A Regional Approach to Nitrogen Fertilization Guidelines

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- Purdue University
  - Brad Joern and Sylvie Brouder
- The Ohio State University
  - Robert Mullen

Reasons for Exploring a Regional Approach

- Diverse N rate recommendation systems across states
- Lack of optimum N rate relationship with corn yield
- Concerns about N rates with corn yields at record levels
- Historically high N fertilizer prices

Database Driven Approach

- Described by Nafziger, Sawyer, and Hoeft (2004)
  - Accumulate corn N response data from many recent trials
  - Determine economic response and most profitable N rates directly from trials in N response database

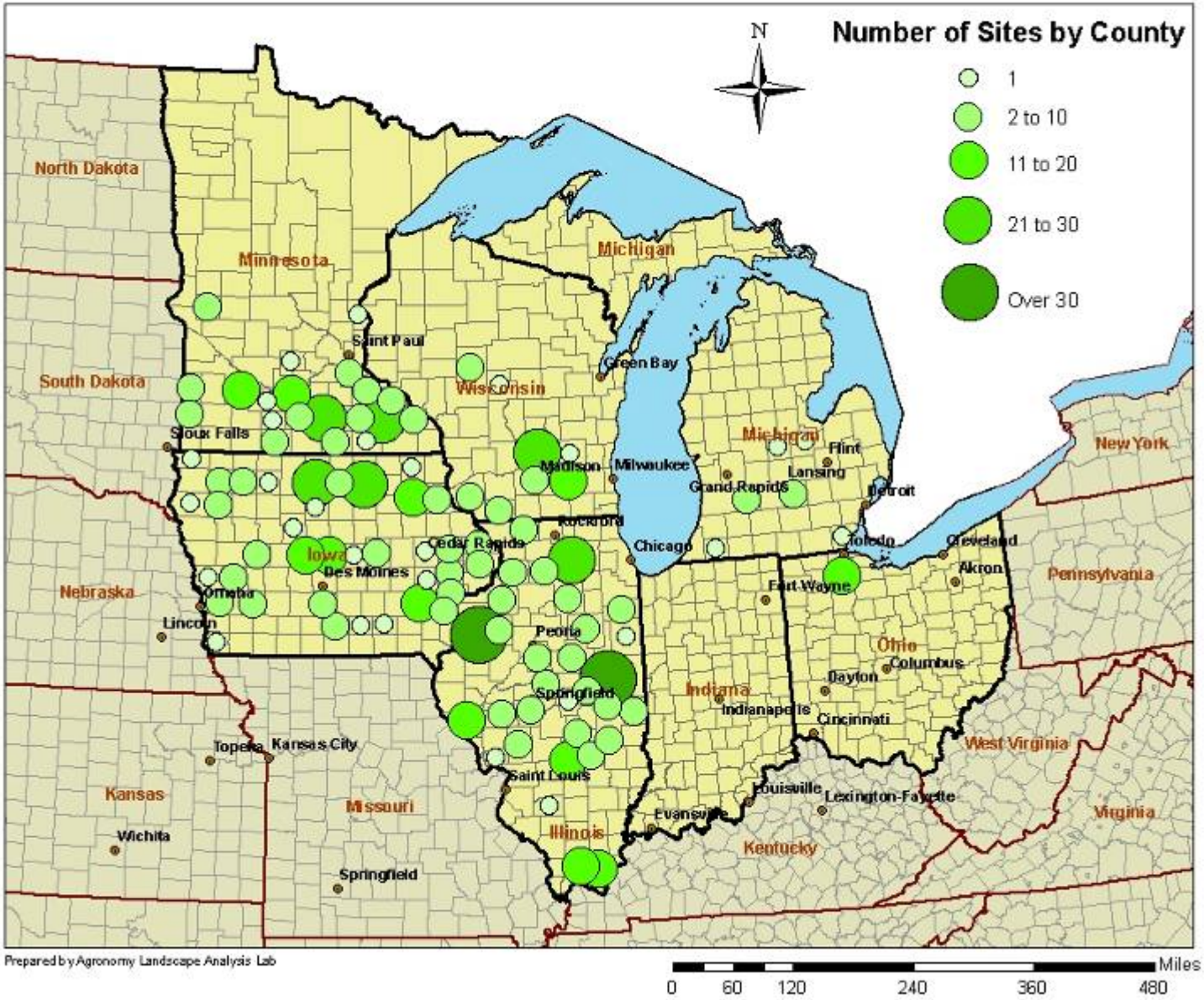
Maximum Return To N (MRTN)

Data → N Rate Guidelines

N Response Trials in Database

- 3 to 4 replications
- 5 to 7 N rates
- Non-irrigated
- Experiment station or producer field
- Corn following Soybean (SC) and Corn following Corn (CC)
- Grain yield measured for each N rate
- N Response curve fit to each trial

Regional N Rate Database



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Six-State Database Summary

- 698 trials
  - > 95% since 1990
  - > 60% since 2000
- 86% VH and 12% H yield potential
  - CC – 157 bu/acre; SC – 176 bu/acre
- 98% with tillage; 2% no-tillage
- 67% loess; 29% glacial till
- 53% experiment station; 47% producer fields

