Groundwater Quality- Nitrate Leaching

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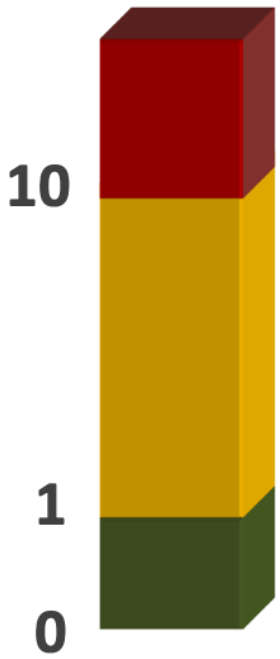
Nitrate and Human Health

- Infants and pregnant women
  - Methemoglobinemia or “blue-baby syndrome”
  - Central nervous system malformations (birth defects & miscarriages)

- Adults- Possible correlations to:
  - Non-Hodgkin’s lymphoma
  - Various cancers (ex. gastric, bladder)
  - Thyroid function
  - Diabetes in children

Nitrate-Nitrogen Concentrations



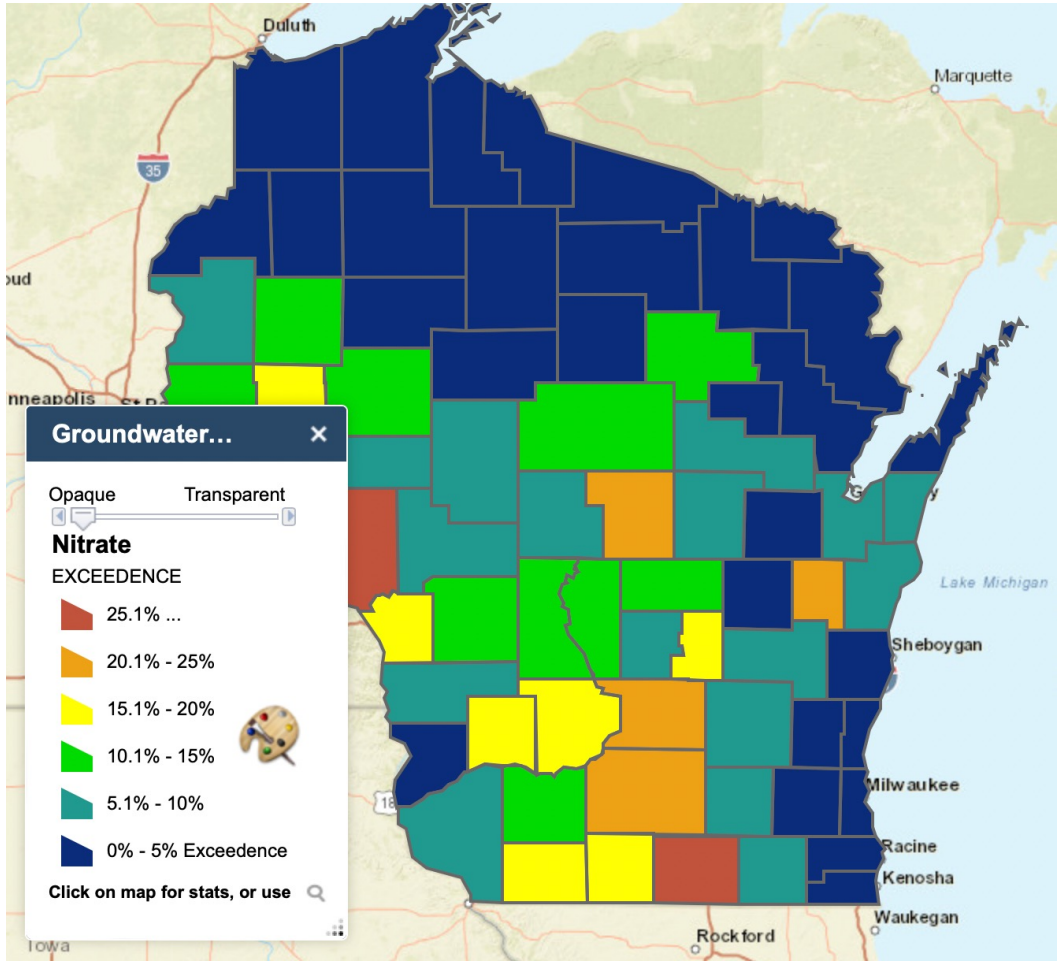
- **Greater than 10 mg/L**
  Impacted at a level that exceeds state and federal limits for drinking water

- **Greater than 1 mg/L**
  Evidence of land-use impacts

- **Less than 1 mg/L**
  Natural or background levels in WI groundwater

- DO NOT give water to infants
- DO NOT consume if you are a woman who is pregnant or trying to conceive
- RECOMMEND everyone avoid long-term consumption

