# A synergistic mitigation technology for nitrate leaching and nitrous oxide emissions for pastoral agriculture




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## Introduction

- Nitrate ($NO_3^-$) leaching from agricultural land into groundwater is a major environmental issue worldwide.
- Nitrous oxide ($N_2O$) is a potent greenhouse gas. In New Zealand, agricultural greenhouse gas emissions account for nearly 50% of the national inventory. One third of the agricultural greenhouse gas emissions is $N_2O$.
- The major source for both $NO_3^-$ leaching and $N_2O$ emissions is nitrogen (N) from animal urine excreted onto grazed pasture soil.
- Here we report a mitigation technology which is synergistic for the reduction of both $NO_3^-$ leaching and $N_2O$ emissions and also for the improvement of pasture yield.

## Materials and Methods

- Soil ammonia oxidizing bacteria (AOB) population abundance was determined by real-time PCR by targeting the functional *amoA* gene.
- Nitrate leaching losses were determined using undisturbed soil monolith lysimeters (50-80 cm diameter by 70-120 cm depth).
- Nitrous oxide emissions were determined using closed chamber methods.
- The nitrification inhibitor dicyandiamide (DCD), was applied in a liquid form at the rate of 10 kg $ha^{-1}$, twice per annum, once in the autumn and once in late winter/early spring; as per commercial practice for 'eco-n' technology.
- Fresh dairy cow urine was collected and applied at 1000 kg N $ha^{-1}$.
- The pasture was a mixture of perennial ryegrass (*Lolium perenne*)/white clover (*Trifolium repens*).


## Acknowledgments

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## Results and discussion

- Ammonia oxidizing bacteria population abundance was significantly inhibited by the application of DCD.

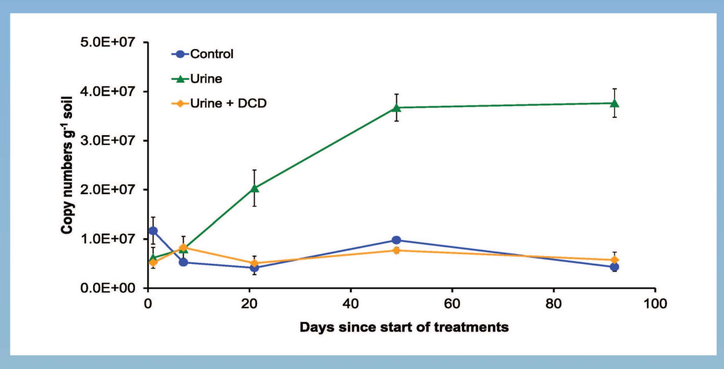


Figure 1. *amoA* gene copy numbers of ammonia oxidizing bacteria as affected by urine and DCD (Di *et al.*, 2009a).

- Nitrate leaching losses were decreased by about 60% from cow urine patches by the use of DCD.

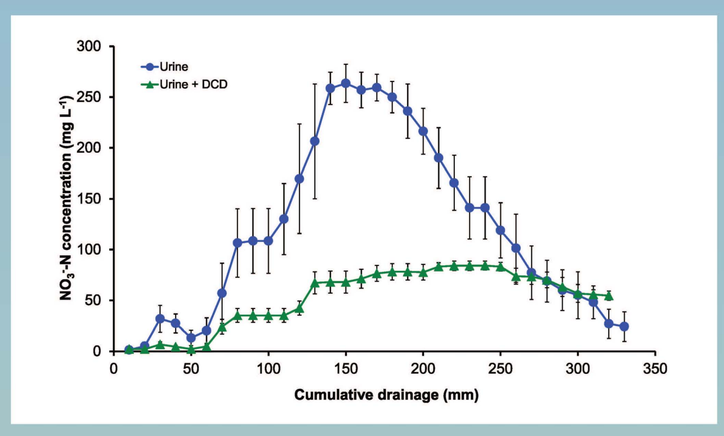


Figure 2. Nitrate-N concentrations in the drainage water from urine-treated lysimeters with or without DCD (Di *et al.*, 2009b).

- Nitrous oxide emissions were decreased by about 60% from cow urine patch areas by DCD.

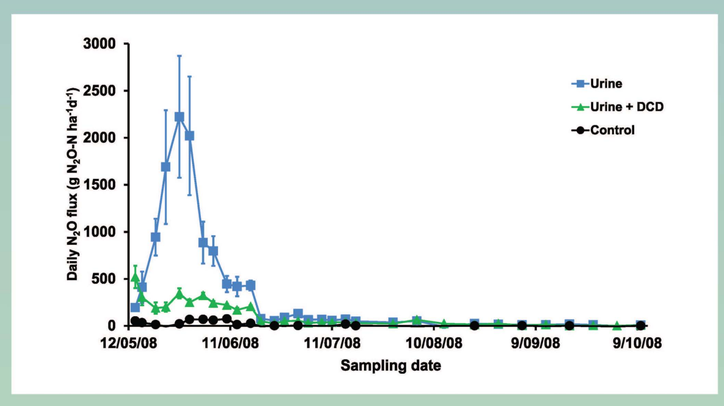


Figure 3. Daily $N_2O$ fluxes from urine-treated lysimeters with or without DCD (Di *et al.*, 2010).

- Pasture yield was significantly increased by up to 20% with the use of DCD.

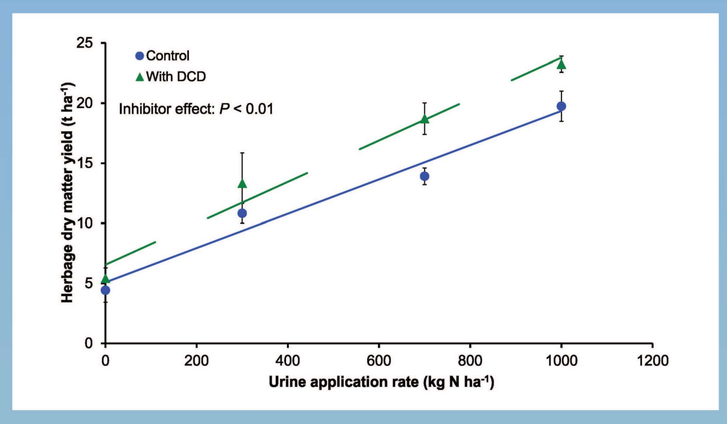


Figure 4. Pasture yield from urine-N applied at different rates as affected by DCD (Di and Cameron, 2007).

- Recent on-farm paddock scale pasture yield measurements across NZ (132 data sets) showed a 19% average pasture yield response to DCD (eco-n) (Carey *et al.*, 2012).
- Other microbial communities, such as methanotrophs were not affected by DCD (Di *et al.*, 2011).

## Conclusions

- **The nitrification inhibitor DCD was highly effective in inhibiting the soil AOB population and produced significant decreases in nitrate leaching and nitrous oxide emissions; as well as significant increases in pasture yield.**
- **DCD has been shown not to affect other non-target soil microbial communities.**
- **Spray application of DCD ('eco-n') is therefore an effective synergistic mitigation technology to reduce environmental impacts and improve the sustainability of grazed grassland.**

## References


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