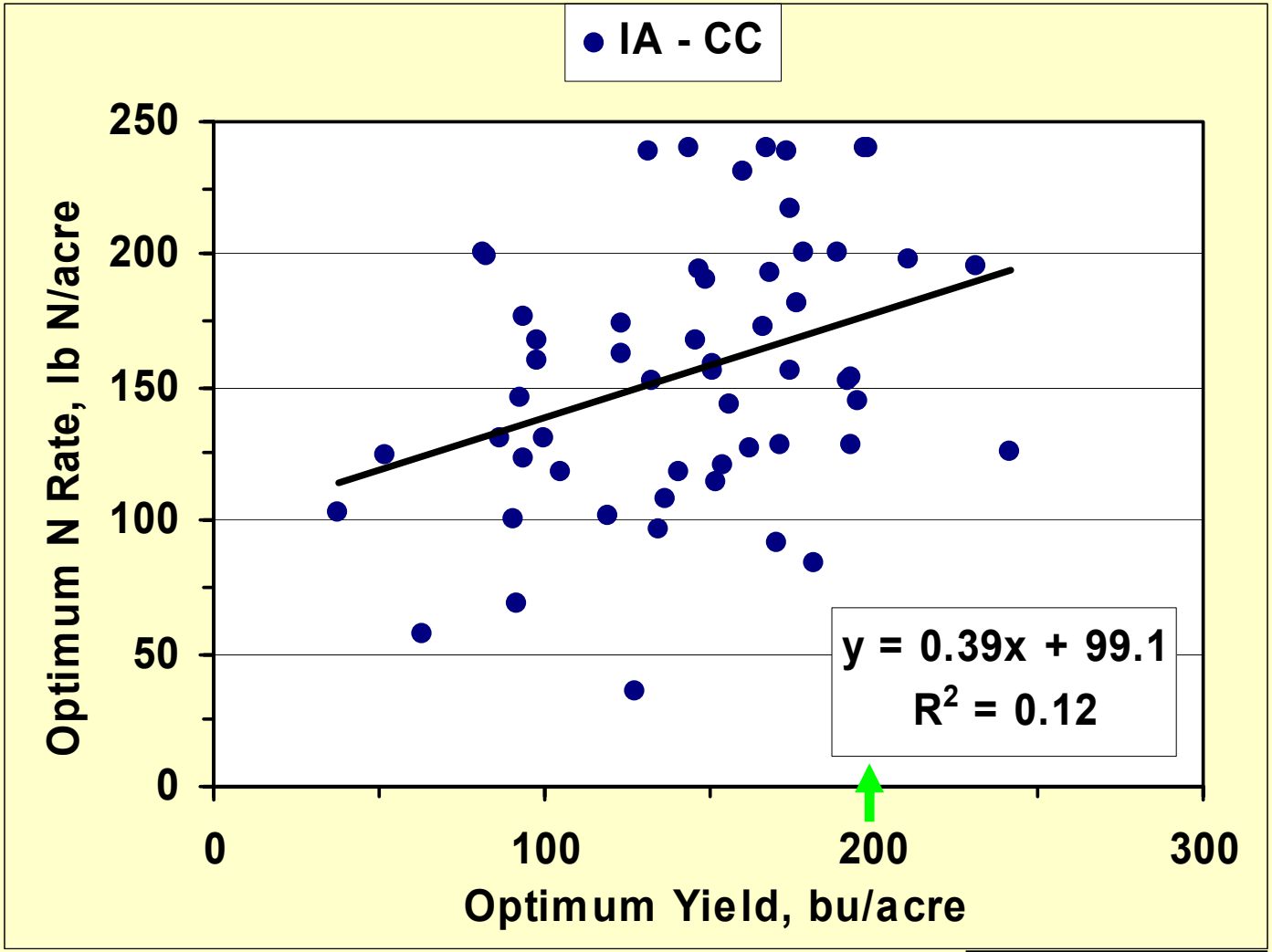
Six-State Database

	Corn–Corn		Soybean–Corn	
State	Total	Responsive	Total	Responsive
IL	93	82	185	172
IA	60	56	136	121
MI	1	1	9	9
MN	73	68	55	50
OH	5	4	8	7
WI	39	33	34	30
All	271*	244	427*	389

* 65 Non-responsive sites, 60% had manure history

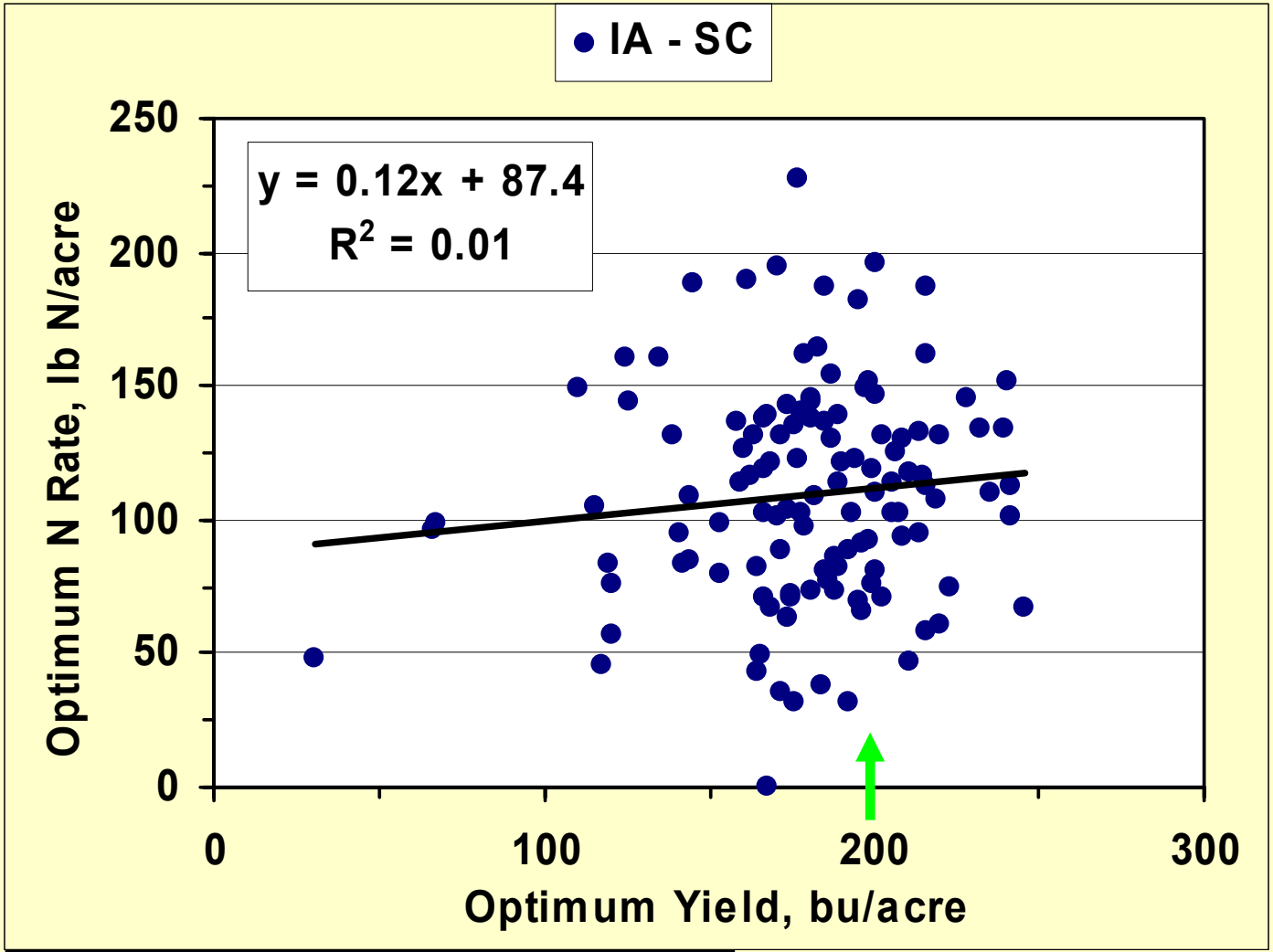
Total of 698 trials

Corn Yield and N Rates



0.10 Price Ratio
$0.22/lb N:$2.20/bu

Corn Yield and N Rates



Maximum Return To N at 123 lb N/acre
Average Yield at Optimum = 179 bu/acre
(179 x 1.2) – 50 = 165 lb N/acre

