Fall Nitrogen Management

IFCA Webinar, October 23, 2023

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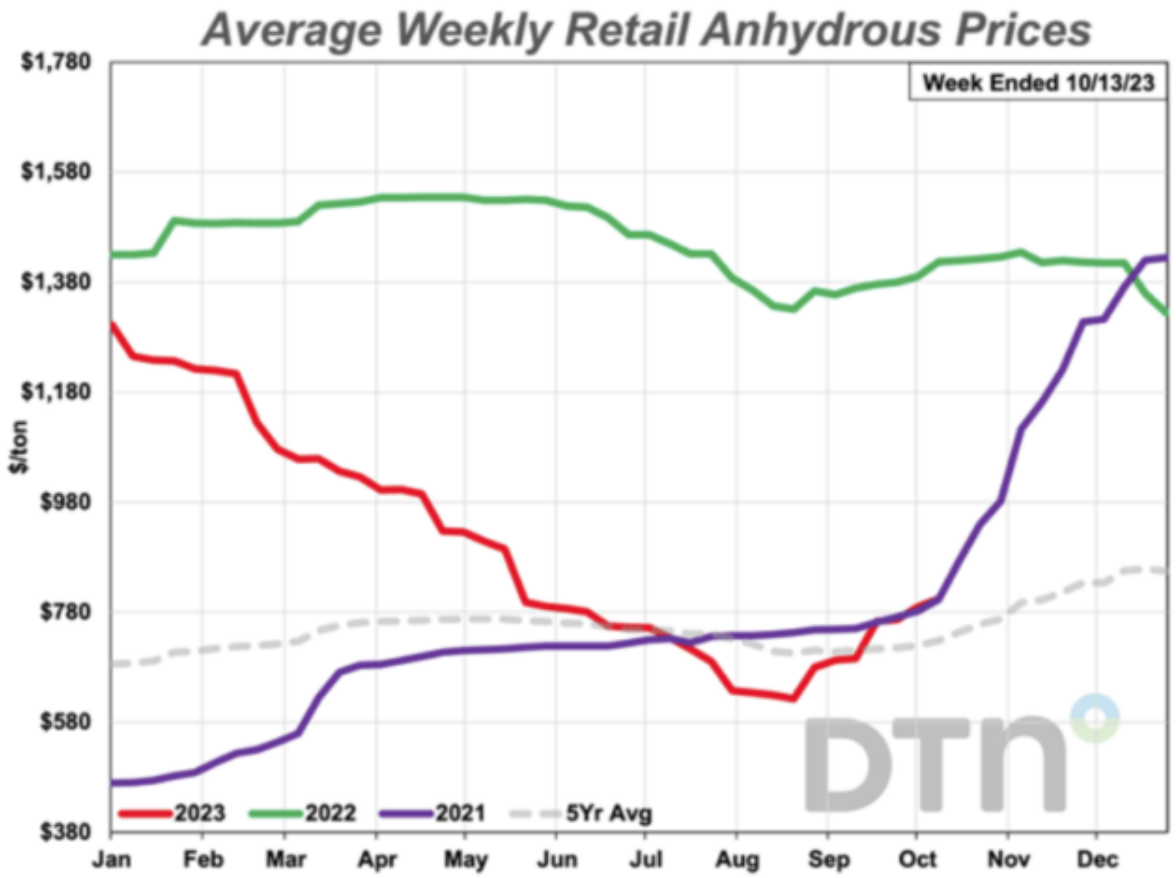
Fertilizer Prices: on the move?



"DTN Retail Fertilizer Trends," by Katie Micik Dehlinger, DTN- Progressive Farmer (October 18, 2023).

From USDA (Oct. 19)
Illinois

	$/ton	$/lb nutr.
NH_3	806	0.49
DAP	692	0.75
MAP	747	0.72
Potash	495	0.41

USDA/AMS report for Iowa on 10/17 had AA at $671/ton

P and K Removal Numbers

Corn: 0.37 lb P_2O_5, 0.24 lb K_2O per bushel

Soybeans: 0.75 lb P_2O_5, 1.17 lb K_2O per bushel

Wheat: 0.46 lb P_2O_5, 0.28 lb K_2O per bushel

Example:

200 bushels of corn remove 74 lb P_2O_5 and 48 lb K_2O

65 bushels of soybean remove 49 lb P_2O_5 and 76 lb K_2O

Together, that's **123 lb P_2O_5** and **124 lb K_2O**

To replace using MAP for P, total cost = **$139/acre**
(covering two years): corn $73; soybean $66

Timing for P and K

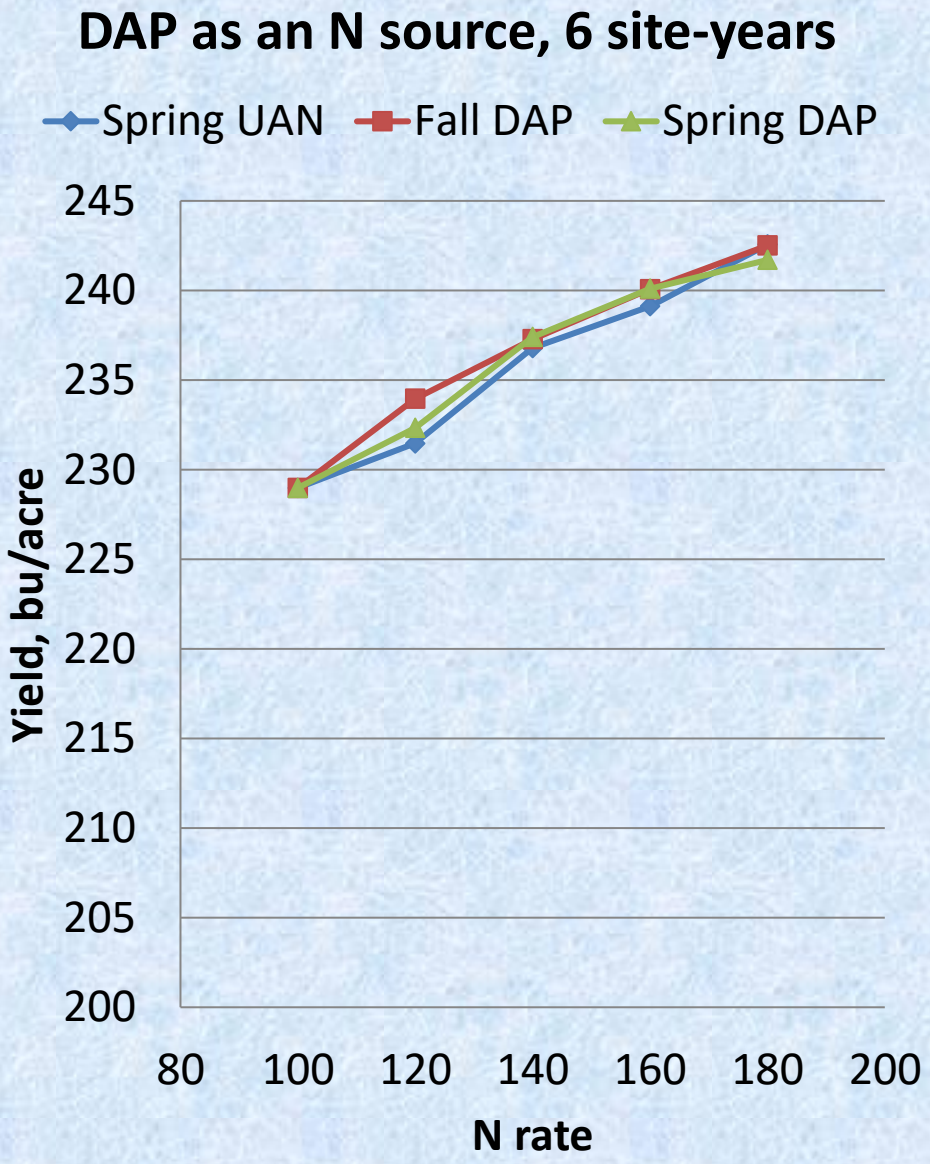
- If soil test levels in medium– to heavy-textured soils currently exceed 25 ppm for P and 150 ppm for K, applying none for the 2024 crop carries little risk of yield loss
  - One caution: root-restricting conditions (no-till, dry soils) caused some K deficiency symptoms in 2023, even where soil-test K levels were adequate
- <u>However</u>: P and K removed by crops will need to be replaced eventually (maybe not fully if ST levels are high), and future supplies and prices are uncertain

Testing Soil P and K

- Soils have been relatively dry from late summer through early October: this sends K “into its shell” where soil-test extractants don’t extract it, lowering K test values
- P availability is less affected by dry soils, unless probe depth biases the sample
- The solution: apply removal amounts since the last time P and K were applied
- Sampling in the spring, when K availability is higher, is usually more accurate; this can be for immediate application or for fall application

Availability of MAP/DAP N

- The data aren't very clear:
  - Fabian Fernandez published a study that measured soil N levels and yield in the spring after fall DAP, and found little of the N to be available to the next crop
  - We ran a study over six IL sites using N rates supplied by fall DAP, spring DAP, and spring UAN, and found that yields curves were nearly the same for all three sources – that is, most of the N from fall DAP was available to the next crop
  - So: count all N from spring MAP/DAP and from fall MAP/DAP applied after Nov. 1



N fertilizer in the news

CORN | MANAGEMENT | SOIL HEALTH

PrairieFarmer

How much nitrogen does corn get from fertilizer?

