Maximizing Returns through MRTN

A Farmer's Guide

farmdoc

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Crop Sciences

College of ACES

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IL Corn Growers Association

Before we talk about nitrogen rate:

- High P and K fertilizer prices and possible supply issues bring questions about applying P/K this fall or waiting until??

- Price and supply are also bringing pressure to apply anhydrous ammonia before soil temperatures drop to below 50 this fall

- See October 6, 2021 Crop Central article (on farmdoc) for more on these issues


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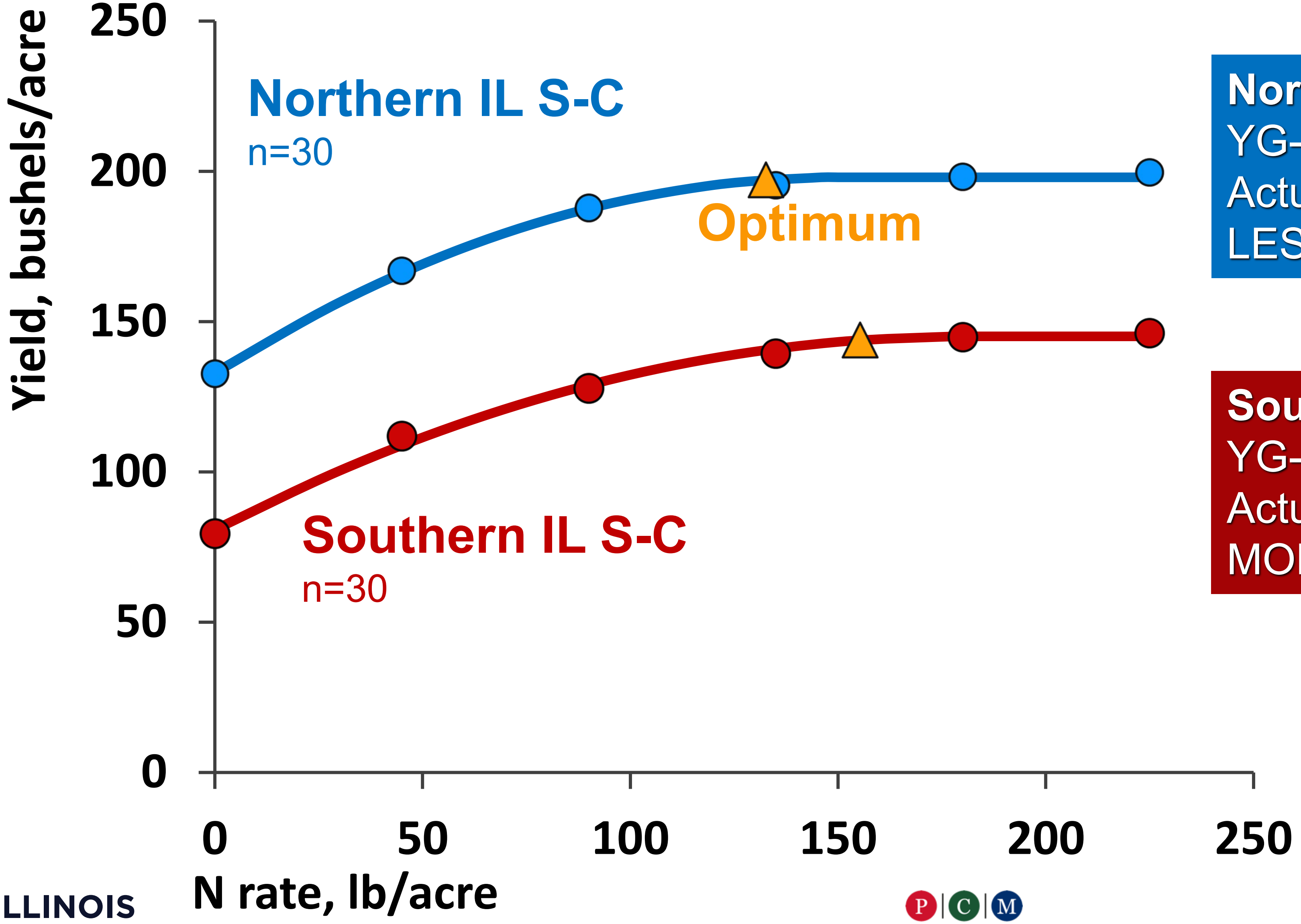
The Bulletin

Fertilizer Decisions, Fall 2021

Emerson Nafziger
Department of Crop Sciences
University of Illinois
October 6, 2021

Why not just use expected yield (yield goal) to set N rate?

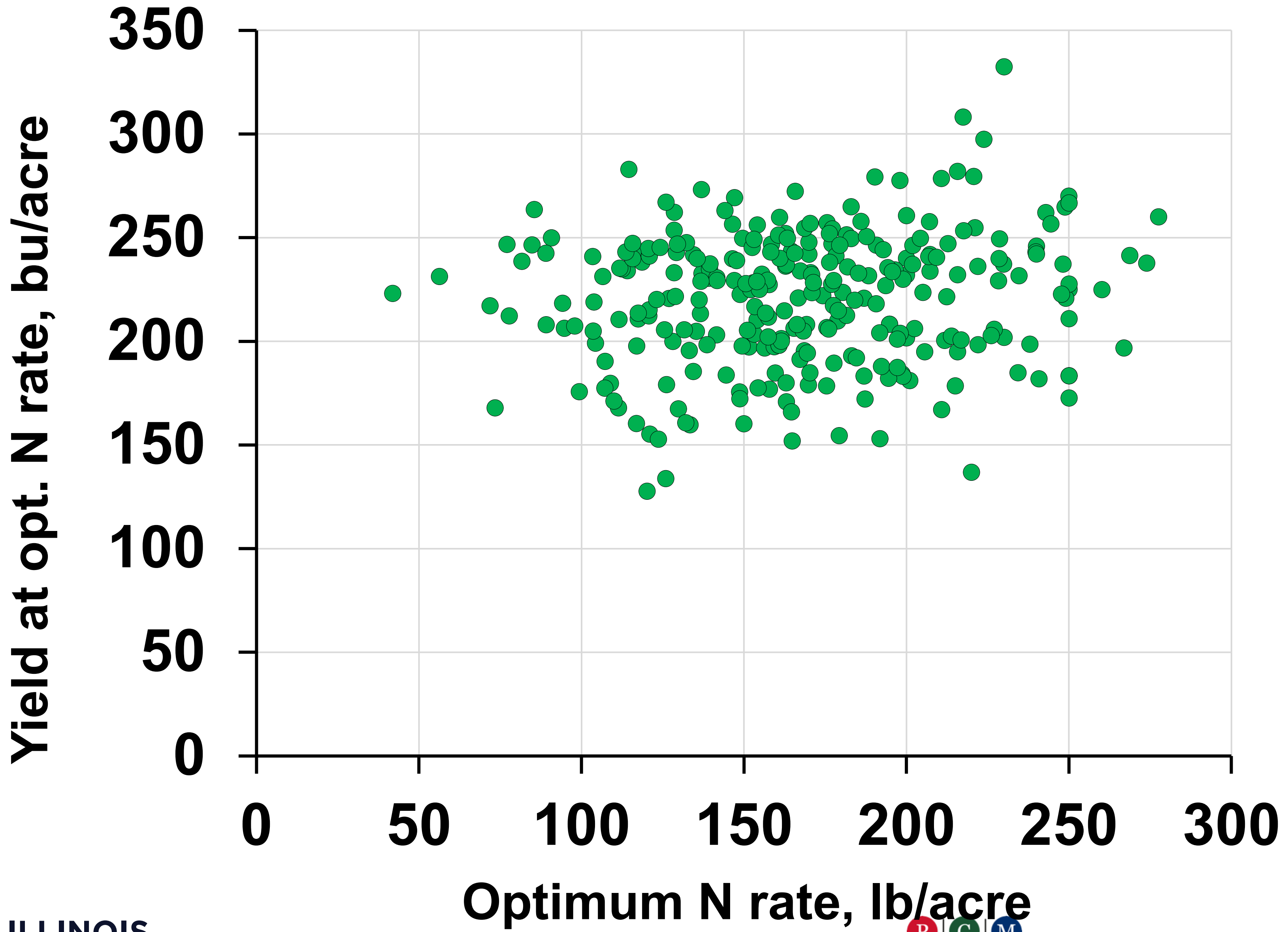
In 1990s it became obvious that yield-goal-based system in place since 1970s was no longer adequate:



Northern IL: Yield = 197 bu/ac
YG-based N recc: 196 lb N
Actual N requirement: 133 lb N (63 lb LESS than recc)

Southern IL: Yield = 144 bu/ac
YG-based N recc: 133 lb N
Actual N requirement: 155 lb N (22 lb MORE than recc)

Yield goal?



Yield and the N rate it took to get to yield were **not correlated** across a lot of trials

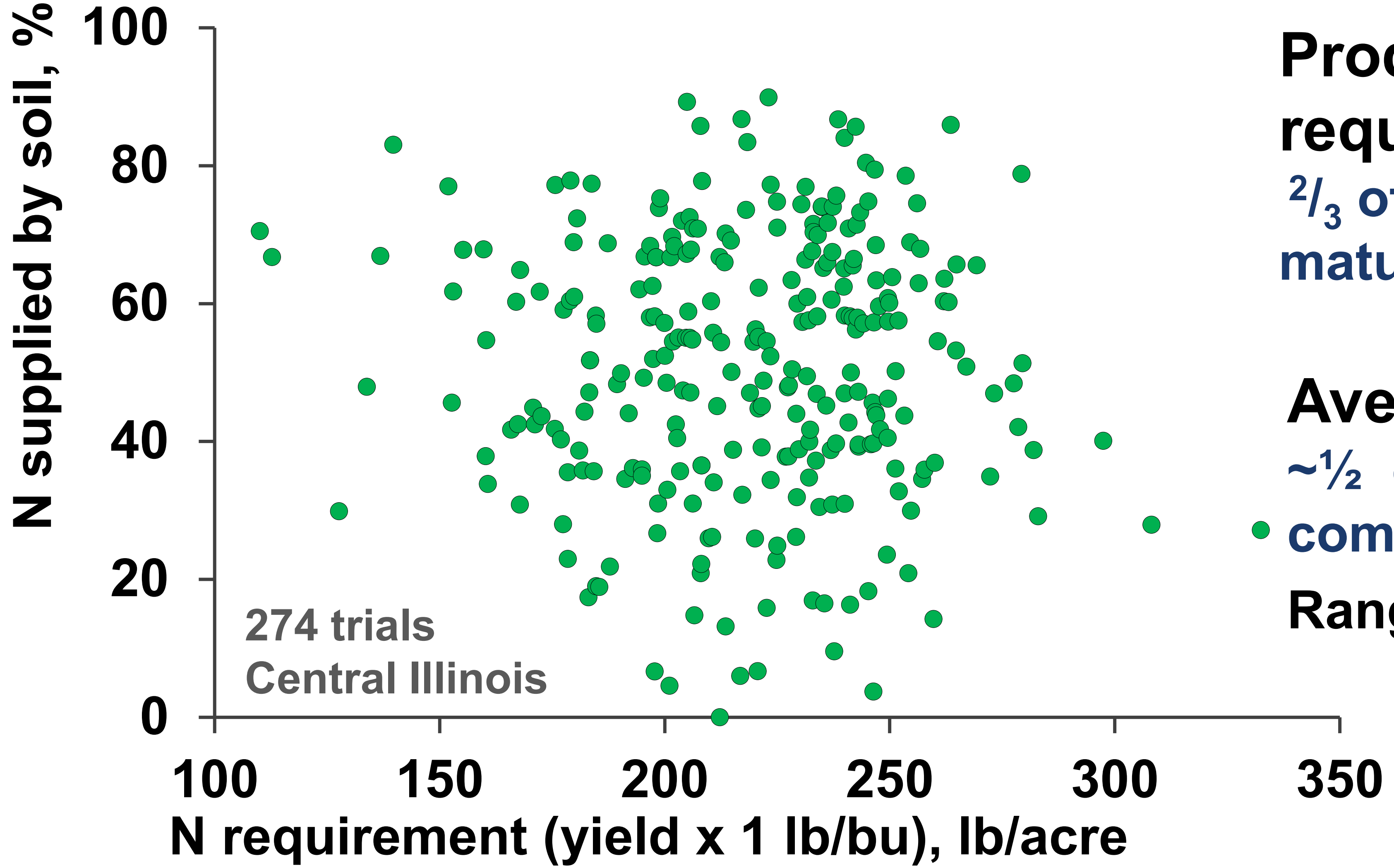
How's that possible?

