LAB ASSESSMENT OF N MINERALISATION FROM DAIRY SLURRY AND MANURES

Moira Dexter[1], Anwar Ghani[1], Paul Johnstone[2], Dave Houlbrooke[1], Matt Norris[2], Joanna Sharp[3], Bob Longhurst[1]

[1] AgResearch, Ruakura Research Centre, 10 Bisley Road, Hamilton 3240
[2] Plant & Food Research, Cnr Crosses and St George's Roads, Havelock North 4130
[3] Plant & Food Research, Canterbury Agriculture and Science Centre, Lincoln 7608
Email:moira.dexter@agresearch.co.nz

Introduction

To 'close the loop' on farm nutrient management and improve nutrient use efficiencies, an increasing proportion of slurry and manure effluents are being used to grow forage and arable crops (Houlbrooke *et al.* 2011). Application rates of these effluents are typically based on Total Nitrogen (N) content (i.e. inorganic and organic forms) and the common assumption is that all of the N in these effluents will be mineralised and available for plant uptake within a short period of time. However, a range of physical and chemical effluent characteristics can have a significant effect on the net mineralisation of N and need to be considered when applying these effluents to ensure that the potential risks associated with over or under supply of nutrients are minimised.

This manuscript summarises preliminary results from a laboratory incubation experiment conducted to quantify net N mineralisation rates from slurry and manure effluents over a six month period and link release rates to initial physical and chemical characteristics. Results will subsequently be used to help develop a tool to assist land managers in their decision around effluent application to cropping systems.

Methodology

The first step of the project was a laboratory based N mineralisation incubation using five slurry effluents and six manure effluents collected from various Waikato dairy farms. The effluents were classified as slurry or manure effluents based on their solids content (Houlbrooke *et al.* 2011) and were characterised for total N, P, K, and C, Na, Mg, Ca, pH, ammonium, nitrate, dissolved organic carbon and N, anaerobically mineralisable N and hot-water extractable N and C (Table 1).

Table 1. Selected effluent characteristics at application (wet weight basis).

Effluent class	Dry Matter (%)	Total Nitrogen (mg/kg)	C:N ratio	Ammonium-N (mg/kg)	Nitrate-N (mg/kg)	Anaerobically Mineralisable N (mg/kg)	Hot Water Extractable N (mg/kg)
Slurry	6.2 - 17.7	1,900 - 3,600	12.4 - 26.3:1	1 - 164	0.4 - 1.4	380 - 2,800	360 - 2,800
Manure	23.4 - 61.3	4,100 - 15,100	13.0 - 41.0:1	1 - 112	0.8 - 991	590 - 3,040	700 - 4,400

These effluents were applied at c.100 kg N/ha into soil columns, incubated at 20°C and 85±3% water holding capacity and periodically leached with one pore volume of distilled water over the 182 day study period.

Leachates collected were analysed for nitrate, ammonium and dissolved organic N as indicators of N mineralisation. The differences between N concentrations in the leachates of the control (soil only) and effluent treatments were used to estimate net N mineralisation from the effluents over time.

Results

Rates of N mineralisation from the effluents (shown in Figures 1 and 2) were highly variable. On average, by 182 days after application, more N was released from slurries (39% of N applied; range of 0 to 87%) than from manures (13% of N applied; range of -8 to 37.

