Nitrogen in Upland Cropping Systems

Soil Fertility Workshop
Louisiana Agricultural Technology & Management Conference
February 12, 2014
Paragon Casino Resort, Marksville, LA

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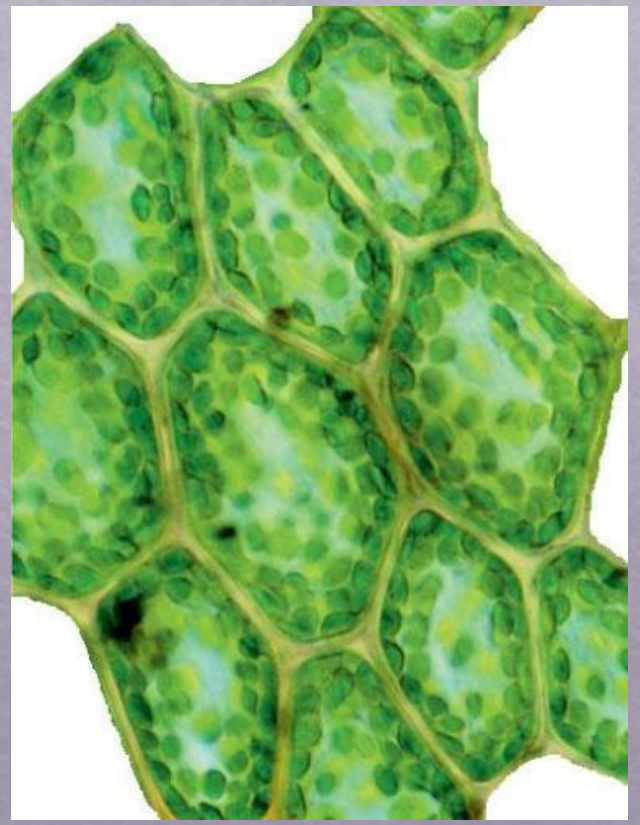
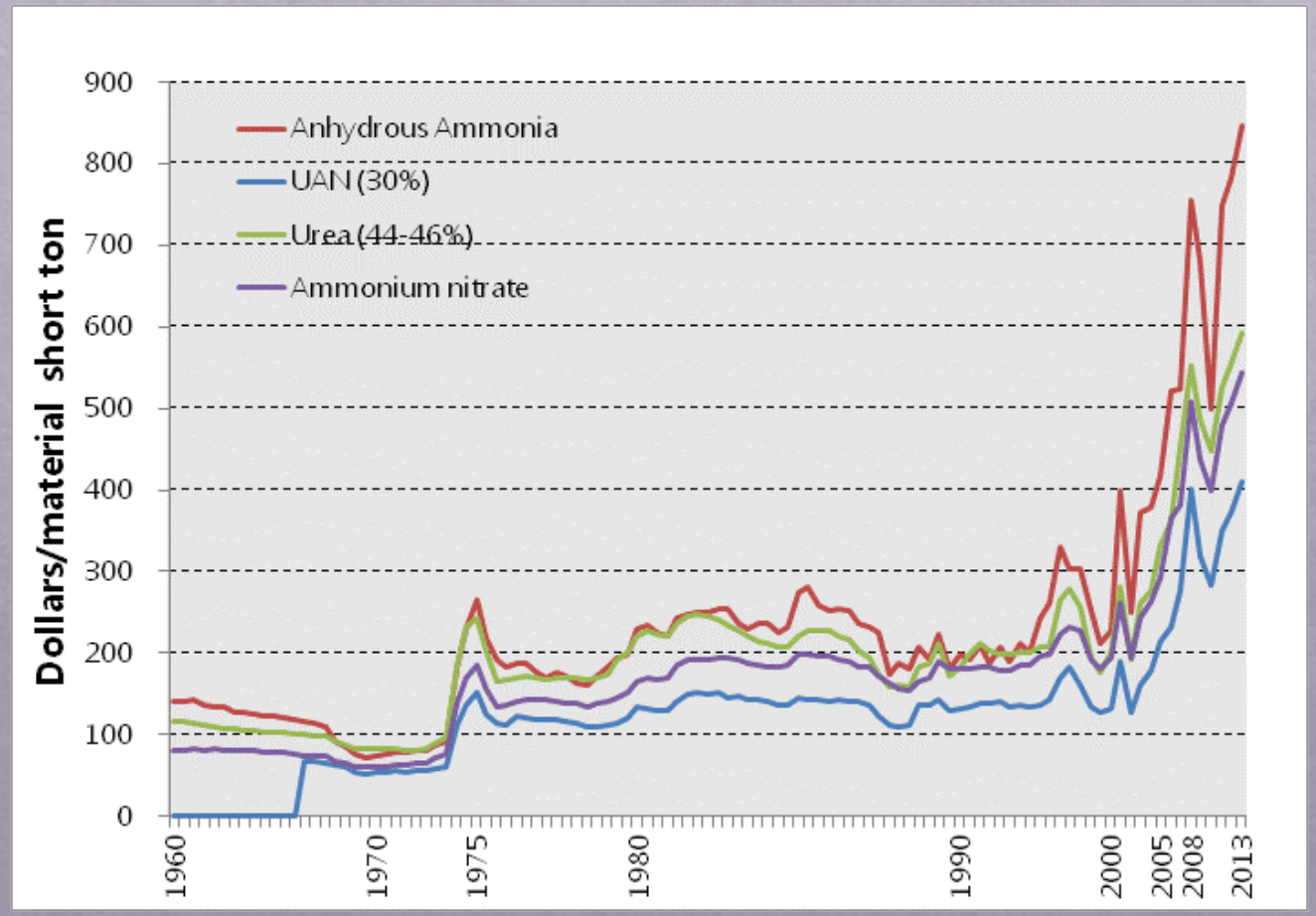
Role of Nitrogen in Plant