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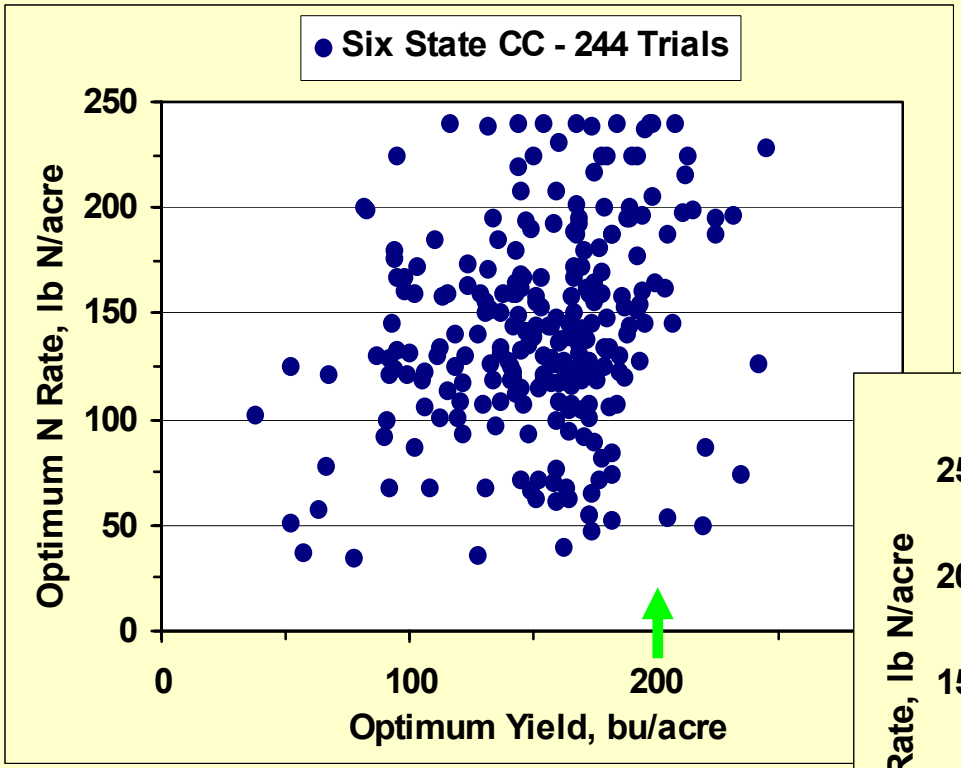
Corn Yield and N Rates



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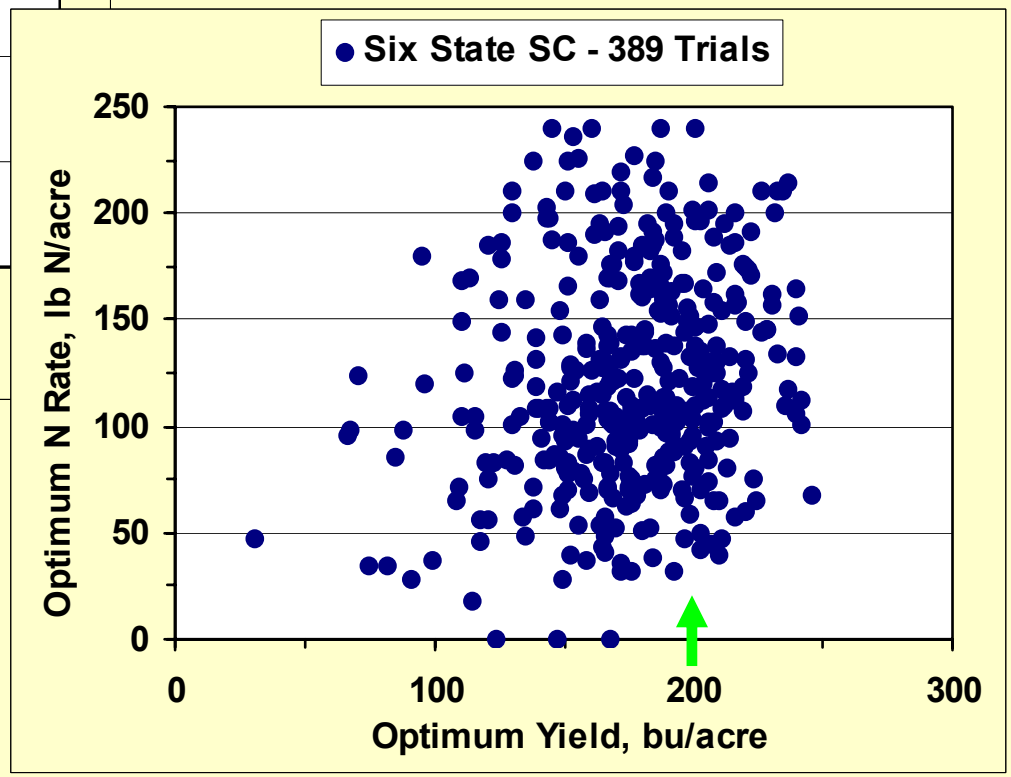

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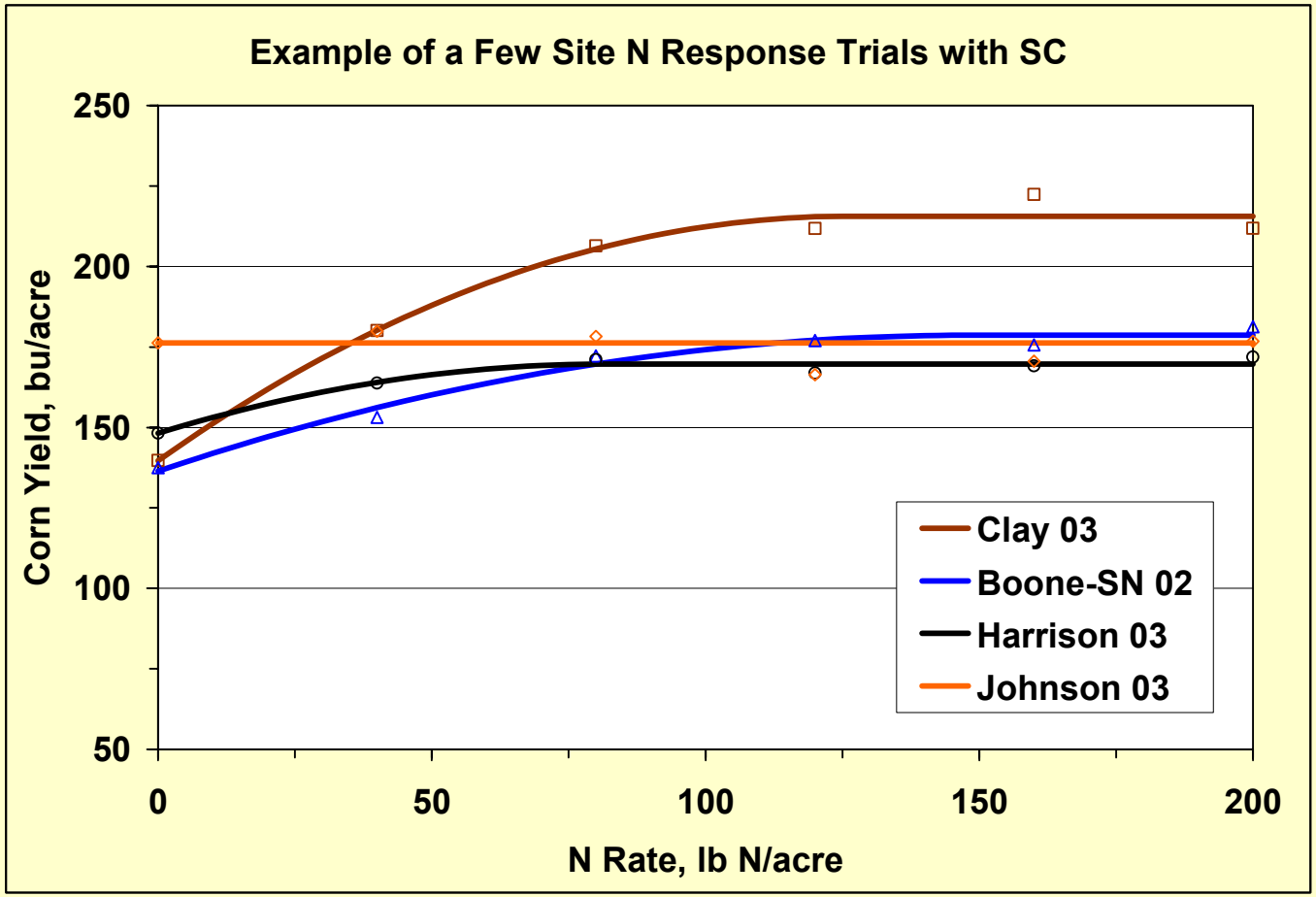
Corn Yield at the Zero-N Rate as a Percent of Yield at EONR (0.10 price ratio)