A new University of Illinois study on nitrogen shows 80% of a corn crop's N comes from the soil, and application timing may not mean what we think.

Betty Haynes
October 11, 2023

3 Min Read

"The team's first study ran from 2017 to 2019, looking at fall applications of anhydrous ammonia. The findings showed a mere 12% to 24% of applied nitrogen was present in corn at harvest.

"Naturally you would wonder where the rest of the nitrogen came from, and the answer is very simple — it came from the soil," Mulvaney says. "About 80% of the N in that grain was being taken up from the soil itself."

Questions for today:

1. **Does 80% from the soil mean that we only need to add 20% of the crops need as fertilizer?**
2. **Is this a good measure of NUE?**
3. **What do other data show?**
4. **Does any of this help to manage N?**

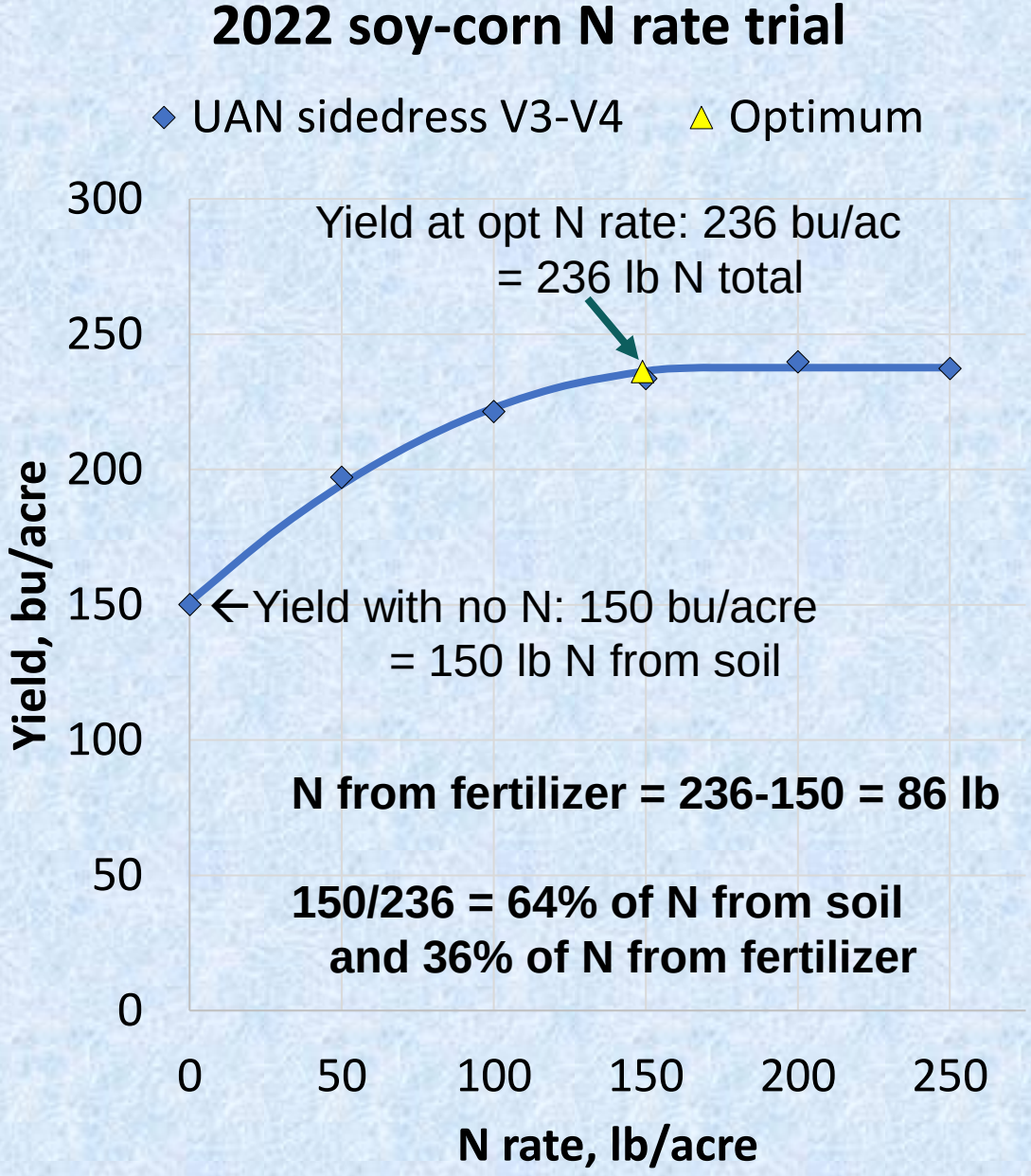
There is an easier way than ^{15}N

N rate trials produce realistic estimates of how much N the soil supplies:

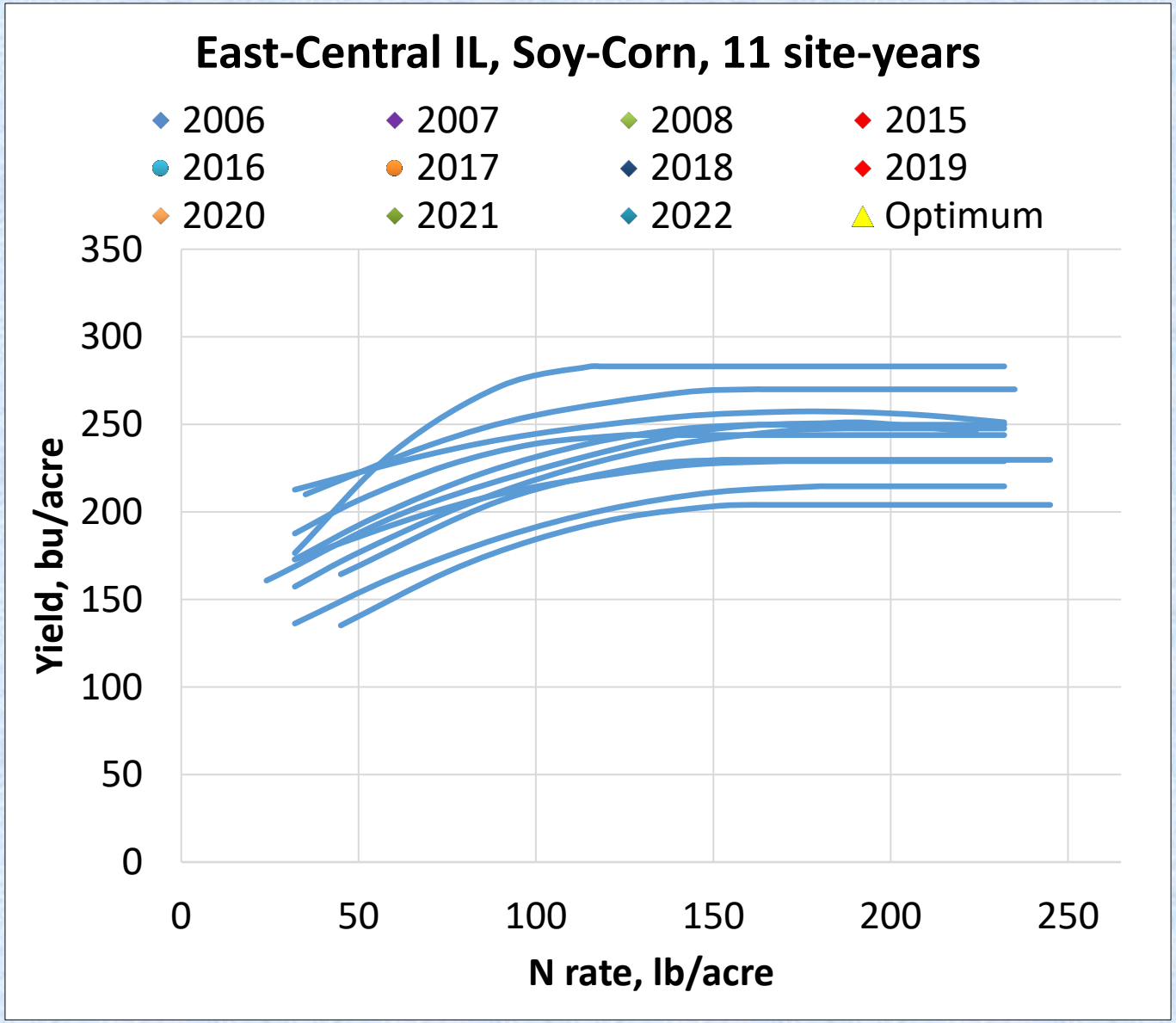
Yield at zero (fertilizer) N times a factor

