MANAGING NITROUS OXIDE EMISSIONS FROM CROPPING SOILS

Improving nitrous oxide abatement in high rainfall cropping systems

Background

Agriculture contributed 73% of Australia’s nitrous oxide (N₂O) emissions in 2009, with nitrogen enrichment of soil the source of 75% of these losses. Recent research has shown exceptionally high N₂O emissions from soils in western Victoria, where an increasing proportion of land is being converted from pasture to crops.

Conversion to grain production releases large quantities of stored soil nitrogen and carbon for crop use, but also results in the loss of nitrogen as N₂O. Nitrogen fertiliser applied to these soils in excess of crop nitrogen demand produces further unnecessary emissions without any production gain. Around 2.5 million hectares of grazing land in the high rainfall zone of south eastern Australia could be used for grain production, so there is the risk of generating nationally significant additional quantities of N₂O if better management strategies are not identified and adopted.

Hamilton experimental site with rain-out shelter for determining crop wilting points down the soil profile.
The project is building on PICCC’s earlier study of N₂O emissions from high rainfall cropping systems. Researchers are aiming to improve nitrogen use efficiency through a better understanding of the interactions between management, soil carbon and soil nitrogen, and their impact on productivity and N₂O emissions. The work will evaluate different management and fertiliser strategies for avoiding excess nitrogen inputs and reducing emissions, while delivering adequate nitrogen to meet crop demand.

This knowledge will facilitate the development of new Carbon Farming Initiative offset methodologies to help landholders reduce input costs while earning carbon credits from their land.

**Project outline**

The research team are conducting field experiments in key cropping soils varying in background carbon and nitrogen. The study is comparing crop and N₂O responsiveness to different nitrogen fertiliser management strategies, including rate and timing of application and the use of inhibitor-coated fertiliser. An additional study is assessing how the depletion of soil carbon and nitrogen stores following pasture termination might be controlled to reduce emissions, through strategies such as catch cropping and varying the timing of pasture conversion.

Automated and manual gas chambers will measure emissions of N₂O and carbon dioxide from soil, while soil carbon and nitrogen dynamics will be monitored via in-crop nitrogen mineralisation, crop productivity and gas fluxes. Labelled nitrogen fertiliser studies will determine crop uptake of fertiliser, losses through leaching, the amount of nitrogen fertiliser left over for subsequent crops and unaccounted nitrogen assumed as gaseous loss.

The data collected will improve understanding of the conditions and soil types under which N₂O emissions are likely to be significant in the high rainfall cropping zone. Researchers will use the results to determine best practice fertiliser strategies for optimising nitrogen use efficiency and minimising N₂O emissions following conversion of pasture to grain production.

**Research location**

The research is being undertaken at the Department of Environment and Primary Industries’ Hamilton and Horsham research facilities in western Victoria.

Throughout this information sheet are photos from the Hamilton experimental site, taken over the 2012–13 growing season.

Research progress

Preliminary results from the 2012–13 experiment at Hamilton suggest supplying nitrogen fertiliser in excess of crop demand resulted in unnecessary N₂O losses (Figure 1) and reduced cropping income (Figure 2) — the latter a result of higher fertiliser costs and a reduction in grain quality. High N₂O losses coincided with high soil water levels and increasing soil temperature during the early spring period, soon after the second application of fertiliser as a top dressing.

While there was no improvement in grain yield at higher fertiliser rates, there was a significant reduction in quality, with lower grain weights and higher grain screenings. High levels of plant available nitrogen and organic carbon stored throughout the soil profile at seeding appeared to reduce the crop’s responsiveness to nitrogen fertiliser, highlighting the importance of measuring soil nitrogen to help make better nitrogen fertiliser decisions.

The preliminary data on the use of the nitrification inhibitor-coated urea fertiliser indicates some reduction in N₂O production relative to the equivalent nitrogen rate top-dressed as urea (TD85N@Z31) (Figure 1). However, results so far suggest that matching nitrogen supply with crop demand is a better strategy for reducing emissions and improving on-farm profitability (Figure 2) in the high rainfall zone of western Victoria.
Next steps
Field experimentation will continue in 2013 with new nitrogen use efficiency trials established in the Hamilton, Horsham and Lake Bolac districts. A pasture termination field experiment, complete with automated gas sample collection, has also been established at Hamilton with the aim of examining emissions under different termination strategies when transitioning from long-term pasture to cropping.

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