Considered suitable for drinking water

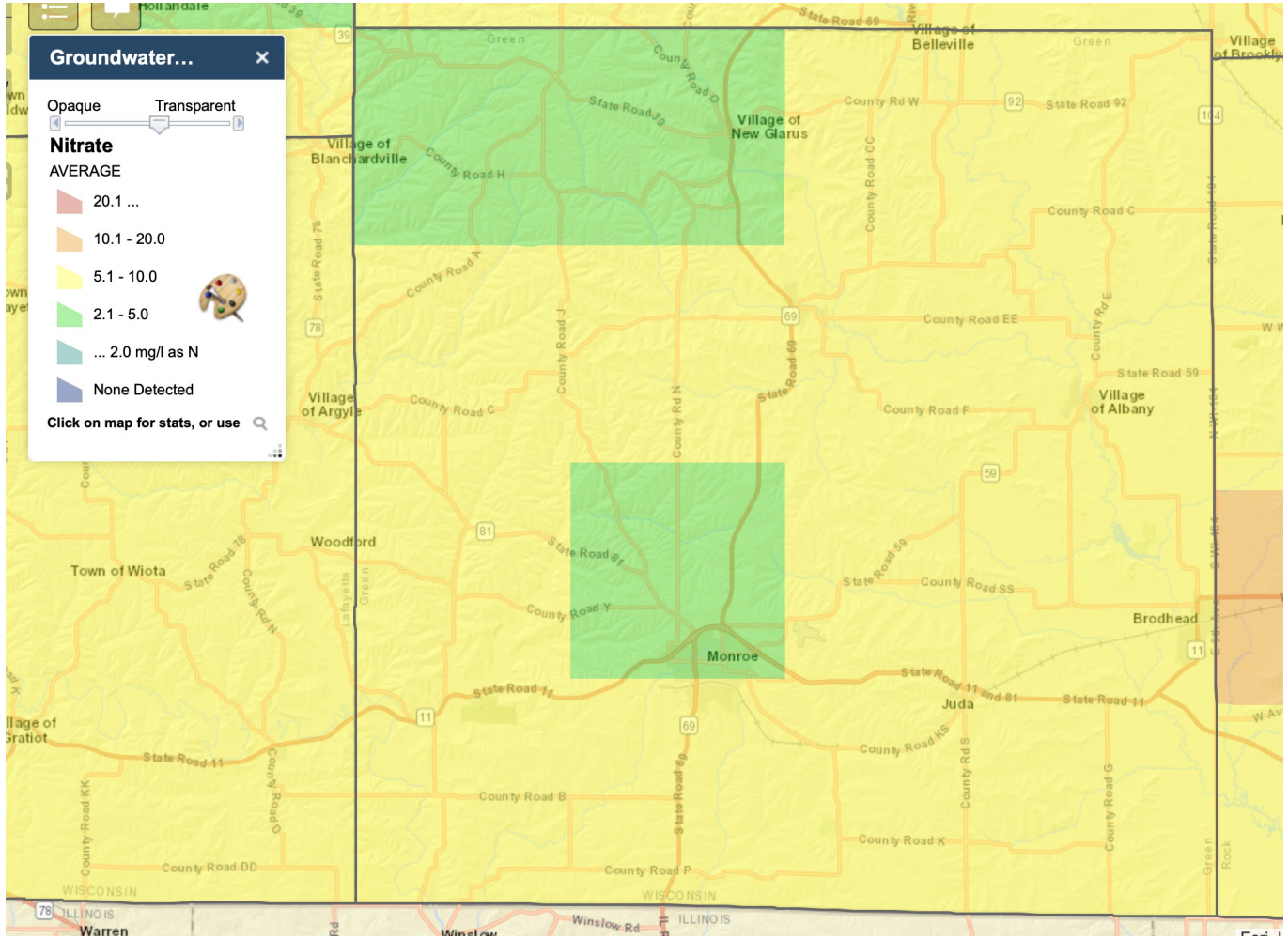


Groundwater Quality in Wisconsin

- Around 10% of private wells in Wisconsin have >10 mg nitrate/L
- Increases to 20% where land is >75% cultivated

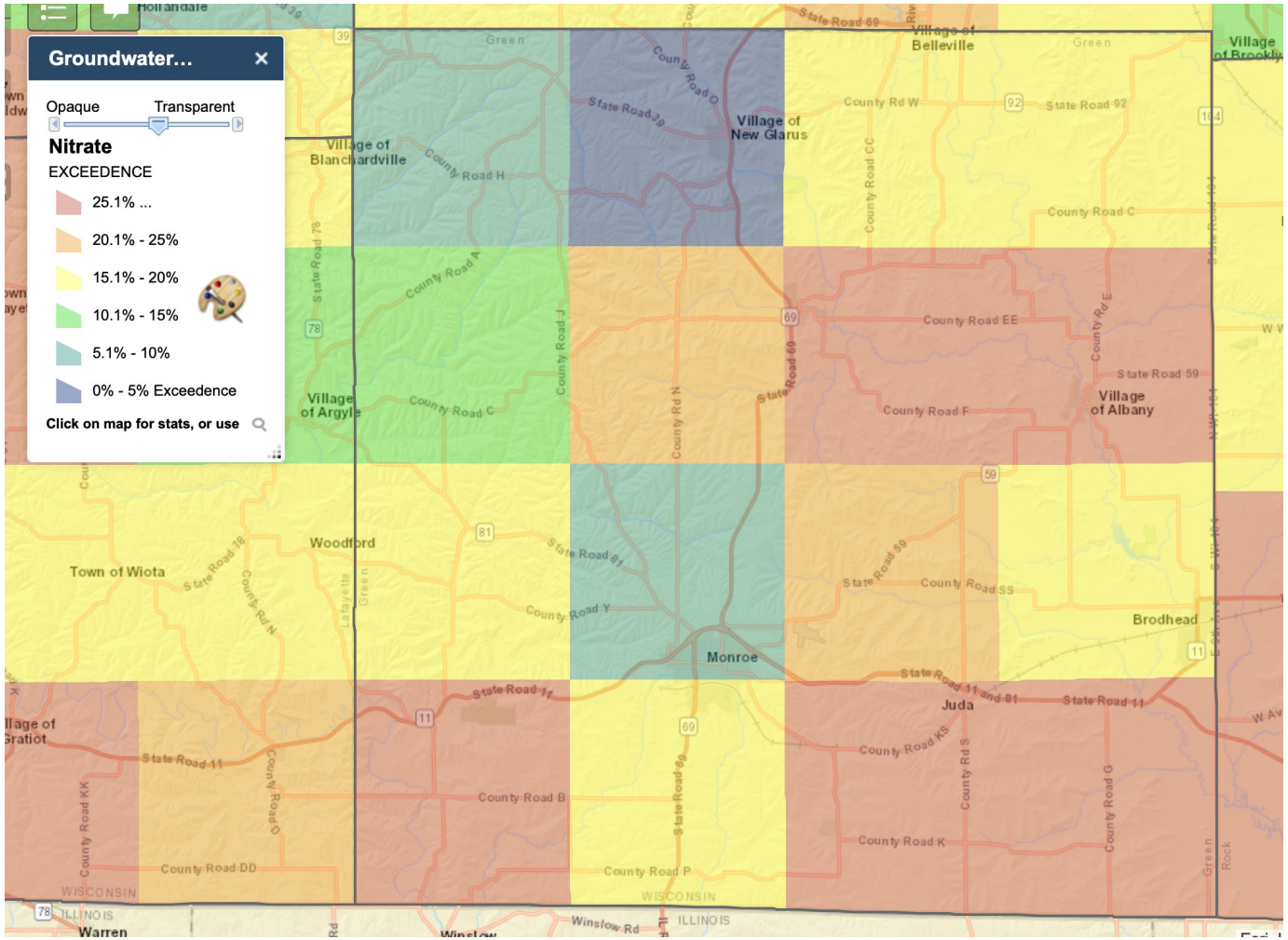
Groundwater Quality in Green County

- Average Nitrate Concentration (mg nitrate/L)



Groundwater Quality in Green County

- Percentage above 10 mg nitrate/L



Nitrogen Leaching 101

- Fallow ground + warm soil + excess nitrogen
- Corn typically utilizes 50% of nitrogen applied
- The largest nitrate leaching occurred during the corn phase of the corn-soybean-wheat rotation (Syswerda et al, 2012).
    - Around 50% of nitrate loss over the 3 year rotation
    - 85% of the loss occurred during the “off season”, after harvest and before soybean planting
- Kevin’s work showed 70% of nitrate leaching happened between April 1- June 30th

