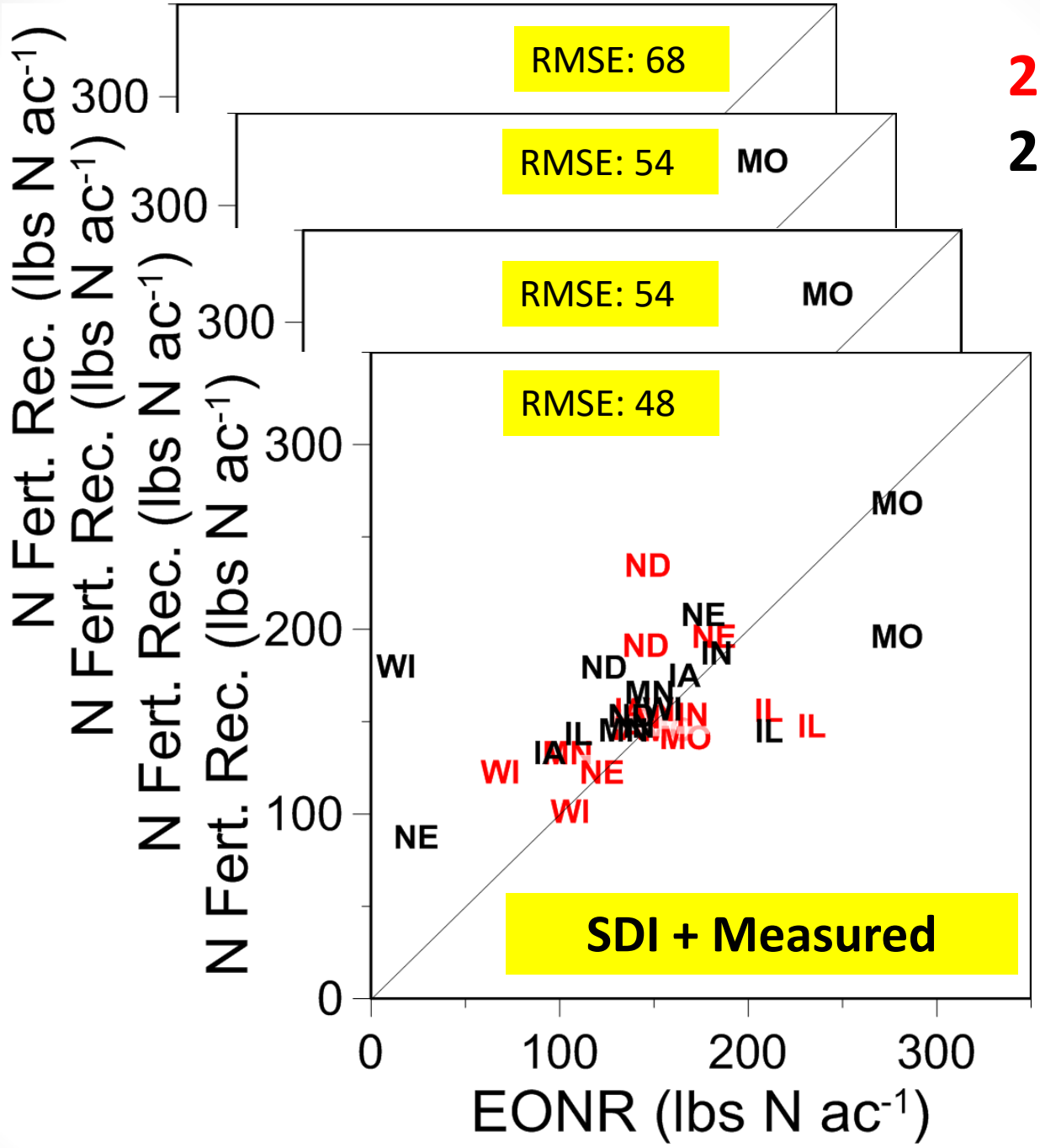

HAGIE

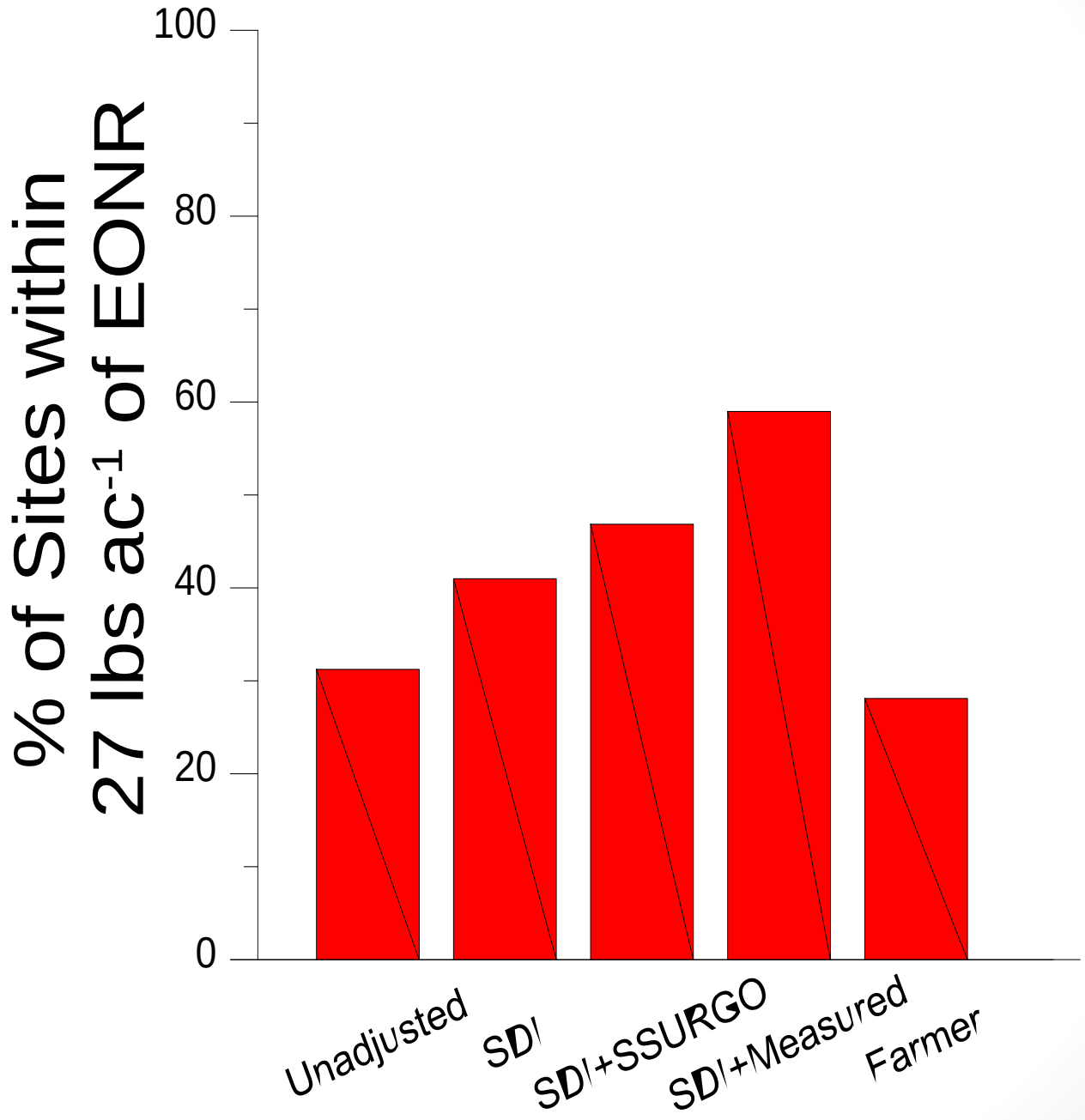
Sensor Algorithm Performance




N Rec - EONR (lbs N ac-1)
200
0
-200
107
-37
-150
206
34
-99
Unadjusted
FarmerNrate