We use 1 lb N per bushel of yield: Corn grain has about 0.60 to 0.65 lb N per harvested bushel; the rest of the plant can take up 0.30 to 0.35 lb N/bushel, depending on hybrid, season, and how green the crop is at maturity

We subtract yield/N at zero N from yield/N at the optimum N rate to estimate how much N came from fertilizer



A set of trials in the same location over 11 years showed the following



Across these trials:

Yield without N

Average: 126 bu/ac

Range: 73 to 191 bu/ac

Yield at optimum N

Average: 243 bu/ac

Range: 204 to 283 bu/ac

Optimum N rate

Average: 151 lb N/ac

Range: 115 to 176 lb N/acre

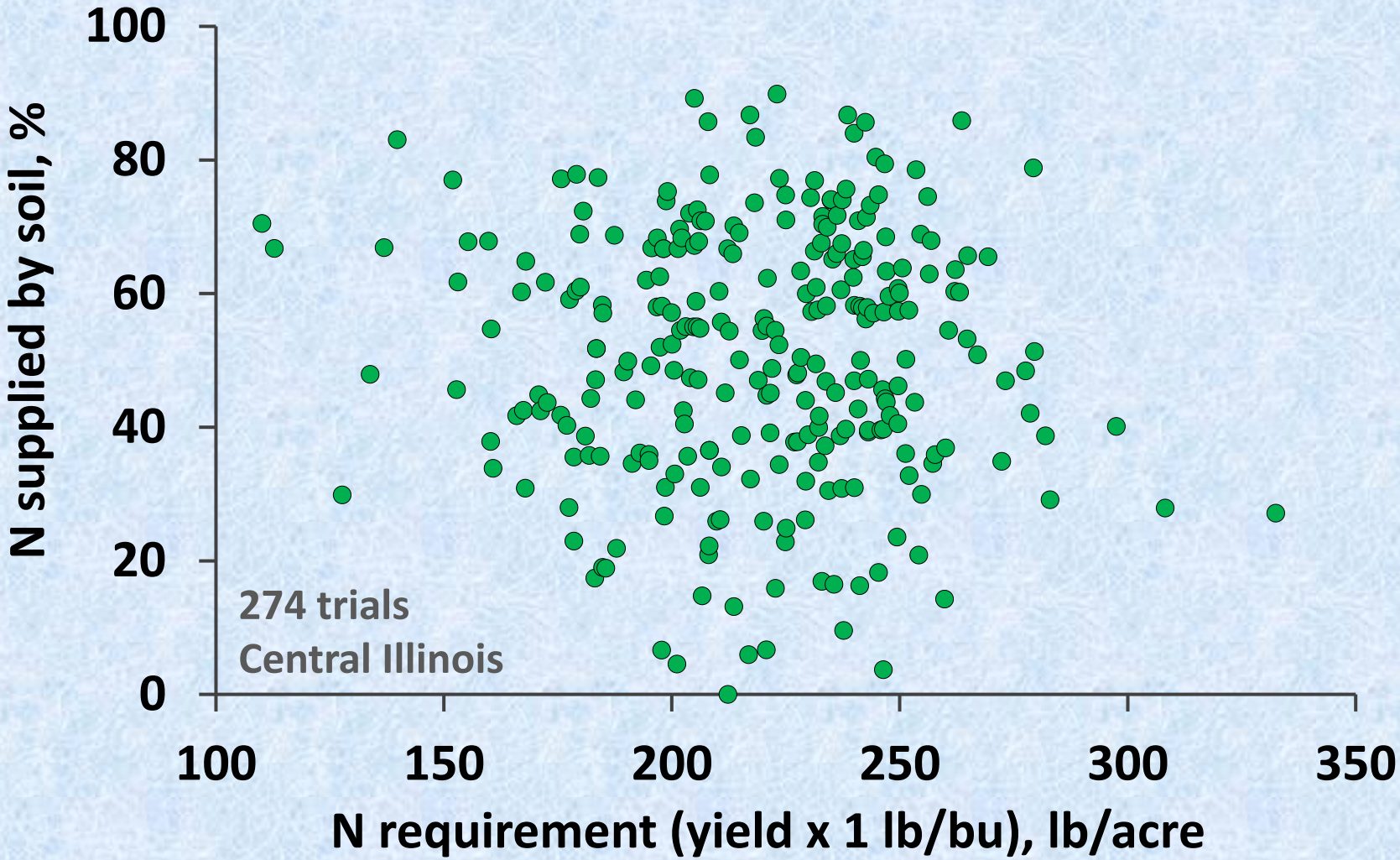
% of N from soil

Average: 52%

Range: 29 to 75%

Yes, soil N is a critically important source of N for the corn crop.

Figuring out N fertilizer rate N rate is so difficult because it means having to know what the yield (N need) will be and also how much N the soil will supply



Across these trials:

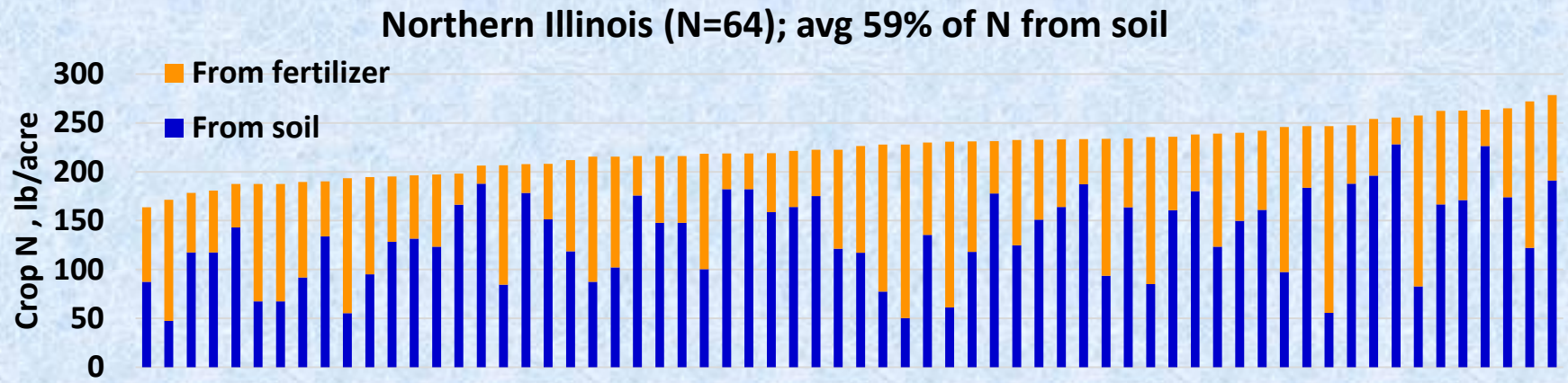
~½ crop's N requirement comes from the soil