Potential Best Management Practices

- Source + Transport = Nutrient Loss

- Limiting Fallow Ground
  - Crop rotation
  - Cover Crops
- Limiting Source
  - Crop Rotation
  - Cover Crops
  - Nitrogen Rate

Crop Rotation Impacts Risk- How can we minimize bare ground

- Corn – Soybean



Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer

- Corn-Soybean-Wheat



Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer

- -Corn-Soybean Wheat + Cover Crop

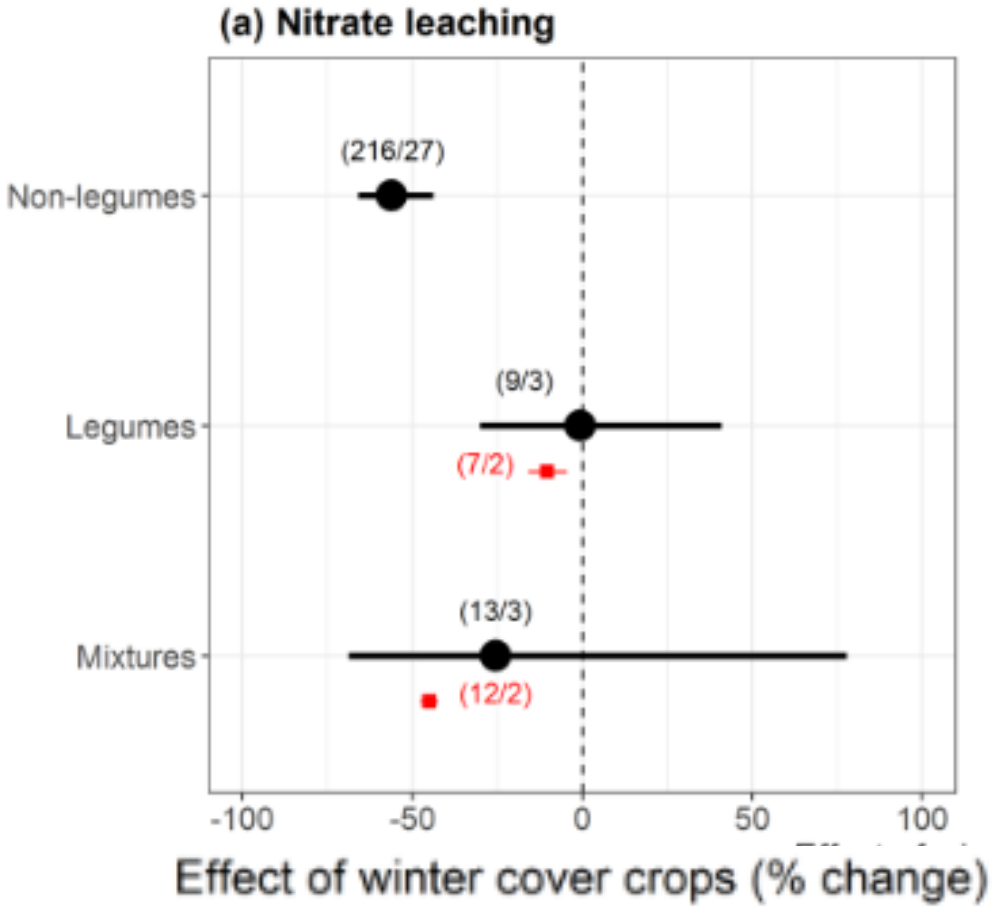


Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer

Cover crop specifics

Nitrogen leaching is impacted by cover crop nitrogen content

- Species Selection is key!
  - Grasses vs legumes
  - Over-wintering species
- Biomass accumulation differences

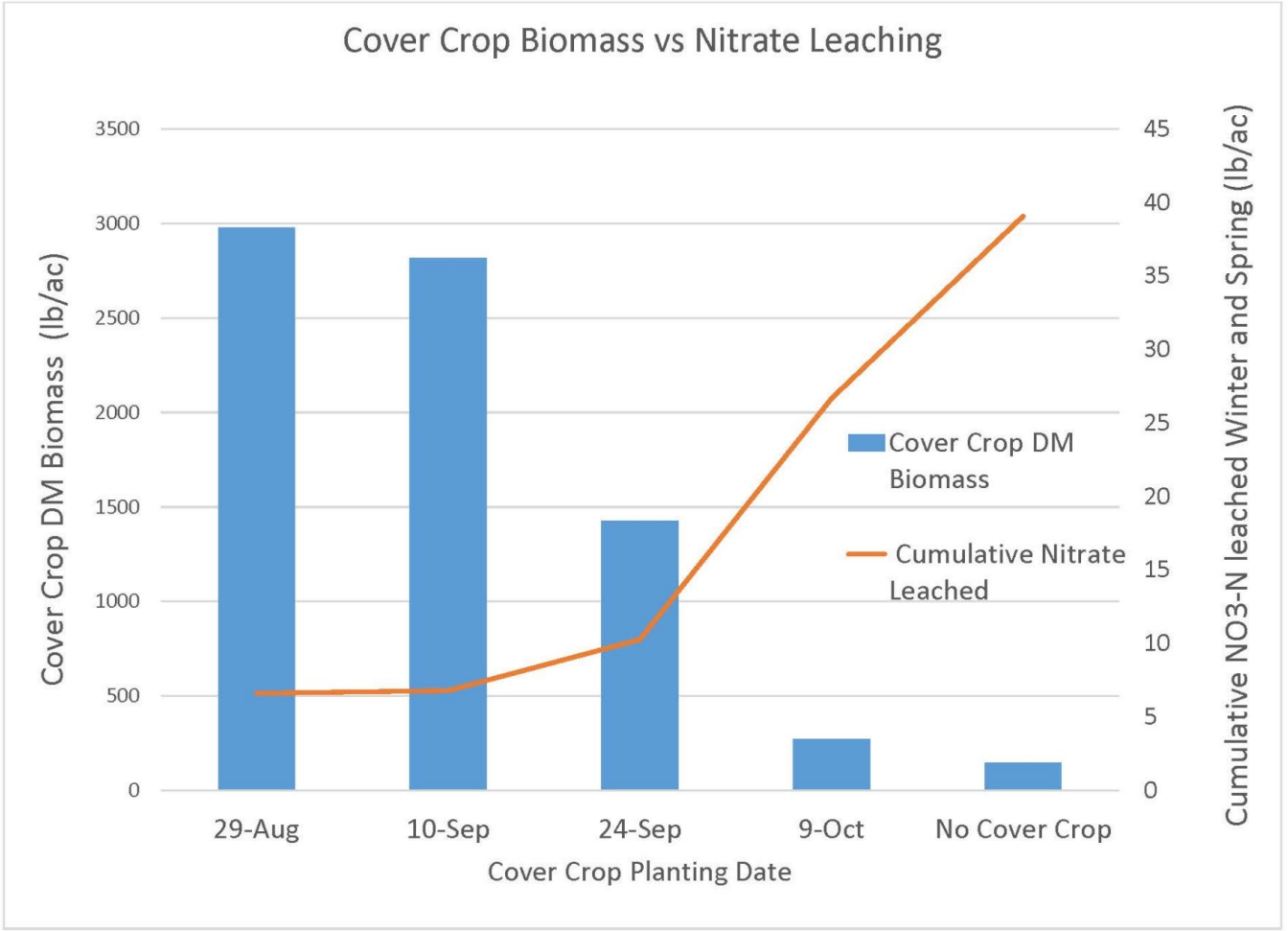


(Thapa et al. 2018)

...and biomass produced!

