Agronomic Directions
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# Understanding the Role and Fate of Nitrogen: Part-Two of a Two-Part Series

*According to John Lamb, Fabian Fernandez and Daniel E. Kaiser, Extension Specialists in Nutrient Management at the University of Minnesota.*

**Part one discussed the various forms of nitrogen (N) inputs for plant growth. The N is subject to several changes that dictate the availability of N to plants and influence the potential movement of nitrates to water supplies.**

**Nitrogen is available to plants as either ammonium ($NH_4^+$) or nitrate ($NO_3^-$).** Ammonium has a positive charge and is held by negatively charged soil and soil organic matter, not allowing it to move downward in soils. Nitrification is a biological process that converts $NH_4^+$ to $NO_3^-$, and proceeds rapidly in warm, moist, well aerated soils. This process slows at soil temperatures below 50°F. Nitrate is a negatively charged ion and is not attracted to soil organic matter. This allows the $NO_3^-$ to move below the root zone under certain conditions.

## Nitrogen Loss From The Soil System:

**Leaching.** Leaching is the loss of soluble $NO_3^-$ as it moves with soil water, generally excess water, below the root zone. Nitrates that moves below the root zone have the potential to enter either groundwater or surface water through tile drainage systems. Coarse-textured soils have a lower water-holding capacity and, therefore, a greater potential to lose nitrate from leaching when compared with fine-textured soils. Some sandy soils, for instance, may retain only 1/2 inch of water per foot of soil while some silt loam or clay loam soils may retain up to 2 inches of water per foot. Nitrates can be leached from any soil if rainfall or irrigation moves water through the root zone.

**Denitrification.** Denitrification can be a major loss mechanism of $NO_3^-$ when soils are saturated with water for 2 or 3 days. Nitrogen in the $NH_4^+$ form is not subject to this loss. Management alternatives are available if denitrification losses are a potential problem.

**Volatilization.** Significant losses from some surface-applied N sources can occur through the process of volatilization. In this process, N is lost as ammonia (NH3) gas. Nitrogen can be lost in this way from manure and fertilizer products containing urea. Ammonia is an intermediate form of N during the process in which urea is transformed to $NH_4^+$. Incorporation of these N sources will virtually eliminate volatilization losses. Loss of N from volatilization is greater when soil pH is higher than 7.3, air temperature is high, soil surface is moist, and there is a lot of residue on the soil.

**Crop Removal.** Substantial amounts of N are lost from the soil system through crop removal. A 250 bushel per acre corn crop, for example, removes approximately 175 pounds of N with the grain. Crop removal accounts for a majority of the N that leaves the soil system.

**Soil Erosion and Runoff.** Nitrogen can be lost from agricultural lands through soil erosion and runoff. Losses through these events do not normally account for a large portion of the soil N budget, but should be considered for surface water quality issues. Incorporation or injection of manure and fertilizer can help to protect against N loss through erosion or runoff. Where soils are highly erodible, conservation tillage can reduce soil erosion and runoff, resulting in less surface loss of N.

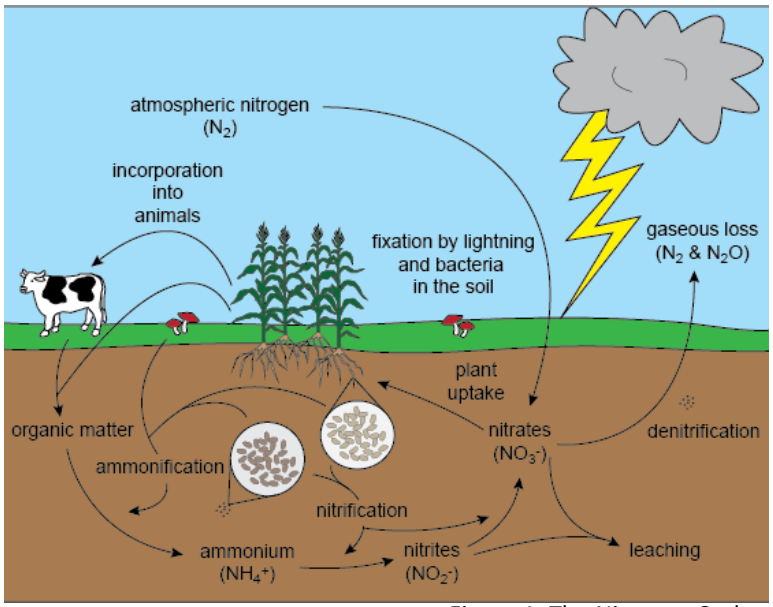


Figure 1. The Nitrogen Cycle.
Image from http://www.shmoop.com/ecology/nitrogen-cycle.html