In-Season N Predications: The Modeling Approach

Nutrient Management Conference

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Morton, MN

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Disclosure/Disclaimer

- Working on a N management project funded by Pioneer
  - Data is being used to develop Encirca
  - I am not involved with Encirca development
  - I have not used Encirca
- I have not used N Advisor from Monsanto
- I have evaluated Adapt-N

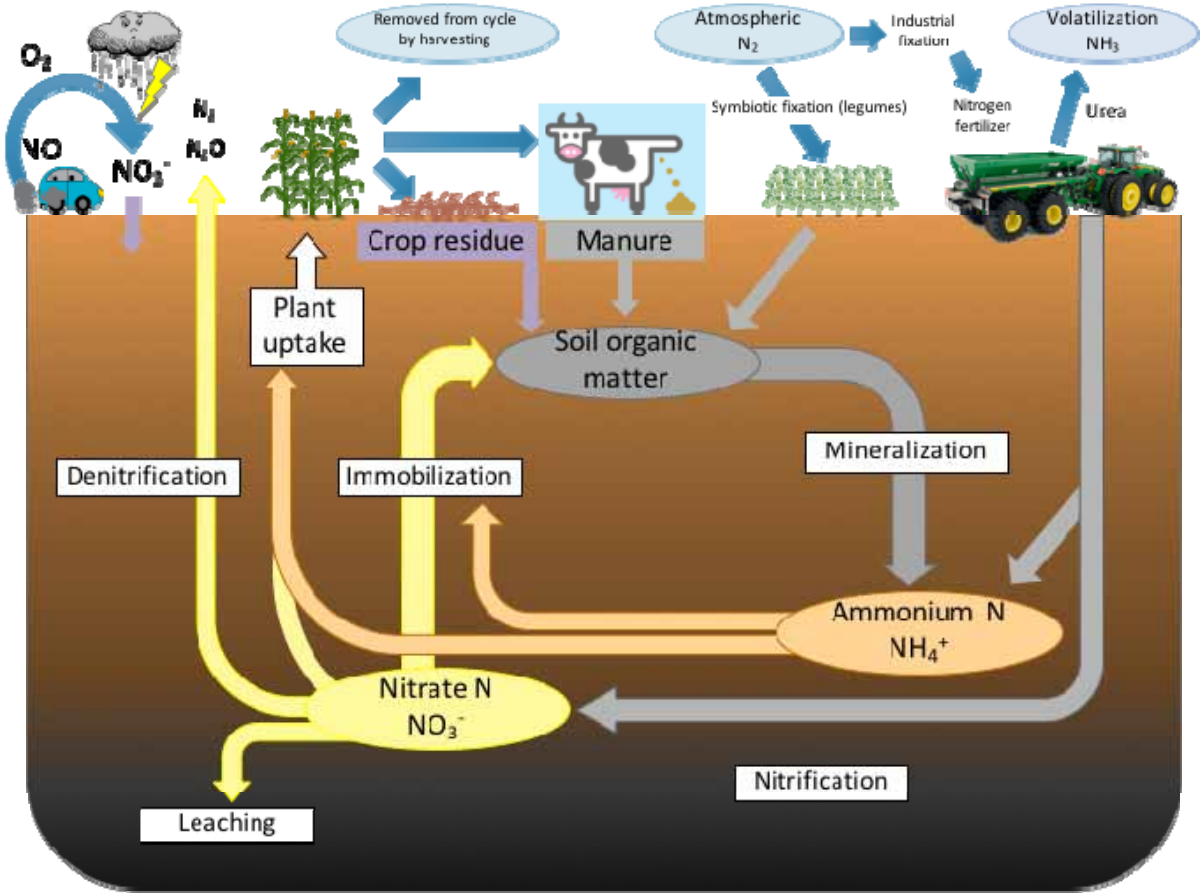
- I will not discuss specifics of any model, but will provide an overview of what the modeling approach to N management is attempting to do

The Goals

- Improve N use efficiency
  - Improve profitability
  - Minimizing N loss to the environment
- Guide rescue N applications
- Do a better job than current N management tools
- Easier to use than current N management tools
- Profitable for model developer

The Challenges

- Predict
  - Weather
  - Crop growth
  - N cycling
- Risk of under fertilization



Inputs

- Site
  - Geo-referenced location
  - Rotation
  - Tillage, residue cover
  - Irrigation
  - Artificial drainage
- Soil
  - Texture
  - Drainage
  - Slope
  - Organic matter
- Crop
  - Hybrid info (RM)
  - Planting date
  - Planting population
  - Rooting depth
- Fertilizer and manure applications
  - Source/Analysis
  - Rate
  - Date
  - N Stabilizers/Extenders