State	Previous Crop	
	Corn	Soybean
	- - - - - % - - - - -	
Illinois	54	64
Iowa	45	75
Minnesota	60	76
Wisconsin	71	77
Mean	56	70

Calculation of MRTN

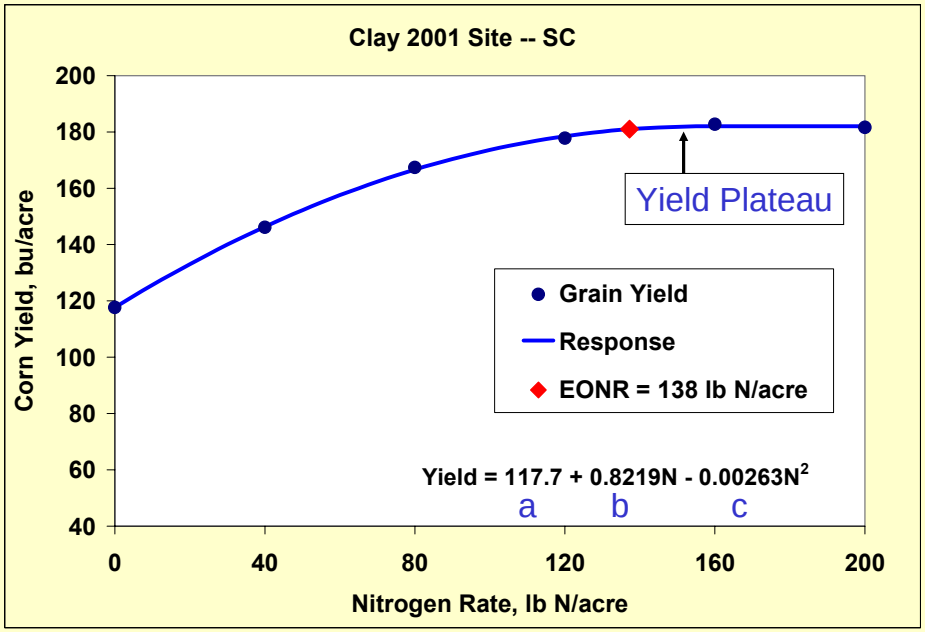
- 1st - Compile database from corn yield N response trials for desired rotation

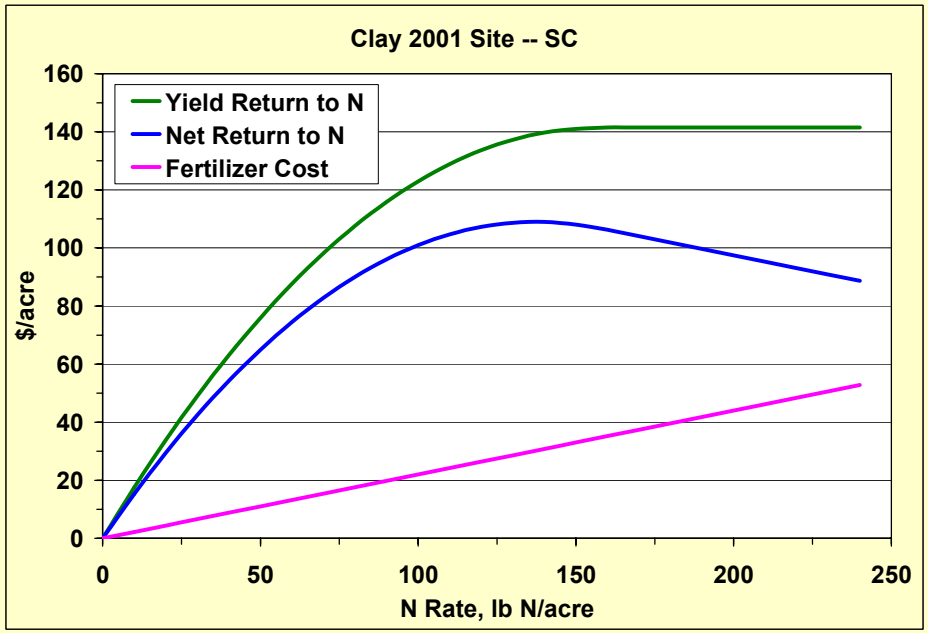


Calculation of MRTN

- 2nd – For each trial in database calculate Return To N (RTN) using the a, b, c and plateau values from each response curve
  - For every 1 lb N/acre from 0 through 240 lb N/acre calculate the yield increase over the yield obtained with zero lb N/acre
  - RTN = yield increase times price of corn minus the cost of N

Calculation of MRTN





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Calculation of MRTN

- 3rd - Find the N rate with the greatest average return to N, this is the MRTN and N rate at the MRTN

Site	Return to N at various N rates (lb/acre)						
	80	90	100	110	120	130	140
	$/acre						
1	113.96	115.43	115.10	113.16	110.96	108.76	106.56
2	63.80	70.18	76.56	82.94	89.32	87.98	85.78
3	79.20	81.31	82.37	82.37	81.31	79.29	77.09
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
92	94.60	98.98	102.43	104.96	106.57	107.25	107.01
Average	69.24	72.00	72.59	72.98	72.44	72.03	71.05