Wheat harvest -> manure applied -> cover crop mixture planted every 2 weeks.

- Planting early has major impacts on the amount of nitrate leached



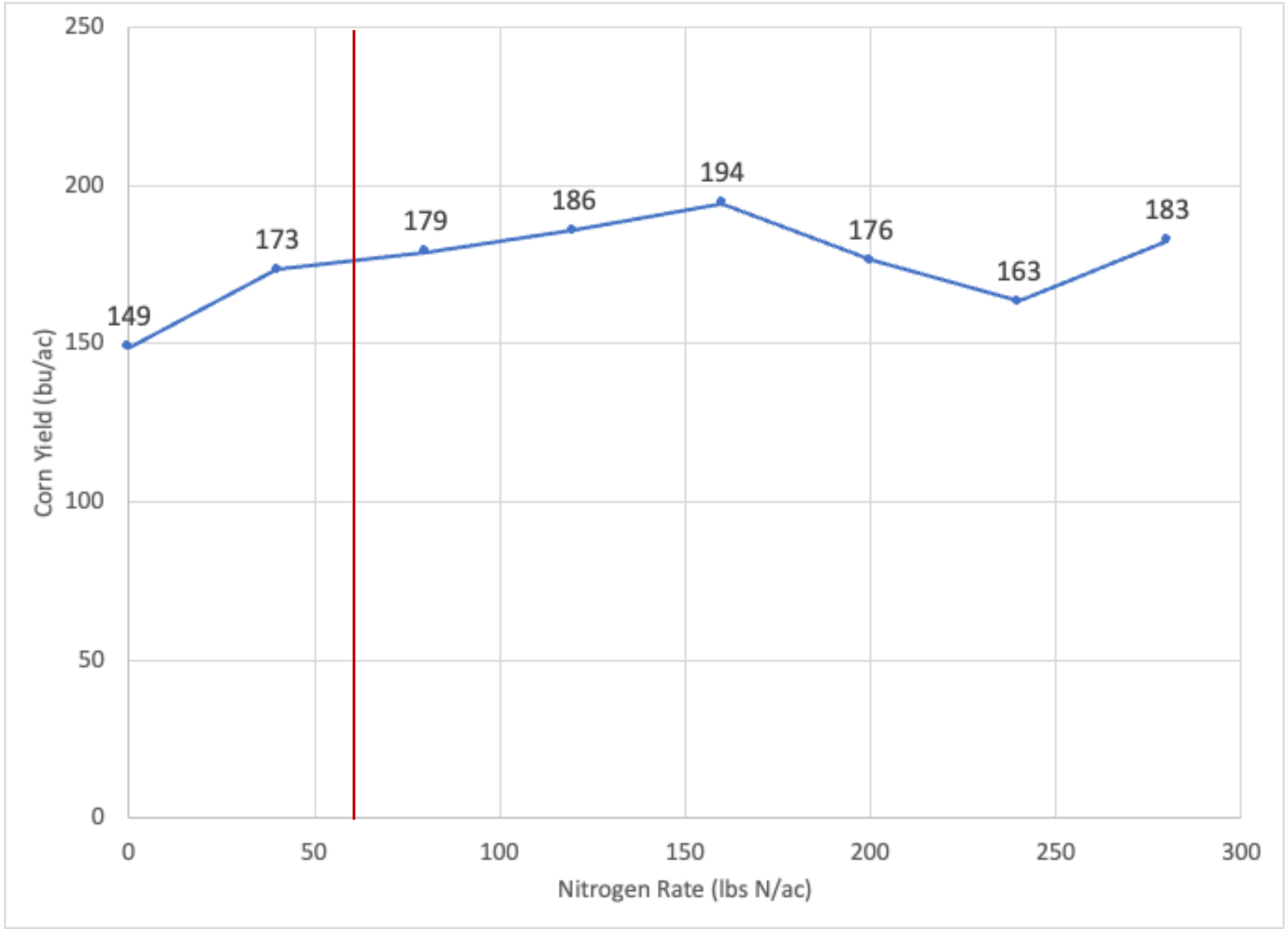
(Sedghi and Weil 2022)

Rock County Example

Rock County Data

- Ammonium Nitrate (not incorporated) applied at planting
- pH <7, OM 2-5%

Treatment (Nitrogen Rate)	Yield (bu/ac)
0	149
40	173
80	179
120	186
160	194
200	176
240	163
280	183


250
200
150
100
50
0
Corn Yield (bu/ac)
149
173
179
186
194
176
163
183
0
50
100
150
200
250
300
Nitrogen Rate (lbs N/ac)

