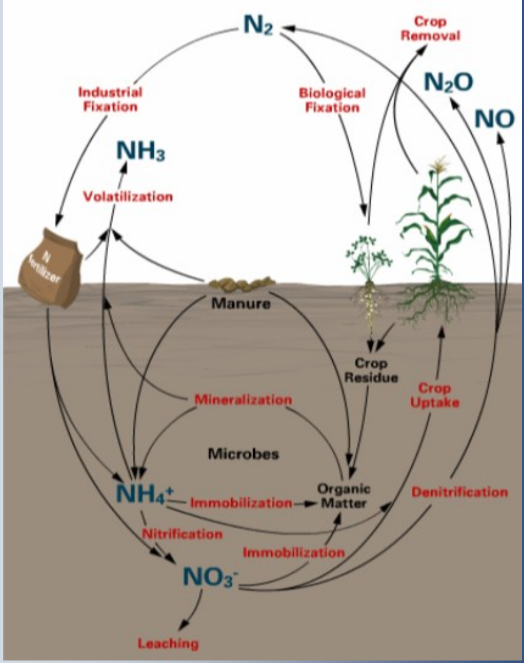
FACT SHEET
nitrous oxide emissions
& its relevance to North Burnett grain growing

The Nitrogen Cycle



Source: Cornell University Co-operative Extension Agronomy fact sheet series – Fact Sheet 2, Nitrogen Basics – The Nitrogen Cycle

Nitrogen Cycle Processes

⇒ N-fixing bacteria convert N2 into ammonium (NH_4+)

⇒ nitrifying bacteria convert ammonium into nitrite (NO_2-) and then into nitrate (NO_3-)

⇒ plants take up ammonium and nitrate, and convert it into plant tissue which then is eaten by animals

⇒ organisms (bacteria and fungi) convert animal waste and plant tissue to ammonium, which then also goes through the nitrifying process

⇒ denitrifying bacteria complete the N cycle by converting nitrate back to gaseous nitrogen compounds (N2, N2O & nitric oxide)

Key management techniques to minimise soil N loss from denitrification, leaching or runoff:

⇒ Reduce fallow period where there is a high probability of N loss (ie fallow period after a legume crop).

⇒ Follow legume crops with high N use crops

⇒ Deep-rooted crops can be used to mop up the N left in the subsoil by shallow-rooted crops

⇒ Limit practices that result in soil compaction as good soil drainage is required to prevent waterlogging.

⇒ Avoid excessive fertilisation

⇒ Avoid over-irrigation

What is nitrous oxide?

Nitrous oxide (N_2O) is a greenhouse gas that is 300 times as potent of carbon dioxide (CO_2). Under certain soil and environmental conditions, N_2O is produced from both soil and fertiliser nitrogen (N) by nitrifying and denitrifying bacteria. Agriculture is responsible for approximately 85 per cent of Australia's emissions.

Why is it important?

In farming systems, generally speaking, N_2O emissions represents a loss in soil or fertiliser N . Therefore, lowering the amount of N gas lost from the soil through efficient fertilise use could mean on-farm cost saving for the farmer.

The 3 main drivers of N_2O emissions:

1. **The amount of Carbon (C) in the soil**
   This labile highly reactive form of carbon is used by denitrifying bacteria as an energy source. Fresh organic matter such as brown and green manure crops, crop stubble, volunteer weeds and manures contribute most of the labile C in our soils.
2. **High soil moisture content**
   Wet soil conditions are the most conductive to N_2O emissions, with the peak occurring at around 70% water filled pore space. Soils prone to waterlogging are at high risk of N_2O emissions.
3. **The amount of nitrate (NO_3-) in the soil**
   When the amount of NO_3- (ie from N fertilisers, manures, or breakdown of organic matter) in the soil is in excess of what the crop can utilise, increased N_2O emissions are more likely to occur under wet conditions.

