

TOWARDS A BETTER UNDERSTANDING OF NITROGEN LOSS PATHWAYS & FERTILISER MANAGEMENT

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There has been a significant effort in Australia and internationally to better understand and optimise the use of nitrogen fertilisers, both to improve productivity and to reduce nutrient pollution in the broader environment.

The chemical transformation of nitrogen in soil is affected by many factors such as soil biological activity, rainfall (soil water content), and temperature, as well as soil texture, chemical and physical properties.

Nitrogen applied as fertiliser on farms is exposed to a myriad of loss pathways including transformation into the greenhouse gas nitrous oxide (N_2O), gaseous loss as dinitrogen (N_2), volatilisation as ammonia (NH_3), and leaching as nitrate (NO_3^-).

Plants can also struggle to access nitrogen as it becomes locked in soil organic matter.

These loss pathways often result in poor fertiliser use efficiency, that is, poor plant recovery of the nitrogen applied as fertiliser to the crop.

The use of enhanced efficiency nitrogen fertilisers (EENFs) has been put forward as a method of increasing plant uptake of nitrogen while reducing environmental losses (Rose et al. 2018a).

One form of EENF is based on the application of nitrogen fertiliser in combination with a biochemical inhibitor, such as a nitrification inhibitor that maintains nitrogen as ammonium (NH_4^+) in soil and lowers the rate of conversion to NO_3^- .



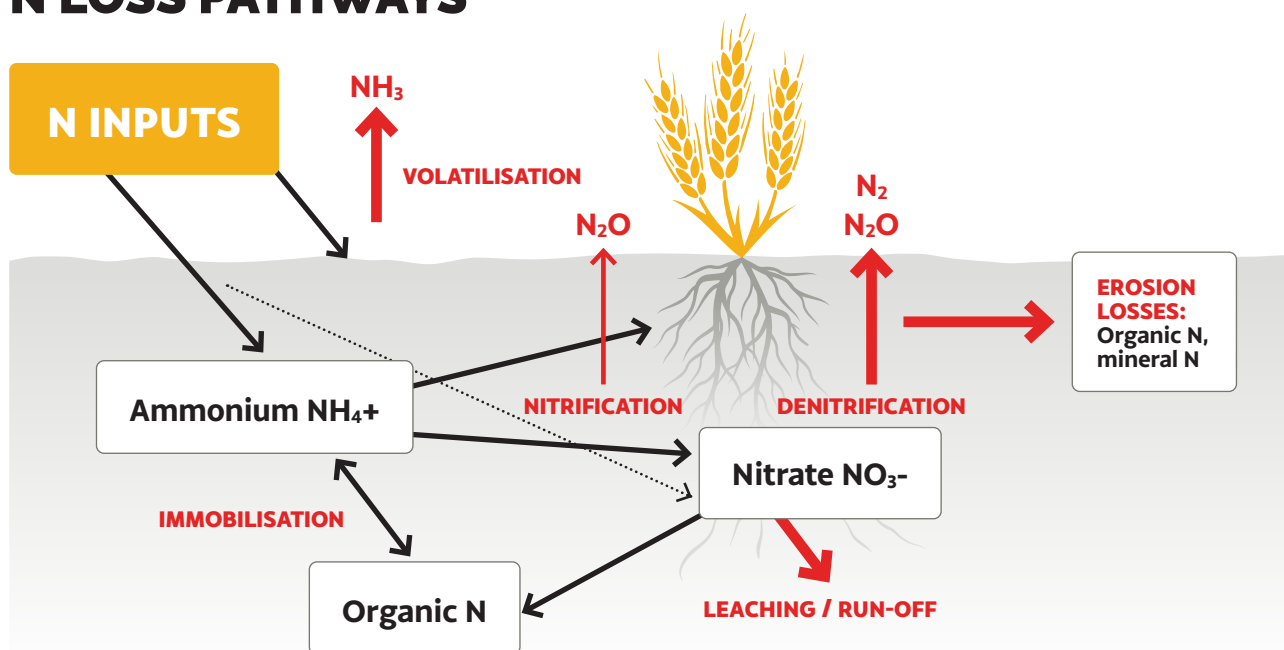
Dr Lukas Van Zwieten. Source: NSW DPI

However, as Rose et al. (2018a) point out, there is a lack of knowledge regarding the agronomic benefits of EENFs, as most studies on these products have focused on assessing their effects on soil greenhouse gas emissions rather than their agronomic effectiveness.

There also seems to be some inconsistency in their performance, (Rose et al., 2018b; Dougherty et al., 2016) that may limit their usefulness in warmer or wetter environments.

A more reliable method of increasing nitrogen fertiliser use efficiency and lowering environmental impacts, is through better matching of nitrogen supply with plant nitrogen demand.

N LOSS PATHWAYS



Source: Lukas Van Zwieten, NSW DPI

Many farming systems will apply nitrogen fertiliser at or near seeding, many weeks (or months in some systems) before plant demand reaches its peak. This practice exposes the nitrogen to loss pathways over an extended period.

The use of slow release fertilisers (for example, polymer coated urea) provides greater potential for reducing losses, particularly where the nitrogen demand from the crop is known, and the release curve of the fertiliser is understood.

It is also important to understand how much plant accessible nitrogen is already in the soil. While many agronomic soil tests will assay mineral N (usually NH_4^+ and NO_3^-), these tests do not account for the mineralisation of organic matter in the form of crop residues, leaf litter, composts, other amendments, and soil organic matter.

By factoring in the natural supply of nitrogen from this microbial degradation of organic matter, farmers will be better able to calculate their actual requirements for additional fertiliser. However, testing for potentially mineralizable nitrogen (commonly known as PMN) is a lengthy and expensive procedure and the test is not commonly available. Researchers at NSW DPI are working on the development of rapid testing methods based on spectroscopy to predict soil PMN, with initial work happening in NSW sugarcane farming systems.

The supply of nutrients from organic amendments has recently been reviewed (Van Zwieten, 2018) as a special edition in the journal, 'Nutrient Cycling in Agroecosystems'. The principal benefit of organic amendments over the long term was shown to be their supply of nutrients to the crop. Understanding 'how much' to apply and 'when' is increasingly important as the use of organic amendments becomes a more common practice.

Another opportunity to lower fertiliser inputs is through biological N_2 fixation, where legumes are incorporated into the farming system to supply a slow release form of nitrogen.

Research on coppiced tree crops (Rose et al., 2019) has shown the potential for faba beans and soybeans to fix over 90 kilograms of nitrogen per hectare, which becomes available to the crop once the organic material is mineralised in the soil. This rate of nitrogen fixation equates to around 200 kilograms of urea applied as fertiliser.

In conclusion, a better understanding of loss pathways, improved matching of nitrogen supply with plant nitrogen demand, and the development of more effective testing procedures for potentially mineralizable nitrogen, should enable agricultural industries to achieve greater fertiliser use efficiency while minimising losses of nitrogen into the environment.



This article was compiled by the Clean Coastal Catchments project which is funded through the NSW Government under the Marine Estate Management Strategy. The ten-year Strategy was developed by the NSW Marine Estate Management Authority to coordinate the management of the marine estate.

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