- **Photosynthesis**
  - Nitrogen is an integral component of chlorophyll
- **Metabolism and growth**
  - At least one nitrogen in every amino acid; amino acids polymerize to form proteins and enzymes



Nitrogen in Crop Production

- The most limiting nutrient
- Most expensive nutrient input
  - Apply in the largest amount
  - Increasing cost in the market



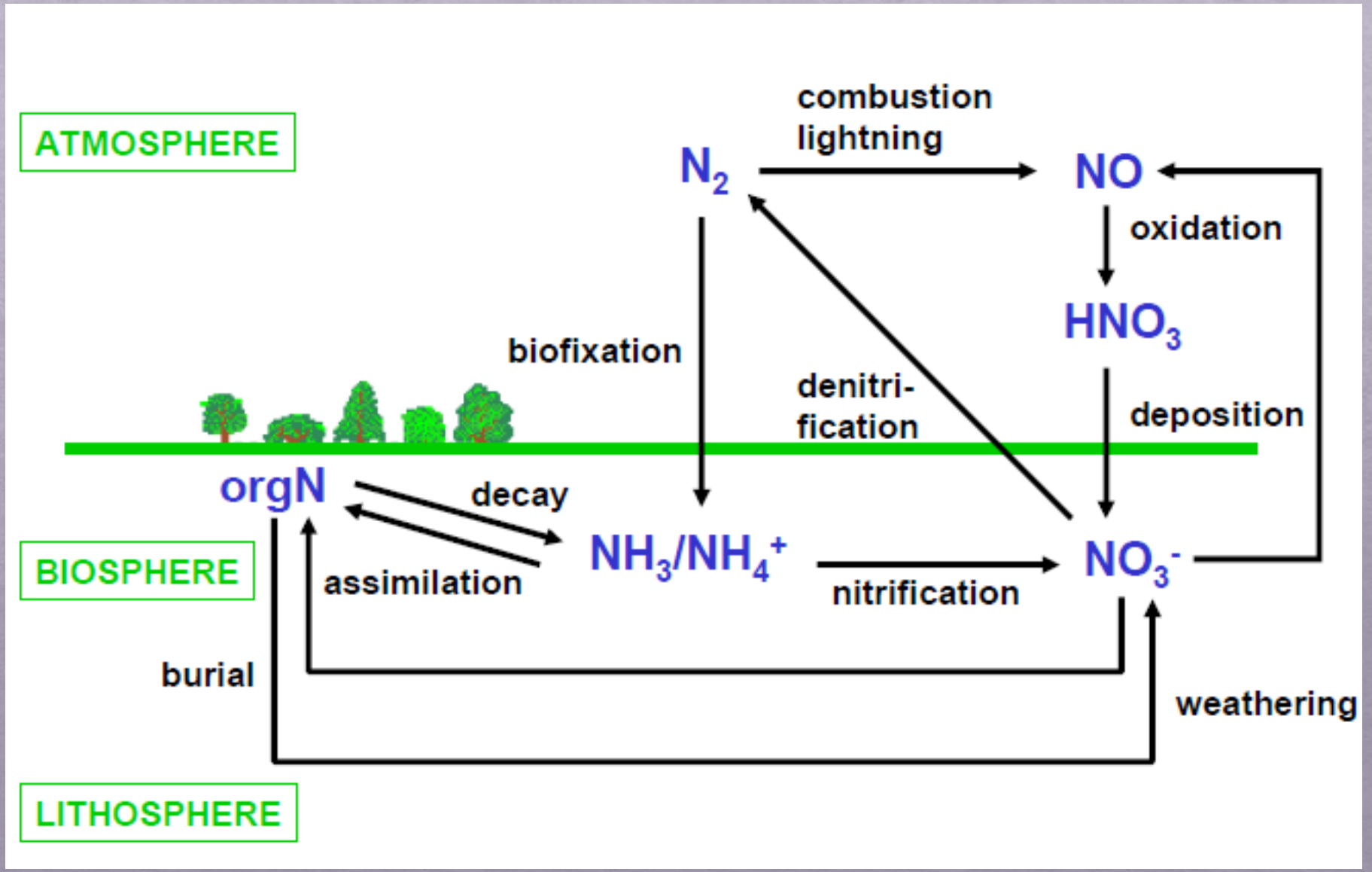
Sources: USDA-NASS, USDA-ERS, & Energy Information Administration- DOE3