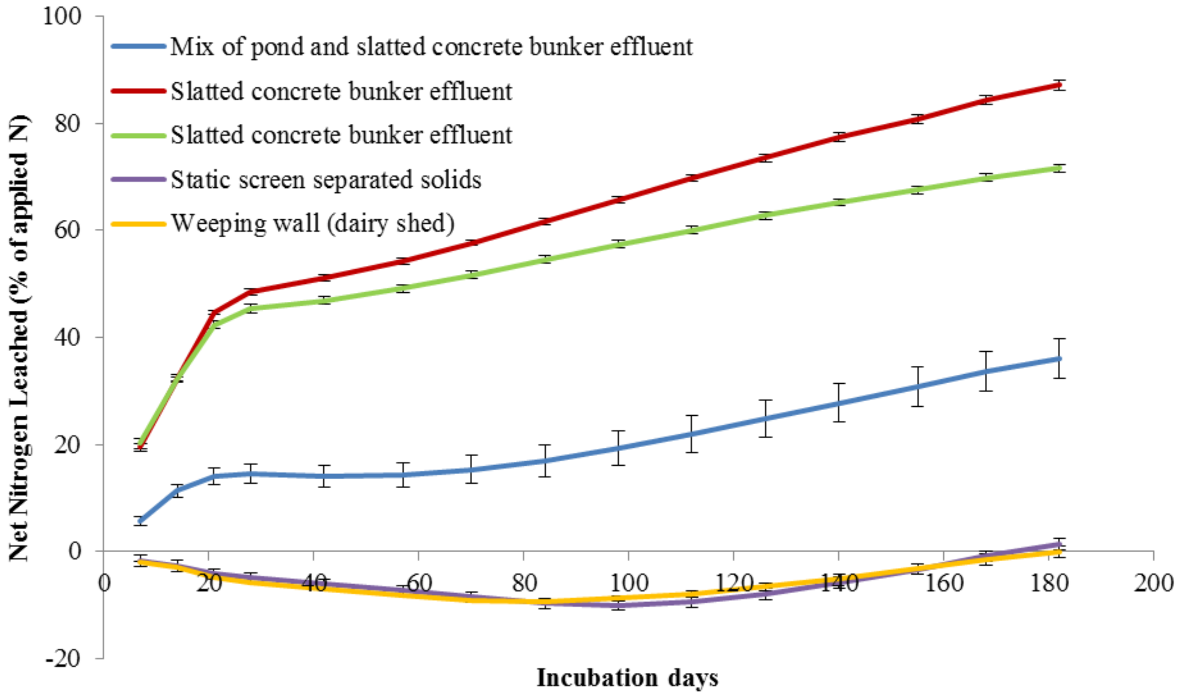

Figure 1. Net release of N from slurries as a percentage of the applied N.

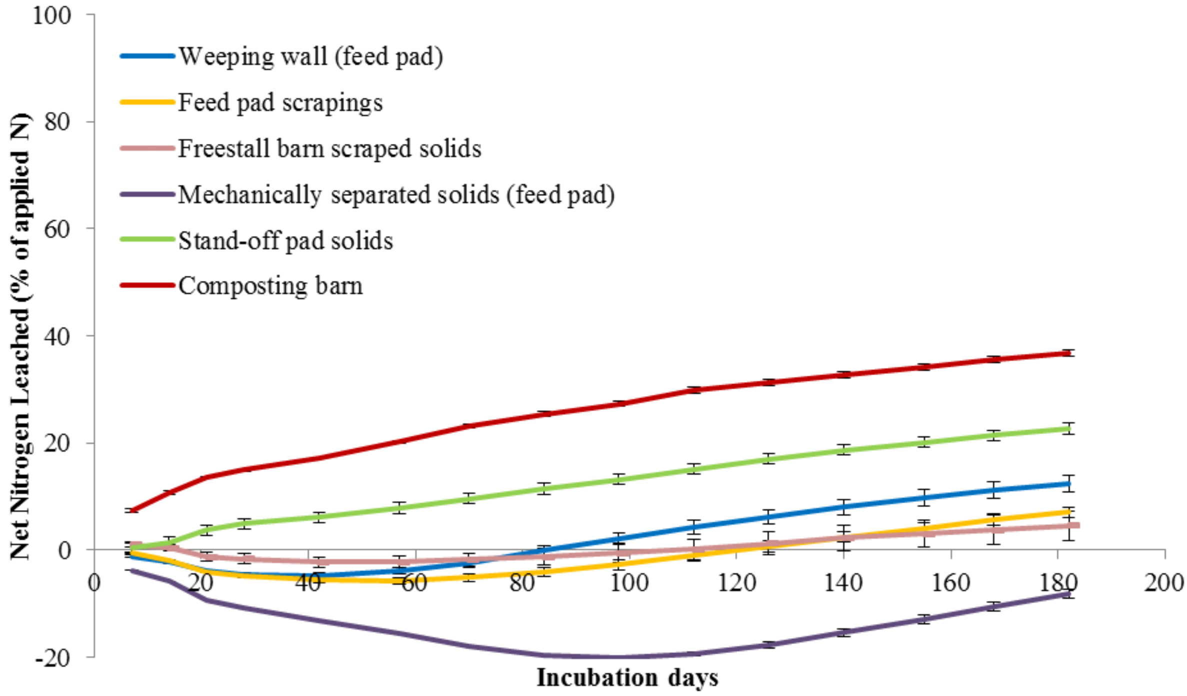

Figure 2. Net release of N from manures as a percentage of applied N.

The flush of N during the first 28 days of incubation correlated well with initial inorganic N concentration in the effluent (Figure 3), such that the effluents with larger early flushes tended to have a higher proportion of inorganic N in their total N pool. The main form of inorganic N in all effluents was ammonium (0.04 - 6.75% of total N).

