Nitrous oxide emission factor from animal dung on different soils in New Zealand

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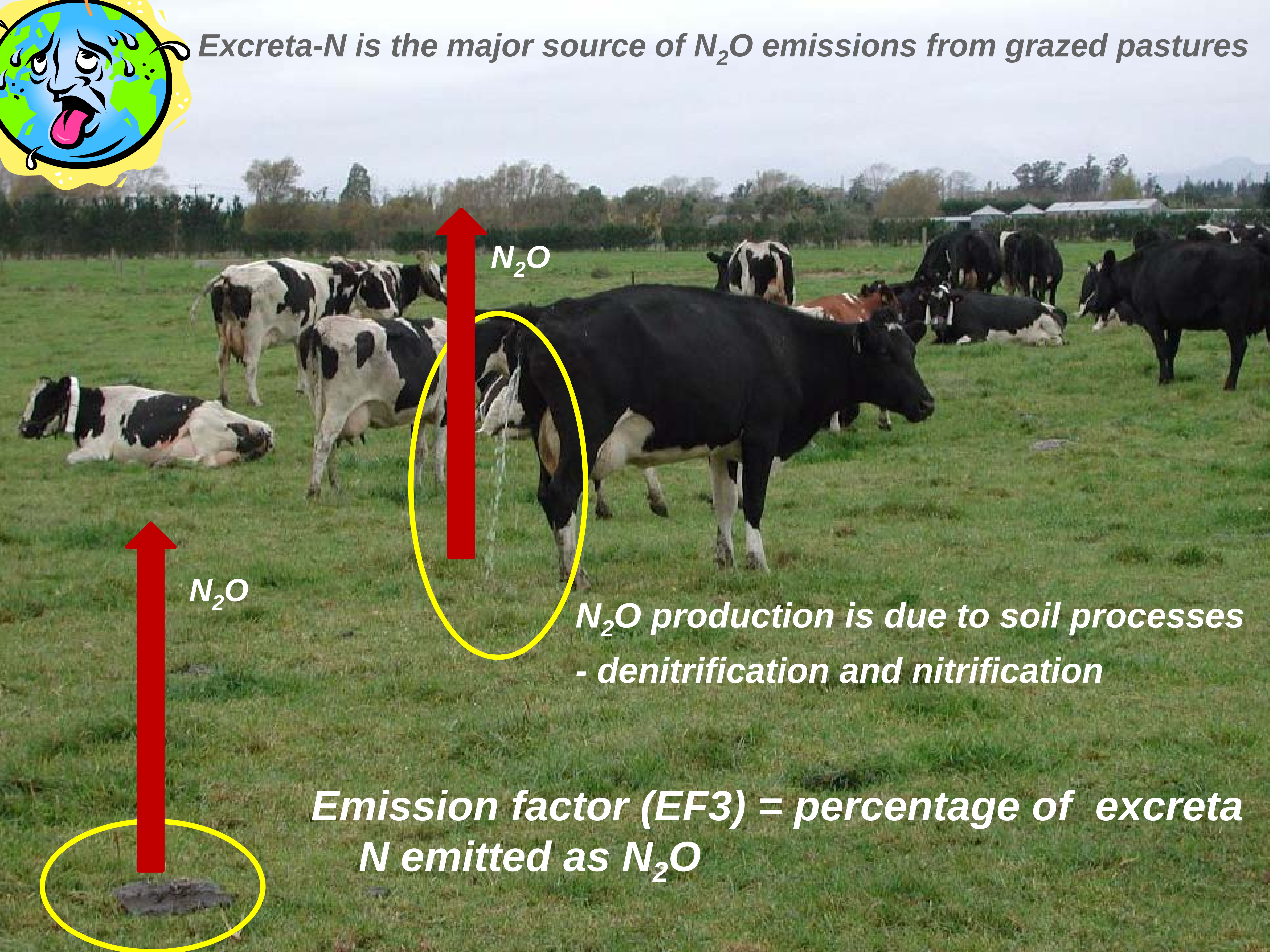
Te Ahuwhenua, Te Kai me te Whai Ora. Tuatahi


