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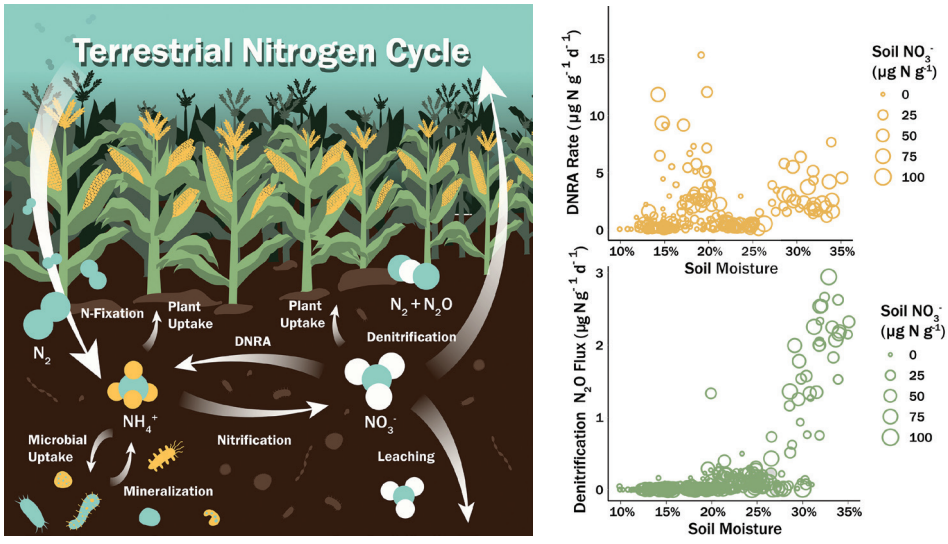
Investment Insight

What is Dissimilatory Nitrate Reduction to Ammonium (DNRA)?

Dr. Angela Kent, along with colleagues Wendy Yang and Sada Egenriether at the University of Illinois have explored a unique concept of retaining nitrogen through DNRA. DNRA is a microbially-mediated process instrumental to the regulation of ecosystem nitrogen (N) retention versus loss. Unlike denitrification, which removes reactive nitrogen from the system, DNRA conserves nitrogen within the system. Since DNRA takes nitrate and converts it into ammonium, it does not produce N2 or N2O. Consequently, DNRA recycles nitrogen rather than causing N-loss.

- By converting nitrate to ammonium, DNRA retains N in ecosystems to support crop growth, reduces nitrate leaching to ground and surface waters, and competes with denitrification to decrease gaseous dinitrogen and nitrous oxide losses.
- Despite its importance, DNRA has been disregarded in upland terrestrial ecosystems because of the misconception that the process is restricted to reducing conditions typically found in flooded environments.
- However, we have found that upland **agricultural soils exhibited DNRA rates high enough to represent an important N-retention process** in all management practices tested, regardless of differences in microbial community composition.
- Meaningful levels of DNRA activity were measured under both saturated soil conditions **as well as** drier conditions. The activity under soil moistures low enough to completely prevent denitrification **suggests that DNRA may act as an alternative nitrite reduction pathway** when reduction via denitrification has been inhibited by the presence of oxygen.
- Analysis of gene expression (mRNA) of the microbes carrying out DNRA revealed that the **DNRA communities active under each moisture condition (low vs. high) differ from one another.**

These findings demonstrate that DNRA can occur both within the conventionally recognized reducing conditions characteristic of saturated soils—such as **during the early growing season** in central Illinois—as well as **within the substantially drier soils characteristic of the late growing season**, due to the presence of distinct DNRA communities that are 'activated' at these different moisture levels.



DNRA rates exhibited a bimodal response across the moisture gradient (upper), and a roughly unimodal response across the nitrate gradient (lower), with a significant positive interaction between the two effects.

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