Outputs

- Nitrogen
  - Crop N content
  - Soil N content
    - N transformations
  - N lost
  - N rate recommendation
- Available water

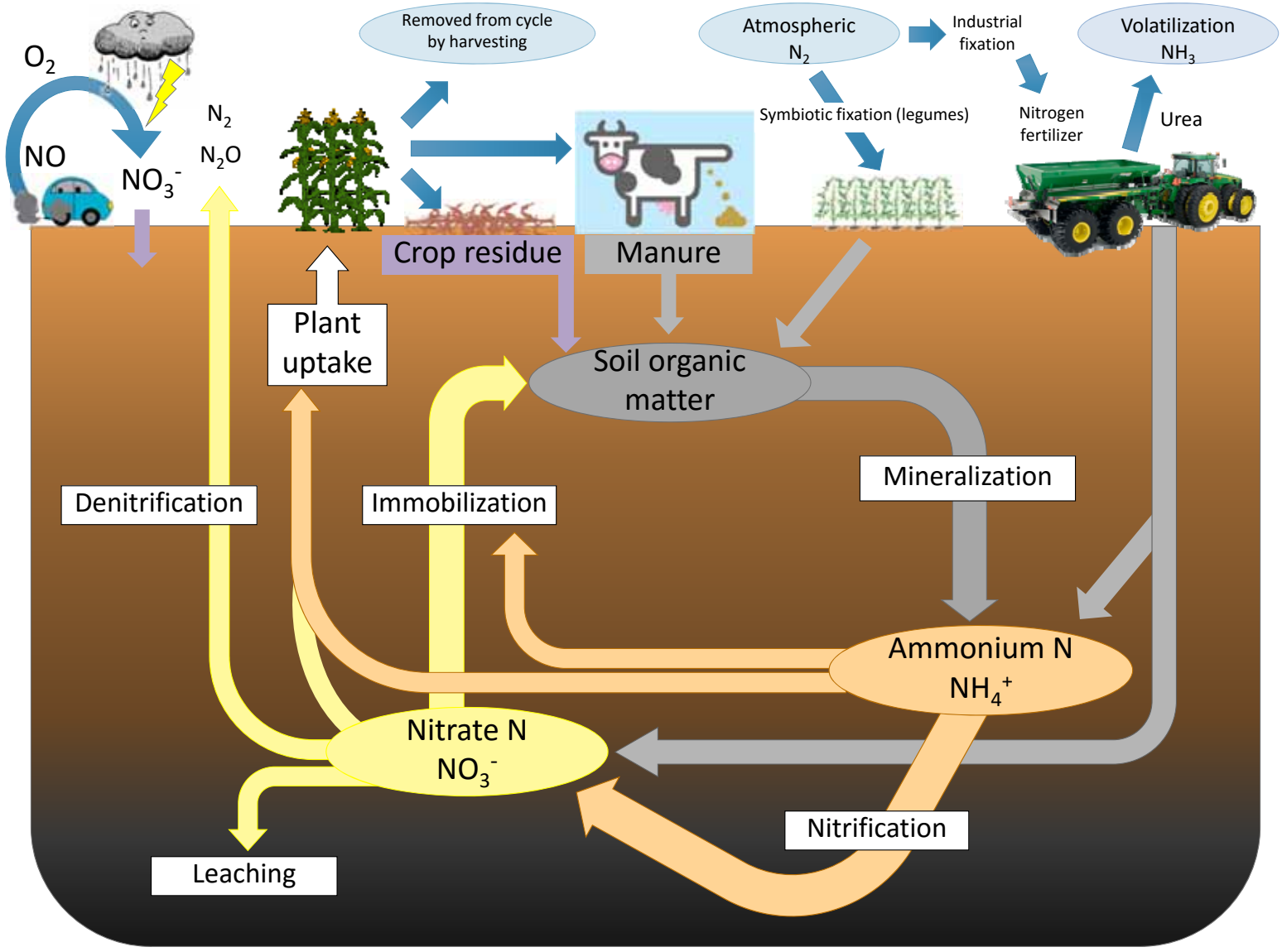
Estimates,
Likely not measured

- Weather

Measured, past
Estimated, future

Variability of estimate may be given
- Short-term better than long-term

Example of complexity of estimating denitrification N losses


O_2
NO
NO_3^-
N_2
N_2O
Removed from cycle by harvesting
Atmospheric N_2
Industrial fixation
Volatilization NH_3
Symbiotic fixation (legumes)
Nitrogen fertilizer
Urea
Crop residue
Manure
Plant uptake
Soil organic matter
Denitrification
Immobilization
Mineralization
Ammonium N NH_4^+
Nitrate N NO_3^-
Nitrification
Leaching

Denitrification

- NO_3^- ---> N_2 or N_2O
- Need organic matter (carbon)
- Need NO_3^-
- Wet soils with low O_2 content
  - Greater saturation periods results in more denitrification
- Temperature (bacteria prefer > 75°F)
- pH (bacteria prefer >5.0)

Estimated N losses from denitrification as influenced by soil temperature and number of days the soil is saturated (Bremner & Shaw, 1958)

Soil Temperature	Days Saturated	
	4	10
° F	N loss (% of NO_3 applied)	
50	3	6
60	6*	12*
70	12*	26*
77	20	43

*Estimated using exponential function.