The 4R's of N supply & managing denitrification risk

1. **Right Product** – Under wet soil conditions, NO_3- in the soil is converted to oxides of N and dinitrogen (N_2). N_2O emissions are then less where ammonium (NH_4+) is the dominant reaction product and its rate of conversion to NO3- in the soil is slowed. Nitrification inhibitors (e.g. DMPP) can slow the conversion of NH_4+ to NO_3- but its price and logistics need to be considered.

2. **Right Rate** – The optimum N fertiliser rate depends on the crop and the system in which it is growing. Although N_2O emissions may only be a small component of overall N losses from wet soils, it is important to consider the other sources of N supply, type of fertiliser, logistics, cost, crop requirements and N emissions when deciding on the fertiliser application rate. This is why it is so important to do a soil test for mineral N if there is uncertainty about its quantity and location and to check other nutrients are not limiting crop growth and therefore impacting on N use efficiency. Also consider N input from other non-fertiliser sources including organic matter mineralisation during crop growth, Net N mineralisation of residues from previous crops, prior legume crops or pastures, manure applications and irrigation water.

3. **Right Time** – Matching fertiliser application to crop demand makes best use of this resource. Split applications may be appropriate to coincide with the start of rapid crop growth and rapid uptake. Nitrate forms should not be applied in large amounts when denitrification or leaching risk is high. Do not apply fertiliser too far ahead of crop establishment, unless the risk of denitrification and leaching are minimal (e.g. dry soil).

4. **Right Place** – Always apply fertiliser to the root zone or where there is a reasonable expectation that follow-up rainfall will carry fertiliser into the main root zone. Pre-plant band applied N should be placed as deep as practical below the layer of decomposing crop residue. Sub-surface application of N products is recommended if they are prone to volatilisation losses (e.g. Urea).

Sources:
- Fertcare® Carbon Farming Extension Project, Best Management Practices to reduce nitrous oxide emissions for irrigated broadacre Crops (excluding rice), Feb 2015
- NANORP Fertcare Grains Industry Fact Sheet: Nitrous Oxide emissions in the Grains Industry, March 2016

FERTCARE®

A LOCAL EXAMPLE
nitrous oxide emissions
Action on the Ground trial in the North Burnett

The trial

This Action on the Ground project funded through the Australian Government aims to provide North Burnett grain growers with tangible data and agronomic advice on:

⇒ Comparisons of annual or seasonal N_2O emissions between the new farming techniques and the conventional management practices such as bare fallow vs summer legume and emissions in winter cereals, displacement of fertiliser N with biologically fixed N from legumes and with/without the use of nitrification inhibitor in urea.

⇒ Analysis of daily N_2O fluxes in relation to major driving factors such as soil mineral N, water content and climatic conditions.

⇒ Identification of the best farming system that results in the lowest N_2O emissions without sacrifice of cropping yield.

Over the last 3 years gas chambers have been placed in the field to measure N_2O emissions from two trial sites, one (uniform black clay - Black Vertisol) at Fred Jarvis's and the second (gradational clay loam surface over a sandy clay subsoil – Black Dermosol) at Russ Salisbury's.