Excreta-N is the major source of N_2O emissions from grazed pastures
N_2O
N_2O
N_2O production is due to soil processes
- denitrification and nitrification
Emission factor (EF3) = percentage of excreta N emitted as N_2O

Introduction

- Previous studies have confirmed a New Zealand specific N_2O emission factor (EF3) of 1% from animal urine
- The IPCC default EF3 value is 2% for animal excreta
- Limited studies have suggested that EF3 for cow dung ranges between 0.1 and 0.5%, while N_2O emissions from sheep dung are (close to) zero

Introduction

- Currently New Zealand-specific EF3 of 1% is applied to animal urine and also to dung
- A disaggregation of EF3 between deposited urine N and dung N would result in more accurate N_2O inventories

Introduction

Forms of N differ in excreta from different animals

N mineralisation is slower from dung than from urine

Introduction

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Study hypothesis

- **EF3 from different animal and excreta types decreases as follows:**

Cattle urine > cattle dung > sheep dung

Study design

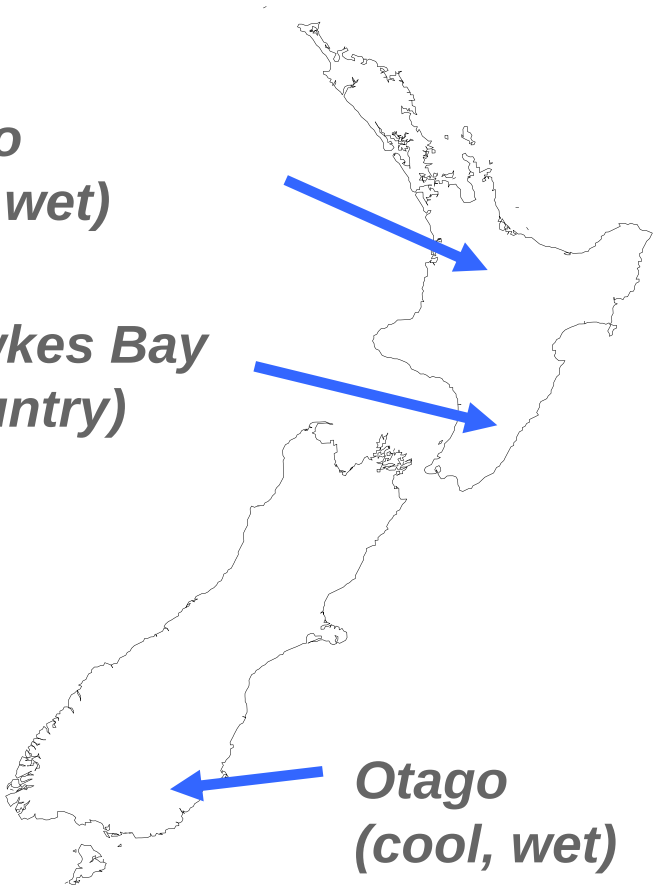
- Plot trial
- Dung: Fresh cattle and sheep dung
- Urine: Fresh dairy cow urine
- Trial on six soils across three regions of New Zealand

3 study sites

New Zealand

Waikato
(warm, wet)

Southern Hawkes Bay
(moist hill country)



Otago
(cool, wet)

Study design

- Plot trial
- Dung: Fresh dairy cow, beef cow and sheep dung
- Cattle urine: Fresh dairy cow urine
- Trial on six soils across three regions of New Zealand
- Each region included both a freely- and a poorly-drained soil
- Treatments were applied in autumn and spring 2008