Nitrogen Budgets

Leachable N = N Input - N Output - ΔN Storage

NO_3^-

Commercial fertilizer

Crop residue, manure, Fixed N

Irrigation

N_2

NH_3

NO_3^-

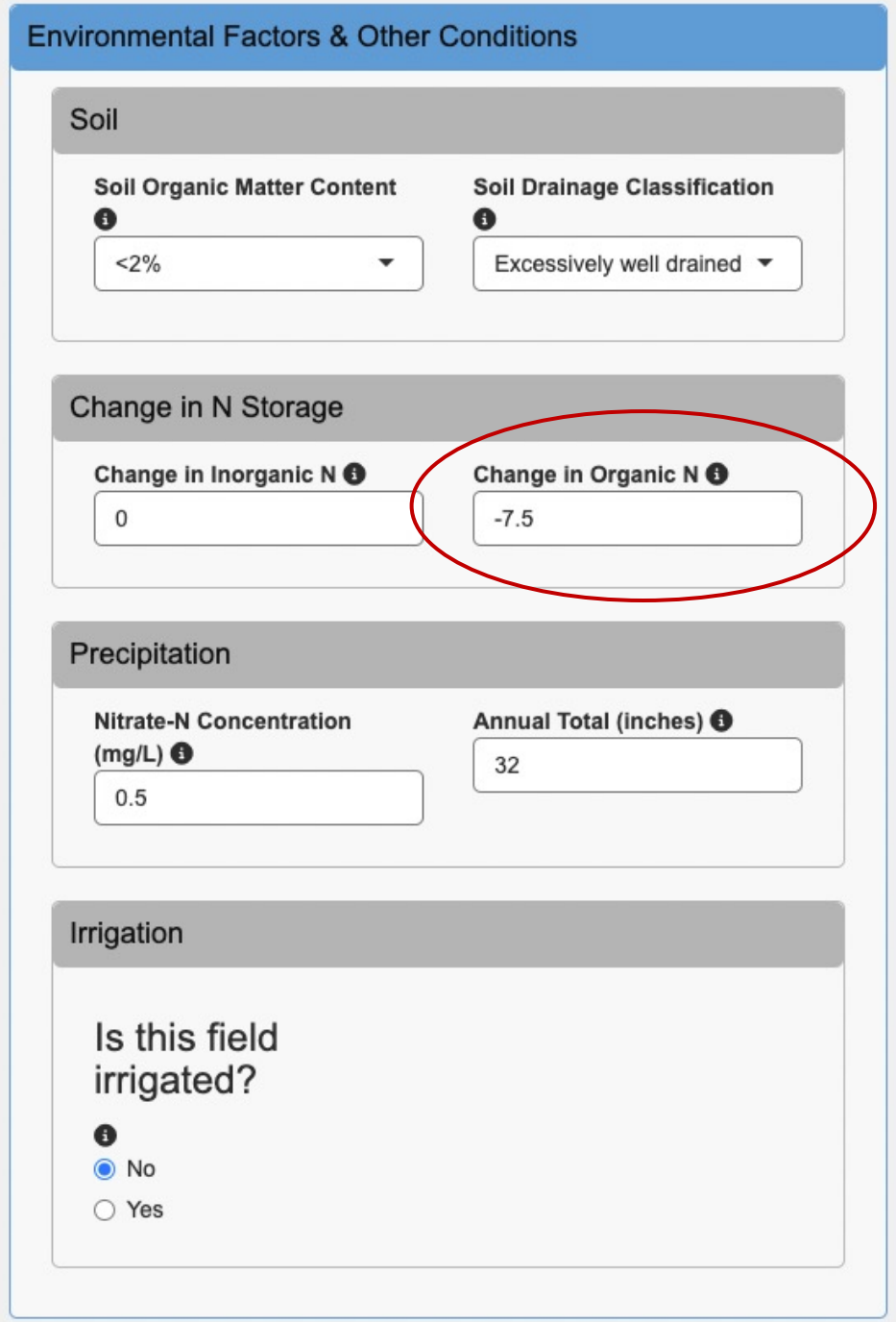
NH_4^+

Organic N

Soil and Weather Factors

- Organic matter
- Precipitation
- Soil drainage
- Change in Organic Nitrogen

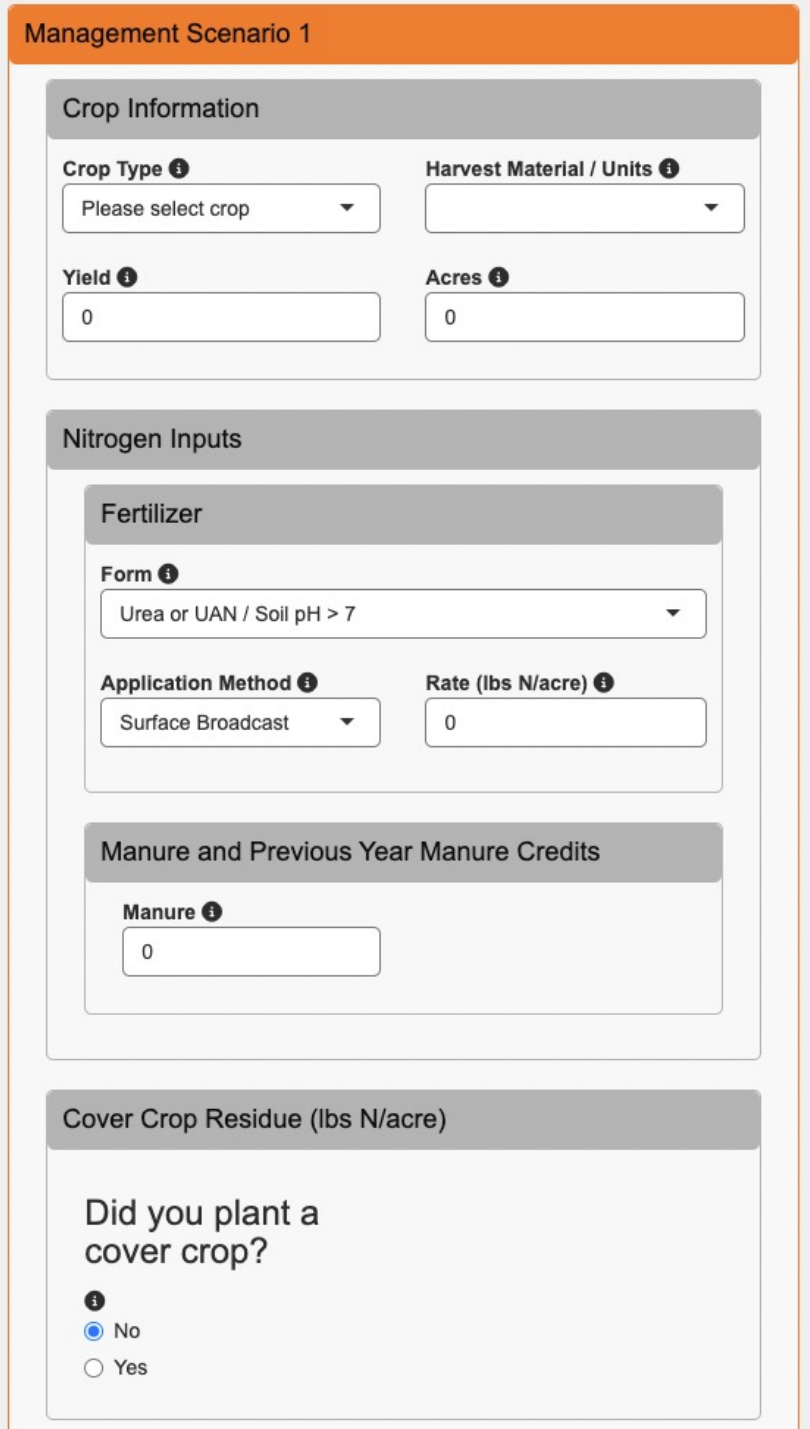
Leachable N =
N Input - N Output –
ΔN Storage