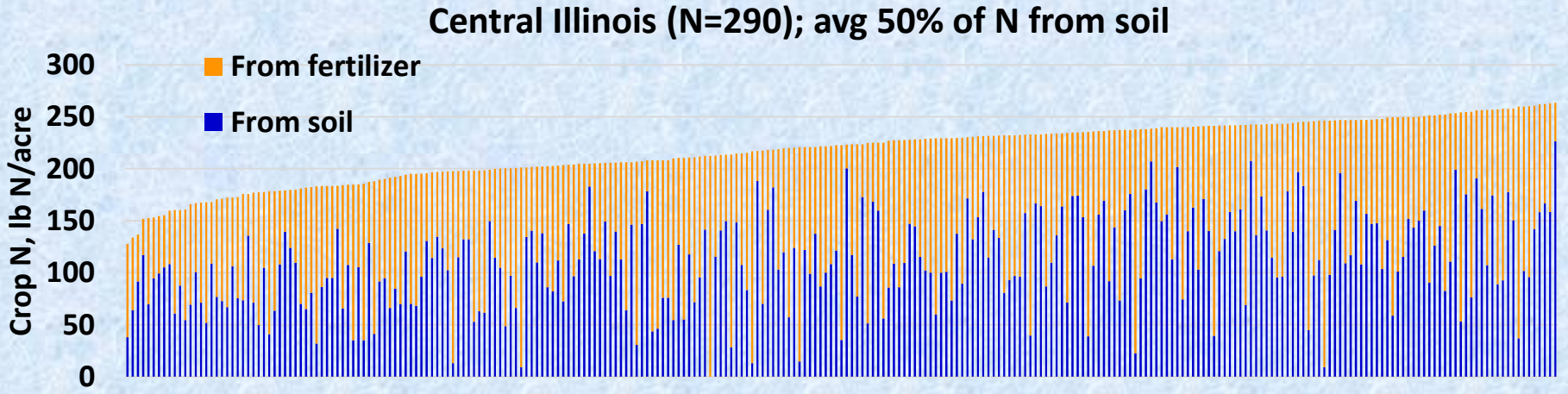
Ranges from <5% to >90%

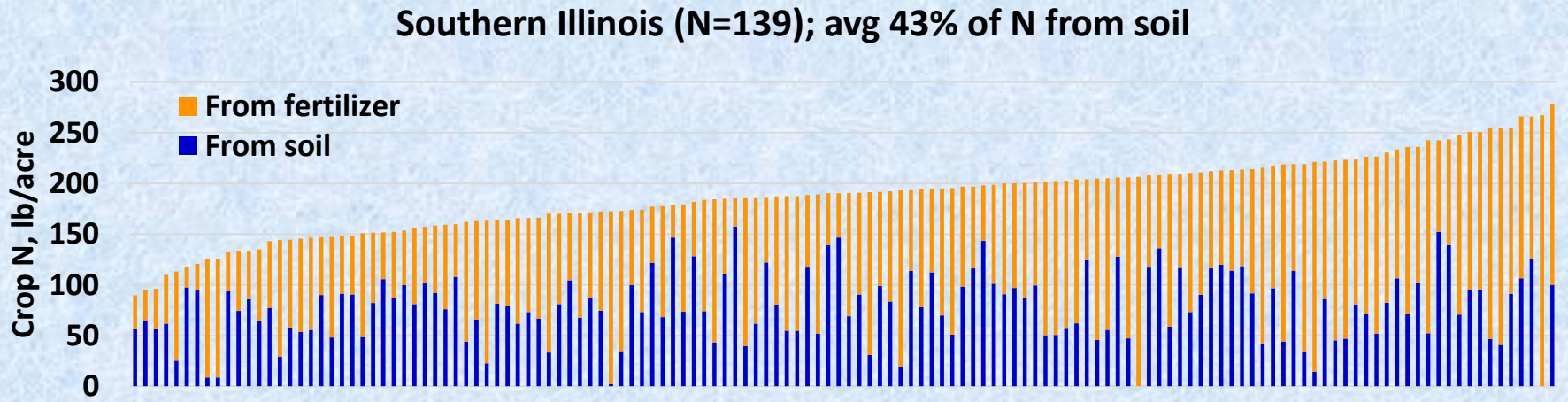
NONE of these would have been predictable before (or early in) the season

Source of N in the corn crop

- These are from all of the soy-corn trials in the Illinois database
- Arranged in order of increasing yield (at opt N)
- There is a slight upward trend (more lb N from soil at higher yields) but not enough to be helpful; % shows no trend







So how much N does corn get from soil v fertilizer?

- Two main problems with the high amounts from soil reported by Griesheim & Mulvaney:
  - Fertilizer N uptake and "cycling" into and through microbes begins immediately upon application: some ^{15}N is exchanged out for ^{14}N during this process, and so isn't in the plant
  - Their experiments were tiny (e.g., 4 site-years) compared to the Illinois database (about 500 site-years), which shows an average of about 50% of N coming from soil, but a very wide range, that includes sites with more than 80% coming from the soil
- Our N response data tells us that, on average, soil provides about 50% of the N in the crop, more in high-OM soils and less in lower-OM soils – the actual amount is always highly unpredictable
- This does NOT mean that we should fertilize with only the half of the N we think the crop will need that isn't supplied by soil:
  - That would, in central IL SC, lower yield by 28 bu/ac and RTN by $88 per acre

Thinking about “NUE”

- “NUE” as typically used includes the N from soil in the yield but not in the N supply
  - Example: 180 lb N to produce 240 bu = 0.75 lb N/bu
- But if soil supplies half of the N, it takes more fertilizer N per bushel added (to the yield above that from soil-supplied N):
  - Example: 120 lb N from soil; 180 lb N applied to provide for the other 120 bushels means that “fNUE” = 180 lb N/120 bu = 1.5 lb N per bushel
- Location in the soil and loss potential make uptake and use of fertilizer N generally less efficient than that of soil-supplied N
- If we keep in mind that fertilizer often provides only half the N for the crop, that should make us cautious about applying high rates to produce the half of the crop not supplied by soil N

First, about fall N:

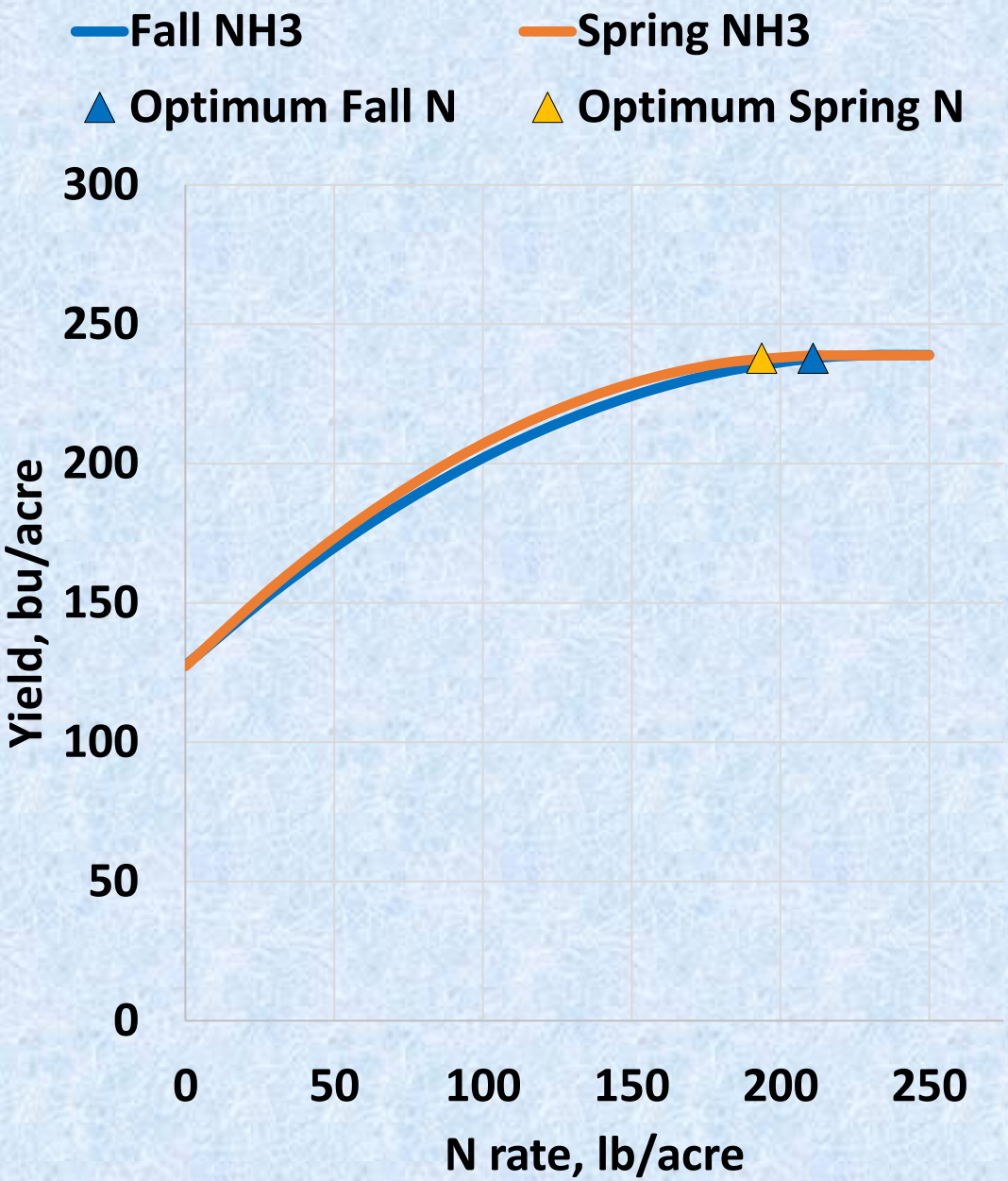
"The(ir) findings showed a mere 12% to 24% of [fall-]applied nitrogen was present in corn at harvest."