Materials and methods

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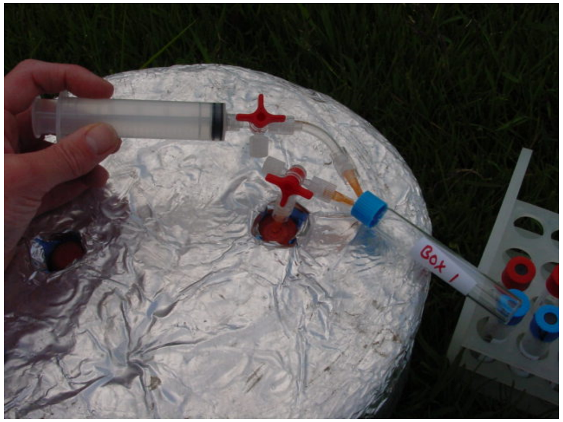
Treatment application

Materials and methods

- Soil chambers were used to measure N_2O emissions

Manual sampling

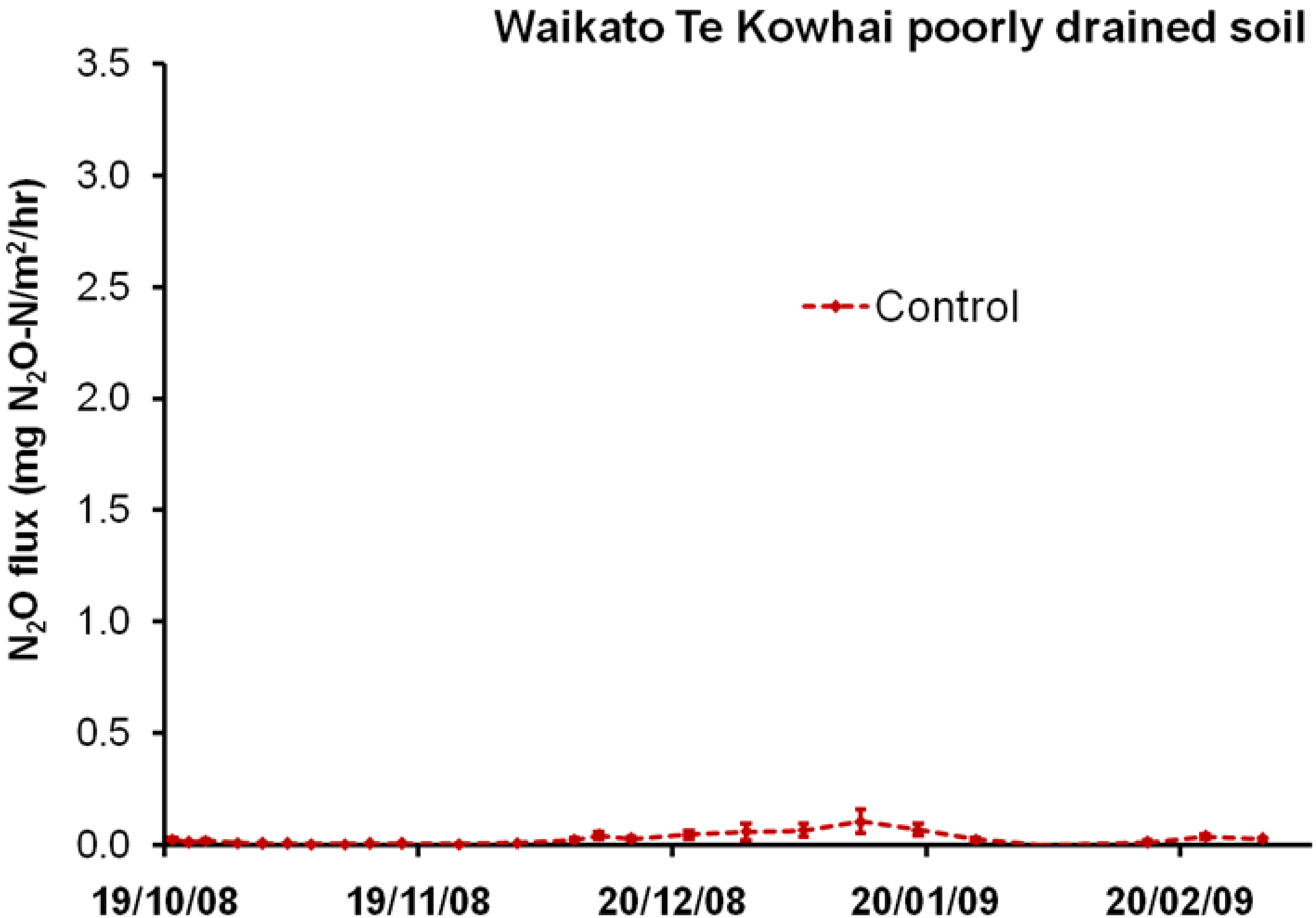


Materials and methods

