Nitrous Oxide Emissions from Dairy Pasture Systems in New Zealand

Jiafa Luo
AgResearch, New Zealand

S. B. Lindsey
AgResearch, New Zealand

Sterwart F. Ledgard
AgResearch, New Zealand

W. Sun
AgResearch, New Zealand

M. Kear
AgResearch, New Zealand

The 21st International Grassland Congress / 8th International Rangeland Congress took place in Hohhot, China from June 29 through July 5, 2008.

Proceedings edited by Organizing Committee of 2008 IGC/IRC Conference

Published by Guangdong People's Publishing House

Nitrous oxide emissions from dairy pasture systems in New Zealand

J. Luo, S.B. Lindsey, S.F. Ledgard, W. Sun, M Kear
AgResearch, Ruakura Research Centre, Private Bag 3123, Hamilton, New Zealand,
E-mail: jiafa.luo@agresearch.co.nz

Key words: dairy farm, nitrous oxide, grazed pasture, maize supplement, New Zealand

Introduction Animal excreta deposited during grazing are the single largest source of nitrous oxide (N_2O) from agriculture in New Zealand. N_2O gas is formed in soils during nitrification and denitrification processes and these processes are affected by many soil and climatic factors (e.g., soil water-filled pore space (WFPS) and nitrate concentrations). There are a number of possible management options that can reduce N_2O emission from dairy farms (Clark *et al*. 2005). These options include using restricted grazing regimes to reduce excreta-N deposited onto wet soil and using low-N feed supplements (e.g. maize) as an alternative to using N-rich pasture. A dairy farm system study was carried out to evaluate effects of these options on N_2O emissions. In this paper we summarise N_2O emission data and environmental efficiencies in terms of N_2O emissions per unit of milk production obtained from this study.

Materials and methods The study site contained white clover-based pasture (perennial ryegrass, *Lolium perenne*; white clover, *Trifolium repens*) on a poorly drained loam soil. Farm systems included: 1) Control: a normal rotational pasture grazing regime with a stocking rate of 3.0 cows ha^{-1}; 2) Maize supplement: a rotational grazing regime with a stocking rate of 3.8 cows ha^{-1}. About 5 tonnes DM ha^{-1} of maize silage were brought in annually; 3) Stand-off: Same grazing regime and stocking rate as the control, but cows were kept on stand-off pads for 18 hours each day with grazing for 6 hours on pasture during the winter period. Measurements of N_2O were made for two years on the grazed pastures, maize growing land and stand-off pad (Luo *et al*. 2008a, b). The New Zealand IPCC inventory methodology was used to calculate indirect N_2O emissions from leached and volatilised N.

Results Nitrous oxide emission rates exhibited marked seasonal variation, largely explained by changes in soil WFPS (Figure 1). Annual N_2O emissions from the grazed dairy pastures were 4.7, 4.0 and 3.4 kg N_2O-N ha^{-1} for the control, maize supplement and stand-off treatments, respectively. The N_2O emission rate from the maize growing land was 2.1 kg N_2O-N ha^{-1}, and this was equivalent to emission of 0.1 kg N_2O-N per tonne of maize silage. Emissions of N_2O also occurred from the stand-off pad. Total annual N_2O emissions (including both the field measured and calculated direct and indirect emissions from all components of the farm systems) were 7.7, 8.0 and 7.0 kg N_2O-N per hectare of dairy farm on the control, maize supplement and stand-off farm systems (Table 1). Total N_2O emissions per kg of milk production from the maize supplement and stand-off farm systems were 22% and 9% lower than that from the control system, respectively.

Table 1 *N_2O emissions and environmental efficiency indicators (Luo et al. 2008a, b).*

	Control	Maize supplement	Stand-off
N_2O emissions (kg N_2O-N $ha^{-1} yr^{-1}$)	7.7	8.0	7.0
Change in N_2O emission compared to control (%)		4	-9
Milk solids (kg ha^{-1} yr^{-1})	13.437	17.925	13.437
Efficiency indices (kg N_2O-N $tonne^{-1}$ milk)	0.57	0.45	0.52
Gain in efficiency (%)		22	9

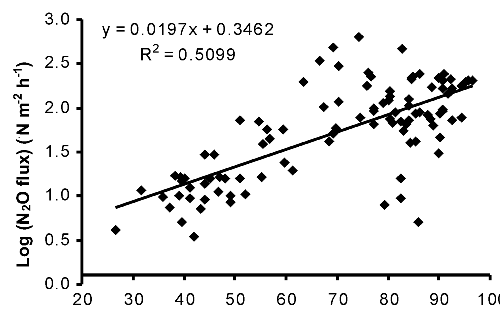

Figure 1 *N_2O emissions as affected by soil WFPS.*

Conclusions The results confirm that the use of low-N feed supplements or restricted grazing regimes during wet winter are effective at reducing N_2O emissions from dairy farms in terms of N_2O emissions per unit of milk production.

References

Clark H, Pinares-Patino C, de Klein CAM (2005) Methane and nitrous oxide emissions from grazed grasslands. In: McGilloway DA, *Grassland: a global resource*, Wageningen Academic Publishers, 279-293.

Luo J, Ledgard SF, de Klein CAM, Lindsey SB, Kear M (2008a) Effects of dairy farming intensification on nitrous oxide emissions. *Plant and Soil*, (in press).

Luo J, Ledgard SF, Lindsey SB (2008b) A test of a winter farm management option for mitigating nitrous oxide emissions from a dairy farm. *Soil Use and Management*, (in press).