One problem: that study did not include spring-applied N

The figure on the right is for fall- versus spring-applied NH_3, averaged over 17 on-farm comparisons organized by Dan Schaefer of IFCA, with NREC funding

Yields at the optimum N rate were identical (238 bu/ac), but the optimum N rate was 17 lb/ac higher for fall than for spring-applied, 211 lb N v 194 lb N

- More fall-applied N was lost

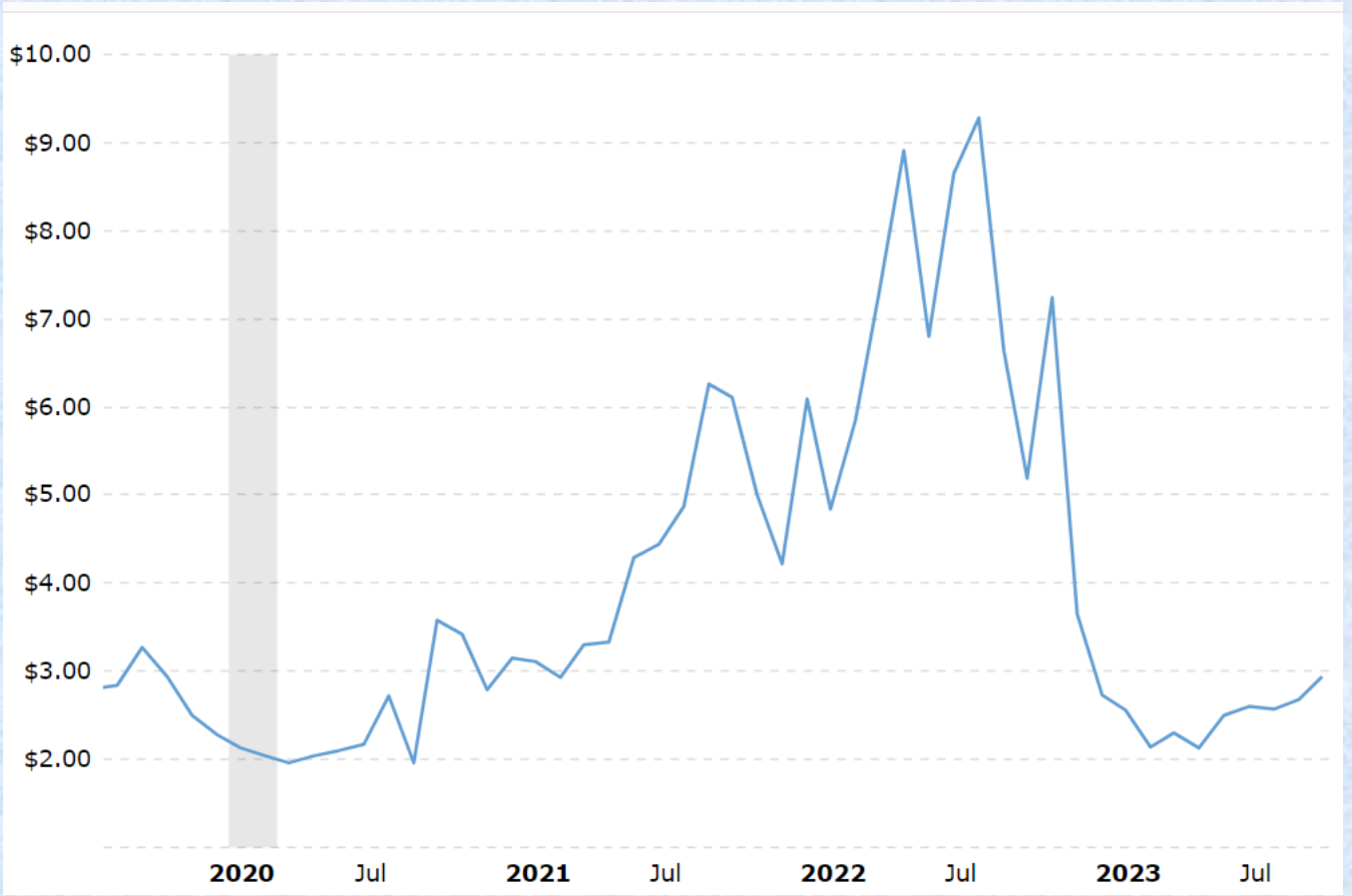


Nitrogen for the 2024 corn crop

Nitrogen and corn prices are factors for the 2024 corn crop, but volatility may be less than in recent years:

- The current price of natural gas (primary feedstock for NH_3 production) is much lower than it was a year ago
- The corn price for 2024 is currently projected at about $4.80 per bushel

Natural gas price, Henry Hub



N rate calculator: https://www.cornnratecalc.org/

Nitrogen Price ($/lb):	**0.49**
Corn Price ($/bu):	**5.00**
Price Ratio:	**0.098**
MRTN Rate (lb N/acre):	**182**
Profitable N Rate Range (lb N/acre):	**170 - 195**
Net Return to N at MRTN Rate ($/acre):	**$449.80**
Percent of Maximum Yield at MRTN Rate:	**99%**
Anhydrous Ammonia (82% N) at MRTN Rate (lb product/acre):	**221**
Anhydrous Ammonia (82% N) Cost at MRTN Rate ($/acre):	**$89.18**

Select State *
Illinois

Select Rotation *
Corn following soybean

Select Region
Central

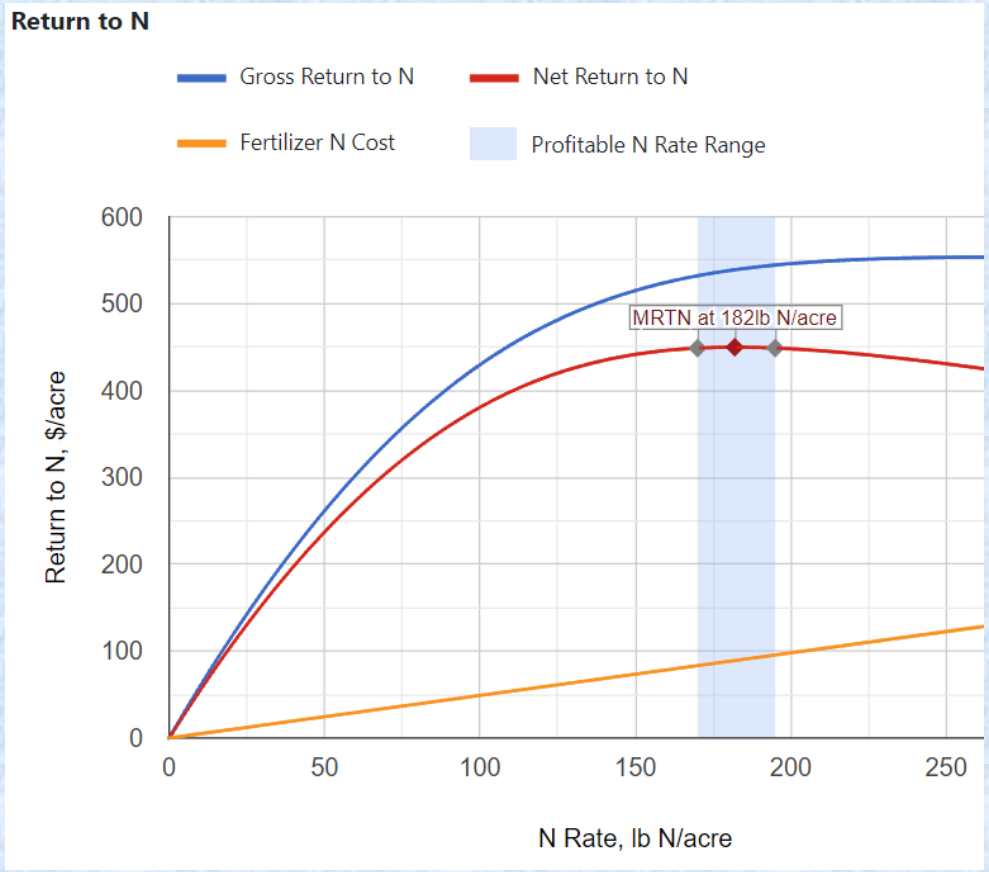
Set Corn and Nitrogen Prices *

Anhydrous Ammonia (82% N) — 800 ($/Ton)

Nitrogen Price — 0.49 ($/lb N)

Corn Price — 5.00 ($/bu)

CALCULATE RESET



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Changing MRTN with changing prices for 2024