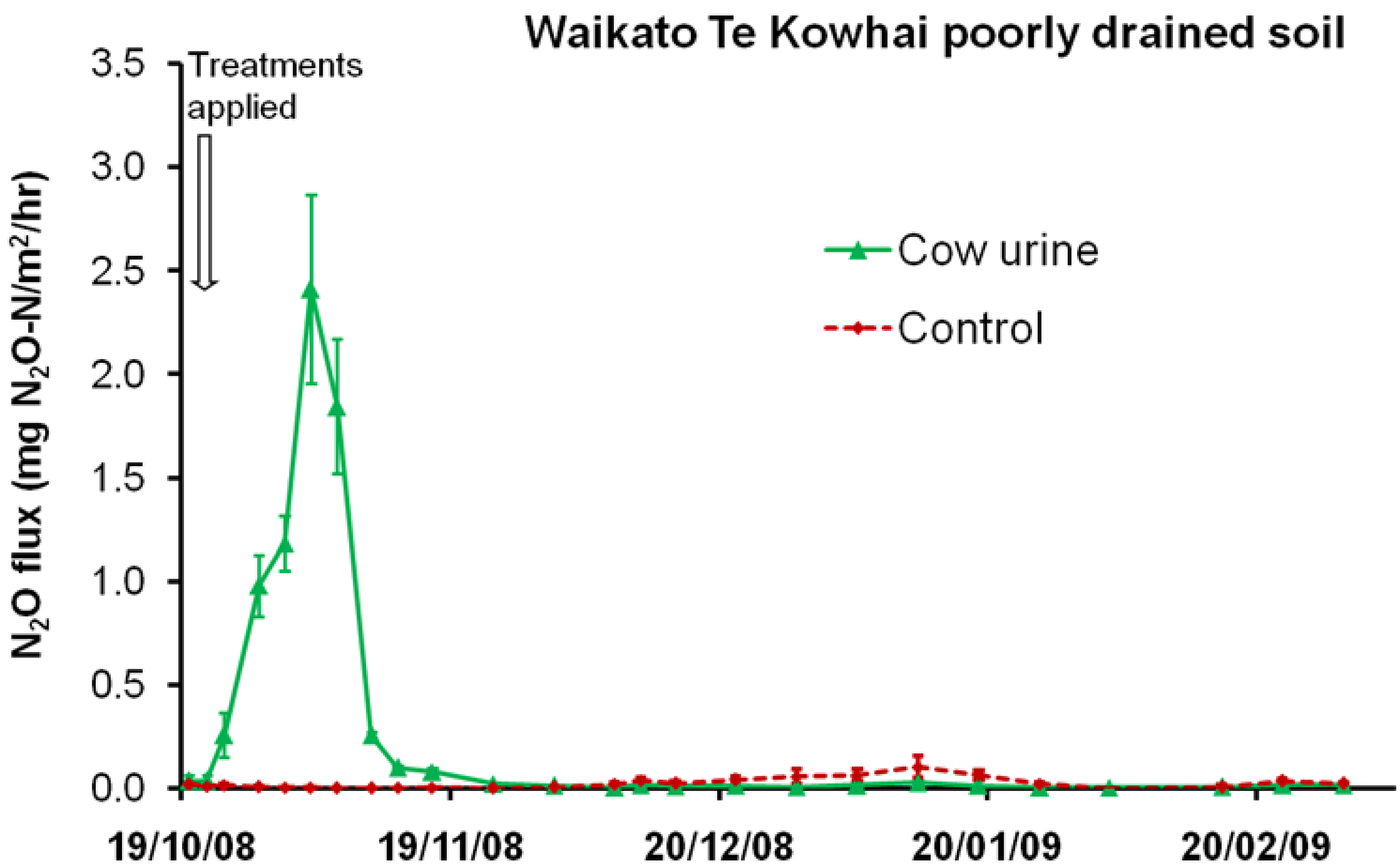
- Soil chambers were used to measure N_2O emissions
- Gas samples were taken twice per week for the first month and then once per week until background levels were reached
- Total emissions over the measurement period were calculated
- EF3 values were calculated for each excreta type