Nitrogen - Chemically Complex, Dynamic

Oxidation State	Species	Name
-3	NH_3, NH_4^+	Ammonia, ammonium
-2	N_2H_4	Hydrazine
-1	NH_2OH	Hydroxylamine
0	N_2	Nitrogen gas
+1	N_2O	Nitrous oxide (laughing gas)
+2	NO	Nitric oxide
+3	HNO_2, NO_2^-	Nitrous acid, nitrite ion
+4	NO_2	Nitrogen dioxide
+5	HNO_3, NO_3^-	Nitric acid, nitrate ion

Nitrogen Cycle – A Gaseous Cycle

- Gains
- Losses
- Sink



SOURCES OF NITROGEN TO THE SOIL

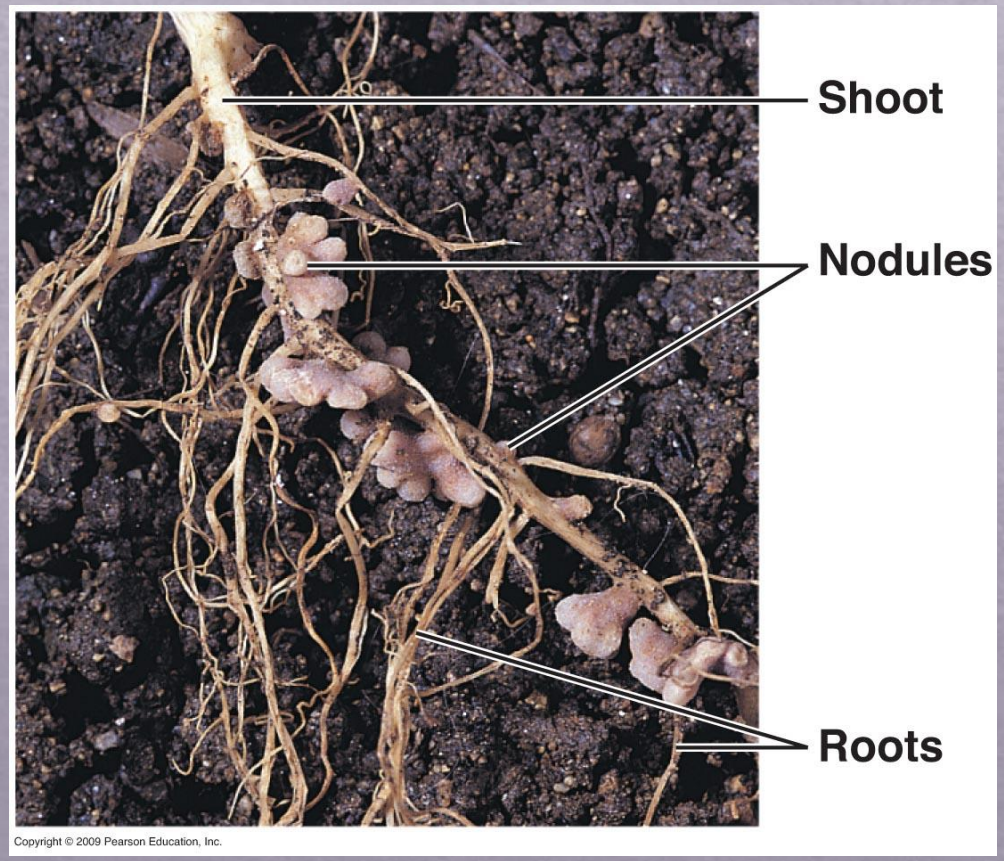
- Biological N fixation
- Deposition (rainfall, dust, alluvium)
- Decomposition of organic matter
- Fertilization
- Organic amendments (manure, plant residue etc.)