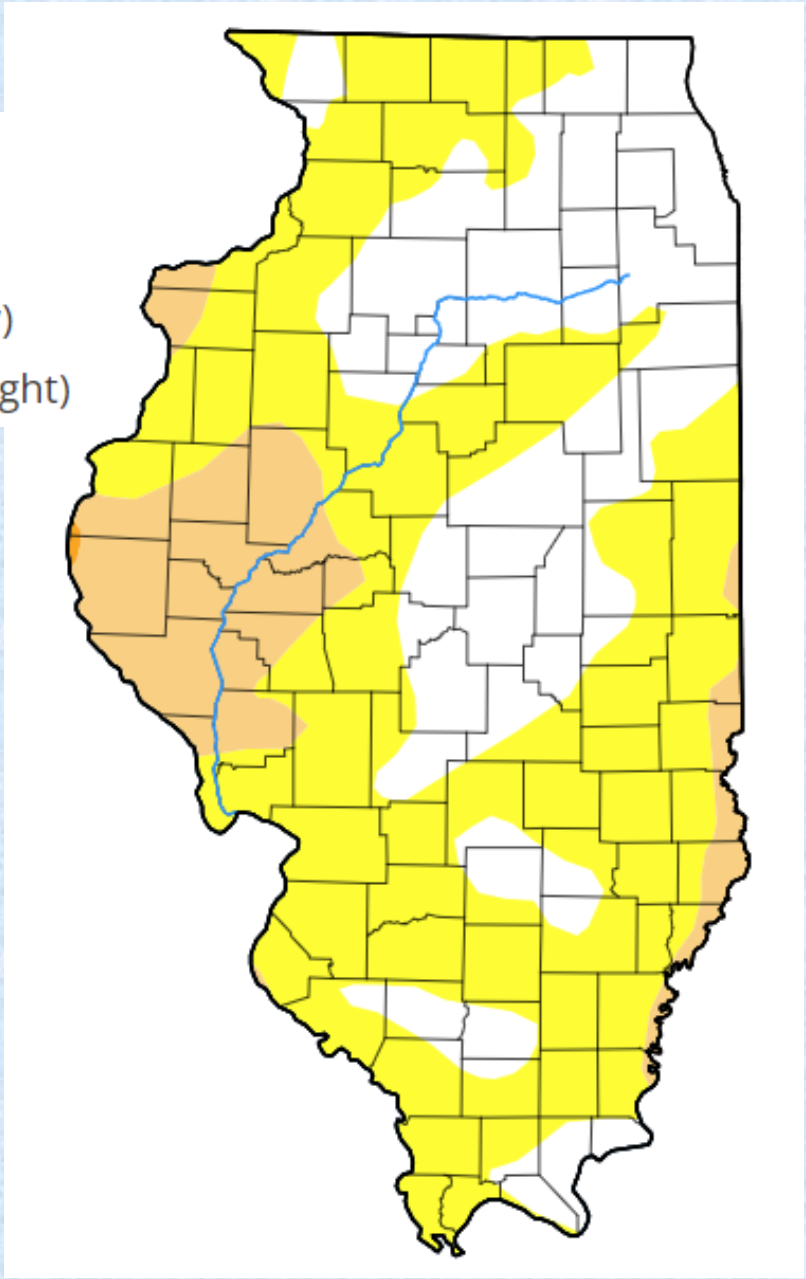
Corn at $5.00; N price as indicated

IL Region	Rotation	MRTN at N price, $ per ton NH_3/$ per lb N $600/0.37	$800/0.49	$1,000/0.61
North	**Soy-Corn**	**193**	**179**	**167**
	Corn-Corn	222	206	197
Central	**Soy-Corn**	**193**	**182**	**174**
	Corn-Corn	212	200	193
South (Spr)	**Soy-Corn**	**214**	**201**	**195**
(Spring)	Corn-Corn	215	198	188

N application in Fall 2023

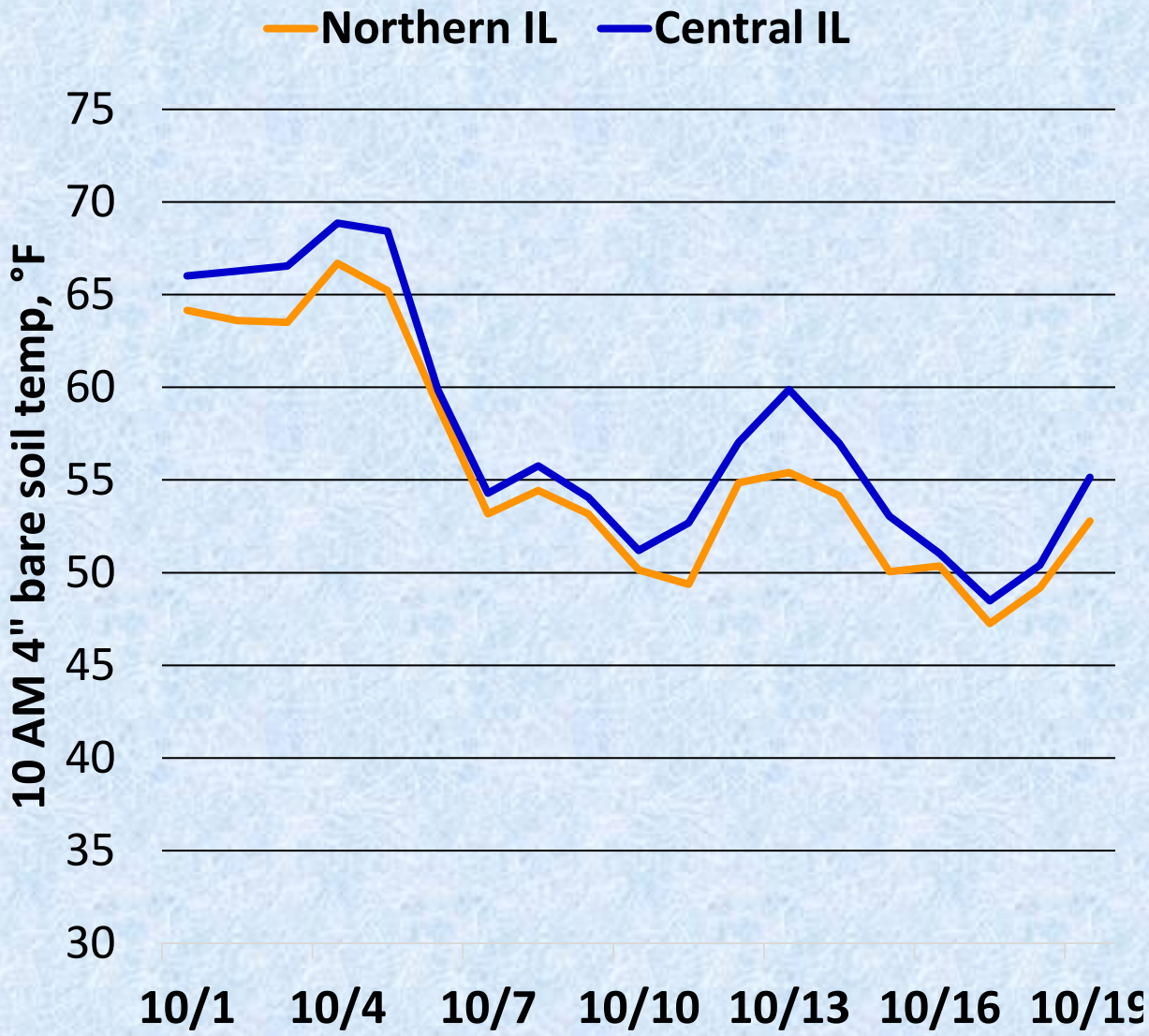
- October rainfall so far is a little above normal in N IL, about normal in central IL
  - Still dry in parts of N & C IL
- Average temperatures have been close to average
- Soil temperatures remain too high for safe application now, need to watch

October 19 drought map



Illinois soil temperatures, October 2023

- Data are from the Illinois Climate Network, WARM program: https://www.isws.illinois.edu/warm/soil/
- Chose 4” depth at 10 AM:
  - Should not be max or min
  - Avg of max & min not is not reliable
- Average of 4 sites in northern IL and 5 sites in central IL
- Oct 24-26 forecast is warm