Note: Actual N loss will vary based on soil texture, organic matter content, microbial population, etc.

Approximate time until fertilizer N is nitrate

Fertilizer material	Approx. time until NH_4^+	Approx. time until NO_3^-
Ammonium sulfate, 10-34-0, MAP, DAP	100% is NH_4^+, 0 weeks	1 to 2 weeks
Anhydrous ammonia		3 to 8 weeks
Urea	2 to 4 days	1.25 to 2.5 weeks
Ammonium nitrate	50% is NH_4^+, 0 weeks	50% is NO_3^-, 0 weeks 50% in 1 to 2 weeks
UAN	25% is NH_4^+, 0 weeks 50% is urea, 2 to 4 days	25% is NO_3^-, 0 weeks 25% in 1 to 2 weeks 50% in 1.25 to 2.5 weeks

NOTE: Slow release materials or use of nitrification & urease inhibitors will generally lengthen the time it takes to convert to NO_3^-.

What constitutes saturated soil?

- Soil with standing water
- Soil where the surface is glistening

Not quite glistening

Example of how to estimate denitrification loss

- Situation
  - If 120 lb N/a as UAN was applied after planting corn
  - N applied 3 weeks before saturated soil conditions existed
  - Soil remained saturated for 5 days
  - Soil temperature of 77 °F

- Steps to take
  1. Need to determine approx. how much nitrate is in the soil
  2. How long was the soil saturated
  3. What is the soil temperature

How much N in nitrate form?

Fertilizer material	Approx. time until NH_4^+	Approx. time until NO_3^-
UAN	25% is NH_4^+, 0 weeks 50% is urea, 2 to 4 days	25% is NO_3^-, 0 weeks 25% in 1 to 2 weeks 50% in 1.25 to 2.5 weeks

120 lb N/a applied as UAN 3 weeks prior to saturation

25 % NO_3^- when applied = 120 x 0.25 = 30 lb N/a

25 % NH_4^+ when applied = 120 x 0.25 = 30 lb N/a
But 3 weeks since application. Therefore assume all NH_4^+ converted to NO_3^-

50% urea when applied = 120 x 0.5 = 60 lb N/a
Enough time elapsed for conversion. Therefore assume all urea converted to NO_3^-

Estimate that all 120 lb N/a was NO_3^- when soil became saturated.

Example of how to estimate denitrification loss

- Situation
  - If 120 lb N/a as UAN was applied after planting corn
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  - Soil remained saturated for 5 days
  - Soil temperature of 77 °F

- Steps to take **120 lb N/a**
  1. Need to determine approx. how much nitrate is in the soil
  2. How long was the soil saturated
  3. What is the soil temperature

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- Steps to take

120 lb N/a

1. Need to determine approx. how much nitrate is in the soil
2. How long was the soil saturated
3. What is the soil temperature