MRTN

Calculation of MRTN

- 4th - Find the N rates with returns to N within $1.00/acre of MRTN
  - This provides a range of most profitable N rates

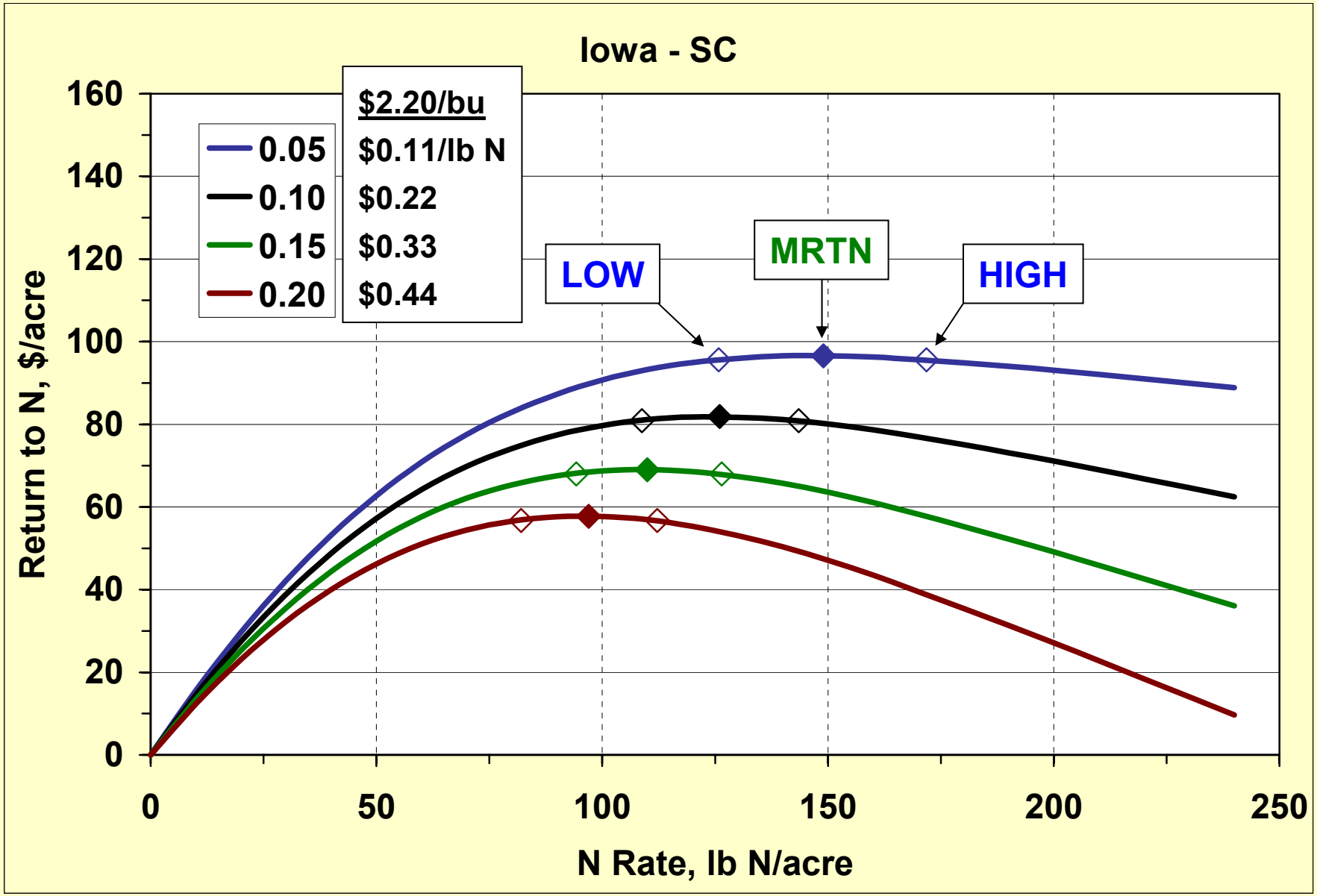
LOW HIGH

Site	Return to N at various N rates (lb/acre)						
	80	90	100	110	120	130	140
	$/acre						
1	113.96	115.43	115.10	113.16	110.96	108.76	106.56
2	63.80	70.18	76.56	82.94	89.32	87.98	85.78
3	79.20	81.31	82.37	82.37	81.31	79.29	77.09
⋮	⋮	⋮	⋮	MRTN ⋮	⋮	⋮	⋮
92	94.60	98.98	102.43	104.96	106.57	107.25	107.01
Average	69.24	72.00	72.59	72.98	72.44	72.03	71.05

Can Easily Examine Different Fertilizer N and Corn Prices

- Corn held at $2.20/bu
- Fertilizer N prices at $0.11, $0.22, $0.33, and $0.44/lb N
- Gives N price:corn price ratios of 0.05, 0.10, 0.15, and 0.20