Think soil N

The result:

We **can't** predict the best N rate even if we **KNOW** what the yield will be

Why is (fertilizer) N rate so "difficult"?
Tough to predict yield/N need AND soil N supply



Producing 1 bu of grain requires ~1 lb of N

$^{2}/_{3}$ of the N is in the grain at maturity

Averaged across trials:

~½ crop's N requirement comes from the soil

Ranges from <5% to >90%

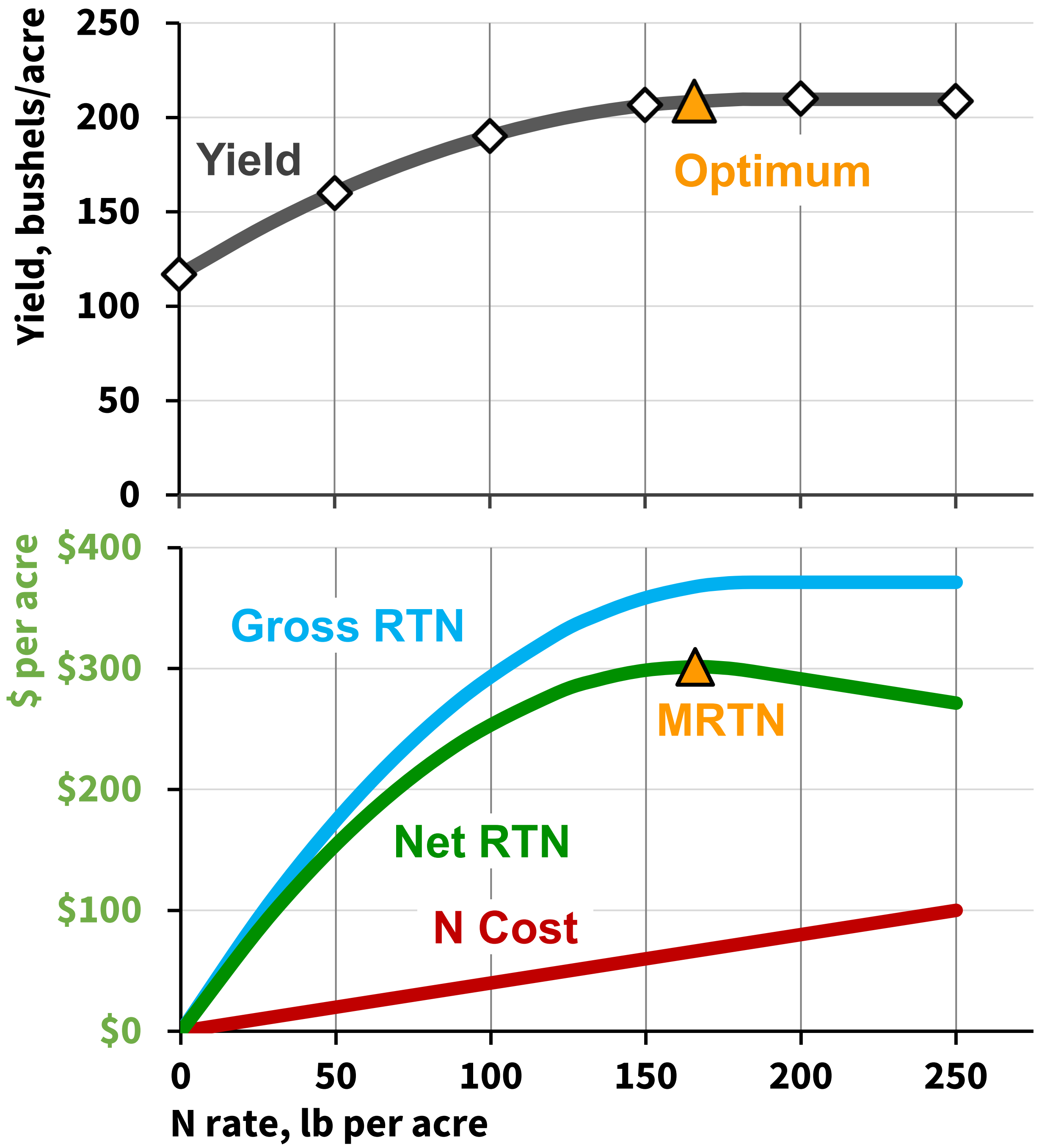
Maximum Return To Nitrogen (MRTN)

The N rate that **maximizes return to N**
at a certain **ratio of N:Corn prices**

AND

across a set of **N response trials**

In Illinois, our sets of response trials are
northern, central, and southern Illinois



The MRTN

The **"economic optimum" N rate (EONR)** is the rate that adds just enough yield to pay for the last lb of N applied

