Building Farmer & Advisor Knowledge in Carbon Farming

The Carbon Farming Knowledge Project involves a series of workshops to increase the understanding of 30 independent agricultural advisers in south-east Australia on reducing greenhouse gas emissions, carbon in farming systems and the Emissions Reduction Fund – where farmers can earn credits for storing carbon or reducing greenhouse gas emissions on their properties. The project helps advisors prepare their clients for potential environmental, economic and social benefits of future carbon management policy.

Session 4: Nitrogen emissions from fertiliser

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SCRIME

There have been a major increase in the use of continuous cropping in southern Australia since the 1990s. A trial site was established in 1998 at Longerenong, Victoria, on a cracking clay soil (425 mm annual rainfall) called **S**ustainable **C**ropping **R**otations in **M**editerranean **E**nvironments (SCRIME), to test different rotations and tillage practices in continuous cropping and mixed farming systems on crop productivity and the soil resource.

The trial has shown that there is significant variability in soil nitrate supply to crops in response to seasonal conditions and practices. While leaching can occur, the SCRIME trial suggested that it is limited and should not generally be of concern to growers in this environment and soil type.

Including a fallow in the rotation decreases soil total N (Figure 1, bar FWP), while green manuring and lucerne both increased soil nitrogen and carbon stocks. Ten years of different tillage practice had no apparent effect on soil carbon.

N_2O losses from fertiliser

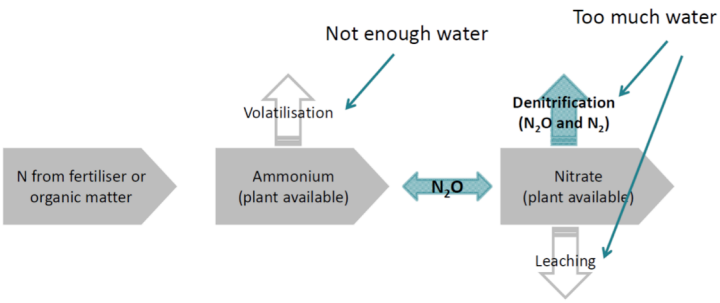

Figure 1: Pathways for nitrogen losses

There are a wide range of ways that fertiliser N can be lost including volatilisation of ammonium, denitrification to N_2O and N_2 and nitrate leaching (Figure 1). Some of the largest losses of N_2O are associated with denitrification, however this does vary with soil type and environment.

Trials across southern Australia have been investigating losses of N_2O from fertiliser from 2012 to 2014. Plots were sown with either no added nitrogen (N) or 50 kilograms of N added. N_2O Emissions were measured by collecting and analysing air over the soil using manual chambers at key times during the growing season.

In both years, adding nitrogen resulted in increased emissions at Horsham in the Wimmera, though emission levels were not high for either the zero N or high N treatments. Other key findings included:

- Rates of nitrous oxide (N_2O) losses were strongly correlated to soil water levels (measured as the percentage of soil pores filled by water).
- Addition of a nitrification inhibitor reduced losses of N_2O at certain times in the season, however the inhibitors did not necessarily provide economic benefit.
- Top-dressing the same amount of N over the season, rather than application at sowing, reduced N_2O emissions.
- Loss of N through other pathways such as denitrification to N_2 can be large. Measurements using ^{15}N tracers have shown a range of loss from 20 to 90 percent of fertiliser applied.

In the high rainfall zone of western Victoria, near Hamilton, there were significant differences in losses compared with Horsham. This was related to a change in soil type with higher soil carbon and nitrogen coupled with higher rainfall and a soil type more prone to waterlogging. Large spikes in losses occurred when soil water content was high. Losses were more difficult to control, however applying N during the season was able to reduce overall losses compared to application at sowing.

While N_2O loss at Hamilton was very high, N_2O loss from dryland cropping is generally low when compared with more intensive situations such as irrigated cropping systems. Recent trial work by the Irrigated Cropping Council in conjunction with DEDJTR suggested that daily N_2O losses from irrigated maize and barley can exceed 1 kg N_2O-N/ha/day in the period following irrigation, compared with 0-5g N_2O-N/ha/day from wheat in the Wimmera and 0-500g N_2O/ha/day in Hamilton.

In conclusion, dryland cropping N_2O losses are low, but can still spike depending on weather and management. However overall losses of applied fertiliser can be more significant depending on the specific situation (ranging from around 15-40% in the Wimmera to a worst case scenario of approximately 90% in the high rainfall zone). Matching fertiliser application rate and timing to the crop requirements is likely to be the best strategy for minimising emissions.

Managing emissions following transition from pasture to cropping

Research at Hamilton has investigated whether N_2O emissions can be reduced through late pasture termination before heading into a cropping phase.

Results show that total N_2O emissions are highly impacted by the time of termination. A number variations were tested including a continuous perennial grass-clover pasture, early (spring 2012) termination followed by summer fallow; and a winter crop and late (autumn 2013) termination followed by a winter crop.

Emissions were significantly higher for early termination (Figure 2), with peaks during winter/spring when crops became water-logged.

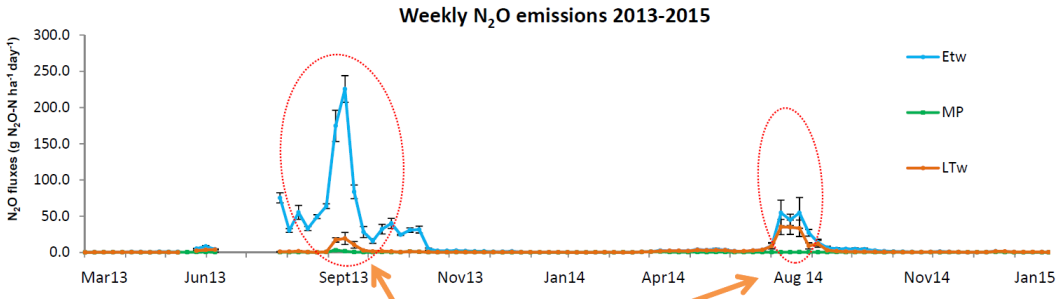

Figure 2: N_2O emissions for early termination (blue), late termination (orange) and pasture (green).

The total N_2O loss over 2013 and 2014 were similar between mown pasture and late termination, equivalent to 0.3-1.2kg/ha urea. In comparison, early termination losses equated to 15kg/ha urea equivalent. This means that late termination can reduce nitrogen losses by nearly 12 times, reducing costs for growers and lowering greenhouse gas emissions.

Useful resources

- The contribution of nitrogen (N) fertiliser to nitrous oxide (N_2O) emissions and wheat productivity in a high rainfall cropping environment: http://soilscienceaustralia.com.au/soil2014/proceedings/Harris.pdf
- Effect of pasture termination practices on nitrous oxide emission in a high rainfall cropping system http://soilscienceaustralia.com.au/soil2014/proceedings/Belyaeva.pdf
- The Carbon Farming Initiative – www.mycfi.com.au
- Building Farmer and Advisor Knowledge in Carbon Farming Project – www.carbonfarmingknowledge.com.au

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