MRTN and Most Profitable N Rate Range



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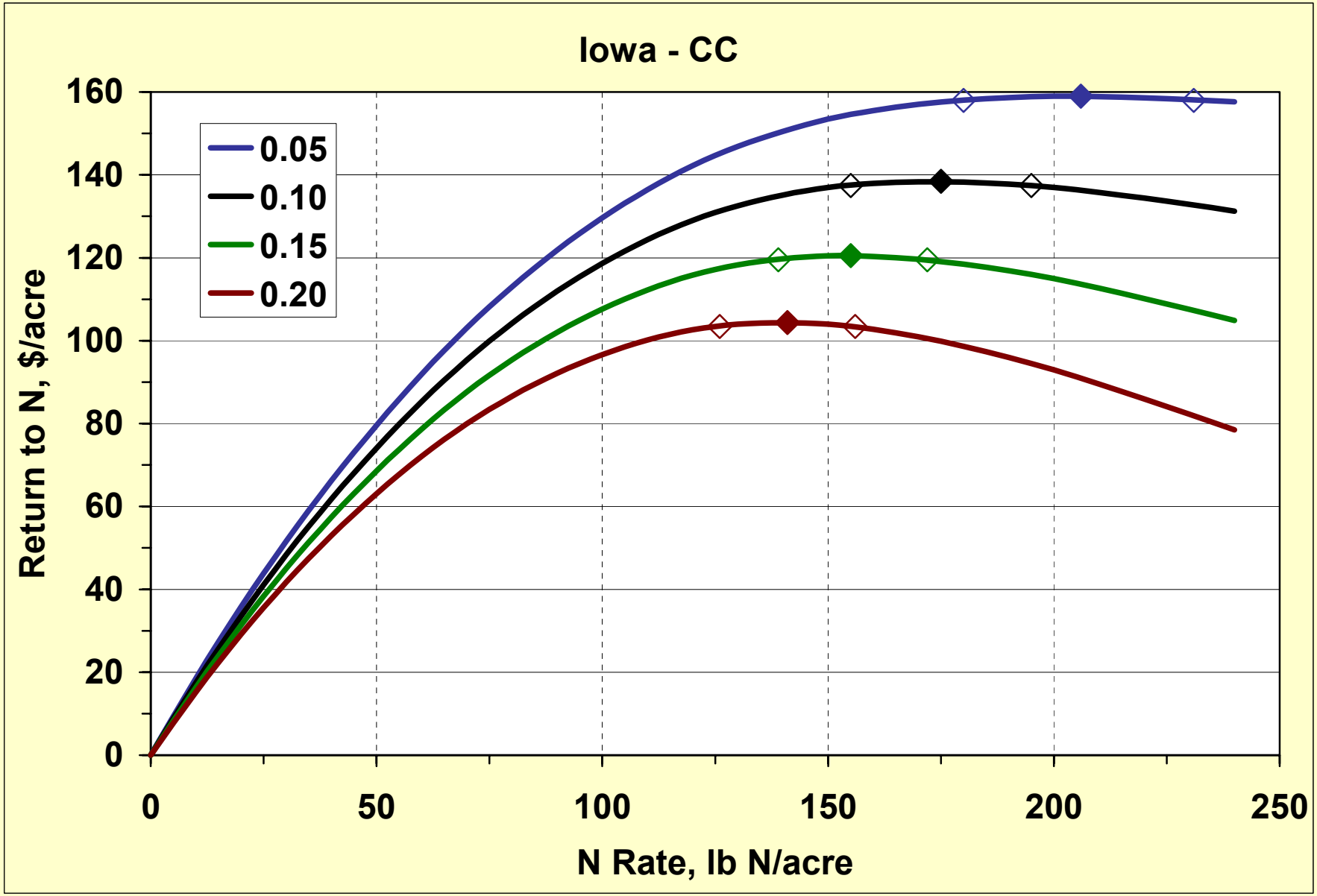
MRTN and Most Profitable N Rate Range



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Potential Iowa N Rate Guidelines Based On MRTN Approach

Price Ratio	Previous Crop					
	Soybean			Corn		
	LOW†	MRTN	HIGH†	LOW†	MRTN	HIGH†
$/lb:$/bu	- - - - - - - - - - - - - - lb N/acre - - - - - - - - - - - - - -					
0.05	125	145	170	180	200	230
0.10	105	125	145	155	175	195
0.15	90	110	125	140	155	170
0.20	80	95	110	125	140	155

† LOW and HIGH approximates the most profitable N rate range providing net return within $1.00/acre of the MRTN for each price ratio.

Economic Analysis of Current Data Similar to N Rate Suggestions Since 1979 in Iowa

Preplant N Applications

Crop Category	N Rate
	lb N/acre
Recently manured soils	0 to 90
After established alfalfa	0 to 30
2nd- year after alfalfa	0 to 60
Corn after corn	**150 to 200**
Corn after soybean	**100 to 150**

Pm-1714 Nitrogen Fertilizer Recommendations for Corn in Iowa, 1997
Pm-905 Crop Rotations, Effect on Yields and Response to Nitrogen, 1979

Fertilizer N Rate that Provides the Maximum Return To N (MRTN)

State	Previous Crop	
	Soybean	Corn
	- - - - lb N/acre - - - -	
Illinois	163	176
Iowa	123	174
Minnesota	101	136
Wisconsin	107	139

0.10 $/lb N:$/bu price ratio.

Example Database Subgroup Analyses

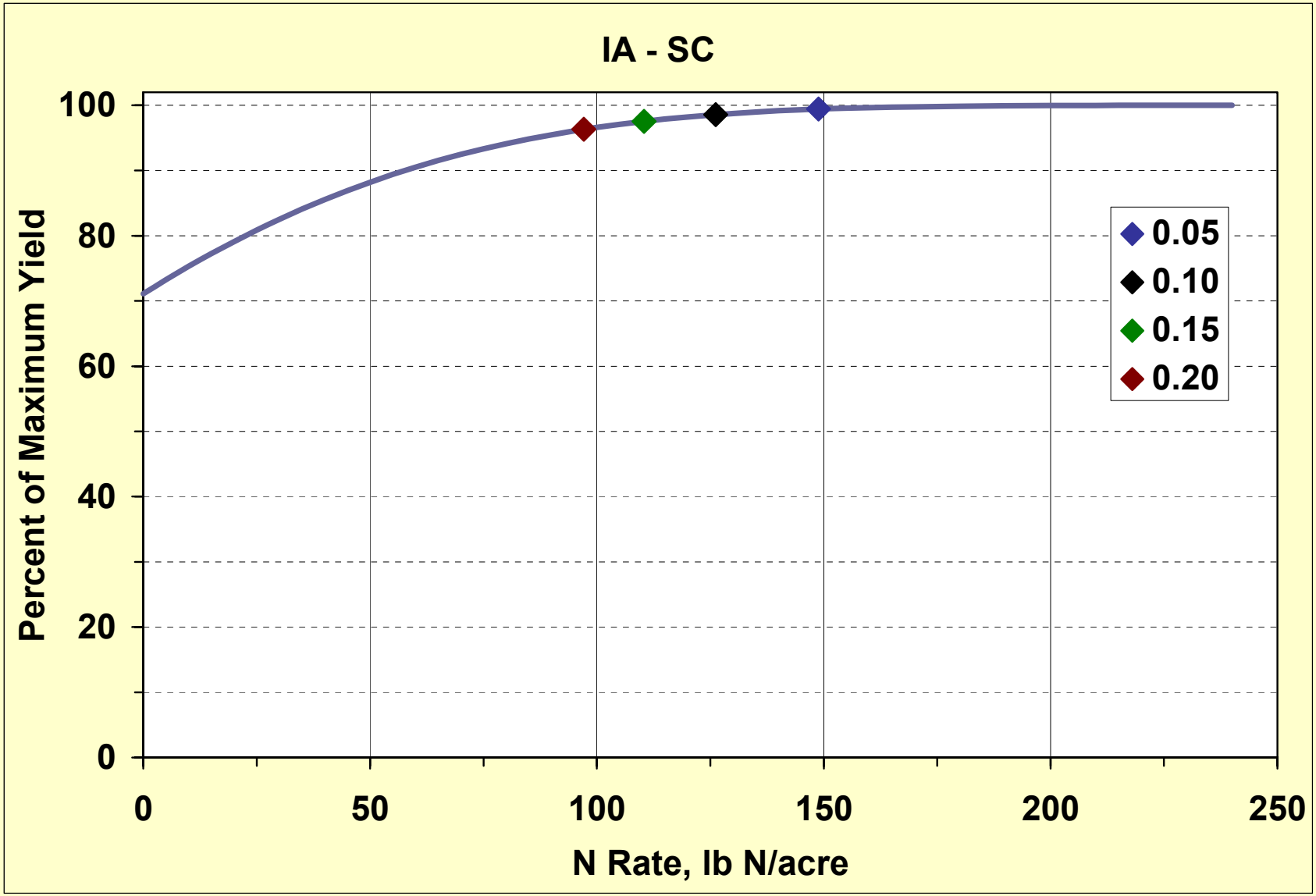
- Iowa Yield Ranges (SC)