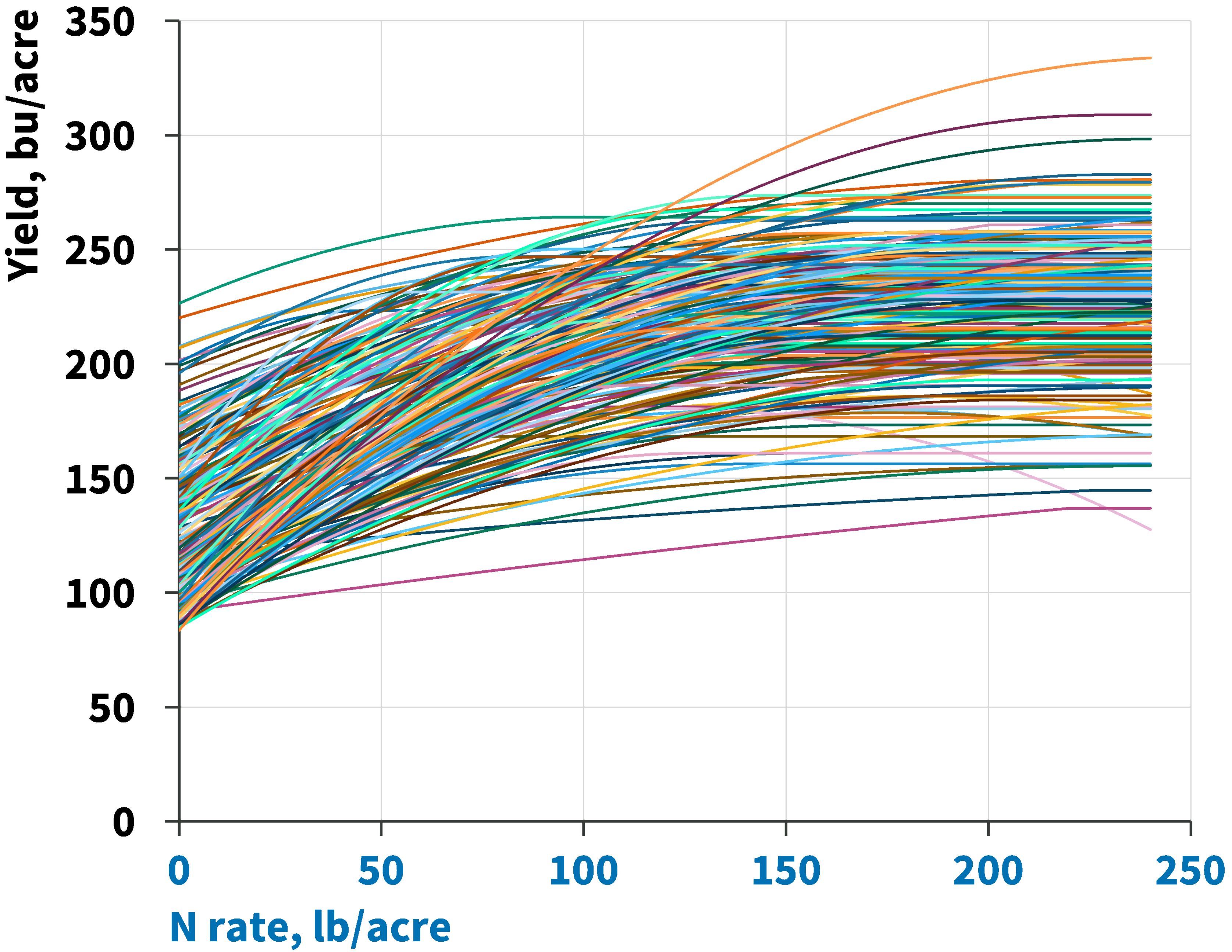
N: $0.50/pound

Corn: $5.00/bushel

The last bushel of corn produced by the EONR pays for 10 lb of N

Basis for the MRTN

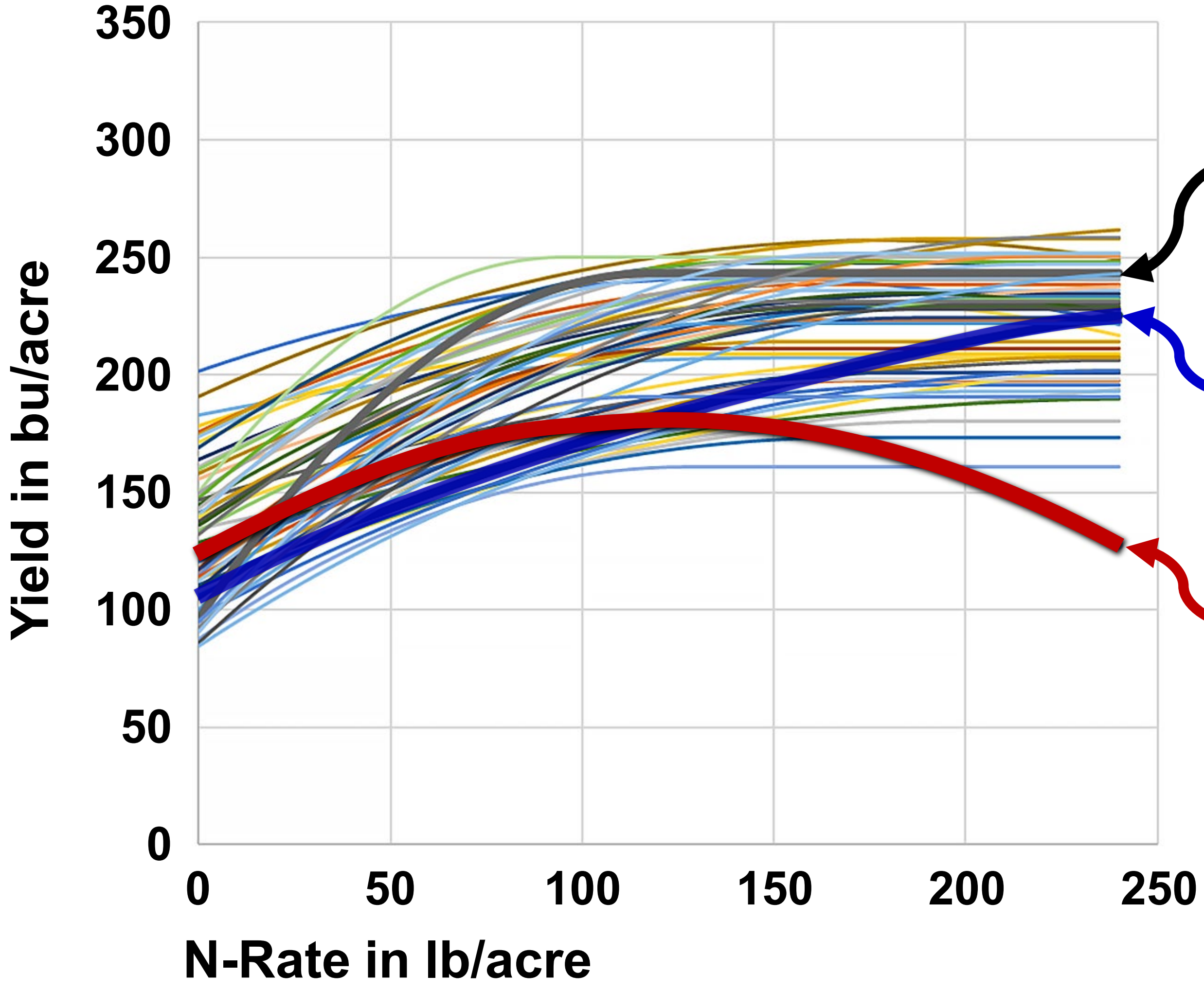
200 N responses
Soy-Corn
Central IL



Thanks to NREC and IFCA, we have by far the best N trial database of any state

N response curves

N responses subset, S-C Central Illinois



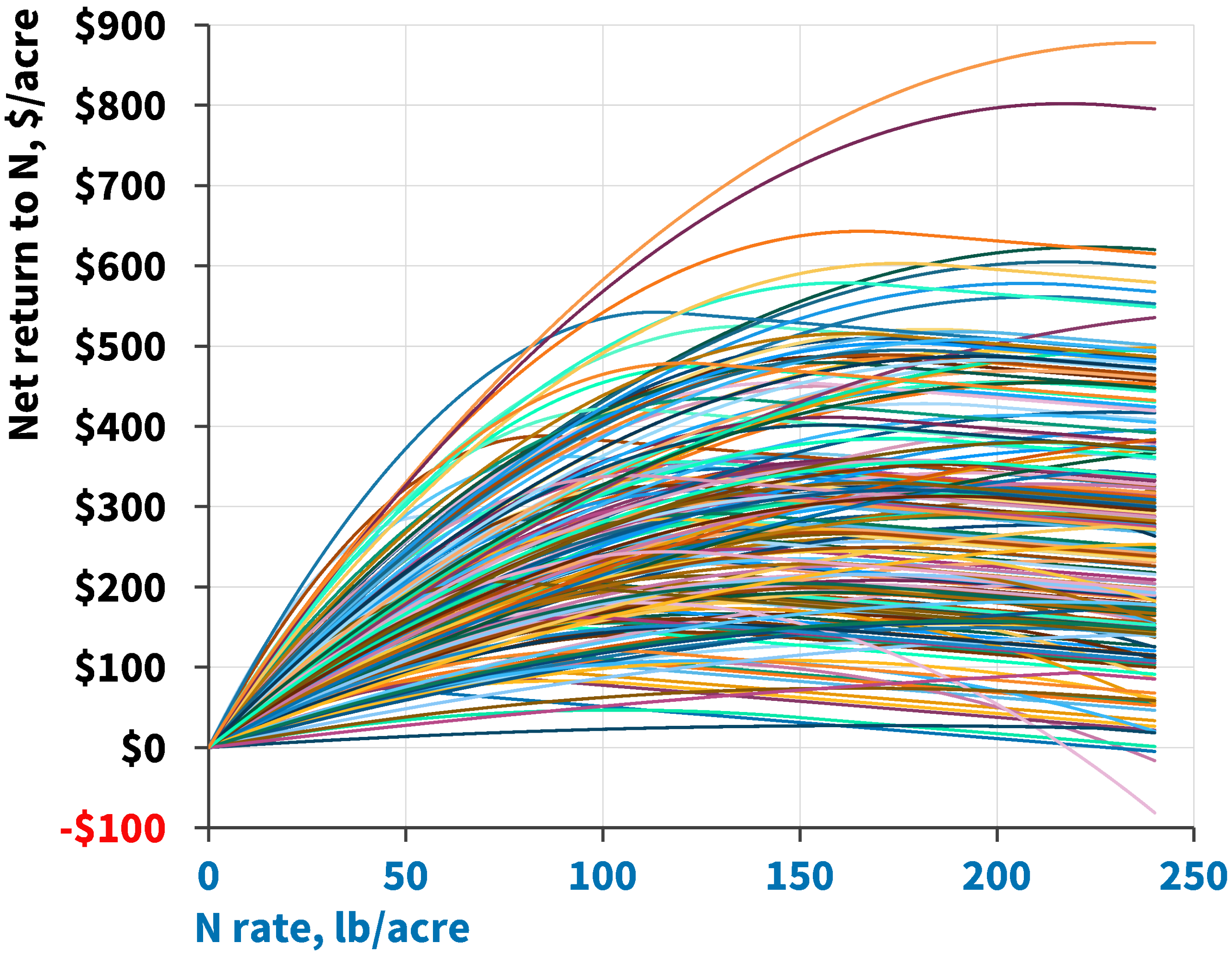
Most curves rise to a maximum (as "plateau") then level off as N rates go higher

A few keep going up (usually with some curve) and don't level off

A few rise to a maximum then decline as N rates continue to increase (rare - current hybrids don't "fall apart" at high N)

Return to N

Net RTN, 200 S-C trials, Central Illinois



Convert yield responses to "return to N" (RTN) responses

- Subtract yield without N in each trial
- Convert yield response to $ response

Gross return
yield (increase) x price/bu

N cost
N rate x cost/lb N

RTN
= gross return minus N cost

Final step

Average all RTN curves

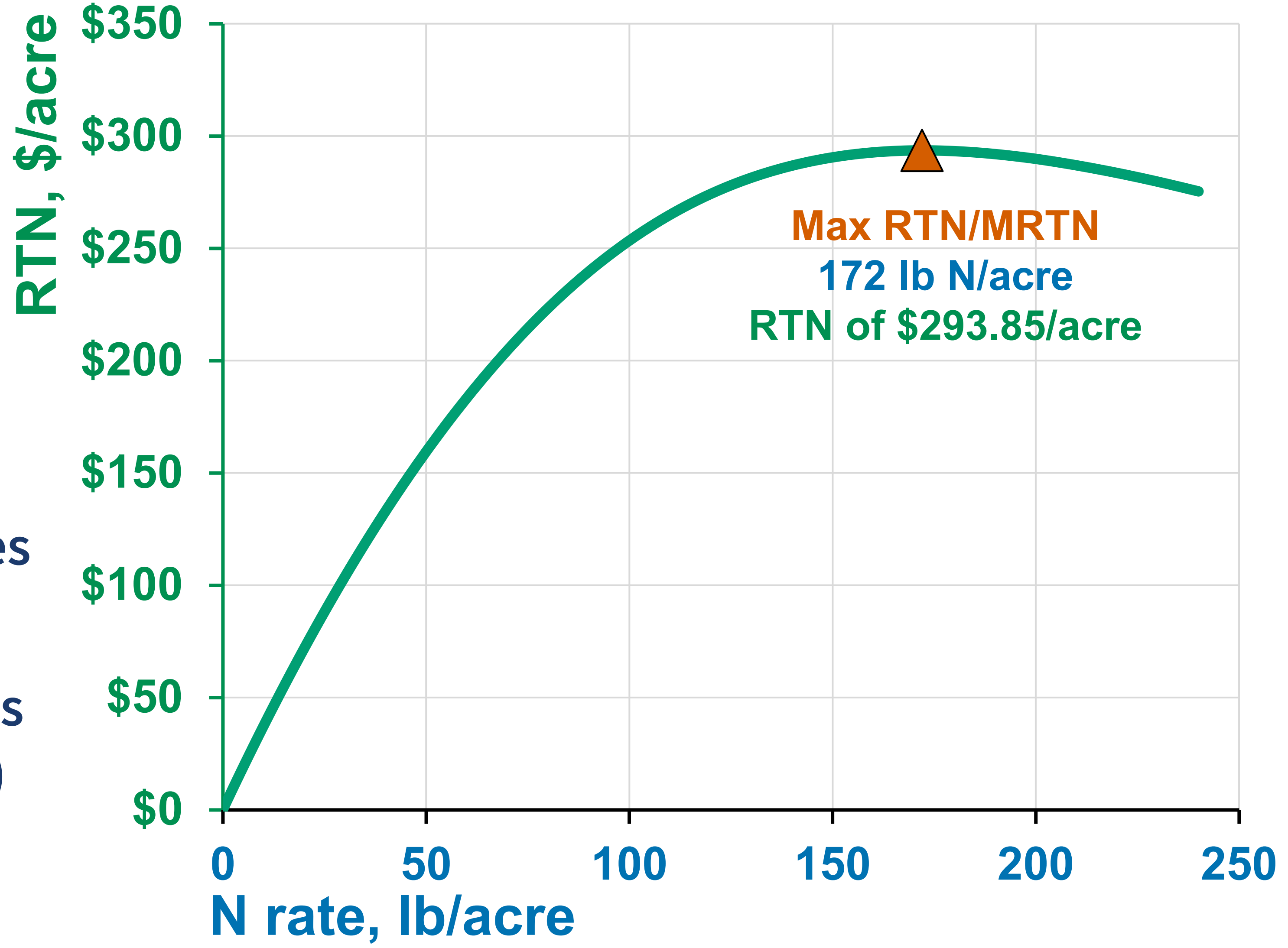
The high point of the average curve = MRTN

The shape of each curve changes as the N:corn price ratio changes:

- Lower corn/higher N price moves curves to the left (lower MRTN)
- Higher corn/lower N price moves curve to the right (higher MRTN)