Yield and Management

- Yield
- Soil pH
- Manure credit
- Fertility
- Cover Crops

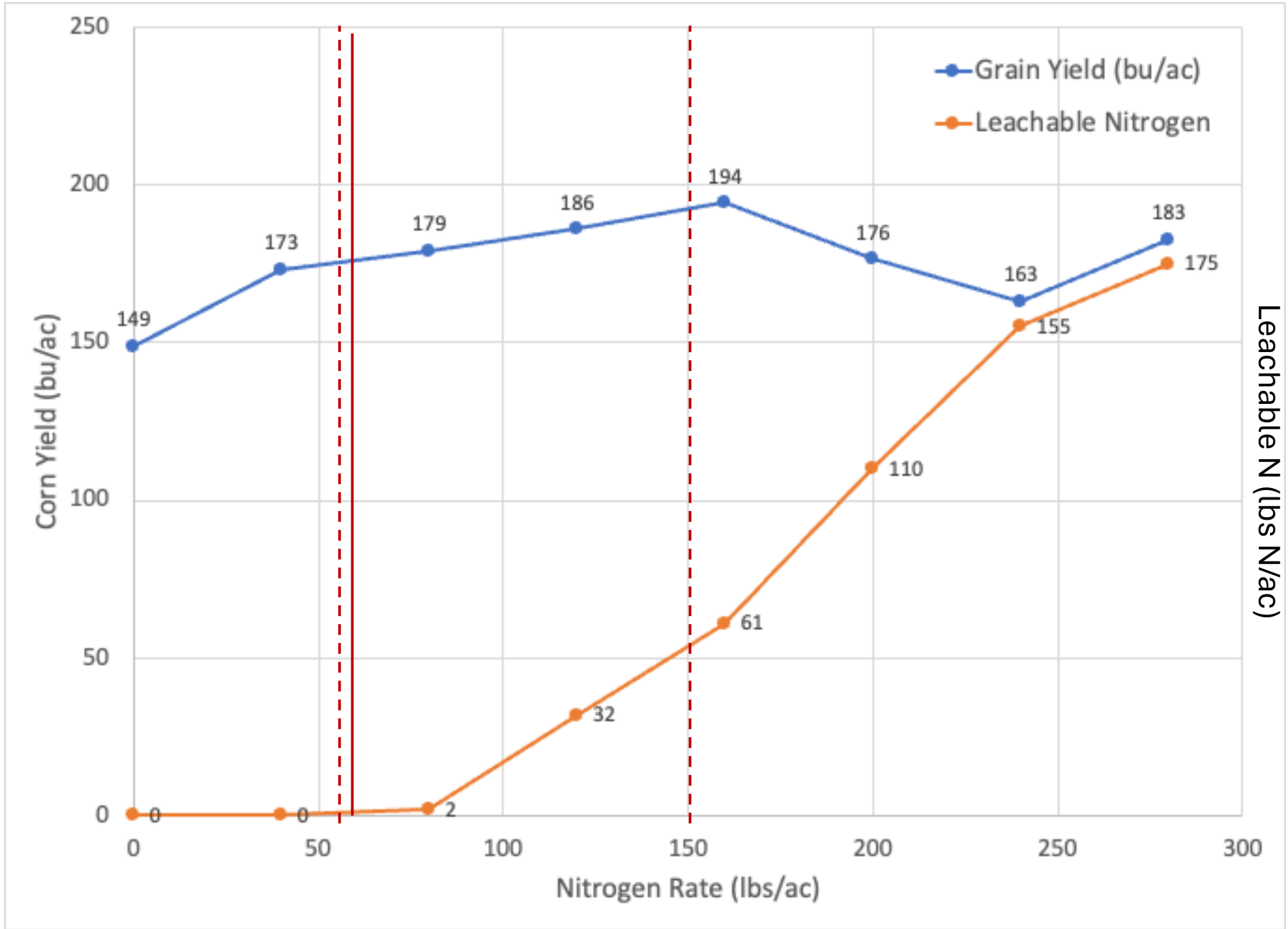
Leachable N =
N Input - N Output –
ΔN Storage



What’s missing from the calculator?

Leachable N under variable N rates

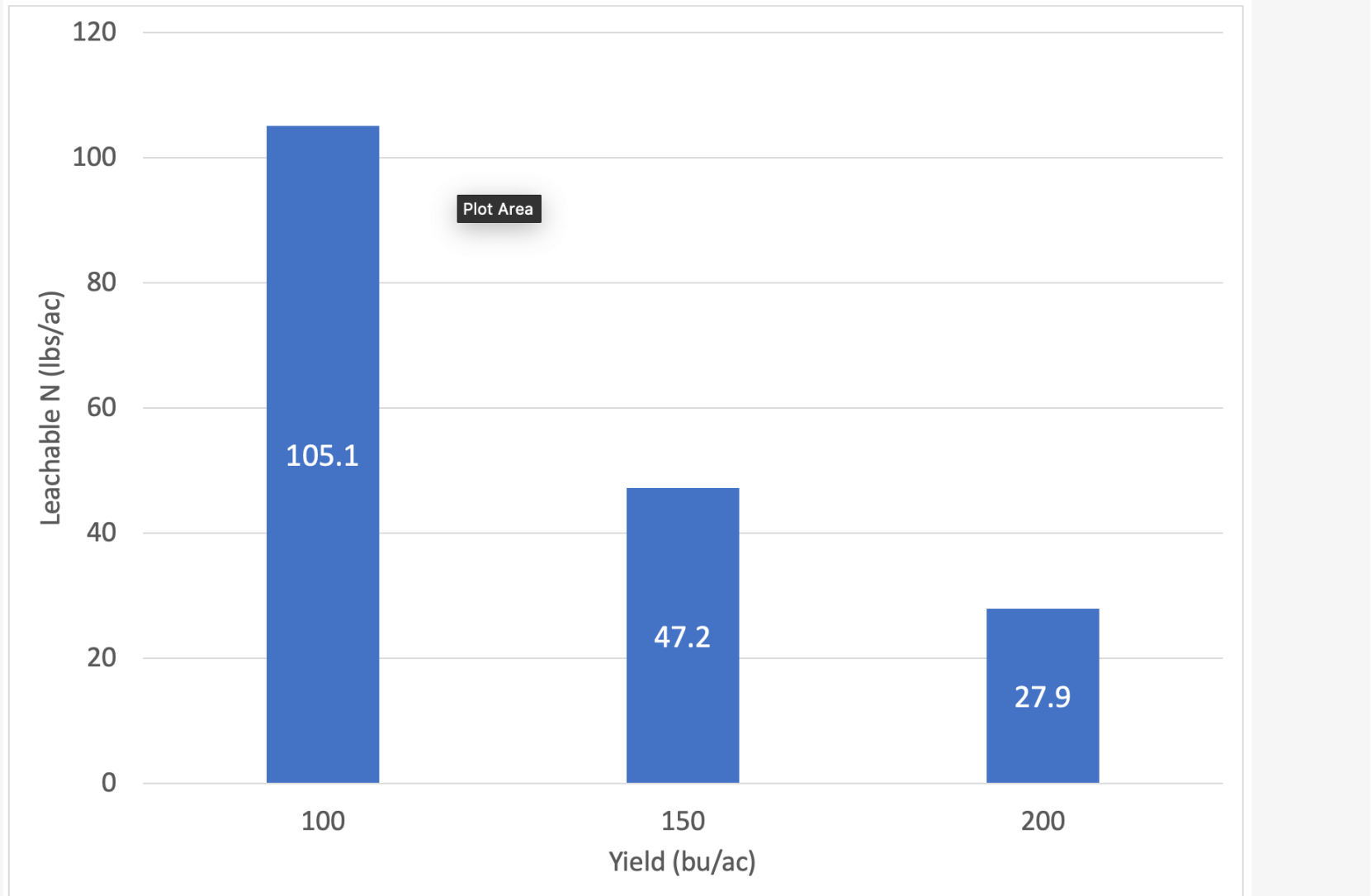
Treatment (Nitrogen Rate)	Leachable N
0	0
40	0
80	0
120	0
160	18
200	67
240	112
280	132