A new MRCC tool for historical soil temp data:

https://mrcc.purdue.edu/clim/Soil-T

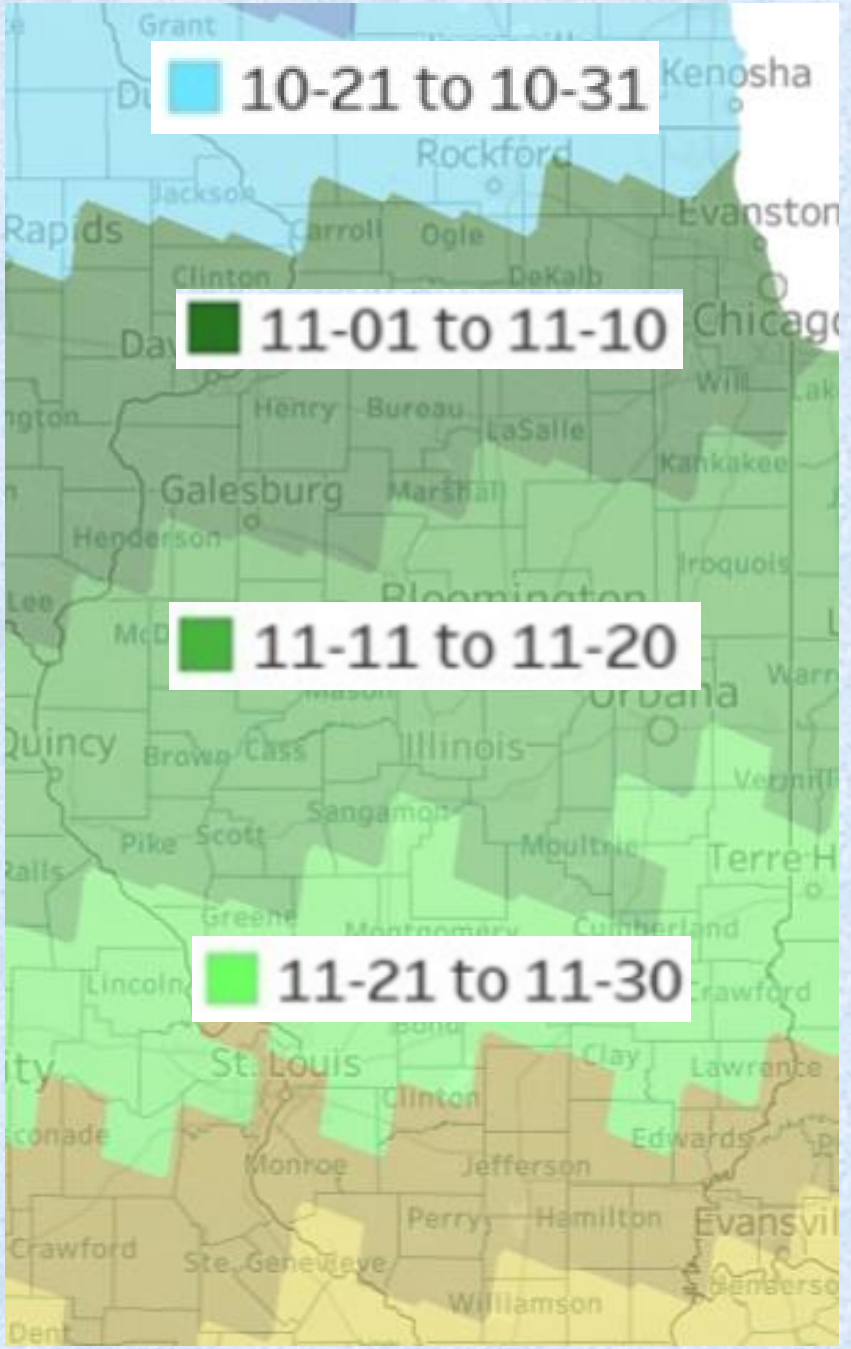
Date When Soil Temperature Cools Below 50 °F

Based on 30-yr data 1991-2020, 4” depth

Numbers are 7-day moving averages

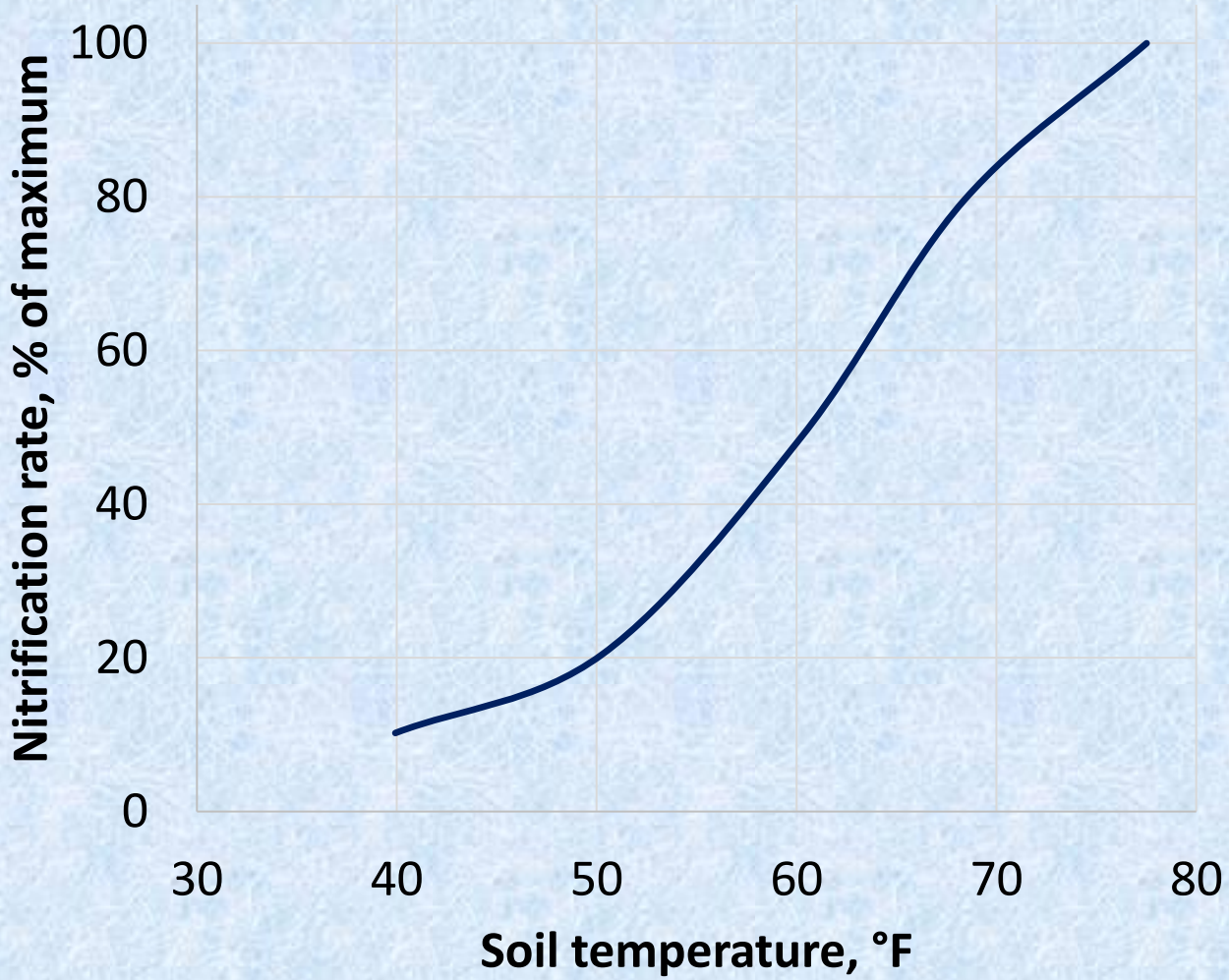
10 days later than normal rec in central IL

- Probably a little safer, but not much
- Doesn’t include current conditions



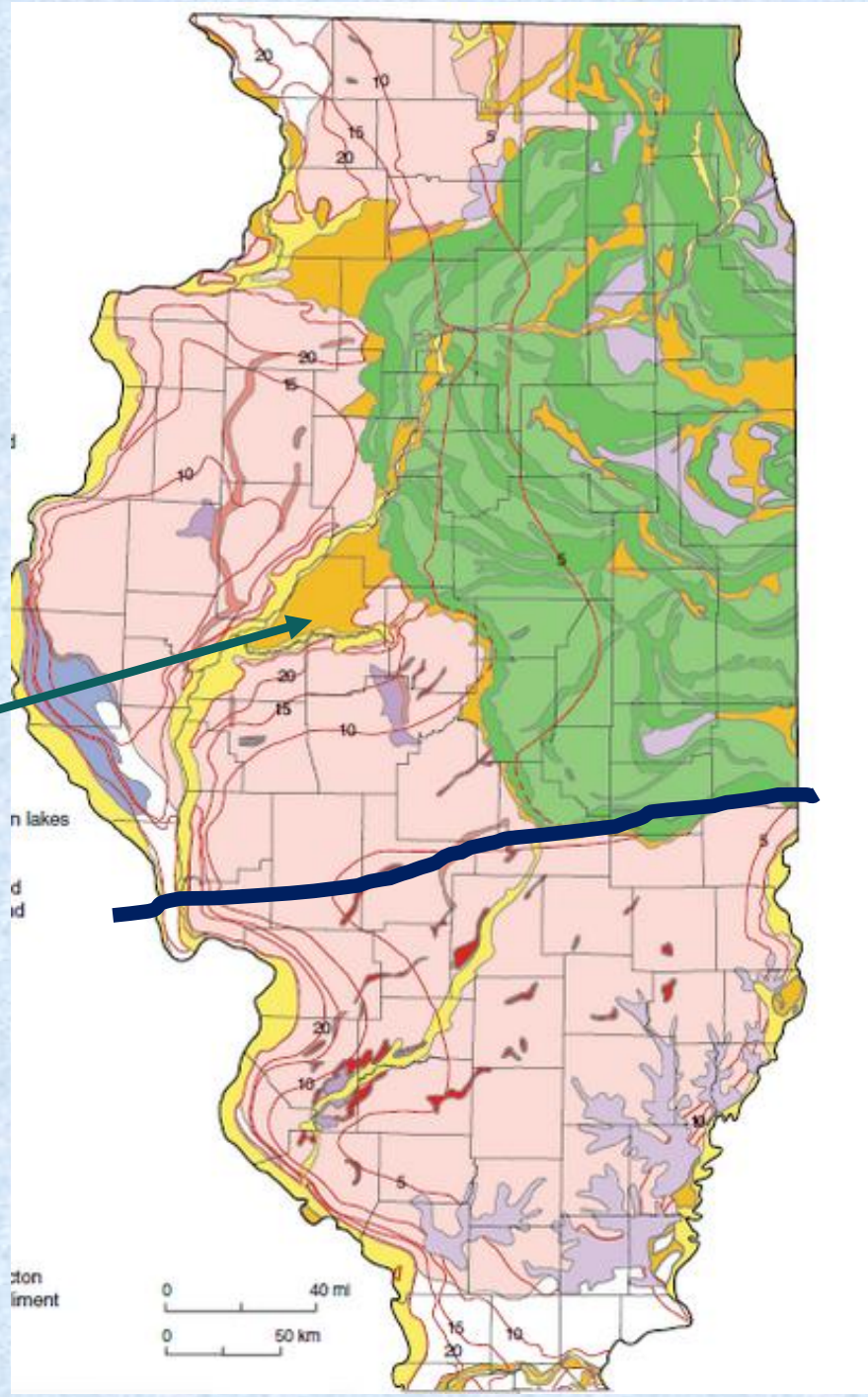
Is soil temperature really that critical?