Natural Ecosystem

Agricultural Ecosystem

Biological Nitrogen Fixation

- Symbiotic
  - 357 lbs N/ac/year
  - e.g. Rhizobium and soybean
- Association
  - 178 lbs N/ac/year
- Free living
  - 70 lbs N/ac/year



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Deposition

- Rainfall

Atmosphere acts as a reservoir for nitrogen.

Atmospheric N – lightning
Nitrous oxide – acid rain

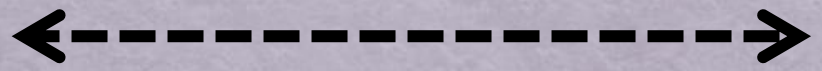
- Dust

- Alluvium

Organic Matter Decomposition

Mineralization (inorganic form)

NH_4^+
NO_3^-



TEMPERATURE
MOISTURE
ENERGY SOURCE
SOIL pH
AVAILABLE NUTRIENTS
C:N RATIO
QUALITY OF MATERIAL

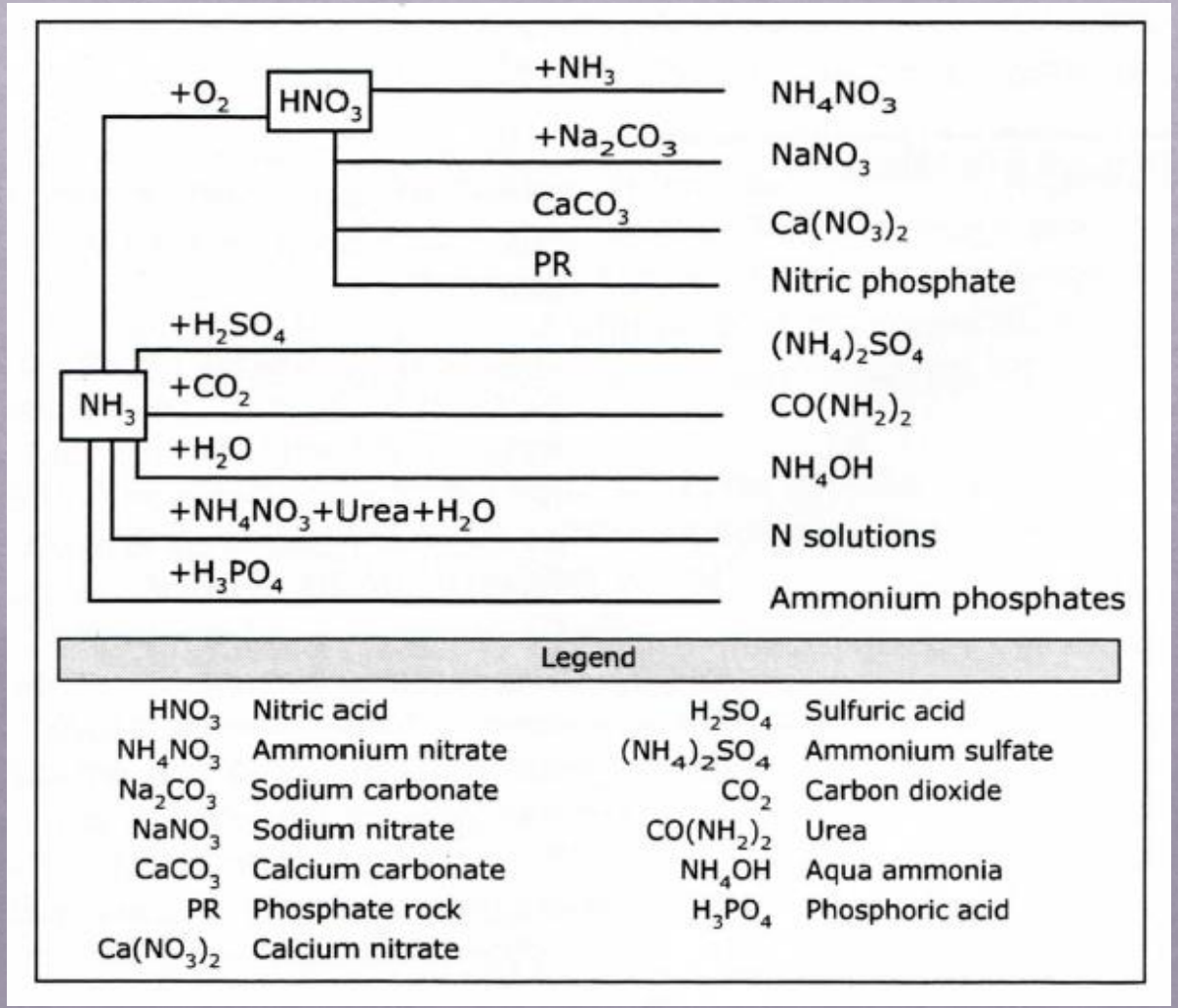
Immobilization (organic form)