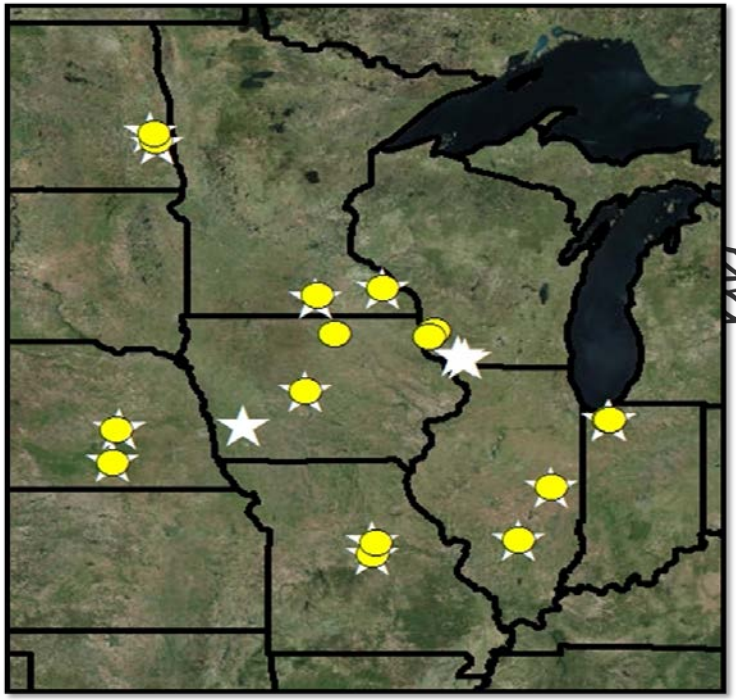

Alg. N Rec - EONR (kg N ha-1)
200
100
0
-100
-200
107
182
184
156
-37
11
21
0.28
-150
-99
-90
-97
Unadjusted
SDI
SDI + SSURGO
SDI + Measured


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


% of Sites within 27 lbs ac-1 of EONR
100
80
60
40
20
0
Unadjusted
SDI
SDI+SSURGO
SDI+Measured
Farmer

Tool's Strengths are at Different Scales

Model
Soil and Weather

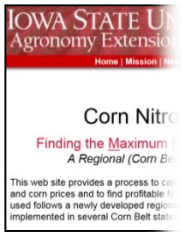


Canopy Sensor

Photo courtesy of Henrietta Christensen

Crop Growth Models

Empirical-Based Models

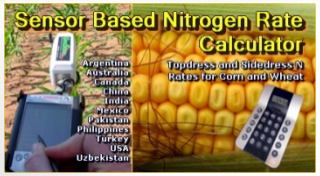


trogen Advisor

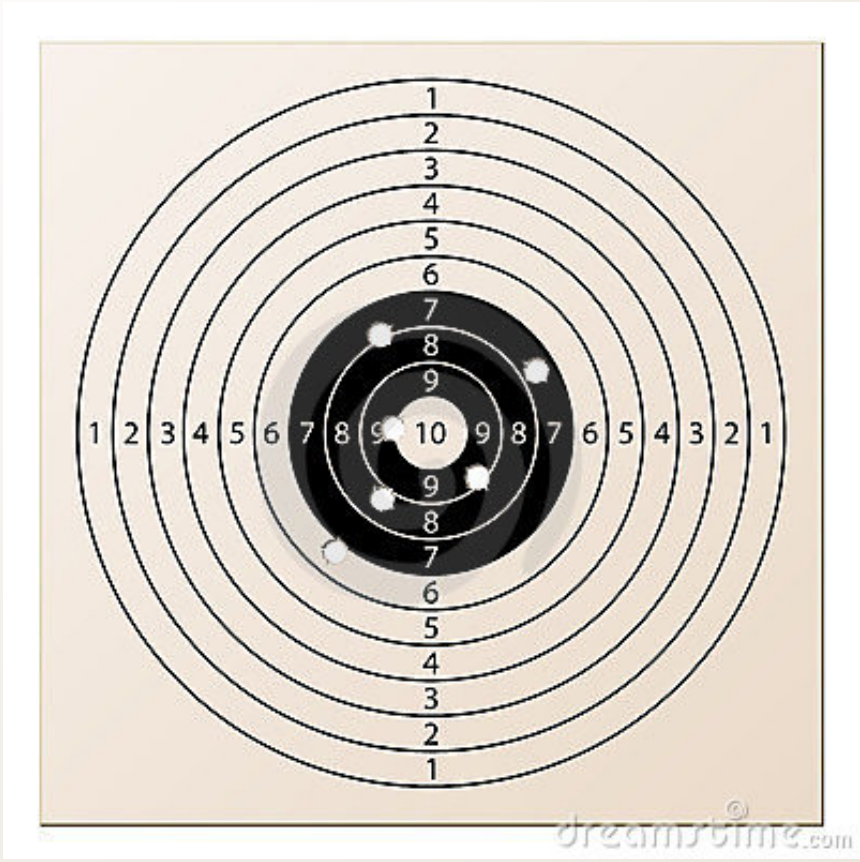
Proximal Ca

ant Soil Nitrate Test

ress Soil Nitrate Test



Traditional N Tools vs Precision Agriculture Tools



Acknowledgements / Questions