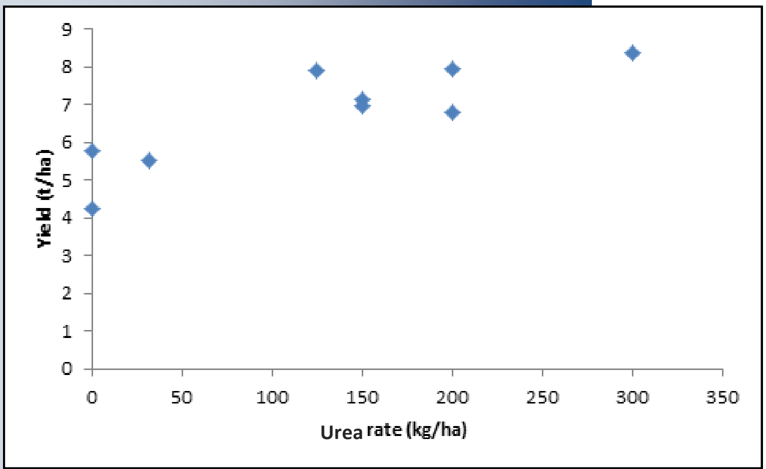


Figure 1: *Winter cereal yield (t/ha) versus Urea rate (kg/ha)*

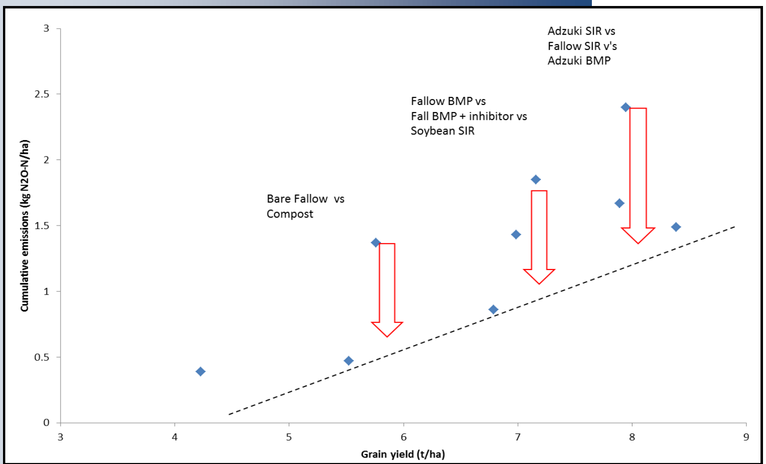


Figure 2: *Cumulative N_2O emissions versus winter cereal grain yield SIR=Standard Industry Rate and BMP=Best Management Practice rate as determined by a soil test.*

The results

While the trial is still in progress, not all results have been analysed. It is however worth communicating key results from early in the trial which reflect and demonstrate the key drivers to N_2O emissions.

The first year compared the emissions from a summer legume (mungbean/adzuki bean and Soybean) and a winter cereal (barley/wheat). The results obtained so far are comparable with similar trials and back-up Best Management Practice (BMP) to reduce N_2O emissions.

Figure 1 compares yield of barley in t/ha obtained with varying rates of Urea fertiliser applied in kg/ha. The graph shows increasing yields as a result of increasing rates of Urea, but it also shows a plateau effect at around 200kg/ha where the extra rate of Urea applied has not resulted in a significantly greater yield. There is a point at which any extra N applied is not fully utilised by the plant and is then at risk of leaching or denitrification and loss to the atmosphere.

As expected, emissions increased following rainfall and irrigation events that caused water logged soil for both summer and winter phases and in the legume phase, fallow ground consistently produced more N_2O emissions then legume.

Figure 2 illustrates yield vs emissions. The treatments were grouped into similar yields but it is evident that a change in practice can significantly reduce N_2O emissions.

Depending what the yield target is, in the top clusters, double cropping instead of fallow and using an inhibitor will reduces N losses.

A good point to remember with N_2O, which is easier to measure than other N losses, is it is only an indicator of N loss from the soil. Vastly more than this could be lost in other forms of N gas during denitrification and it is worth looking for ways to reduce emissions in North Burnett crop production systems.

Due to Cyclone Marcia wiping out the 2014 summer legume, the second season of the trial focused on a winter faba bean and summer sorghum.

The final crop, of spring sorghum is in the ground now and the results from this crop will be collated with those from other seasons for a technical report to be produced in early 2017.

The project is an initiative of the Burnett Mary Regional Group and the Burnett Catchment Care Association, supported by funding from the Australian Government Department of Agriculture through their Action on the Ground program.

The project is additionally supported by the Central Queensland University (CQU), the Queensland Department of Science, Information Technology, Innovation (DSITI), the Queensland Department of Agriculture & Forestry (QDAF), FARMStuff Monto and Wide Bay Composts.

Published by:
Burnett Catchment Care Association
6 Lyell St, Monto Q 4630
PO Box 8 Monto Q 4630
P: (07) 4166 3898
www.betterbunett.com

November 2016

BCCA
BURNETT CATCHMENT CARE ASSOCIATION

Australian Government

Burnett Mary REGIONAL GROUP
Practical Solutions for Natural Resource Management

Queensland Government

CQUniversity AUSTRALIA