	MRTN rate
0-150 bu/acre	128 lb N/acre
150-200 bu/acre	126 lb N/acre
200+ bu/acre	127 lb N/acre

- Illinois North – South (SC)

North	163 lb N/acre
South	179 lb N/acre

MRTN and Yield Risk



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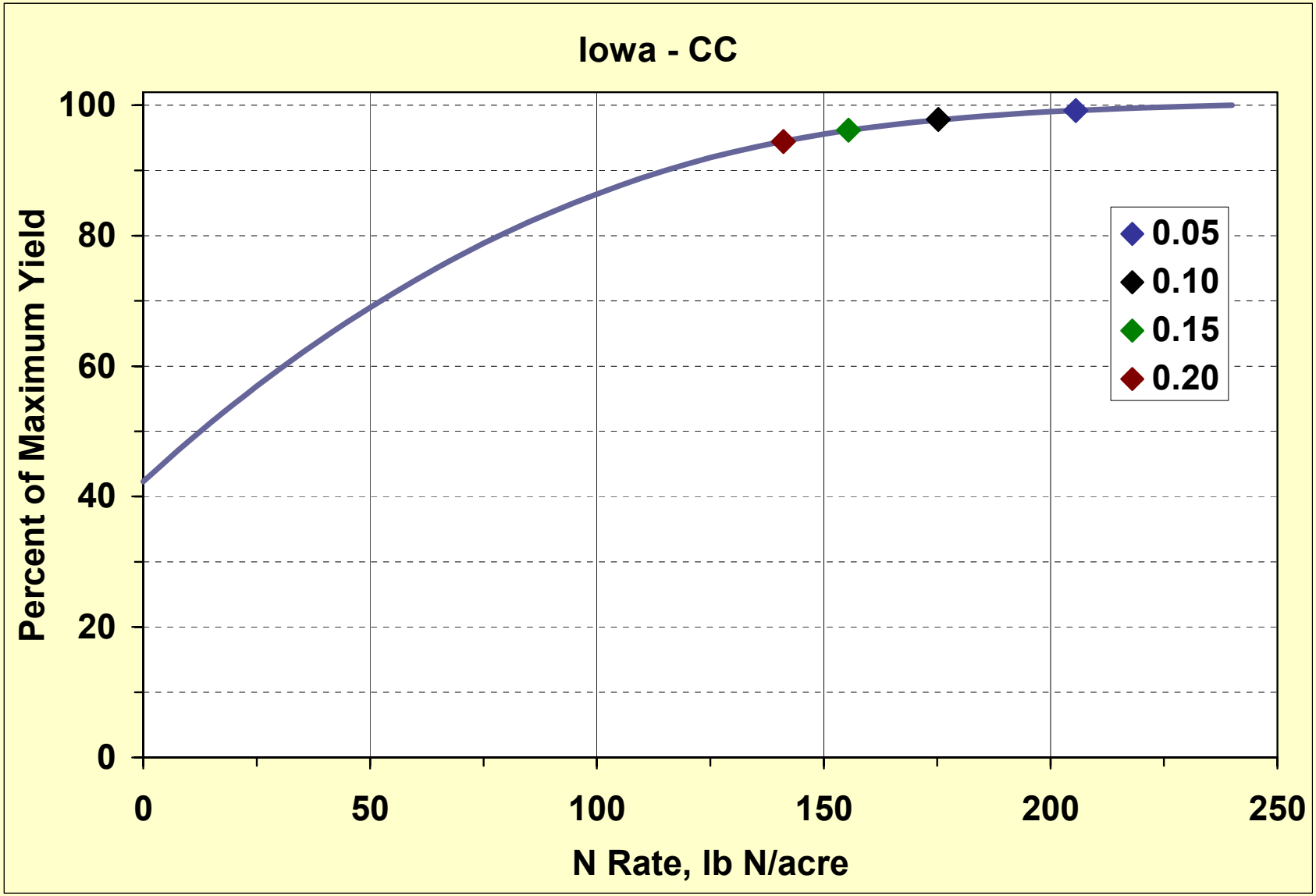
MRTN and Yield Risk



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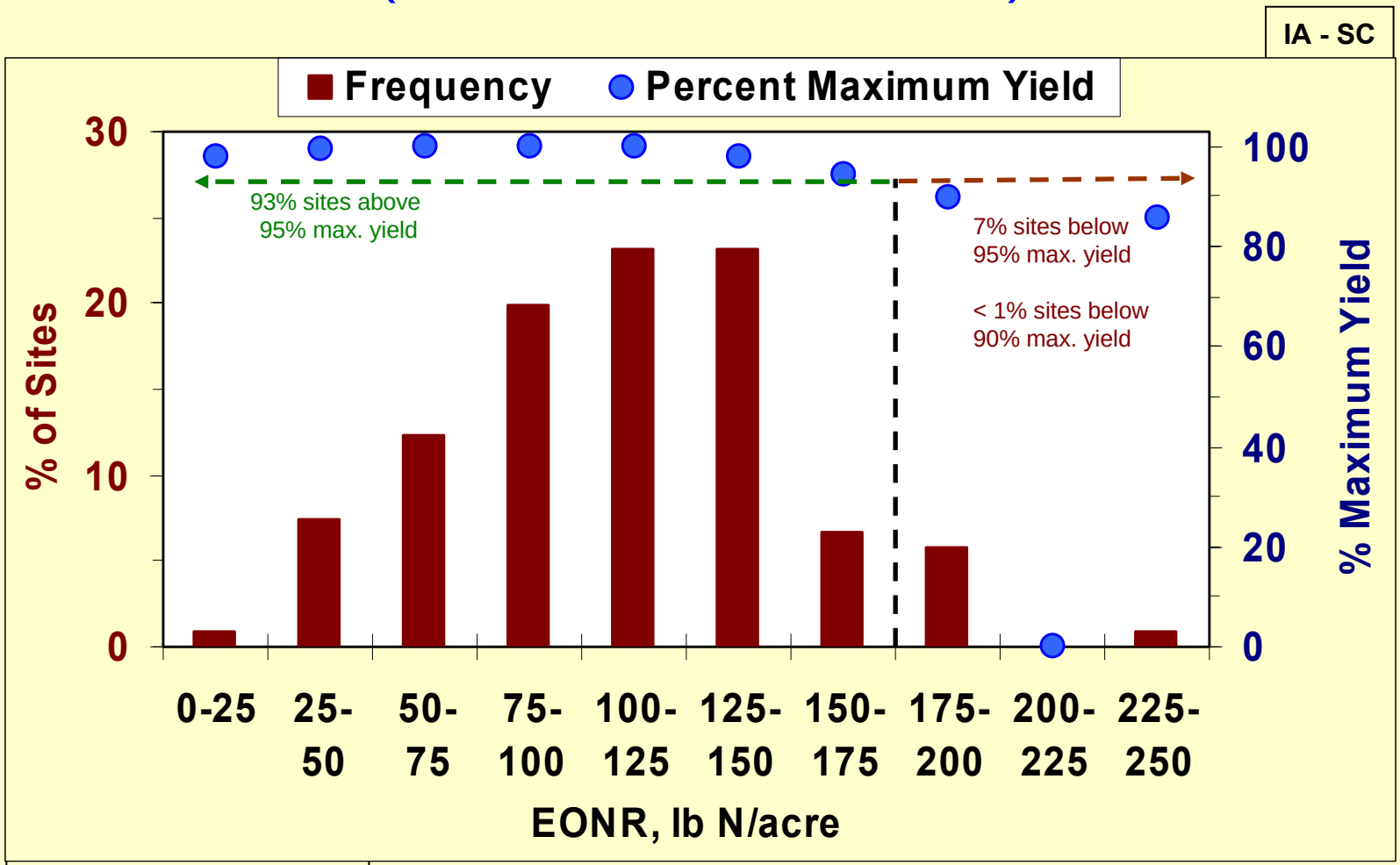
Risk From Applying MRTN Rate