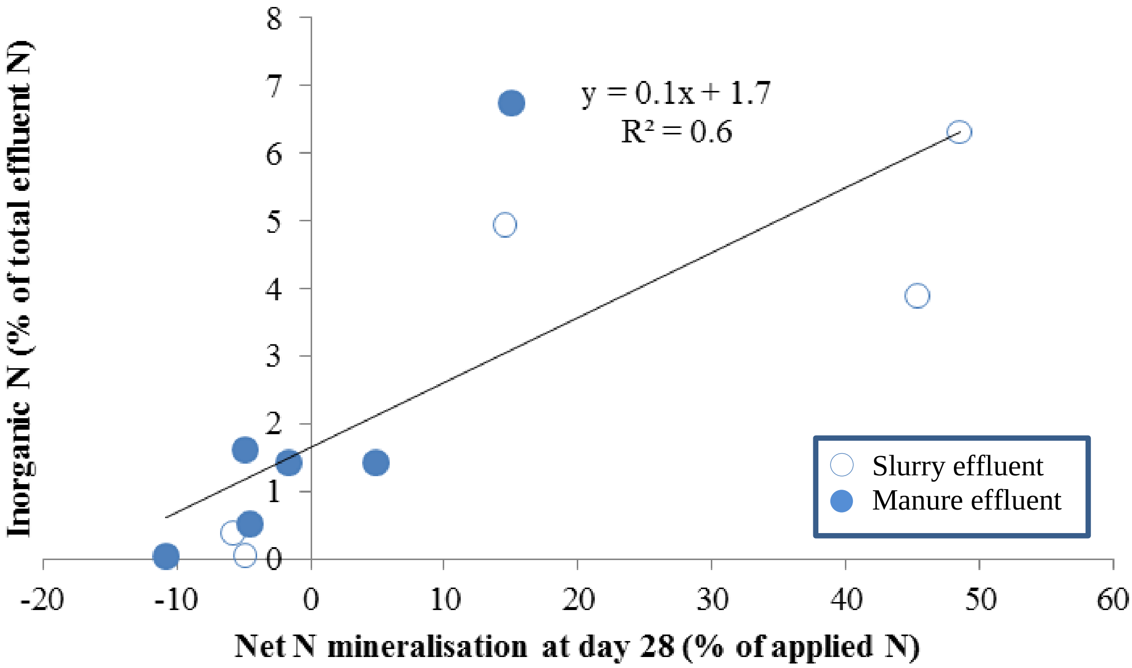

Figure 3. Percentage net release of N at 28 days compared to proportions of inorganic N in effluent.

Two slurries and four manure effluents displayed net immobilisation at 28 days and tended to have lower inorganic N proportions and higher C:N ratios than effluents with net mineralisation. After a period between c.30 and 100 days net mineralisation began to occur, as shown by an upward trend in the cumulative percent of N released in Figures 1 and 2. Of these six effluents two slurries (static screen separated solids and dairy shed weeping wall) and one manure (mechanically separated solids) had the longer immobilisation periods (c.80 - 100 days), the lower N releases after 182 days (-8.2 – 1.4% net N release as a percent of applied) and the higher C:N ratios (19 - 41:1) suggesting C:N ratios may be helpful in predicting N release rates from effluents.

After any initial N flush or immobilisation period there was a steady release of N, averaging 0.15% and 0.10% of applied N per day in the slurry and solids, respectively.

The trajectory of the graphed lines suggests that more N will be released after the 182 days of this experiment. This sustained release under constant moisture and temperature conditions is important in predicting the long term release potential from the effluents.

Data analyses are continuing to explore relationships between the amount and rate of N mineralised and key effluent characteristics measured at application.

Conclusions

Net N mineralisation was greater from the slurries than from the manures tested in these incubations, although rates were highly variable.

In these incubations only -8 to 87% of the total N applied was converted into a plant available form within the trial period. This will have important consequences for matching N supply to crop N demand. In a number of crops, additional N would be needed during the season to ensure deficiencies were avoided.

Any tool developed to help a land manager determine timing and rates of effluent application needs to take into account N forms and possibly C:N ratios in the effluent and not simply Total N.

Future work

Future work planned will look at the effect of variable moisture, temperature and soil type on N release rates from effluents. Field validation of laboratory findings will be performed and a diagnostic test developed for potentially mineralisable N in effluents for use by land managers.

Acknowledgements

Research was completed as part of the Forages for Reduced Nitrate Leaching programme with principal funding from the New Zealand Ministry of Business, Innovation and Employment. The programme is a partnership between DairyNZ, AgResearch, Plant & Food Research, Lincoln University, Foundation for Arable Research and Landcare Research.

We acknowledge the input by technical staff of the Land and Environment group at AgResearch (Emma Bagley and Stuart Lindsey).

References

Houlbrooke, D., Longhurst, B., Orchiston, T., Muirhead, R., 2011. Characterising dairy manures and slurries. Envirolink Tools report AGRX0901. Pp. 118. http://www.envirolink.govt.nz/PageFiles/31/Characterising%20Dairy%20Manures%20and%20Slurries.pdf