Amino acids, protein – crop stubble, soil organic matter, microbial biomass etc.

Trends of Mineral Nitrogen Accumulation (by season)

- **Winter:** lowest due to low temperature
- **Spring:** usually highest
- **Summer:** declines due to plant uptake
- **Fall:** can increase due to residue decomposition

Nitrogen Fertilization

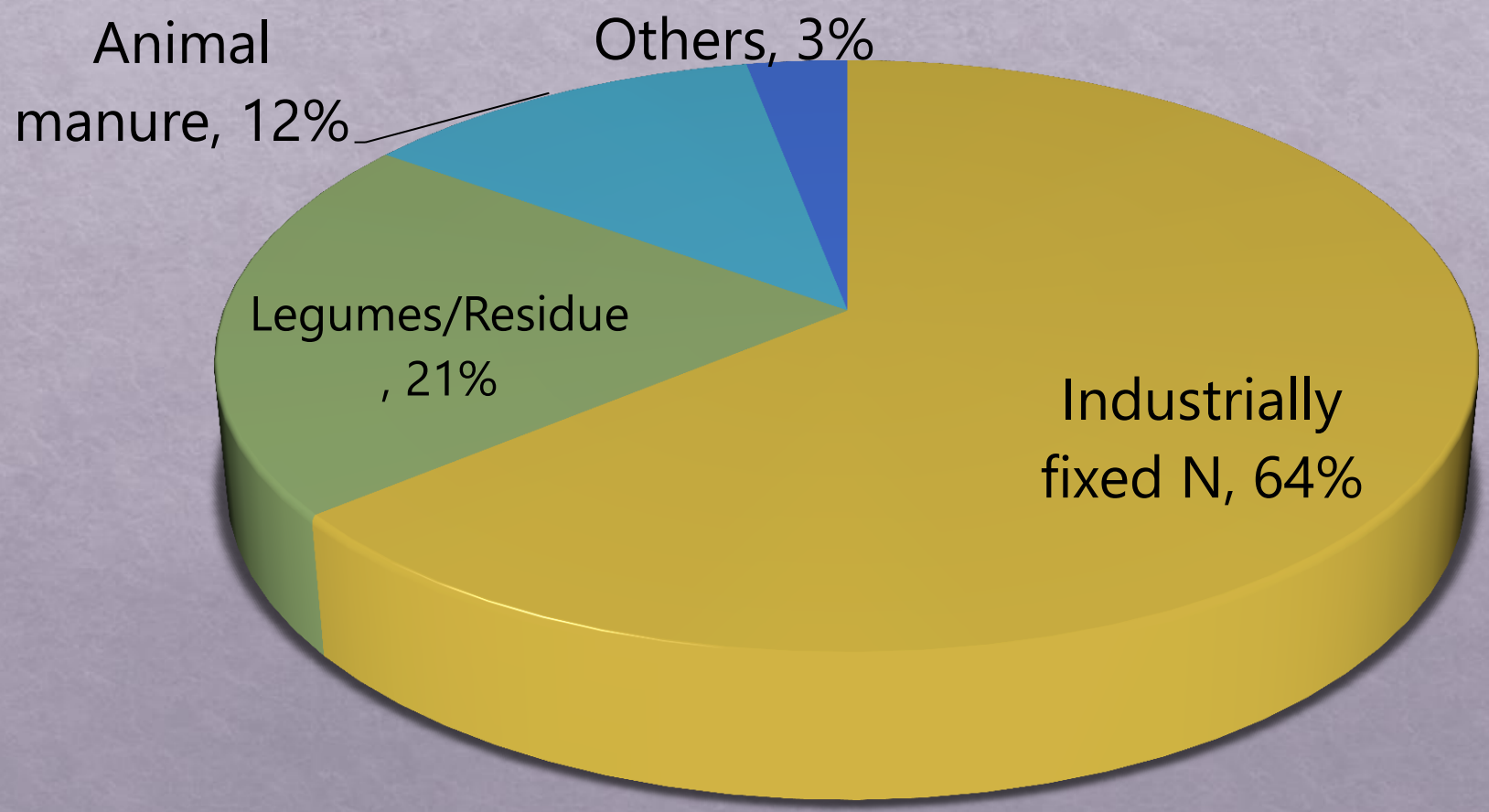


Organic Amendments

Animal manure application

Crop residue incorporation

SOURCES OF N IN US CROP PRODUCTION

