

4R Field Day Extension with a Leaky Nitrogen Cycle

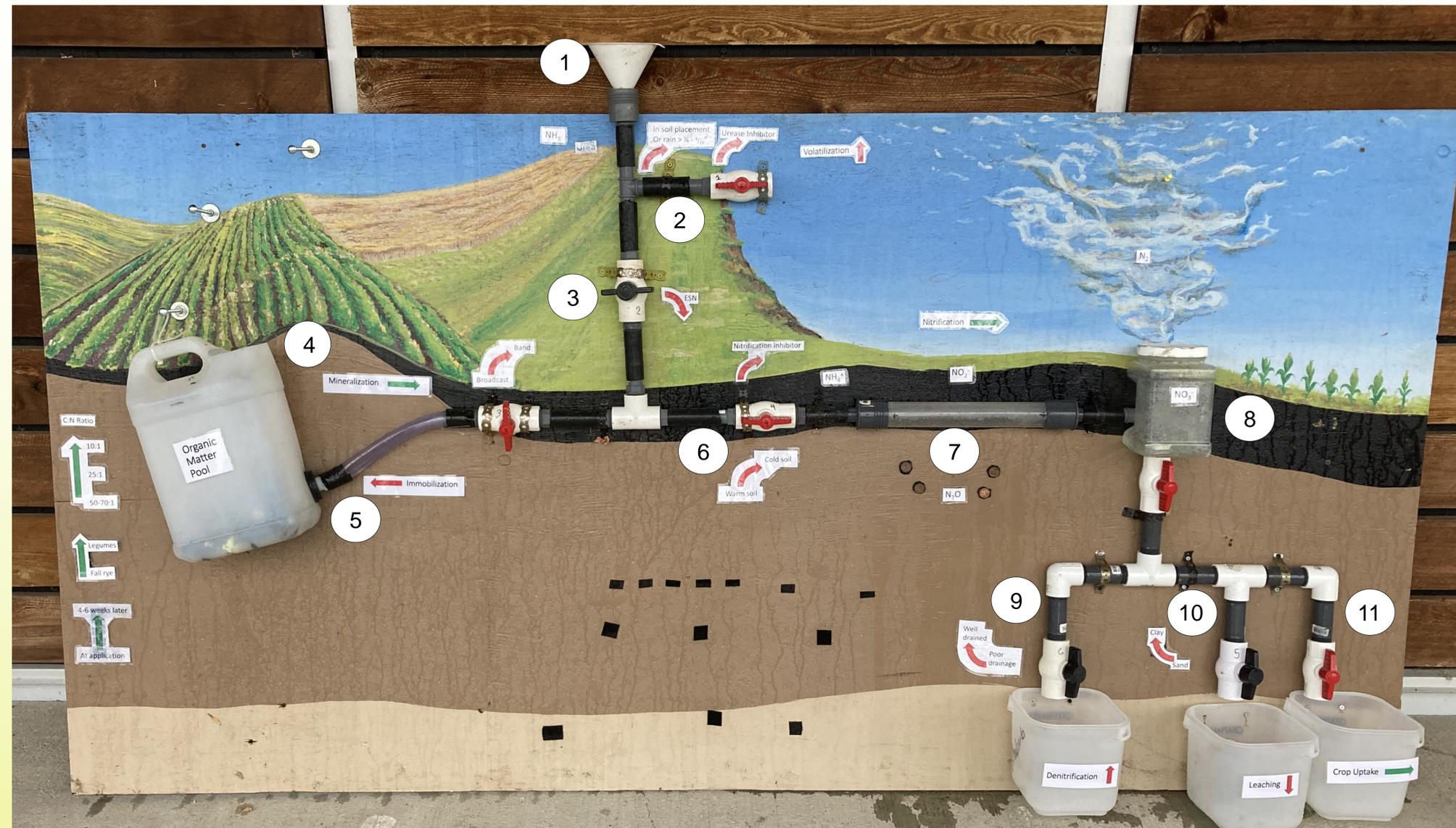
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Overview

