Non-CO_2 Greenhouse Gas Emissions Associated with Winter Management and Farm Effluent Application in Grazed Grassland Systems in New Zealand

Jiafa Luo
AgResearch, New Zealand

Surinder Saggar
Landcare Research, New Zealand

Sterwart F. Ledgard
AgResearch, New Zealand

The XXI International Grassland Congress / VIII 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

Non-CO_2 greenhouse gas emissions associated with winter management and farm effluent application in grazed grassland systems in New Zealand

J . Luo[1] , *S . Saggar*[2] , *S .F . Ledgard*[1]
[1] *AgResearch , Ruakura Centre , Private Bag 3123 , Hamilton , New Zealand , E-mail : jiafa .luo@ agresearch .co .nz .*
[2] *Landcare Research , Private Bag 11052 , Palmerston North , New Zealand*

Key words : Nitrous oxide , methane , stand-off pad , farm effluent , pasture , grazing systems

Introduction In New Zealand , stand-off pads (purpose built , drained loafing space to hold livestock for periods when it is not suitable to have them on pasture) are increasingly used in restricted cattle grazing systems . These stand-off pads are considered to avoid damage to pasture , to minimise soil compaction and to reduce emissions of greenhouse gas nitrous oxide (N_2O) and nitrate leaching during wet periods of the year . However , emissions of N_2O and methane (CH_4) also occur from stand-off pads and from land applied farm effluent collected from stand-off pads . Reducing the emissions from these sources is crucial to the development of successful restricted grazing strategies to reducing their environmental impact . Here we summarise the results of N_2O and CH_4 emissions measured from a stand-off pad and also N_2O emissions from effluent applied to two pastoral soils under contrasting soil moisture conditions .

Materials and methods The stand-off pad was used for holding 21 non-lactating cows for about 18 h per day (following 6 h grazing pasture) for 86-day period between late June and early August when soil was wet . The pad (300 m^2) consisted of screened crushed pine bark and sawdust and an effluent drainage collection system . The effluent from the stand-off pad was applied onto a long-term white clover/ryegrass based pasture on poorly-drained Waikato Te Kowhai silt loam soil during the very dry seasons of 2004 and 2005 . The farm effluent was also applied on poorly-drained Tokomaru silt loam soil in the Manawatu region three times between 2003 and 2004 . The effluent was applied at N loadings between 16 and 50 kg N ha^{-1} per application . Measurements of N_2O and CH_4 fluxes originating from the stand-off pad were made while it was being used (Luo *et al* . 2008a) . N_2O emissions were also measured from the effluent applied and control sites using large numbers of static chambers (Luo *et al* . 2008b) .

Results and discussion Nitrous oxide fluxes from the stand-off pad ranged between 0 and 3 .0 g N_2O-N day^{-1} and were probably related to the concentrations of water and nitrate in the pad materials . Overall only 54 g of N_2O-N was emitted from the stand-off pad supporting 21 cows for the June-August , 86-day period , representing about 0 .01% of the excreta N deposited on the pad . Methane fluxes from the stand-off pad were between 0 and 360 g CH_4-C day^{-1} , and were related to the amount of accumulated dung on the pad surface over time . Methane emissions from the pad during the measurement period were 3 .0 kg CH_4-C , and the CH_4 emission value was 2 .34 g CH_4/kg excretal C deposited on the pad . Application of effluent to grazed pastures increased N_2O fluxes compared to the control . N_2O emissions from effluent applications were most strongly influenced by soil water-filled pore space (WFPS) and excretal-N inputs through grazing , and ranged from 0 .01 to 4 .93% of the effluent N (Table 1) . N_2O emissions were higher when pastures were grazed and soil WFPS was above field capacity , while emissions were lower when pastures were not grazed and soil WFPS was much below field capacity .

Table 1 *Nitrogen applied through farm effluent and N_2O emissions (Luo et al . 2008b) .*

Location	Application time	Soil WFPS (%)	N applied (kg N ha^{-1})	N_2O emitted (kg N_2O-N ha^{-1})	Emission factor (%)
Waikato	Apr 2004	30-53	50 .0	0 .015	0 .03
Waikato	Feb 2005	26-38	50 .0	0 .004	0 .01
Manawatu	Sep 2003	61-90	23 .9	0 .471	1 .97
Manawatu	Jan 2004	69-94	25 .2	1 .243	4 .93
Manawatu	Feb 2004	56-77	18 .0	0 .449	2 .49

Conclusions The use of stand-off pads in New Zealand during winter when soil is wet and strategic application of farm effluent during summer and autumn when soil is dry can significantly reduce N_2O emission from grazed pastures . Delaying effluent-application after grazing events could further reduce N_2O by reducing the levels of surplus mineral-N . Emissions of CH_4 from effluent-application are needed to determine for assessment of effects of using stand-off pads and restricted grazing on total emissions of greenhouse gas from "whole" systems .

References

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

Luo J , Saggar S , Bhandral R , Bolan , N , Ledgard SF , Lindsey SB (2008b) Effects of irrigating dairy-grazed grassland with farm dairy effluent on nitrous oxide emissions . *Plant and Soil* , (under review) .