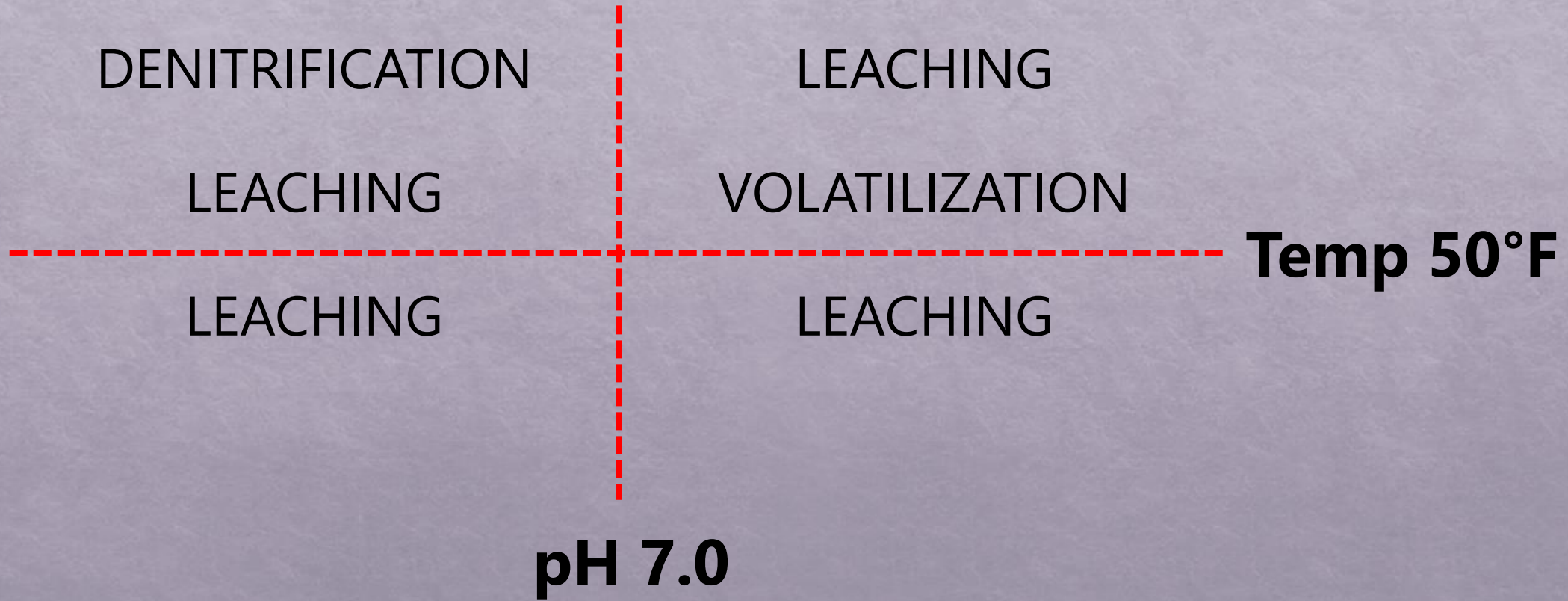


Nitrogen Loss Pathways

- Crop removal
- Nitrate leaching
- Soil erosion and runoff
- Denitrification
- Volatilization
- Plant N loss - volatilization

} Gaseous form

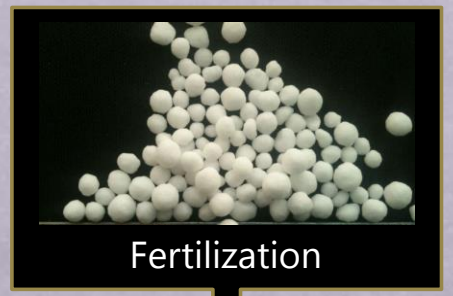
Nitrogen Loss Pathways



Sources of Nitrogen
Upland Cropping System

- Urea
- Urea ammonium nitrate
- Anhydrous ammonia

Nitrate is the major form of plant available N in most agricultural soil (exception - flooded cropping system)



Fertilization