Grain Yield (bu/ac)
Leachable Nitrogen
Corn Yield (bu/ac)
Leachable N (lbs N/ac)
Nitrogen Rate (lbs/ac)
250
200
150
100
50
0
0
50
100
150
200
250
300
149
173
179
186
194
176
163
183
0
0
2
32
61
110
155
175


How effective are best management practices?

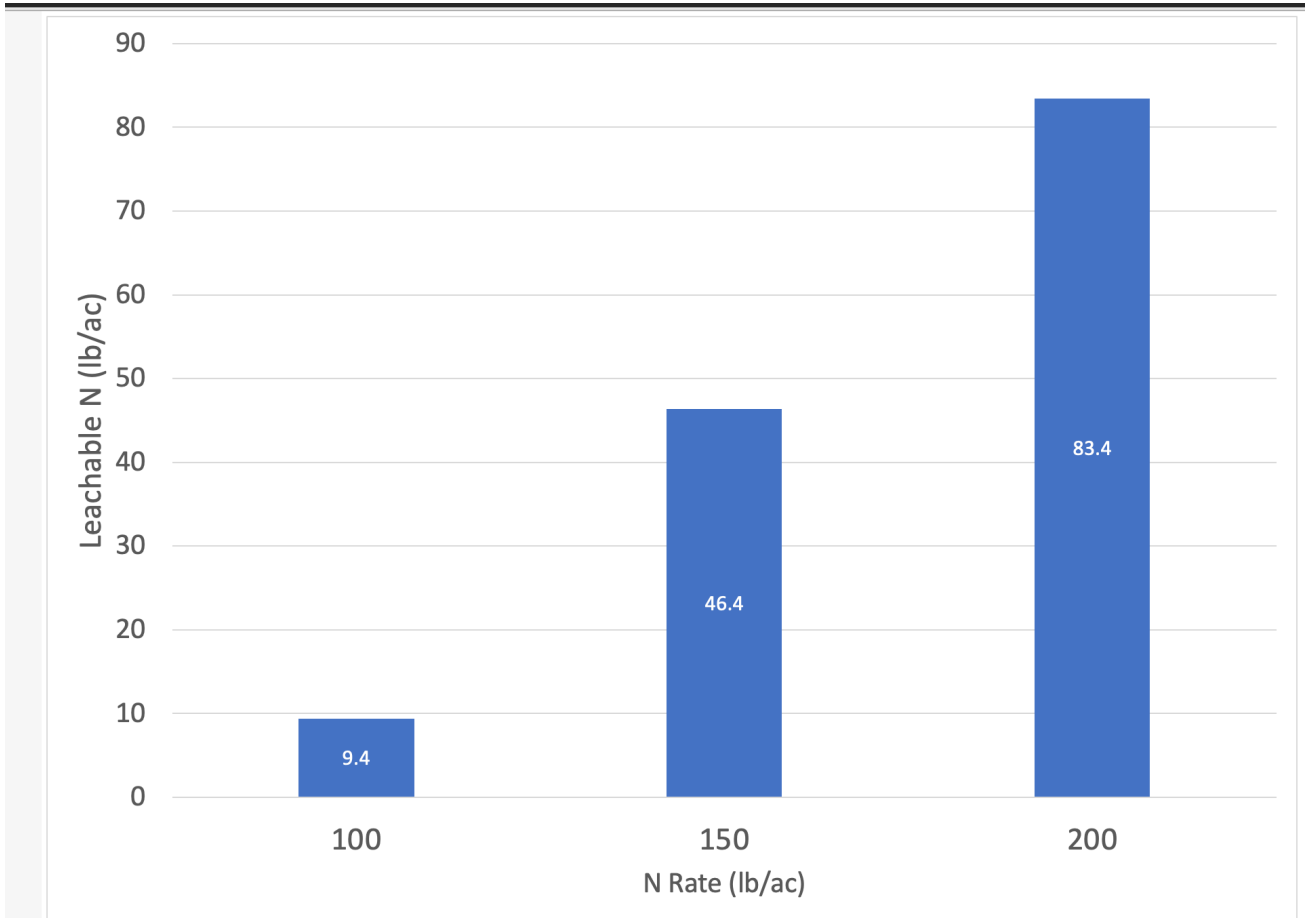
Same N rate, more yield-> less leachable nitrogen

