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*Soil Science Challenge Grants Program*

**The University of Queensland**

# Impacts on soil organic matter and the dynamics of soil water and nitrogen in cropping: project summary

Project period: June 2022 to December 2025

## Introduction

The grain growing regions in northeastern Australia support opportunistic summer or winter cropping. The dominance of grain cropping has meant that the demand for nitrogen (N) is a critical component of successful crop production, and as soil organic matter continues to decline with the duration of cropping activity, fertiliser N inputs are increasingly critical for achieving seasonal yield potentials. This study explored the impact of changing fertiliser N management strategies on N use efficiency in contrasting rainfall environments typical of the broadacre grains industry in northeastern Australia.

The 2 hypotheses being tested in these studies were that:

1) N applications early in the fallow between winter cropping seasons will increase the recovery of applied N by a subsequent wheat crop, due to better co-location of water and N in the soil profile.

2) The crop in the season prior to N application (cereal or grain legume) will affect the distribution of fertiliser N in the soil profile due to differences in immobilisation of N by soil microbial communities in the uppermost soil layers.

These studies utilised long-term farming systems plots that have been established and funded by the Grains Research and Development Corporation near Mungindi in southwestern Queensland (QLD), and near Pampas on the inner Darling Downs in QLD. Measurements were conducted over successive summer fallow/winter crop/summer fallow sequences beginning in the 2022 and 2023 calendar years. At each site, biologically reactive ($^{15}$N-enriched urea fertiliser) or inert (potassium bromide – KBr) solutes were banded into soils at the beginning and end of a summer fallow period in 2022–23 and 2023–24. Applications were made in systems that had a winter cereal (wheat) or grain legume (chickpea) as the previous crop in both sites, while at Pampas there were additional applications made in treatments hosted permanent fallows or where applications of cereal straw had been incorporated into the soil using tillage after a previous wheat crop.

Soil water accumulation and extraction were monitored during the fallow and crop growing seasons, as was the movement of N and bromide (Br) down the soil profile. Crop uptake and removal of both N and Br was also quantified at wheat harvest in 2023 and 2024 crop seasons, with the efficiency of recovery of applied N fertiliser and the residual fertiliser N in the soil profile after crop harvest determined for early and late fallow applications.

## Findings

Results largely supported the first hypothesis but did not support the second. Findings included:

- long-term field experiments provide excellent opportunities to test N management strategies
- early fallow N application can improve fertiliser N recovery, but only under specific seasonal conditions
- water dynamics are the primary driver of N redistribution and recovery
- early fallow N application did not increase apparent N loss risk in this study
- previous crop type had limited influence on fertiliser N redistribution
- microbial immobilisation plays a key role, but mostly as a delay mechanism
- subsurface banding both protects and constrains fertiliser N
- broadcast N application may not offer additional benefits in stored water systems
- yield responses alone are a poor indicator of fertiliser N use efficiency
- seasonal context must underpin N management decisions.

## Publications

This project has resulted in peer review journal papers currently in preparation or in review. This section will be updated once papers are published.

## More information

Learn more about the Soil Science Challenge Grants Program.

Contact the project lead, Professor Michael Bell.

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**Acknowledgement of Country**

We acknowledge the continuous connection of First Nations Traditional Owners and Custodians to the lands, seas and waters of Australia. We recognise their care for and cultivation of Country. We pay respect to Elders past and present, and recognise their knowledge and contribution to the productivity, innovation and sustainability of Australia's agriculture, fisheries and forestry industries.