EF3 = 100% × [N_2O (urine/dung) – N_2O (control)]/applied N

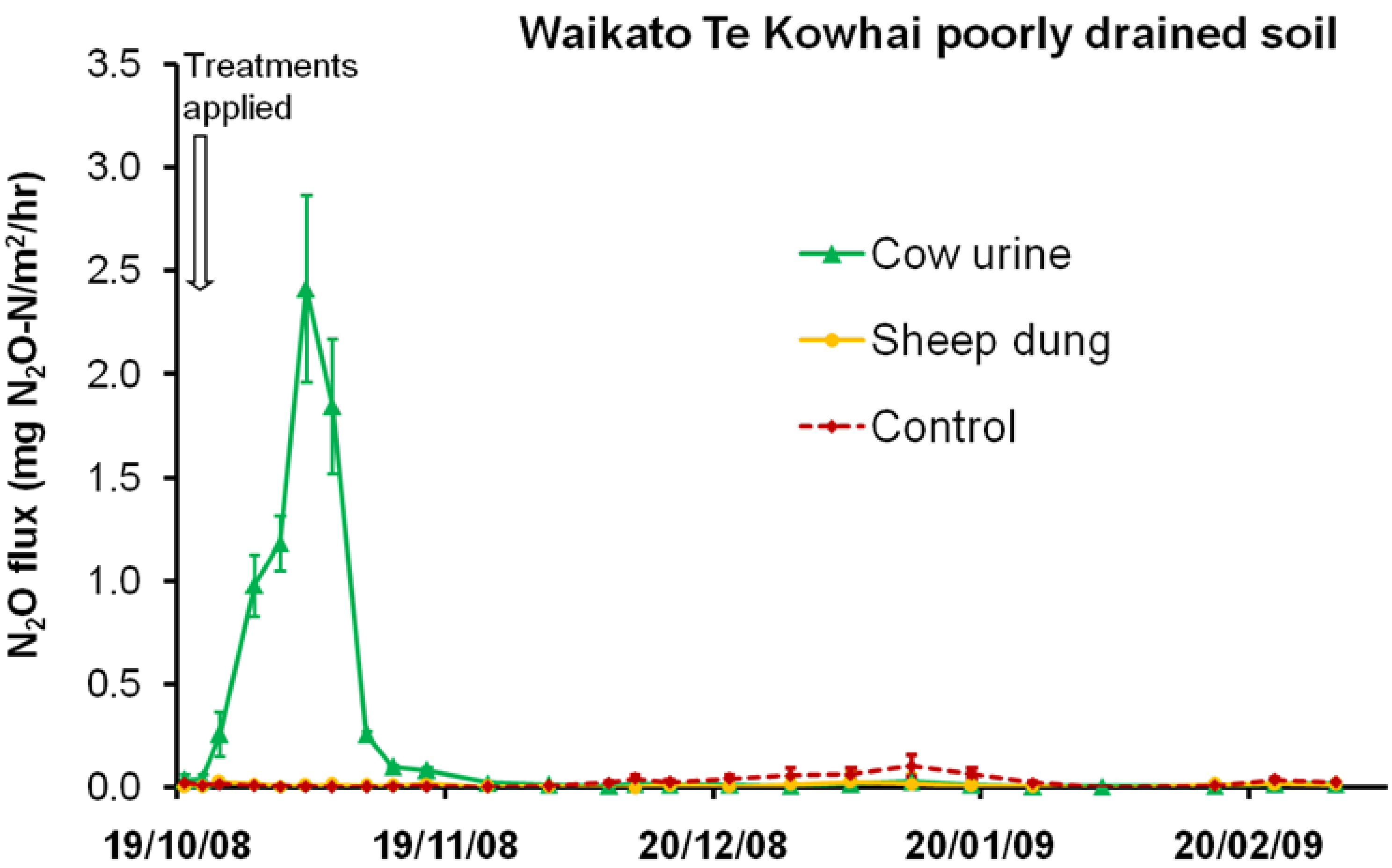
Results and discussion



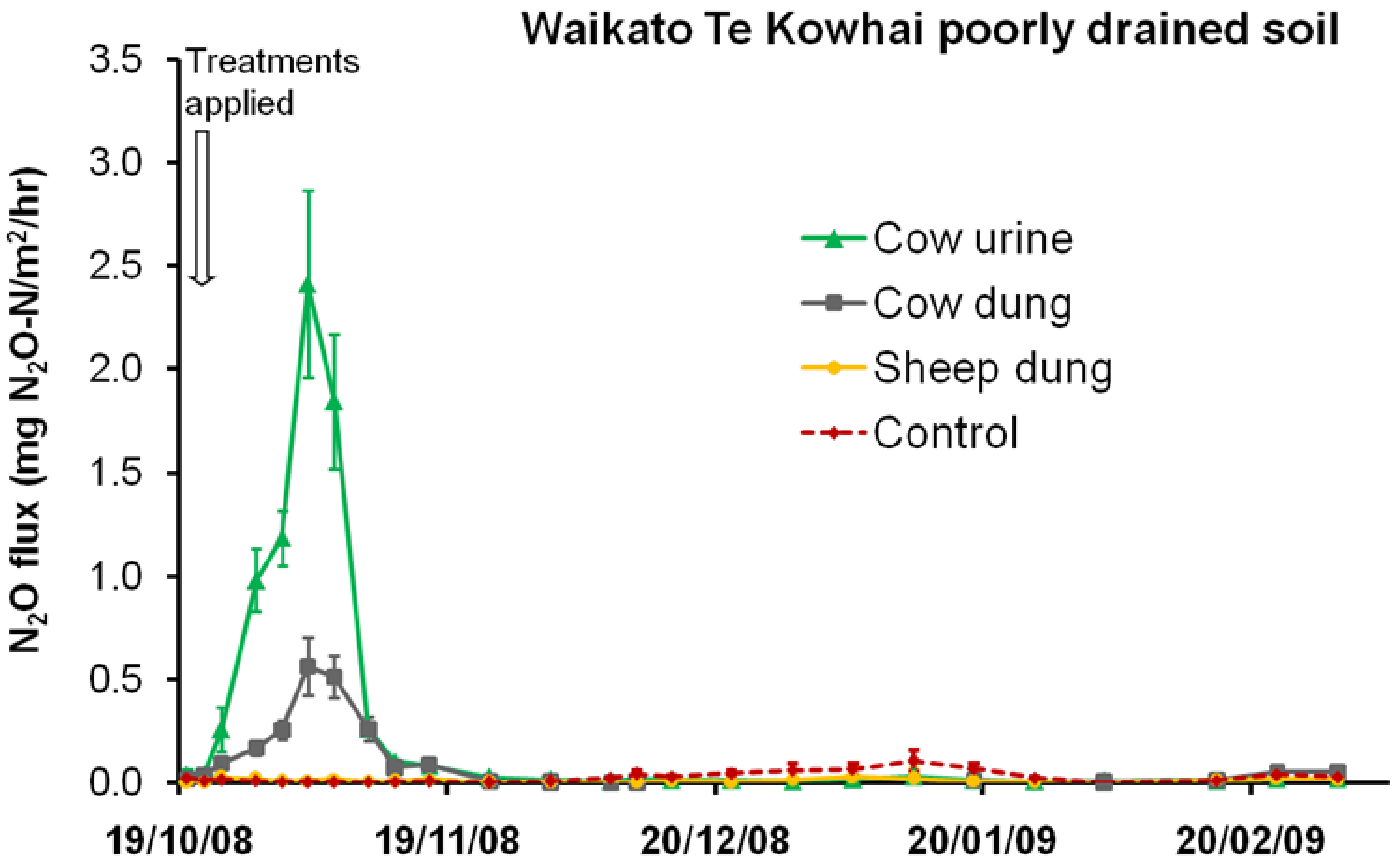
Results and discussion



Results and discussion



Results and discussion



Results and discussion

- The N_2O fluxes in the Controls were very low in all six soils
- N_2O fluxes from urine and dung treatments returned to background (control) level within 2-6 months
- Dairy cow urine treatments always resulted in the largest N_2O fluxes from all 6 soils, followed by dung and control treatments

Results and discussion

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EF3 % (SEM in bracket)

Autumn-winter season (May 08 – Sep 08)

Soil	Waikato			Hawkes Bay			Otago		
	Cow urine	Cattle dung	Sheep dung	Cow urine	Cattle dung	Sheep dung	Cow urine	Cattle dung	Sheep dung
Free-draining	**0.10** (0.05)	**0.03** (0.02)	**0.03** (0.05)	**0.14** (0.04)	**0.05** (0.03)	**-0.01** (0.06)	**0.91** (0.12)	**0.17** (0.03)	**0.12** (0.05)
Poor-draining	**0.50** (0.09)	**0.07** (0.03)	**0.04** (0.05)	**0.07** (0.04)	**0.01** (0.02)	**0.01** (0.06)	**0.49** (0.08)	**0.00** (0.01)	**0.03** (0.05)

Urine EF3 was higher than Dung EF3