(123 lb N/acre for IA - SC)



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MRTN and N Risk Management

- Although you may want to be 100% certain of N sufficiency, being that certain is not most profitable
  - The risk with lower N rates is decreased profitability due to lost yield
  - The risk with higher N rates is decreased profitability and environmental concerns due to unneeded N
  - Most profitable N rate range helps “protect” these risks

Summary

- MRTN – A regional, common approach to N rate guidelines developed for seven Corn Belt states
- Based directly on research results of nearly 700 trials
- Most profitable N rate guidelines developed directly for CC and SC
- N rates vary among states and possibly sub-state regions
- Not yield-based

Advantages of MRTN Approach

- Can use a variety of N response trials
- Easy to add new trial data
- Specific responses of each site considered
- Not excessively influenced by non-responsive sites
- Can analyze dataset sub-groups
- Straightforward calculations and uses economic outcome
- Can include risk assessment

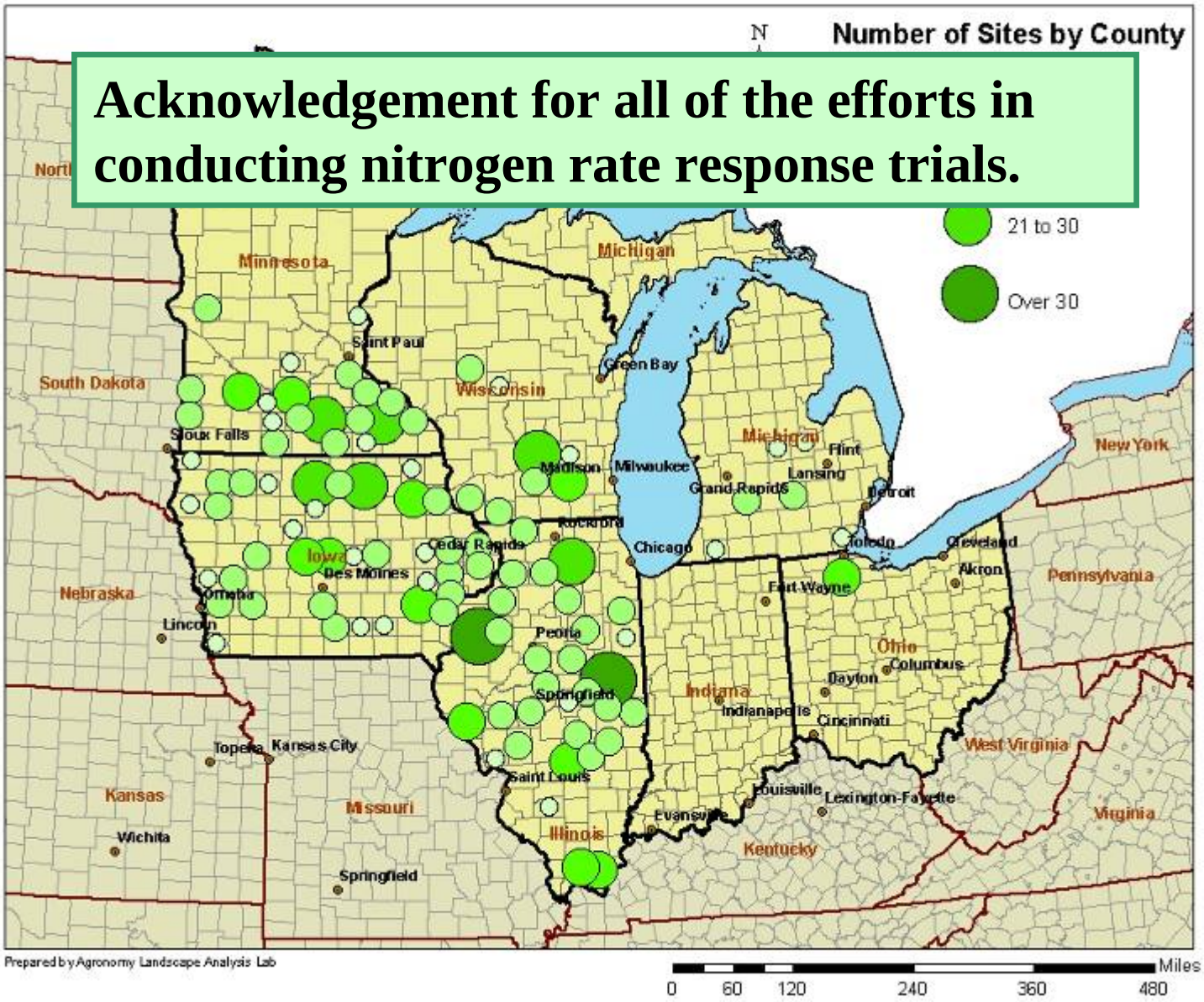
Adjusting N Rate Decisions

- Rotation
- Fertilizer:Corn price ratio
- MRTN and most profitable range
  - **LOW ↔ MRTN ↔ HIGH**
- Producer experience and attitude toward risk, capital allocation, water quality
- Local information, ex. N tests

Future

- N rate research will be needed to:
  - Accompany educational delivery
  - Fill in gaps where data are limited
    - Geographic, soil productivity, rotation
  - Monitor the role of soil N and N use efficiency
  - Assess the effect of improved genetics and higher corn yield potential
- Regional publication
- Web based MRTN calculation tool
  - http://extension.agron.iastate.edu/soilfertility/nrate.aspx

Regional N Rate Database



Acknowledgement for all of the efforts in conducting nitrogen rate response trials.