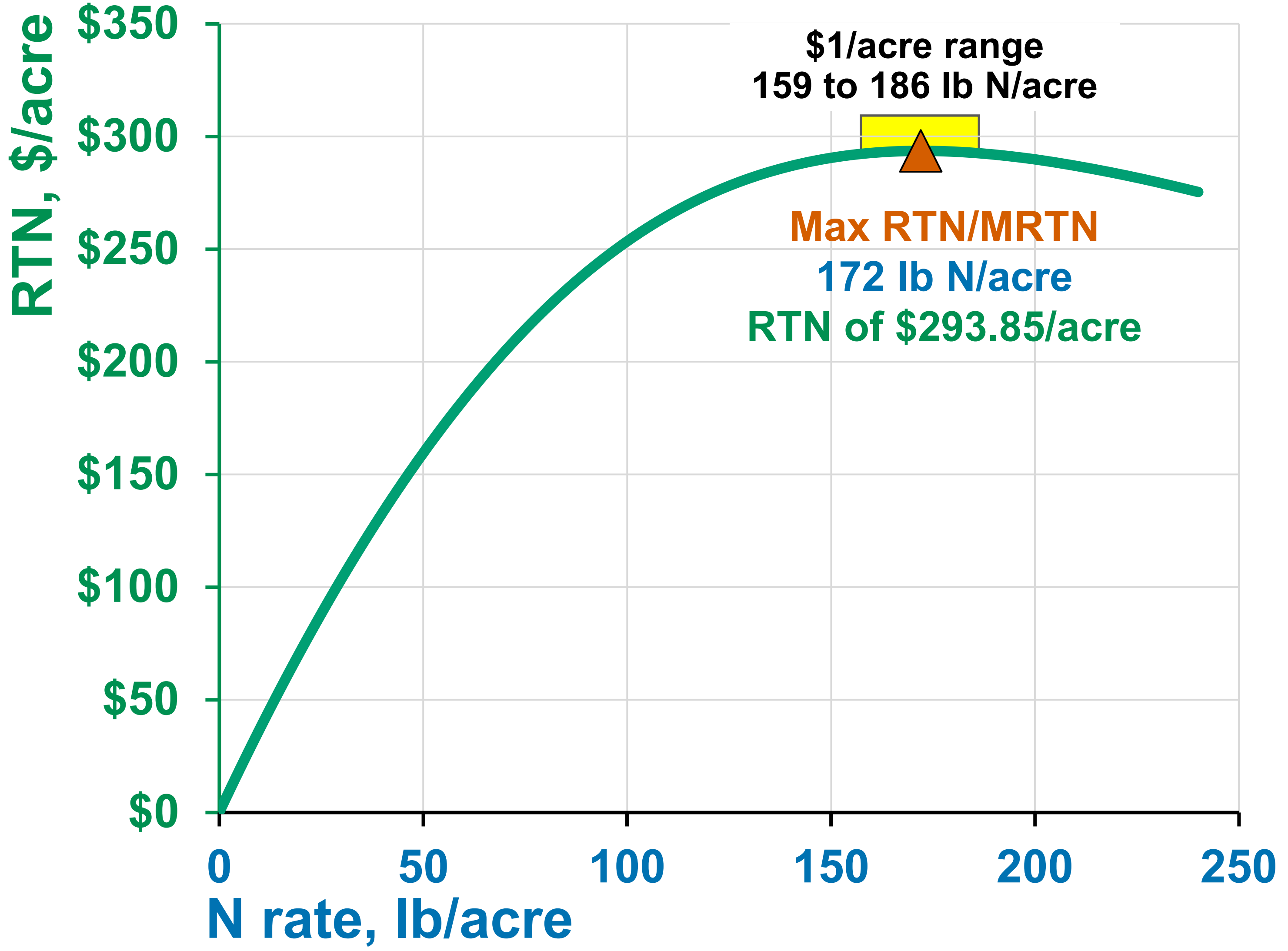
Average RTN across 200 N rate trials

The high point of the avg curve = MRTN



One more thing: Ranges

- The RTN curve is relatively flat on top: RTN is not very sensitive to N rate around the MRTN
- So we added a range of rates within which the RTN is within $1/acre of the RTN at the MRTN (N rate)
- Range is typically ~15 lb N on each side of the MRTN



Points about the MRTN

It’s based entirely on N response data

- More N response data (sites) are better, but we don’t know the number of sites needed for the “best” prediction
- Sites with unusual weather can produce unusual responses: we include these unless there’s a good reason not to
- Data from sites with similar soil (texture, depth, topography, drainage) will make a better prediction for that soil

More about the MRTN

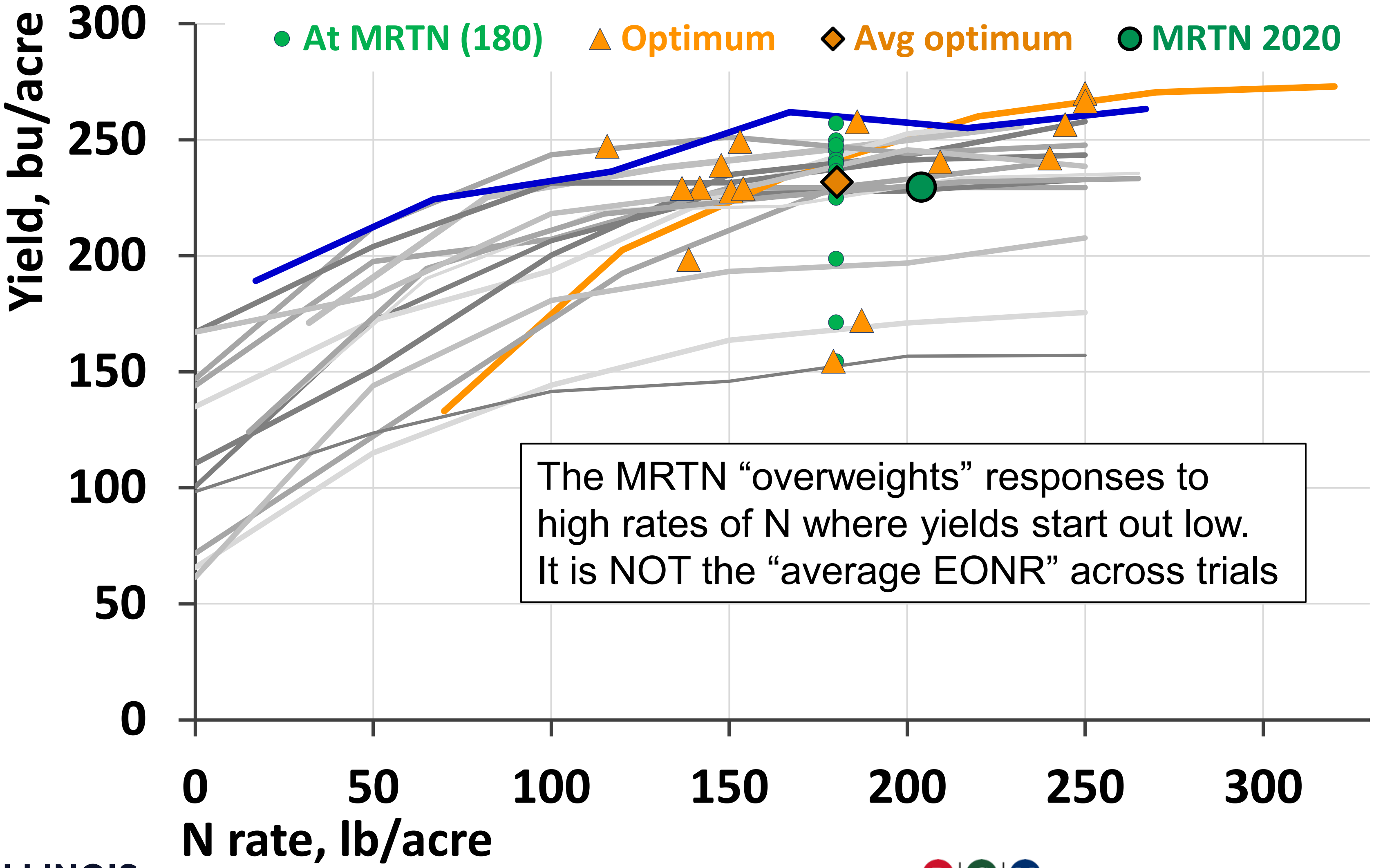
Having it based on data from previous trials means that it can't give a perfect prediction for a given field in a given year:

it is, though, the **BEST GUESS** we have

Finding best N rates is not a "contest":
N responses are not predictable, and we either use results over a lot of trials or we make it up (e.g., "just use plenty of N")

How “imperfect” is the MRTN?

16 Soy-Corn Trials, Central IL, 2020

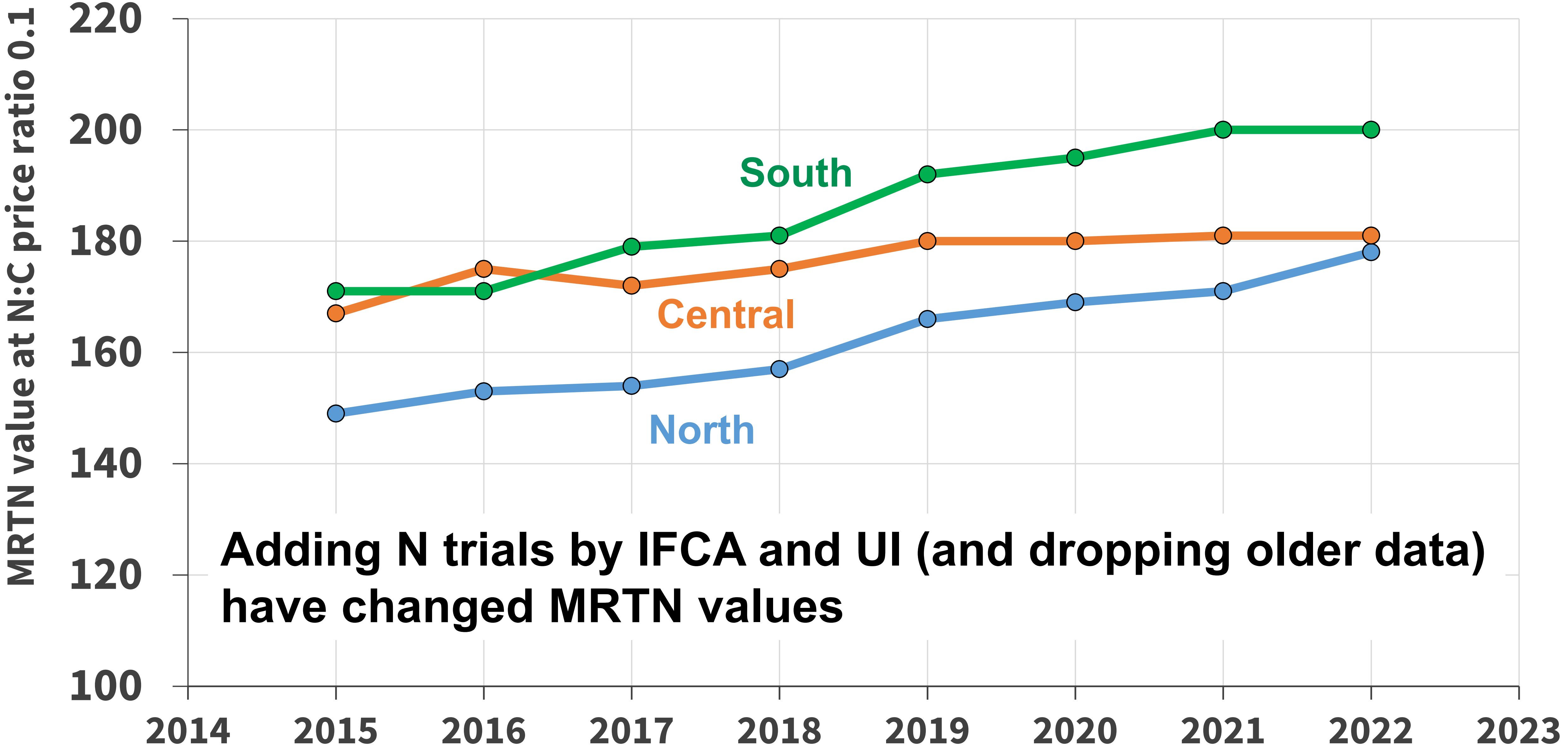


We can assess any set of response data against the predicted MRTN from previous trials

The MRTN based only on only these 16 sites is about 23 lb higher than the prior MRTN