- Yes: conversion of NH_4^+ to NO_3^- makes leaching and denitrification possible; as a biological process, rate depends on temperature
- Figure shows that nitrification is still happening at 50 °F (it doesn't stop until 32 °F) and it accelerates at temps>50
- The more nitrification, the more N will be lost once tiles begin to run
- Nitrification inhibitors help some, but they break down faster at higher temps as well



Basics: apply where it's safer to apply

- Map shows approximate line between safe application (north) and not-very-safe application (south). Prairie soils near the line may be safe
- Waiting until December or January in southern IL would help at the start, but springs are warmer and wetter, and the risk of loss is much higher
- North of the line, sandy soils, soils with gravel underneath, and chronically wet soils are not safe for fall application
- When we pay more for N, we lose more $$s when N is lost



Bottom line(s) on fall NH_3 application

- Will need to wait for dryer conditions in most fields: mudding in NH_3 in the fall is not advised
- Soil temperatures need to get to 50° and be headed down at the time of application to keep most of the N in ammonium form through early spring
- Use a nitrification inhibitor
- If things do not come together to get NH_3 applied this fall, applying next spring remains a viable option, but may mean more uncertainty in N price

Partial N rates this fall?

- Applying half or so of the full rate in the fall lowers potential loss amounts, but carries extra costs per lb of N applied (application, labeled rates of nitrification inhibitor)
- It might be a reasonable option (if done properly) if it's likely that N price will be higher next spring
- It usually commits the field to plant corn next spring
- If any N will be applied next spring, the fall rate should always be "partial" – it's total N application rate that's important, and we need to leave "space" for spring N

NH_3 application for wheat?

- Some producers applied NH_3 on 15” spacing before planting wheat in areas south of I-70. This is a common practice in Great Plains states, where soils tend to stay dry through the winter. It’s much less common in Illinois than applying N as spring topdress, usually UAN using streamer bars

Pros:

1. A cheaper N source than spring UAN
2. Gets N applied without having to spread on frozen or wet soils
3. Subsurface application less likely to move

Cons:

1. Applied on warm soils, will mostly convert to nitrate before crop uptake next spring; can mean more N loss
2. Potential for upward movement and seedling damage if it’s dry after planting
3. Lower rate per knife with 15” spacing may not distribute as uniformly
4. Shallow placement can mean more loss, but deep placement can leave N below the rooting zone in the spring, especially if soils are wet

What's next for improving N rate predictions?

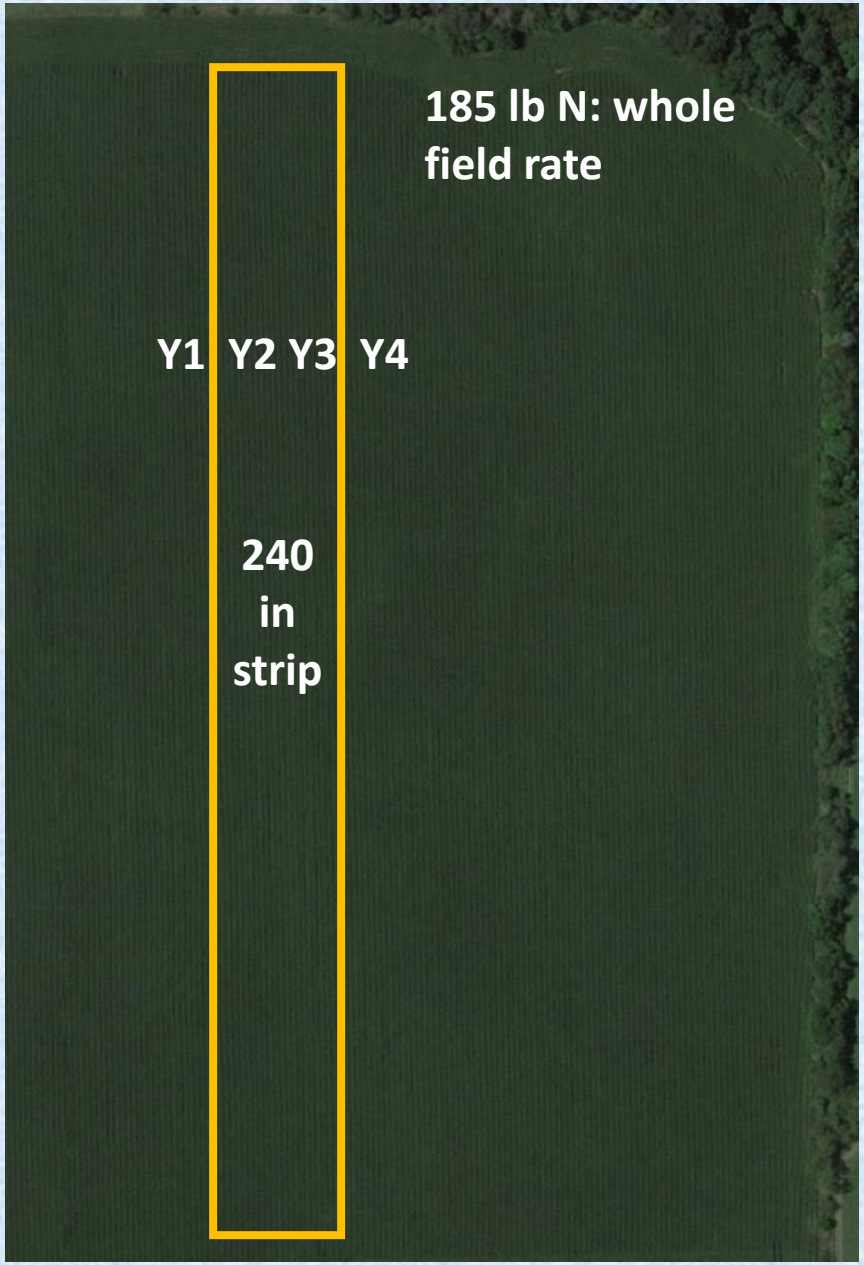
- Fewer full-rate trials, many smaller trials more easily (and cheaply) done by producers, to produce data that will BUILD CONFIDENCE in the MRTN:
  - Only two rates, including the one used in a field plus one lower or higher, chosen to form two rates (one in the MRTN range; one 50-60 lb higher)
  - Strips through the field and wide enough to allow use of normal equipment; sensing (aircraft, drone, etc.) during the season; YM yields from each rate on each side of each strip; two strips in a field would be preferable, but not required
  - On different soils within and across (many) fields
- Sensing & yield monitor data along with weather and soil information can be used to "train" an N prediction model that would improve on the current one
- Dan Schaefer at IFCA [dan@ifca.com] leads the field phase, with cooperation from the Precision Conservation Management program, retailers, and others

N Rate Verification Trials:

- Project in its early years, funded by NREC
- Likely to replace most full-rate trials over time
- Dan Schaefer (IFCA) will coordinate

Instead of this (in few IL fields each year)

This, in 500(?) IL fields each year



THANK YOU

QUESTIONS?

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