*assumes N rate of 125 lb/ac and 2-5% OM with pH <7

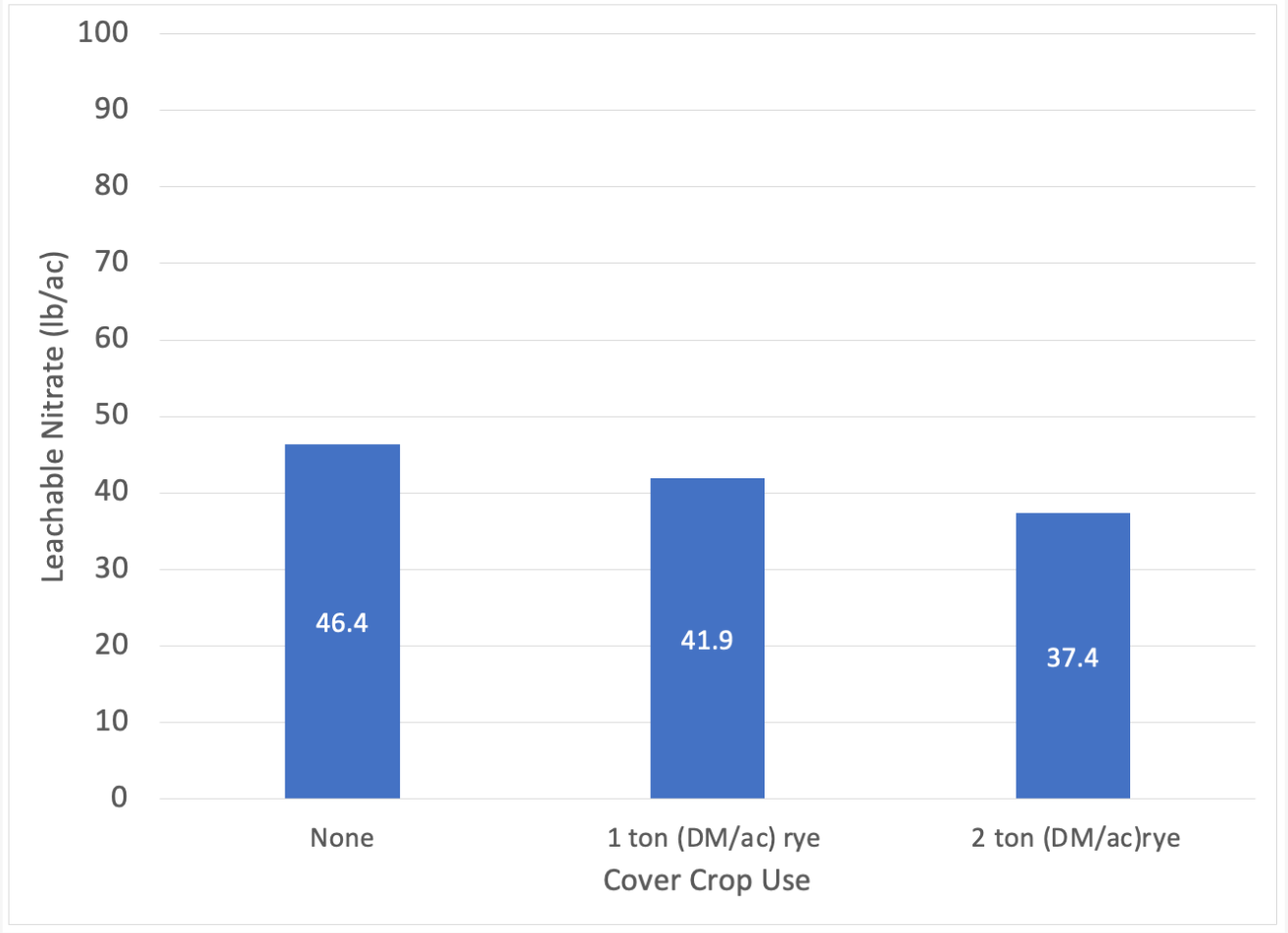


Same yield, less fertilizer -> less leachable nitrogen

*assumes corn yield of 200 bu/ac on soil with 2-5% OM with pH <7

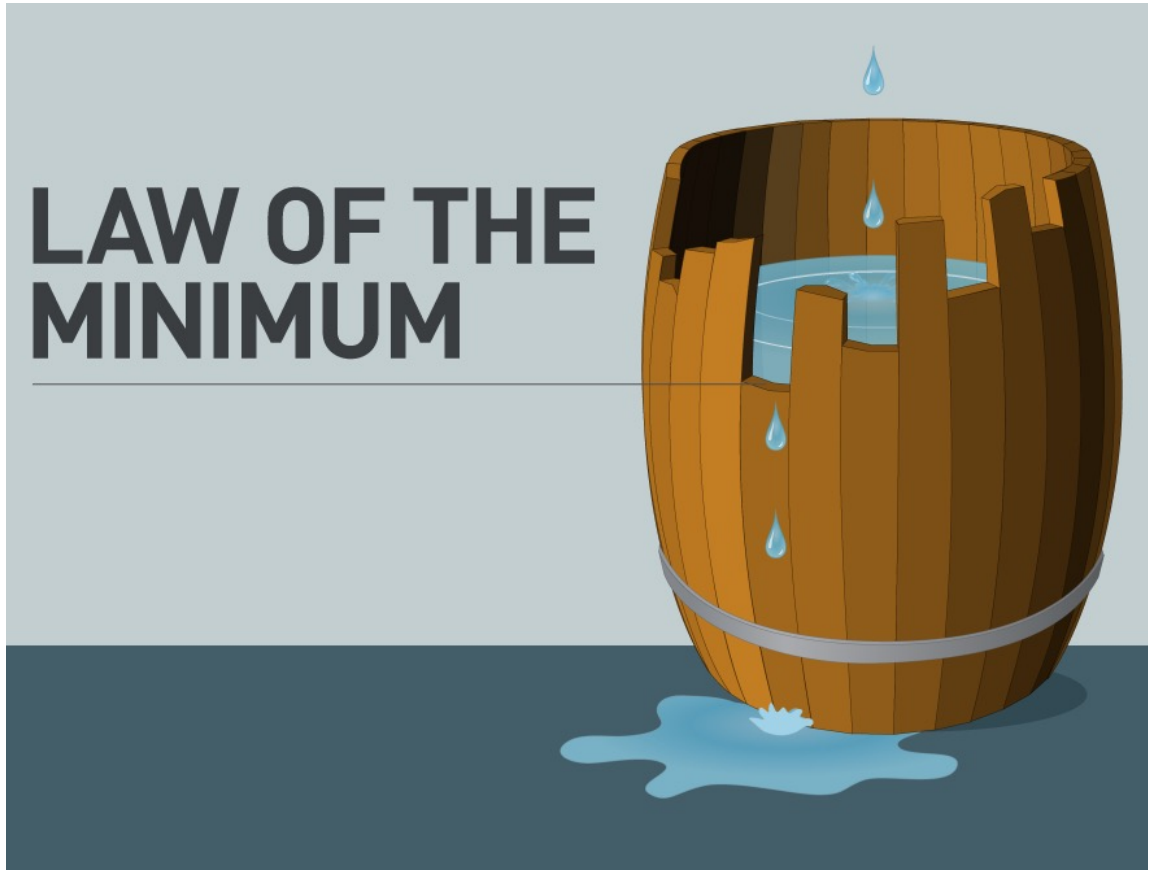


Same yield, more rye-> *less* leachable nitrogen



Strategies to improve farm profitability & water quality

- Accurately credit manure and legume contributions
- Diversify crop rotation (include less N-demanding crops)
- Experiment with cover crops (scavenger, increase soil organic matter)
- Decrease fallow times of the year
- Increase yield with good agronomics



Thank you for your attention

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