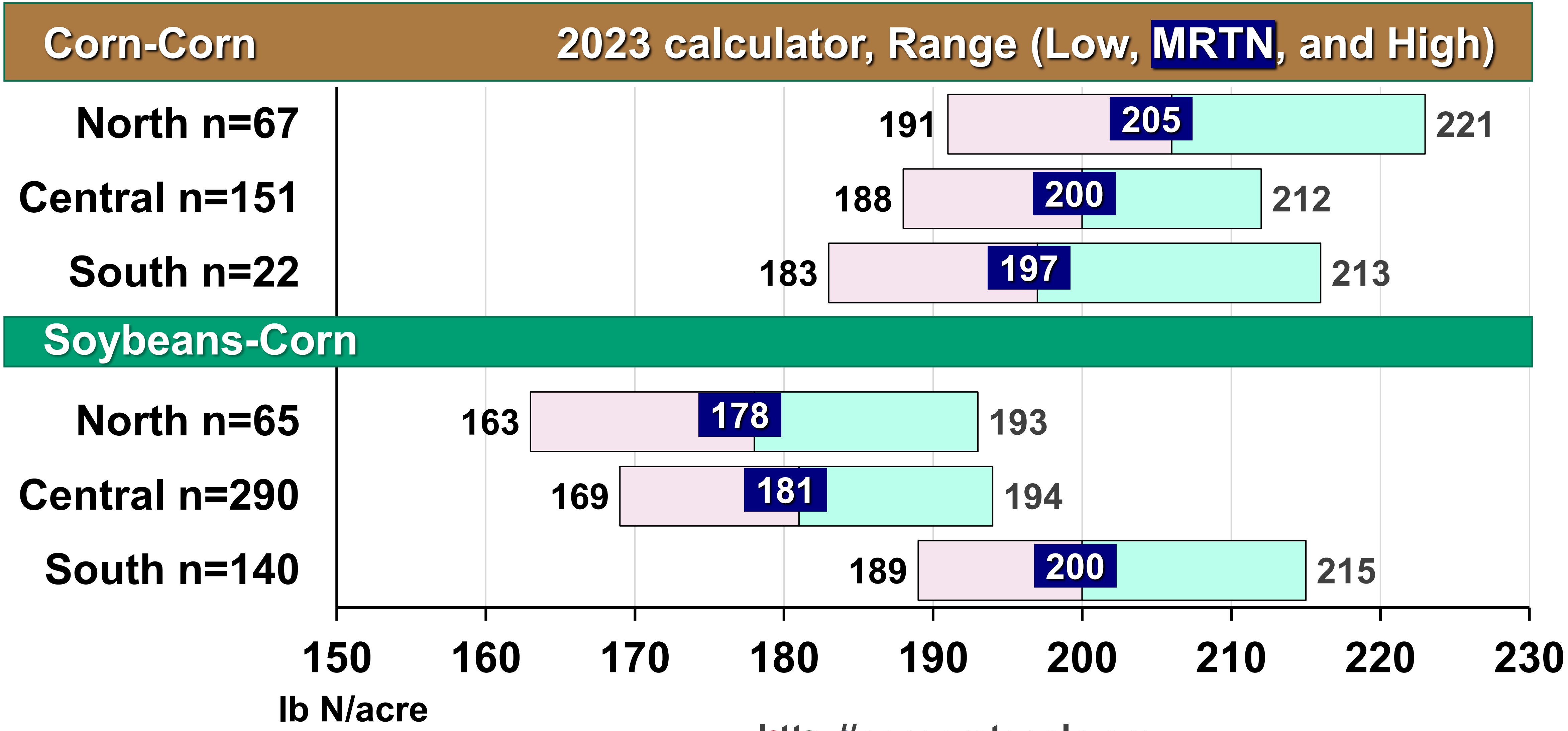
Adding these data into the MRTN database increased the (2021) MRTN slightly

Change in Illinois MRTN for corn following soybean



Illinois corn N rate calculator output for Fall 2023

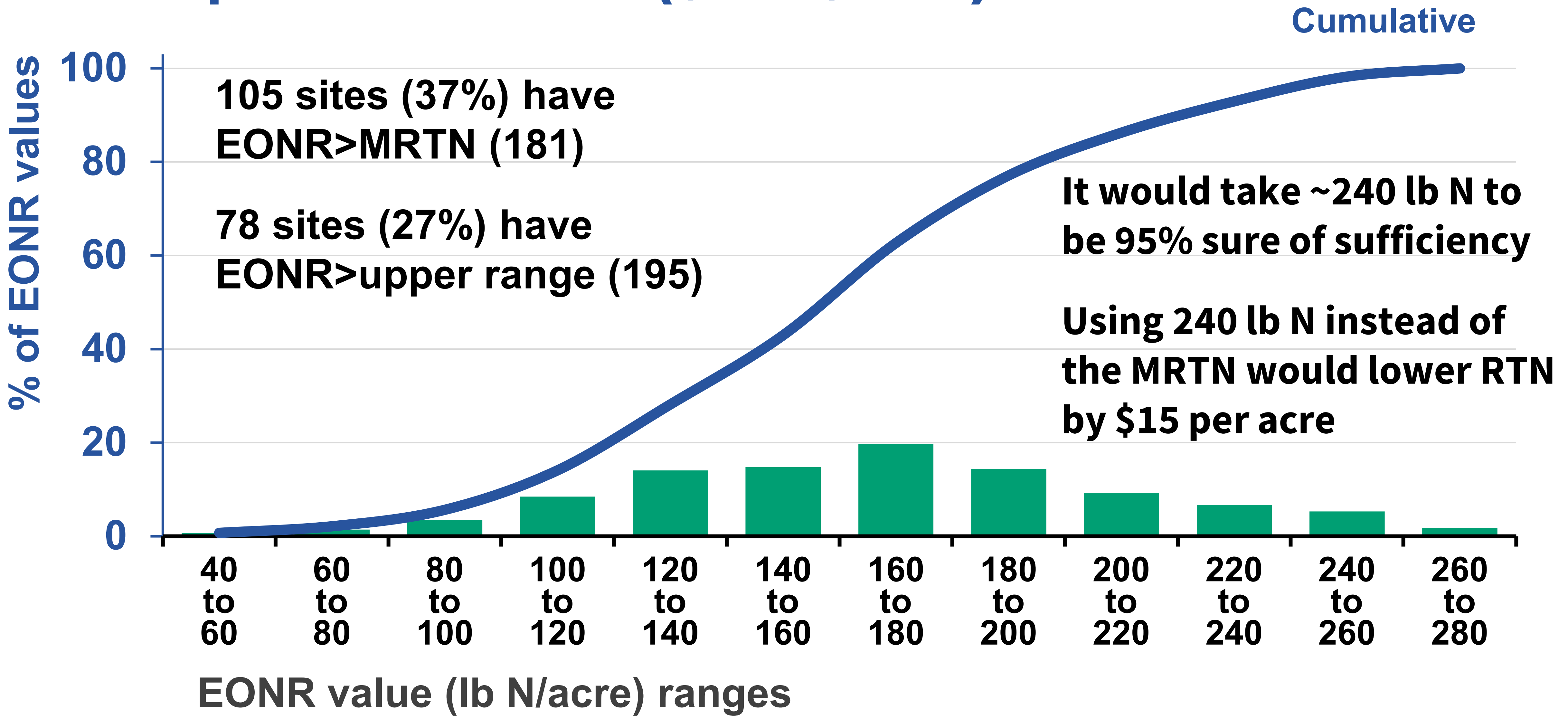
Numbers below at N:corn price ratio of 1:10 (N $0.48/lb; corn $4.80/bu



http://cornnratecalc.org

Central IL soy-corn, 284 trials

N:corn price ratio = 0.1 ($.50/$5.00)



“Knocks” on the MRTN

It’s “one size fits all” without taking into account soils, weather, yields, etc.

- MRTN will (by definition) work better for fields similar to those in the database
- Even knowing yield doesn’t help set N rate
- Weather and its effects are no more predictable than yield
- N loss can be modeled/measured, but is less important in most fields than root issues (growth pattern or waterlogging)
- The inability to estimate soil N contribution early in the season is a major issue, and is likely to remain so

Changing MRTN with changing prices, Fall 2023

Corn at $5.00; N price as indicated

IL Region	Rotation	MRTN at N price, $/lb		
		$0.30	$0.40	$0.50
North	Soy-C	200	189	178
	Corn-C	235	218	205
Central	**Soy-C**	**200**	**189**	**181**
	Corn-C	223	209	200
South	Soy-C	225	211	200
	Corn-C	225	211	197

Fall 2023 (for 2024)

NH_3 $700/ton

Corn $5.00/bu

N:C price ratio 0.085

CIL SC MRTN = 187 lb N/ac

If using more than one source, use the price of the source used for the last (rate-finishing) application to set total rate

"Knocks" on the MRTN

Yields of 250+ bushels surely need more than 185 lb N

Hundreds of N response curves say otherwise: the soil supplies on average about half of the N taken up by the crop

Better crop growing conditions often increase the supply of soil N

N response curves show responses diminish as N rates increase:

It takes about 10 lb of N to add the last bushel up to the yield at the EONR

Today's hybrids grow faster and are better at taking up nutrients and water than older hybrids

- Soil-supplied N is a more consistent part of the crop's N supply
- There is less need for high fertilizer N rates, even when yields are high

Nitrogen and Conservation

Laura Gentry

P | C | M

Precision Conservation Management

Positioning farmers to benefit from conservation outcomes

Precision Conservation Management

Understand how conservation practices impact farm net returns

Address water quality concerns. Prevent agricultural regulation

Position farmers to benefit from positive conservation outcomes

Position farmers to benefit from positive conservation outcomes

1-on-1 technical support

Data collection platform

Individualized yearly RAAP report

- Economic cost tables
- Environmental assessments
- Local practice comparisons

$750 participation payment

Exclusive program offers
cost share, other practice assistance

Networking & education opportunities

Illinois Nutrient Loss Reduction Strategy

Goal: 45% Reduction in **Total N & Total P** Losses by **2035**

Interim: 15% Reduction in NO_3-N & 25% Reduction in Total P by 2025

https://epa.illinois.gov/topics/water-quality/watershed-management/excess-nutrients/nutrient-loss-reduction-strategy.html

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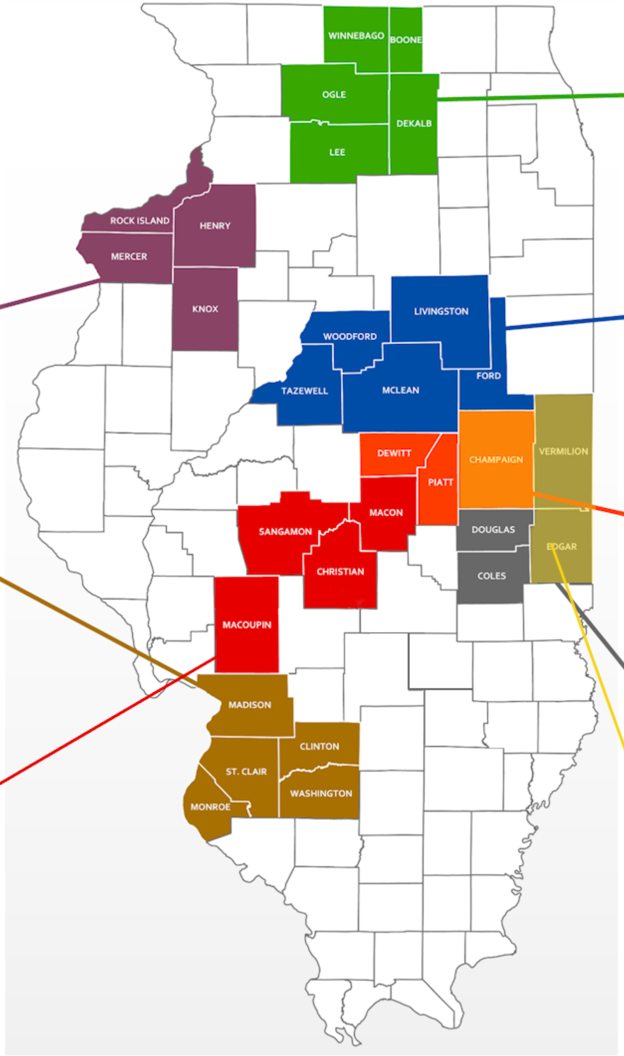

