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## Nitrous oxide emission and methane oxidation potential in the pastoral soil under intensive dairy farm management

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**Key words:** N<sub>2</sub>O, CH<sub>4</sub>, nitrogen, carbon, excreta

**Introduction** Anthropogenic nitrous oxide (N<sub>2</sub>O) emissions from agricultural soils are estimated to contribute ~14% of New Zealand's greenhouse gas (GHG) inventory (New Zealand Climate Change Office 2007). The global annual soil sink for methane (CH<sub>4</sub>) was estimated to be 3-9% of the atmosphere's removal rate (Smith et al., 2000). We report N<sub>2</sub>O emission and CH<sub>4</sub> oxidation rates in freely and poorly drained soils on an intensively managed dairy farm following a cattle urine application.

**Materials and methods** The two soils examined were located beneath pasture grazed by dairy cattle in Waikato region of New Zealand (37°S, 175°E) with average annual rainfall of 1240 mm and air temperature of 14°C. Cow urine was applied to create experimental urine patches in the soils at 10 L/m<sup>2</sup> (650 kg N/ha). Fluxes of N<sub>2</sub>O and CH<sub>4</sub> were measured using static chambers (diameter 250 mm, height 130 mm), with 3 replicates for urine patches and controls, over 100 days in autumn and winter seasons. Gas samples were analysed by gas chromatograph with a <sup>63</sup>Ni-electron capture detector (ECD) for N<sub>2</sub>O and a flame ionization detector (FID) for CH<sub>4</sub>. Soil and relevant environment parameters were measured/monitored over the trial period.

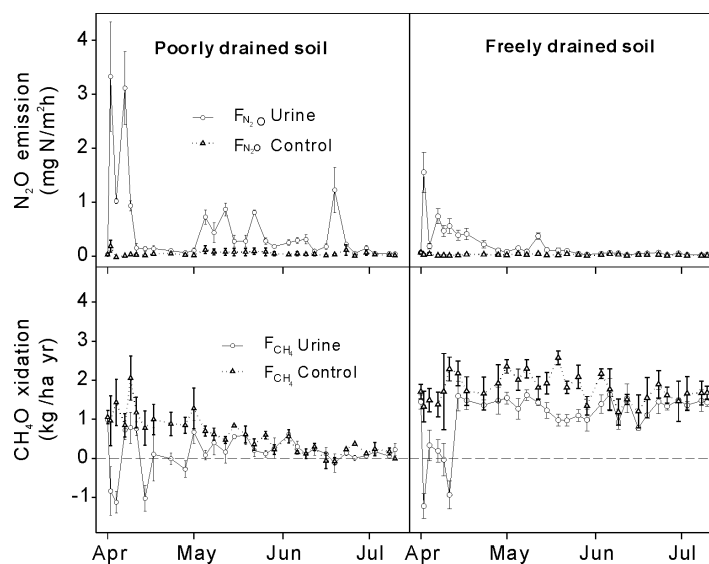
**Results** There were eight occasions for both soils when N<sub>2</sub>O fluxes in the urine patches exceeded the 100-day average. For the freely drained soil, seven of these days occurred during the first 3 weeks after urine application and accounted for 61% of total emissions. Higher than average daily emissions occurred throughout the 100 days of measurement for the poorly drained soil, and 4 of these days during the first 3 weeks after urine application accounted for 41% of total emissions. For both soils, N<sub>2</sub>O emissions of the urine-amended plots always exceeded the controls. Nitrous oxide emission factors (EF<sub>3</sub>) were 1.3 and 0.4% for the poorly and freely drained soils respectively.

Following urine application, the poorly drained soil was a net source of CH<sub>4</sub> on Days 2, 3, 13, 22, 27 and 79. On the day of urine application and 7 and 9 days later, the freely drained soil was also a net source of CH<sub>4</sub>. Over 100 days, for the poorly drained soils, the integrated CH<sub>4</sub> oxidation rates were 0.6 ± 0.1 and 0.2 ± 0.1 kg C/ha yr for the Controls and Urine plots, respectively. For the freely drained soil, the corresponding rates were 1.8 ± 0.2 and 1.1 ± 0.2 kg C/ha yr.

**Conclusions** Applying urine markedly increased soil's N<sub>2</sub>O emissions. The integrated N<sub>2</sub>O emitted from poorly drained soil was 3 times than that from freely drained soil. Cattle urine application reduced the CH<sub>4</sub> oxidation rates of freely and poorly drained soils for up to two months and by 0.7 ± 0.2 and 0.4 ± 0.1 kg C/ha yr. Overall, the two soils' responses were not significantly different.

### References

- New Zealand Climate Change Office (2007) National Inventory Report New Zealand, Greenhouse Gas Inventory 1990-2005.  
Smith KA, Dobbie KE, Ball BC, Bakken LR, Sitaula BK, Hansen S, et al. (2000) Oxidation of atmospheric methane in Northern European soils, comparison with other ecosystems, and uncertainties in the global terrestrial sink. *Global Change Biology*, 6, 791-803.



**Figure 1** Nitrous oxide emission and CH<sub>4</sub> oxidation rates measured over 100 day trial period (n=3).