Deposition (rainfall, dust); N from previous legume crop

Ammonia Volatilization 45 lbs N /acre

Plant loss - Volatilization 70 lbs N /acre

organic matter

Mineralization

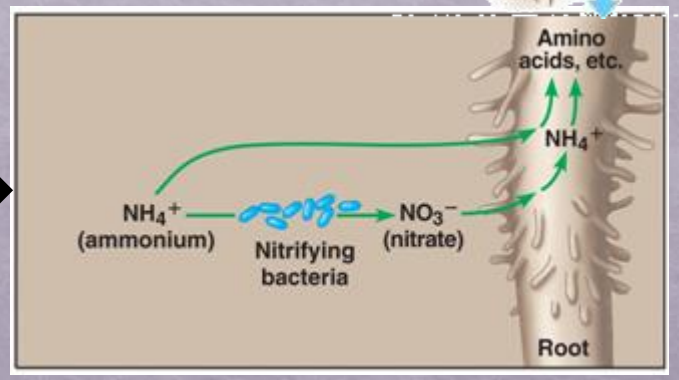
Immobilization

High soil pH; dry condition

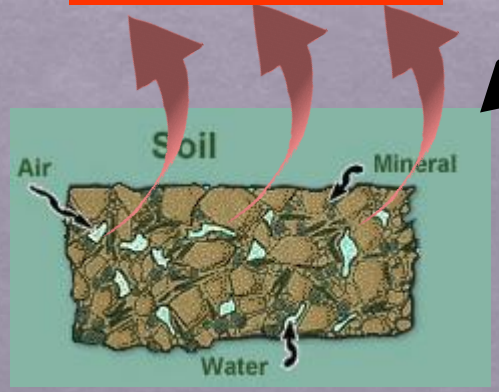
NH_4^+

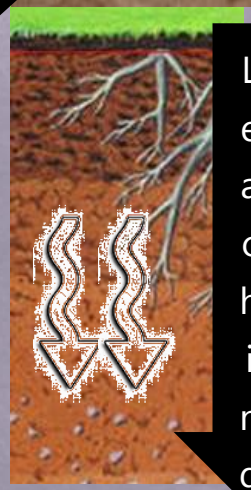
NO_3^-

Plant uptake



Denitrification 36 lbs N /acre





Leaching

Runoff

Rainfall>infiltration

Leaching 36 lbs N /acre

There is a need to “manage” nitrogen fertilizer!