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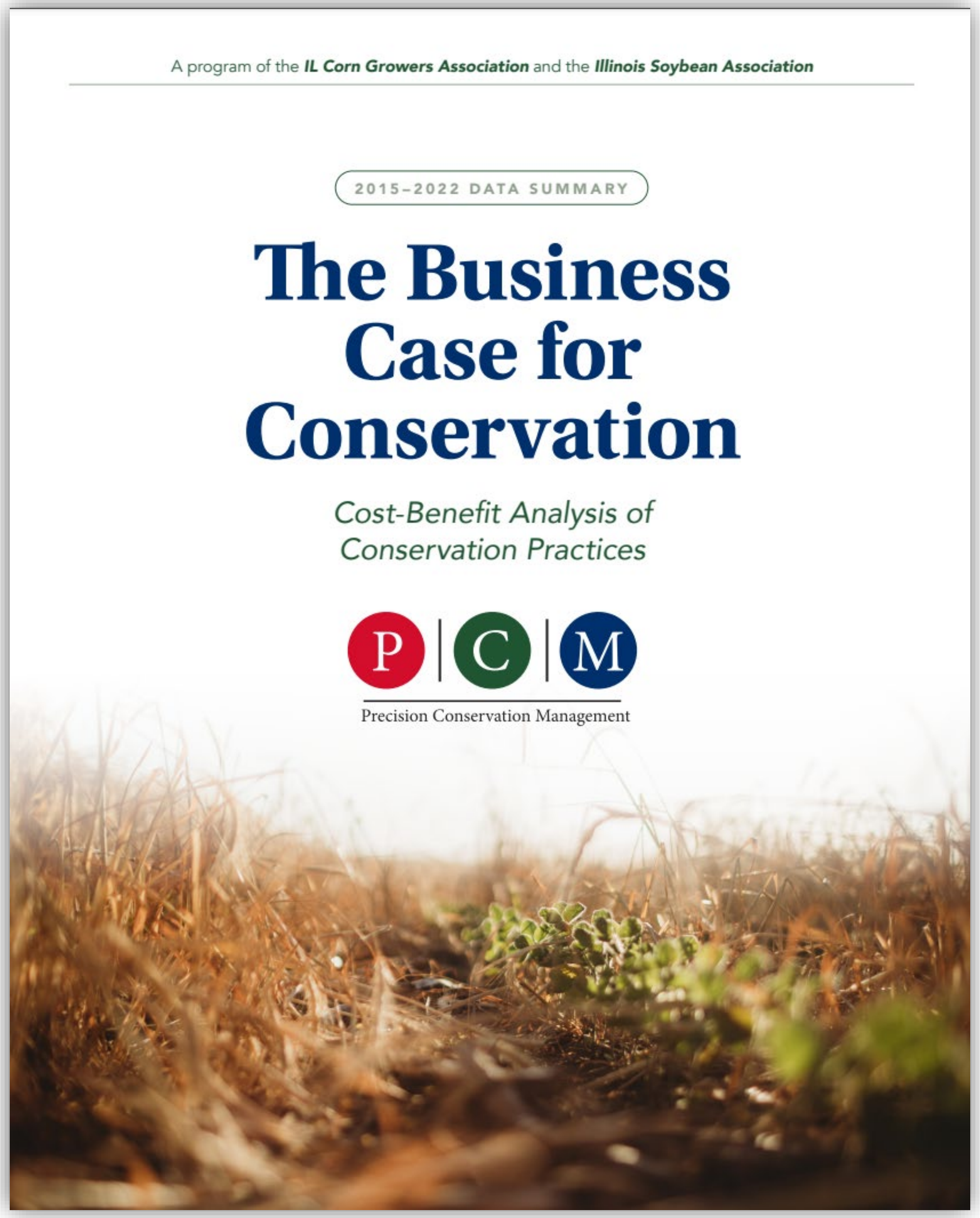
Check us out online: www.precisionconservation.org



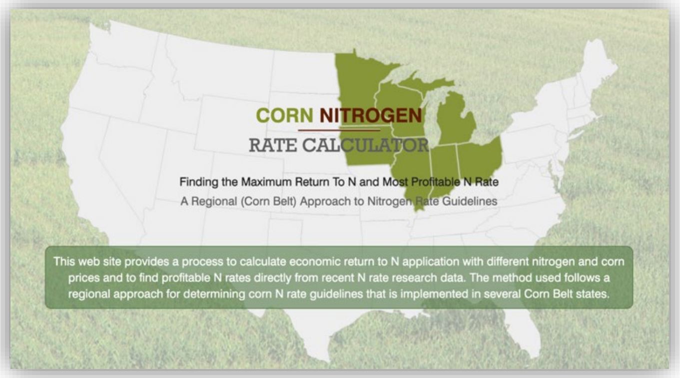
Annual Data Booklet in *PRAIRIE FARMER*

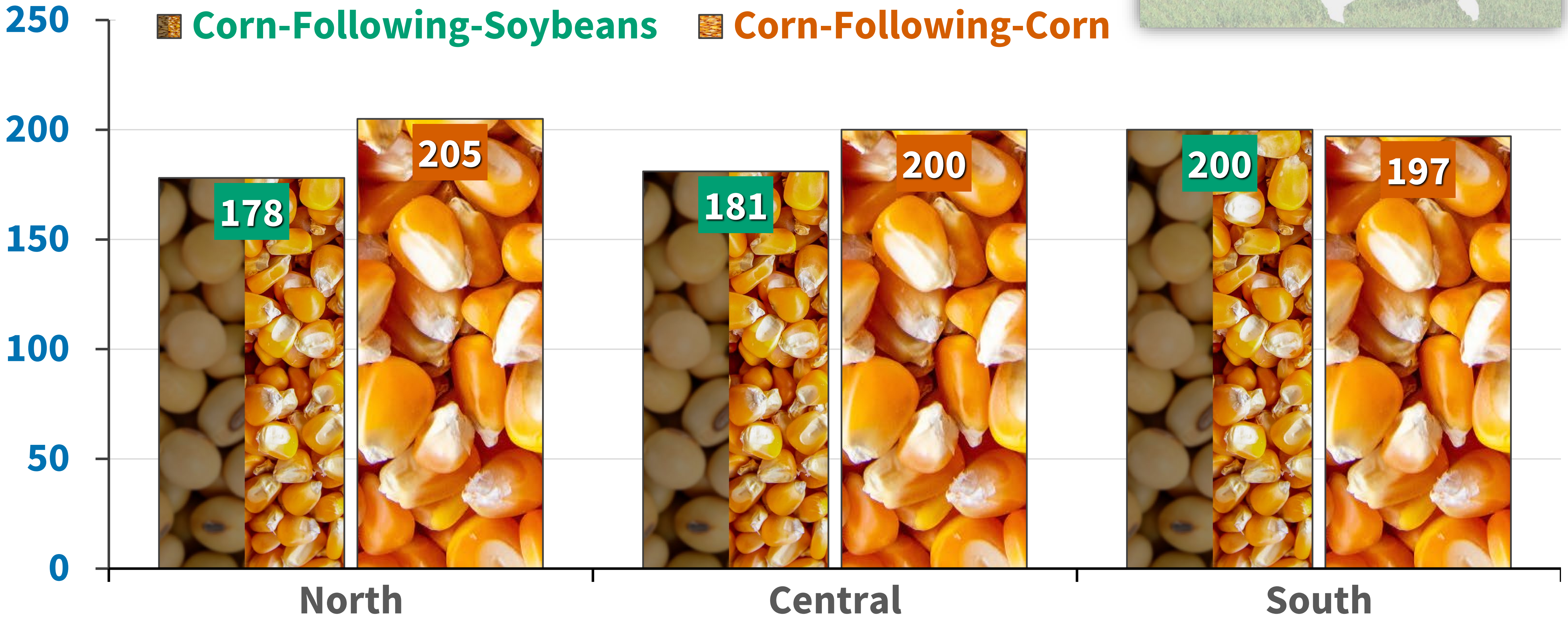
Net Financial Returns and N Fertilizer Timing

Corn, Hi SPR 2015-22 Average Values

	>40% Fall	Mostly Preplant	Mostly Sidedress	50% Pre/ 50% Sidedress	3-way Split
NUE (lb N/bu grain)	0.98	0.92	0.91	0.94	0.92
# fields	1,876	1,126	1,189	367	477
Yield per acre	222	218	221	220	224
Gross Revenue	$941	$918	$933	$929	$948
N Fertilizer	$93	$87	$86	$96	$92
Other Direct Costs*	$335	$308	$321	$324	$348
Total Direct Costs*	$428	$395	$407	$420	$440
Field Work	$16	$15	$16	$15	$18
Other Power Costs**	$102	$94	$100	$100	$100
Total Power Costs	$118	$109	$116	$115	$118
Overhead Costs	$38	$38	$38	$38	$38
Total Non-land Costs	$585	$542	$561	$573	$596
Operator & Land Return	$356	$376	$371	$356	$352

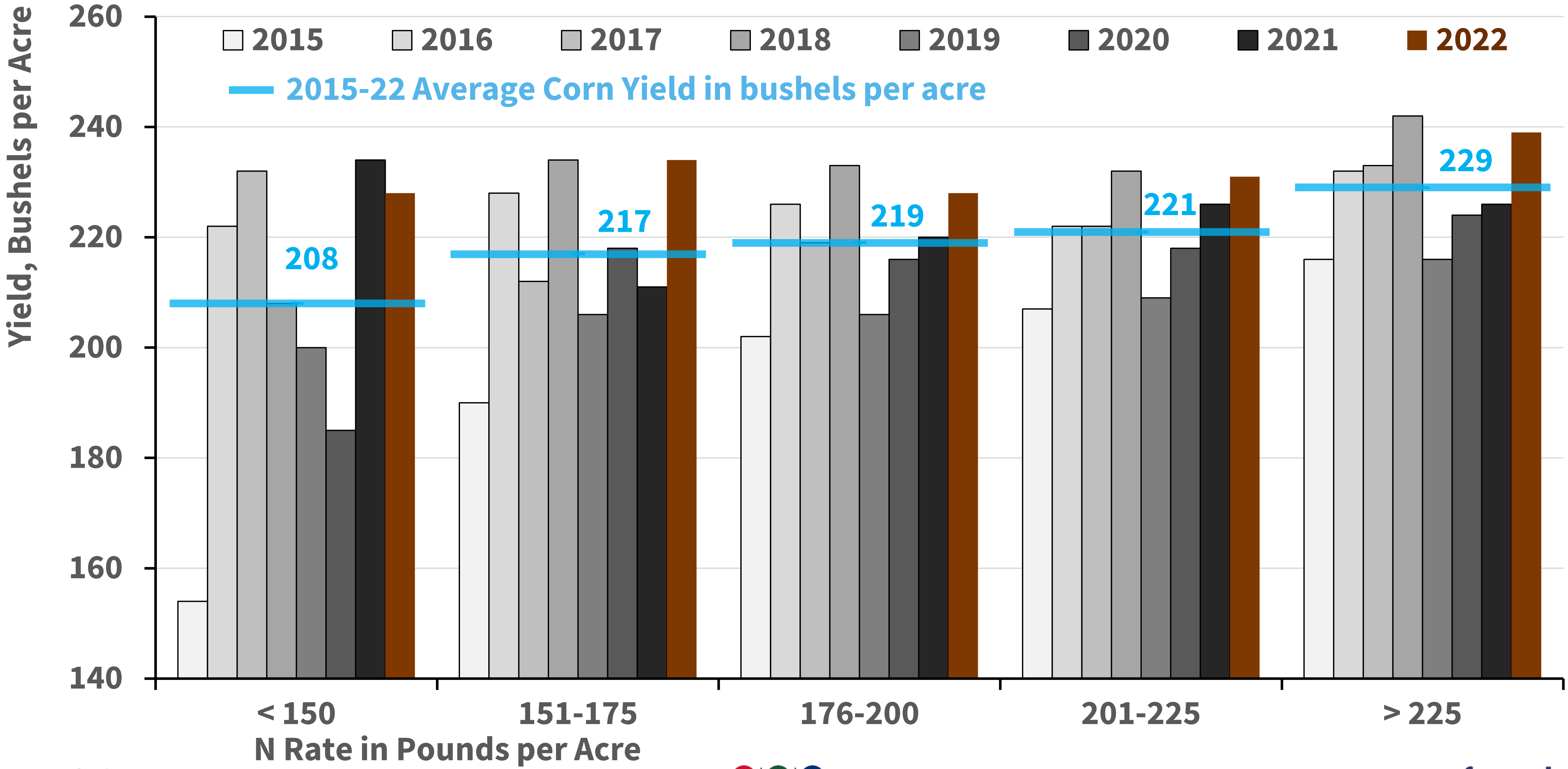
Illinois
2022 MRTN Recommendation
in pounds of N applied[1,2]





