Commercial and Manure Nitrogen Management

Angie Rieck-Hinz
Extension Field Agronomist
Iowa State University
amrieck@iastate.edu
515-231-2830
Twitter: @nciacrops

Goals for N Management

- Achieving most profitable economic return
  - Yield increases pay for additional N
- Advancing environmental stewardship
  - Water quality
  - Soil quality

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Discussion Points for Today

- What is nitrogen?
- Why is it important to crop production?
- Where does it come from?
- Nitrogen Cycle
- Forms
  - Commercial Sources, Manure Sources
  - Availability vs. Supply
- Management

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What is nitrogen?

- Naturally occurring element that is essential for plant and animal growth found as a colorless, odorless unreactive gas that forms about 78% of the earth's atmosphere
- One of the 3 essential nutrients needed for crop production
- Usually the most limiting nutrient in corn production

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Why is nitrogen important for crop production?

- Major component of chlorophyll
- Major component of amino acids, the building blocks of proteins
  - Protein act as structural units or as
  - Enzymes
- Component of energy transfer such as ATP
- Component of nucleic acids such as DNA

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Where does nitrogen come from?

- Atmosphere
- Soils
  - Organic compounds; Ammonium (NH_4^+) Nitrate (NO_3^-)
- Commercial Fertilizer
- Manure
- Other Sources?
  - Sewage Sludge
  - Industrial Processing By-Products

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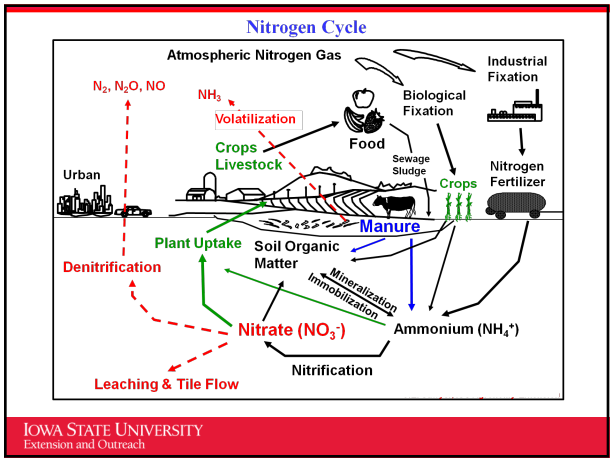
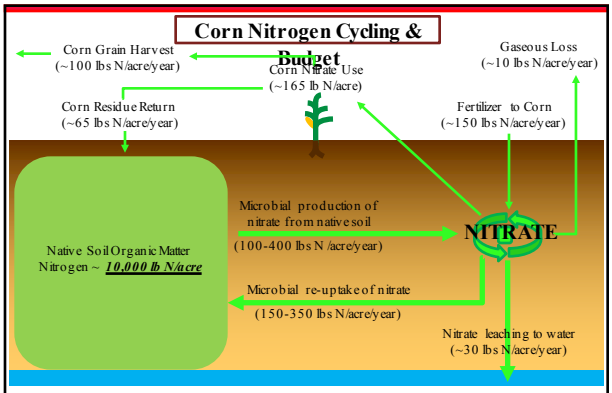
Basic Nitrogen Concepts

- Nitrogen Cycling
- N Use Efficiency
- N Recommendations – to be discussed by Mark Johnson

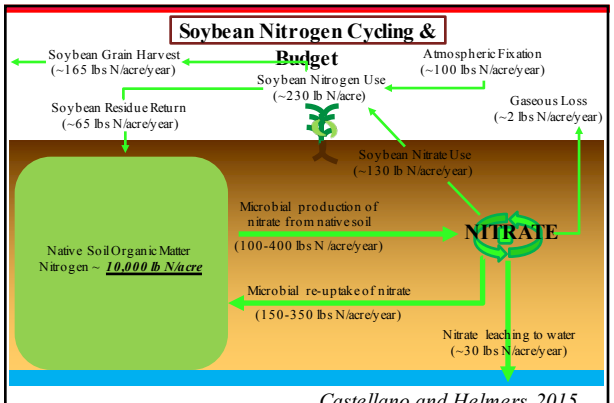
Nitrogen Cycling

- More than 90% of soil N is in organic matter
- Much smaller amounts in ammonium fixed clay minerals, exchangeable ammonium and nitrate
- The surface layer of most cultivated soils contains 0.06 to 0.30% N
  - Roughly 10,000 lbs N/acre





Castellano and Helmers, 2015



Castellano and Helmers, 2015

Maintaining Soil N

- …. Means maintaining soil organic matter
- w/o N fertilization soil N will deplete, and small changes in total soil N can influence plant-available N
- w/o N fertilization, soil organic matter will decline and supply of plant-available N will decrease
- The goal is for optimal N rates to balance inputs and output of N from soil in corn production systems. Possible in CC, but in CS the C can't overcome soil depleting effect of SB

N Use Efficiency

- Commercial fertilizer sources are considered to be 100% immediately available for plant uptake, however:
  - 25% is processed by soil microbes and incorporated into soil organic matter
  - 20% is lost to denitrification, leaching, ammonia volatilization
- Supply and loss varies as does plant N use efficiency
- Makes predicting optimal fertilizer rates VERY DIFFICULT

Commercial N Sources

- Urea
- Urea-Ammonium Nitrate (UAN)
- Ammonia
- Other Sources
  - DAP
  - MAP
  - Ammonium Nitrate