A working model of the nitrogen (N) cycle is created using plumbing to illustrate the fate of applied fertilizer N. Pathways of loss include volatilization, immobilization (and subsequent mineralization), denitrification and leaching. Of particular note are the emissions of nitrous oxide (N_2O) during the process of nitrification, hence the popularly accepted "leaky pipe" terminology. A series of valves are installed in the pathway, showing how and where N management practices can limit or eliminate losses. The model is mounted on 4' x 8' plywood and has been demonstrated at numerous Manitoba field days in 2022, primarily to highlight practices to reduce N_2O emissions from applied fertilizer.

The Working Model



1. Manitoba's Minister of Agriculture, Derek Johnson, applies "Nitrogen fertilizer" (coloured water) via a funnel at the top of the board.



2. Surface applied urea is vulnerable to volatilization. Losses are minimized through rainfall after application, incorporation or urease inhibitors.



3. Controlled release N products (e.g. polymer coated urea or ESN) meter out N supply during the growing season.



4. N can mineralize from the organic matter pool into the cycle.

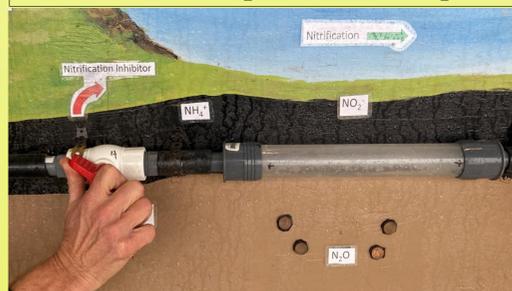


5. N can be immobilized by microbial activity to decompose high C:N ratio residues, like straw. This "loss" is temporary until the C:N ratio narrows. In-soil band placement minimizes the immobilization of N fertilizer.



6. Nitrification of ammonium (NH_4^+) to nitrate (NO_3^-) can be slowed by band application to cold soils, or using of nitrification inhibitors.

7. Nitrification can be a "leaky pipe" allowing small, agronomically insignificant amounts of N_2O to escape (indicated by pennies on the board); however, it is a powerful greenhouse gas. $100 \text{ lb N/ac} = 1 \text{ lb } N_2O/ac = 432 \text{ lb } CO_2e/ac$



8. NO_3^- can "loiter" in the soil making it vulnerable to loss if not taken up by crops. Six months of frozen soil in Manitoba limits potential losses, enabling us to use the fall nitrate soil test.



9. Denitrification losses of NO_3^- can occur during spring thaw, and with warm soils. Loss can be 2-4 lb N/ac/day on saturated soils when soils are $5^\circ C$. N_2O losses can also occur.

10. Leaching losses of NO_3^- below the rooting zone can occur in sandy, excessively drained soils. Leaching during the growing season is often minimal.

11. Crop uptake of applied N is about 40-60%, at best. The remainder may be lost, or retained in the organic pool. Poor growth, such as that during drought, may limit crop uptake.

Highlights of Leaky N Cycle Extension

During the summer extension season, the board was showcased at Manitoba's Crop Diagnostic School (14 showings), two 4R Nutrient Stewardship tours, and multiple field days and staff training events. We anticipate many more showings over the winter months and into summer 2023.

We have received many positive comments from viewers, indicating it's benefit as a visual and interactive demonstration device:

- This has made the N cycle "real"!
- I have a better understanding of where enhanced efficiency fertilizers fit.
- This has helped me decide to go to grad school!

The N Cycle board was constructed using common hardware store supplies for a cost of \$254 CDN (approximately \$185 USD). It was assembled and painted by Katrina Purcha (Manitoba Agriculture summer student and Biosystems Engineering student at the University of Manitoba).

To view a RealAgriculture Wheat School video featuring the N Cycle in action, visit: https://www.youtube.com/watch?v=7Ci_Z4jlmuk Please comment on any improvements.