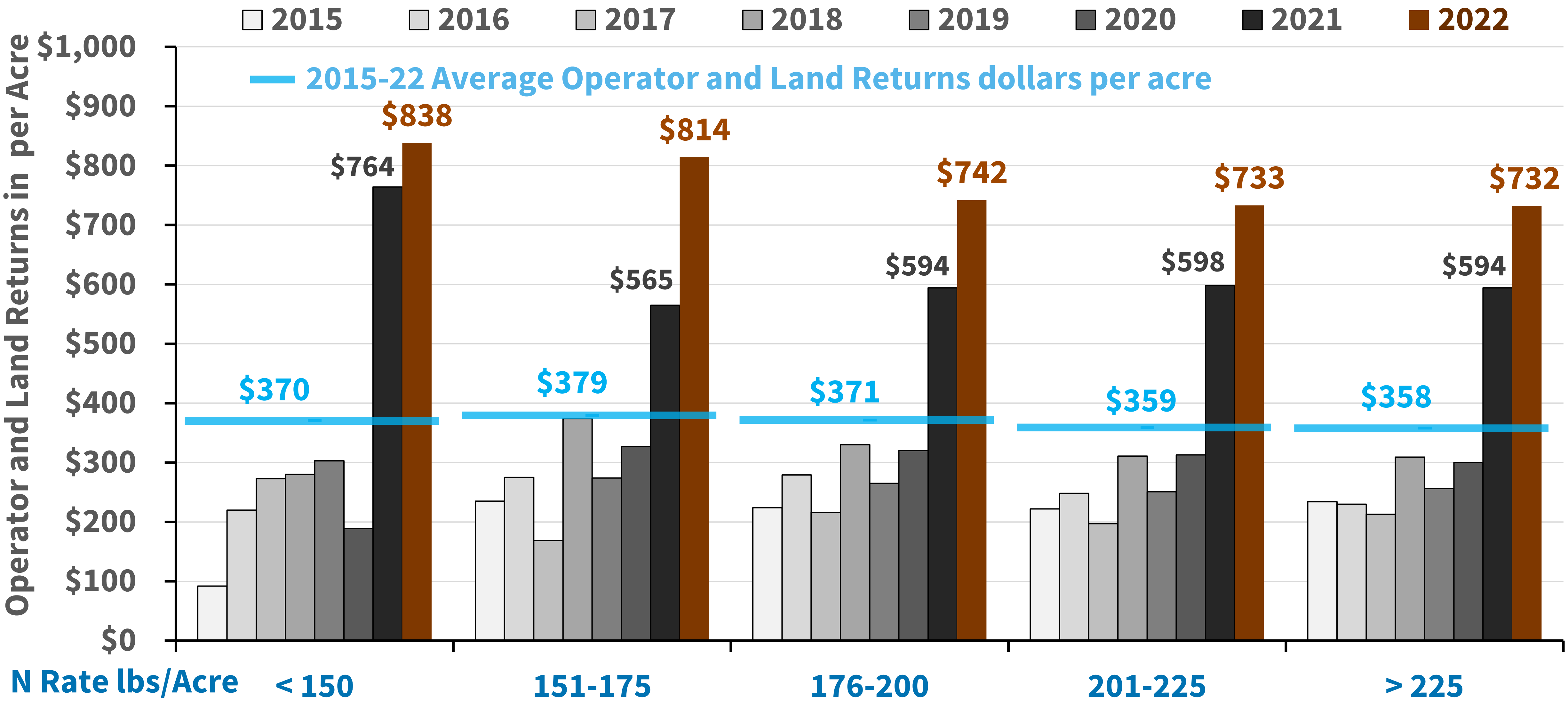
[1]Taken from Corn Nitrogen Rate Calculator (http://cornnratecalc.org)
[2]MRTNs determined with a N:corn price ratio of 1:10 (N $0.48/lb; corn $4.80/bu)

Corn Yield, High SPR, N Rate, Pounds per Acre

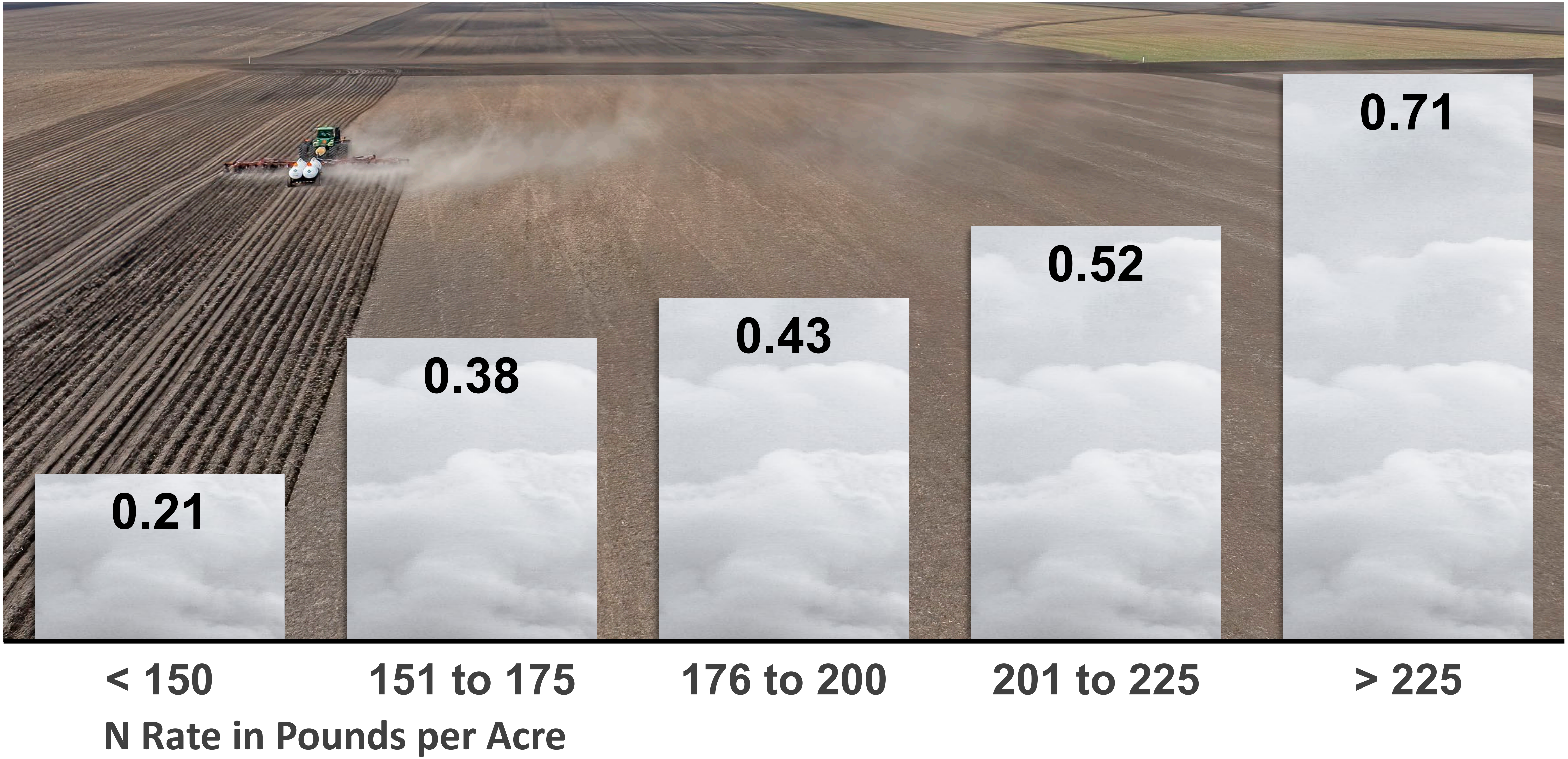


Operator and Land Returns

Corn, High Soil Productivity Rating (SPR)



GHG Emissions in metric tons CO2e/acre



What's next for improving confidence in MRTN?

Many smaller trials more easily (and cheaply) done by producers, to produce data that will show that using the MRTN will usually meet crop needs:

- Two rates — the rate used in a field, and a rate lower or higher — resulting in one rate in the MRTN range and a rate 50-60 lb higher
- The "different" rate in (two?) strips through the field wide enough to allow use of normal equipment and for two combine passes
- YM yields from each rate, with two passes in rate strip and on each side of rate strips
- On different soils within and across (many) fields

What's next for improving confidence in MRTN?

- Sensing & yield monitor data along with weather and soil information should allow us to "train" a prediction model to improve on in-season N mgt
- Dan Schaefer at IFCA will lead the field phase, with cooperation from the Precision Conservation Management program, retailers, and others