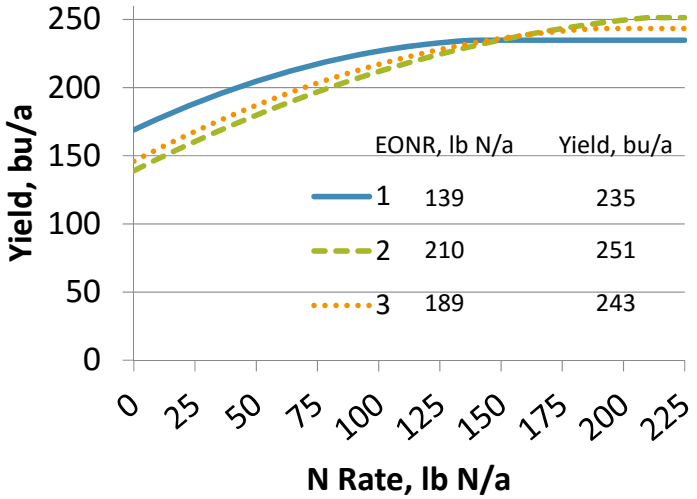
Potentially 20% lost

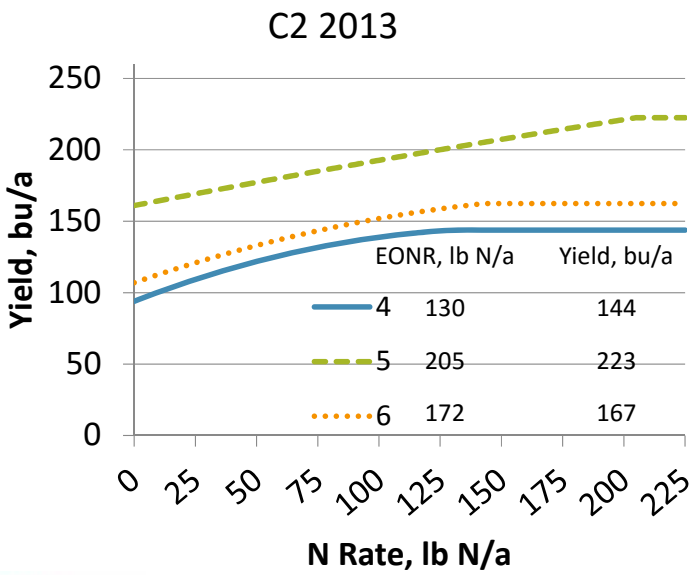
120 lb N/a x 0.20 = 24 lb N/a potentially lost

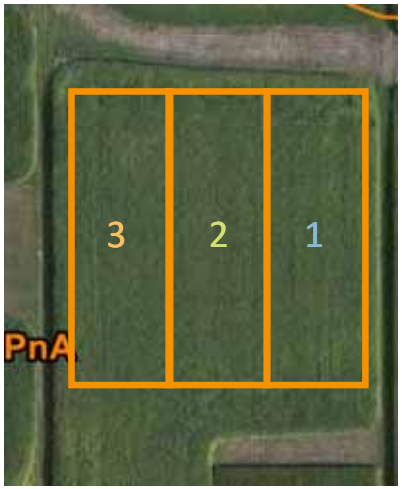
Spatial Variability

- Are model inputs sensitive enough to capture spatial variability within a field

Spatial Variability in N Response



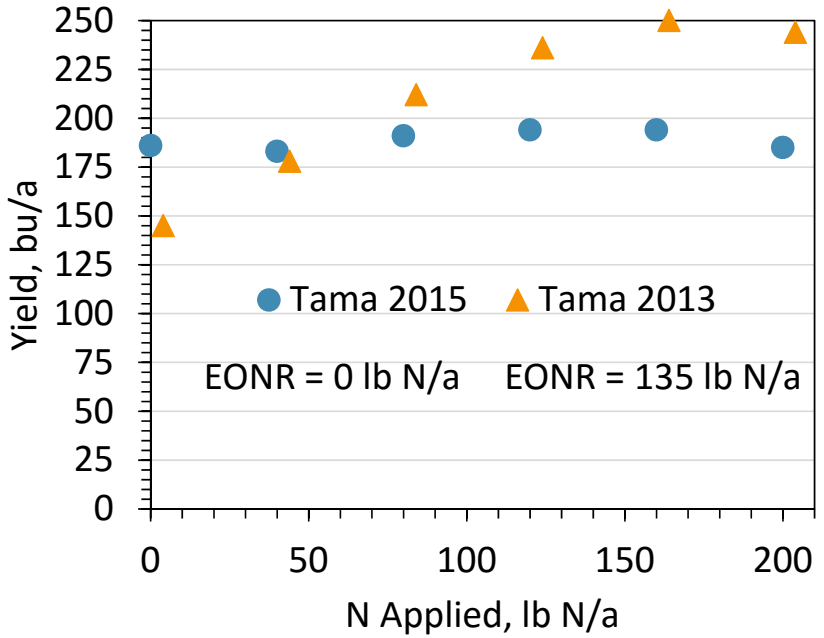




A2 2013

Variability from Management

- Compaction
- Soil test levels
- Long term rotation and manure history



2 different farms
Previous crop soybean
2015 no-till
2013 soil finisher, 47% residue

Validation

- Need independent validation of models
  - Across many geographies
    - Different soils
    - Different weather conditions
- Models need to be adequately tested
  - Comparing model rate to farmer rate is not adequate
  - How does model compare to actual optimum N rate for the site conditions?
    - Need a N rate trial to do this

Summary

- Modeling approach has a lot of appeal
  - Precision management, increased NUE
- Probably not enough validation at this time
- If you want to experiment, enroll a limited number of acres
- How will you determine if it …
  - did a better than your usual management?
  - came closer to using the economic optimum N rate?

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