Urea

- 46% N
- $CO(NH_2)_2$
- Most widely used fertilizer in the world
- Can be applied as a dry (granular) or liquid.
- Urease converts urea to NH_3 via hydrolysis
  - Must consider gaseous losses
  - Further hydrolysis = NH_4^+ and nitrified to NO_3^-
- Timing
  - Avoid application when urea will be left on soil surface for a long time
  - Use tillage or rainfall to incorporate urea

Urea Ammonium Nitrate (UAN)

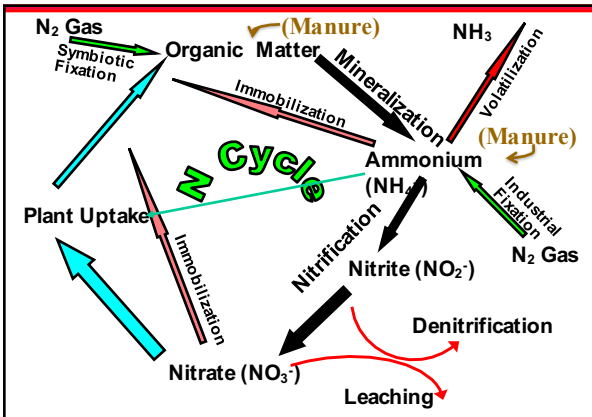
- 28% or 32% N Liquid fertilizer
- $CO(NH_2)_2$ and NH_4NO_3
- Composition
  - NO_3^- is 25%; immediately available to plants
  - NH_4^+ is 25%; plant uptake or oxidized to NO_3^-
  - Urea is 50%; hydrolyzed to form NH_4^+ and subsequently NO_3^-
- Injected; sprayed on soil surface; or dribbled used as herbicide carrier

Ammonia

- 82 % N
- NH_3
- Applied as a high pressure liquid that immediately becomes a vapor after leaving the tank.
- Rapidly reacts with soil water to form ammonium or NH_4^+ which is retained on cation exchange sites
- Under warm soil temps, will convert to NO_3^-

Manure Nitrogen Management

- Same processes as commercial fertilizer
- NH_4+ and NO_3-
- Bigger challenge due to variability
- Balance nutrient conservation, odor management, and tillage/erosion concerns



Manure Nitrogen

- Not all sources of Manure N are immediately available for plant growth; depends on species, storage, diet
- Availability = present or ready for immediate use
- Supply = concentration, rate, distribution,
- Loss= volatilization, leaching, etc.
- Availability, supply and loss varies as does plant N use efficiency
- Makes predicting optimal fertilizer rates VERY DIFFICULT

First-year nutrient availability of different animal manures.

Manure Source	Nitrogen[1]	Phosphorus[2]	Potassium[2]
	Percent of Total Nutrient Applied		
Beef cattle (solid or liquid)	30–40	60–100	90–100
Dairy (solid or liquid)	30–40	60–100	90–100
Liquid swine (anaerobic pit)	90–100	90–100	90–100
Liquid swine (anaerobic lagoon)	90–100[3]	90–100[3]	90–100
Poultry (all species)	50–60	90–100	90–100

PMR 1003

Nitrogen Crop Availability from Manure

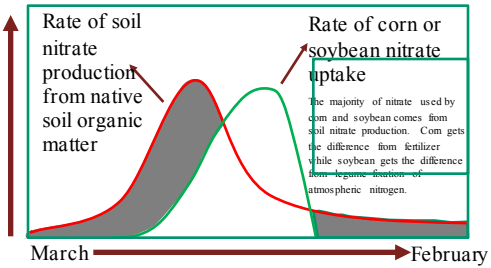
Nitrogen Availability for Different Manure Sources			
	First Year	Second Year	Third Year
	Percent of Total Nitrogen Applied		
Beef Cattle (solid or liquid)	30-40	10	5
Dairy (solid or liquid)	30-40	10	5
Liquid Swine (anaerobic pit)	90-100	0	0
Liquid Swine (anaerobic lagoon)	90-100	0	0
Poultry (all species)	50-60	0-10	0

From ISU publication PMR 1003.

Nitrogen Management

- Nitrogen fertilizer mismanagement is not the primary reason for nitrate loss.
- Most nitrate loss is to Iowa waterways is caused by a mismatch in timing between nitrate production from native soil organic matter nitrogen and the demand for soil nitrate by crops

Soil Nitrate Production *vs.* Crop Nitrate Uptake



In the shaded areas, the soil produces nitrate, but there is no crop to use it. As a result, some nitrate is lost to waterways.

Castellano and Helmers, 2015

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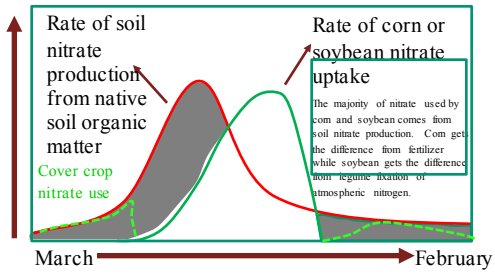

In the shaded areas, the soil produces nitrate, but there is no crop to use it. As a result, some nitrate is lost to waterways. The dashed green line represent a conceptual thought on what cover crops can do for nitrate uptake by plants when crops are not growing.

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Castellano and Helmers, 2015

Management Considerations?

- Timing
- Split applications
- Nitrification Inhibitor/Urease Inhibitor
- Appropriate Application (includes timing and rate and source)
- Calibration to achieve correct rate
- ??

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