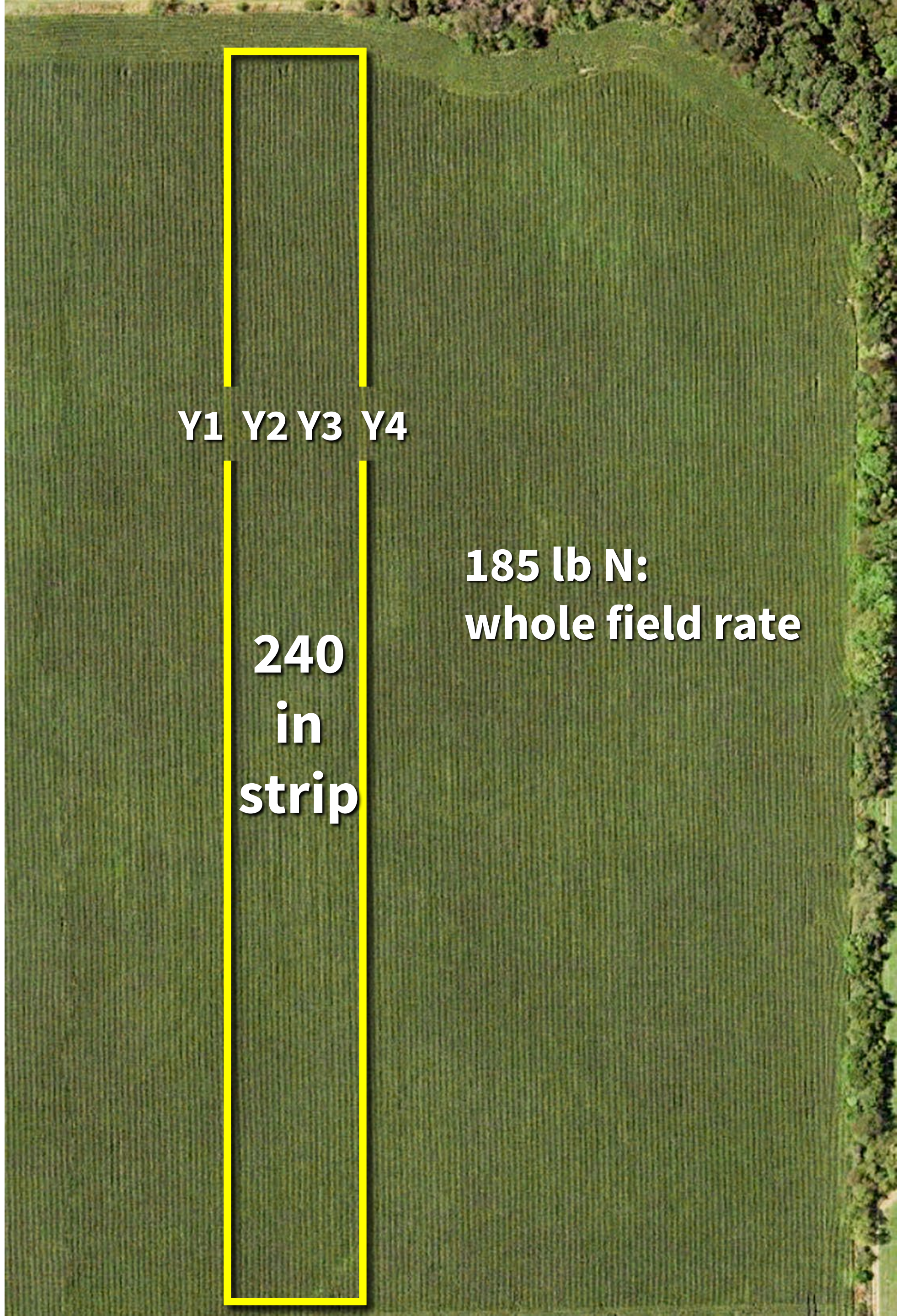
Dan Schaefer

Illinois Fertilizer & Chemical Association

N Rate Verification Trials:

- Project in its early years
- Funded by NREC
- Dan Schaefer (IFCA) will coordinate

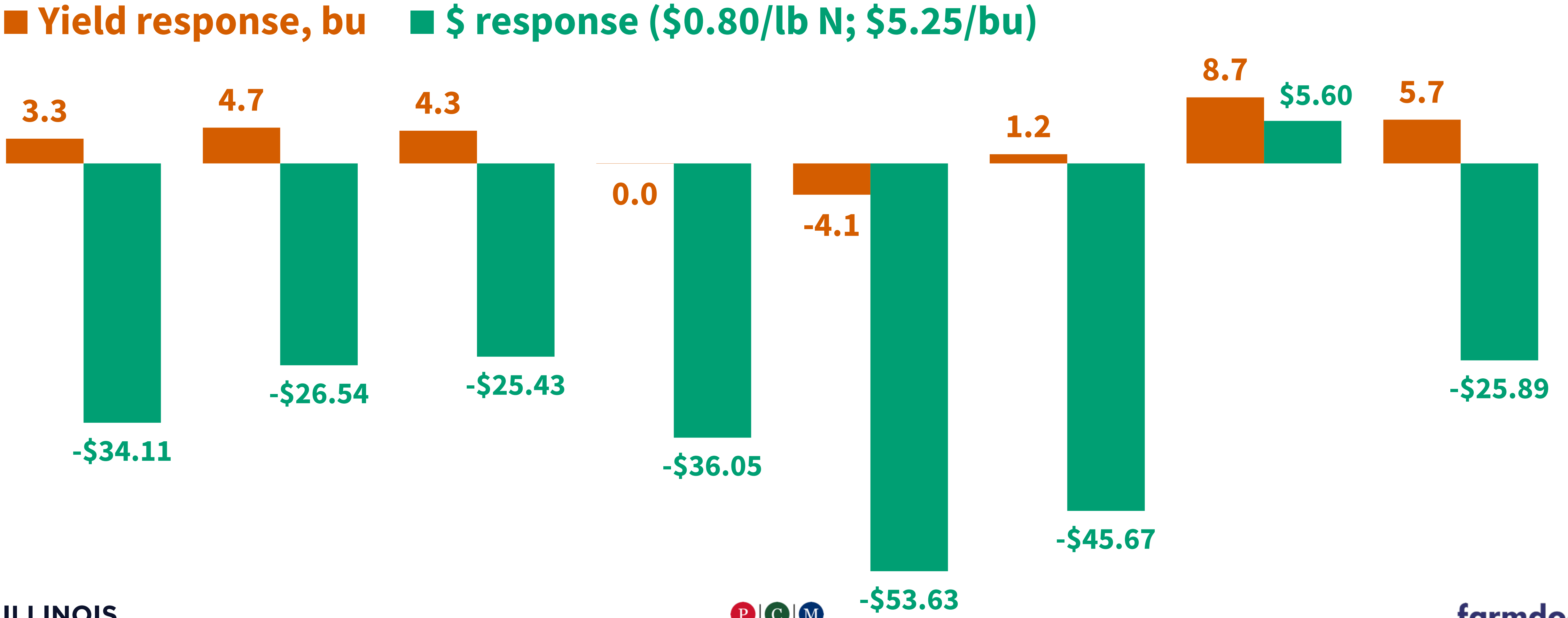
This, in **500**(?) IL fields each year



Illinois two-rate N trial results from 2022

Change from medium nitrogen rate (Average of 185 lb N/acre) to high nitrogen rate (average of 242 lb N/acre)

Using higher rates added 3 bushels of yield and produced a net loss of $30 per acre



A BIG question:

- How can anyone really know whether the N rate used was too low, about right, or too much?

- Providing more N than the crop needs seldom leaves visible clues: the only way to know if too much N was used is to do a comparison trial with (at least two) different rates in the field

- Applying somewhat less fertilizer N than the crop needs often doesn't produce visible signs of deficiency (except in our imagination)
  - Water in low spots → N-deficient corn, mostly due to root issues not lack of N
  - Corn without N fertilizer is often dark green early; uniform deficiency across entire fields is very rare in higher-OM soils with >150 lb N applied

N Rate Reduction Incentives through IL NREC and USDA Climate Smart Grants

Precision Conservation Management

Field to Market®

The Alliance for Sustainable Agriculture

College of Agricultural, Consumer & Environmental Sciences

UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

MRTN On-Farm Strip Validation Trial

PCM Incentive Programs

- **Payments coming from USDA and PepsiCo/Walmart**
- **PepsiCo and Walmart sharing claim on the carbon asset**

Field to Market®
The Alliance for Sustainable Agriculture

USDA United States Department of Agriculture

2023 PAYMENT STRUCTURE

<table>
<tr><th>COVER CROPS</th><th>NO-TILL/STRIP-TILL</th><th>MRTN/10% NITROGEN REDUCTION</th></tr>
<tr><td>**$15**, 1st/2nd year</td><td>**$10**, 1st/2nd year</td><td>**$10**, 1st year</td></tr>
<tr><td>**$10**, 3+ year OLD</td><td>**$5**, 3+ year OLD</td><td>–</td></tr>
<tr><td colspan="3">**$25**, 1st/2nd year NEW | **$15**, 3+ year OLD</td></tr>
<tr><td colspan="2">**$20**, 1st/2nd year | **$15**, 3+ year OLD</td><td>–</td></tr>
<tr><td>PEPSICO</td><td colspan="2">**$15**, 1st/2nd year</td></tr>
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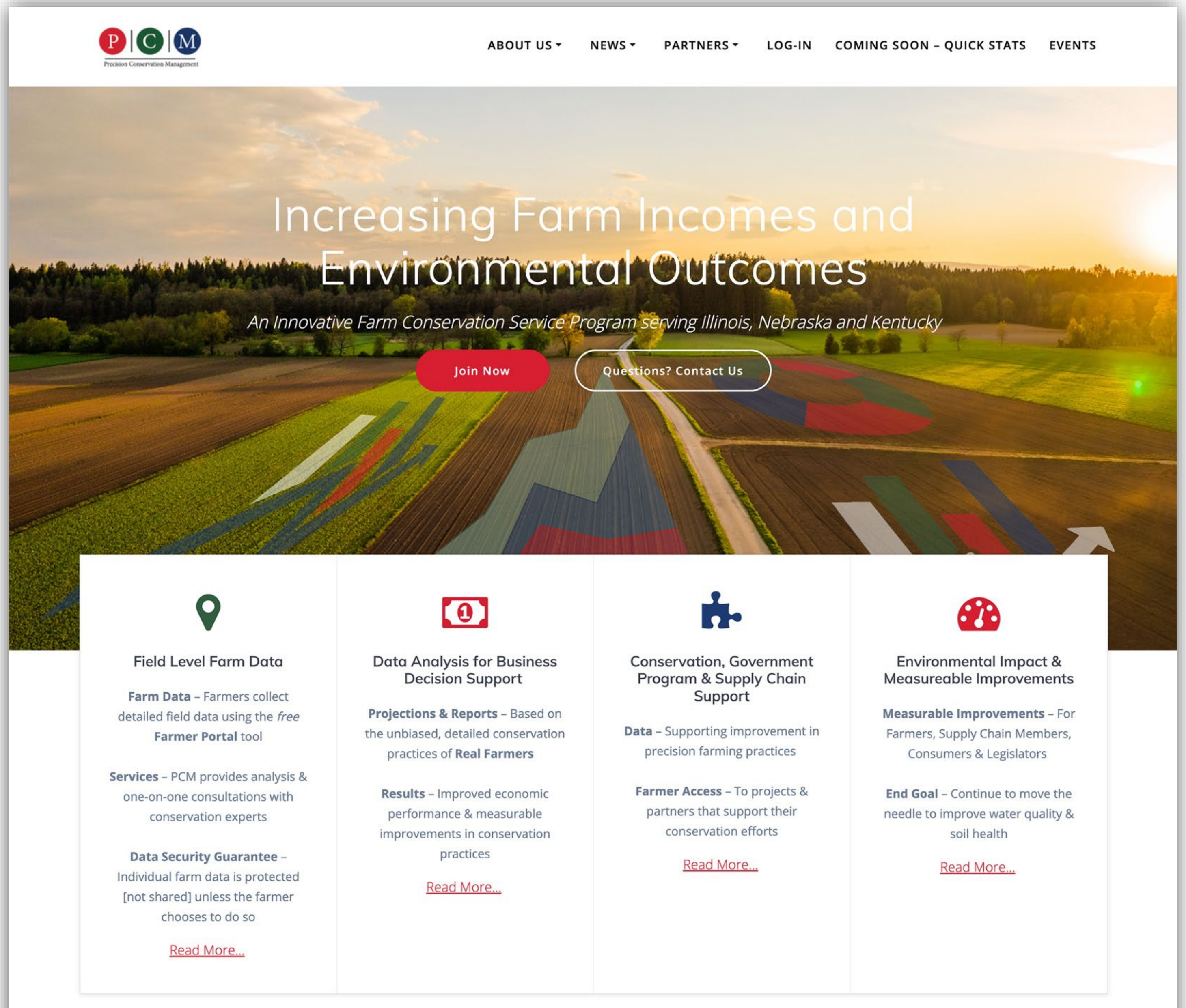
Learn more at www.precisionconservation.org



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