Results and discussion

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EF3 % (SEM in bracket)

Autumn-winter season (May 08 – Sep 08)

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	Cow urine	Cattle dung	Sheep dung	Cow urine	Cattle dung	Sheep dung	Cow urine	Cattle dung	Sheep dung
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- **In the Waikato Urine EF3 from the poorly drained soils was higher than that of the well drained soils**
- **However, the reverse was found in Otago and Hawkes Bay**

Results and discussion

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EF3 % (SEM in bracket)

Autumn-winter season (May 08 – Sep 08)

Soil	Waikato			Hawkes Bay			Otago		
	Cow urine	Cattle dung	Sheep dung	Cow urine	Cattle dung	Sheep dung	Cow urine	Cattle dung	Sheep dung
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There was no significant difference in EF3 between the cattle dung and sheep dung

Results and discussion

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Average EF3 (%) using data across all three regions and both soil drainage classes

Excreta	Cow urine	Cattle dung	Sheep dung
Autumn-winter	0.30 (0.03)	0.05 (0.01)	0.04 (0.04)
Spring-summer	0.26 (0.04)	0.04 (0.02)	-0.02 (0.05)
Average	0.29 (0.07)	0.04 (0.02)	0.01 (0.05)

- EF3 values for each excreta type were generally similar in both seasons
- The difference in EF3 between the cattle dung and sheep dung was not statistically significant

Results and discussion

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Average EF3 (%) using data across all three regions and both soil drainage classes

Excreta	Cow urine	Cattle dung	Sheep dung
Autumn-winter	**0.30** (0.03)	**0.05** (0.01)	**0.04** (0.04)
Spring-summer	**0.26** (0.04)	**0.04** (0.02)	**-0.02** (0.05)
Average	**0.29** (0.07)	**0.04** (0.02)	**0.01** (0.05)

- **EF3 decreased as follows:**

  cow urine > cow dung = sheep dung

- **Differences were primarily due to higher readily available N in urine compared to dung (supported by simultaneous soil mineral N analyses)**

Results and discussion

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Average EF3 (%) using data across all three regions and both soil drainage classes

Excreta	Cow urine	Cattle dung	Sheep dung
Autumn-winter	**0.30** (0.03)	**0.05** (0.01)	**0.04** (0.04)
Spring-summer	**0.26** (0.04)	**0.04** (0.02)	**-0.02** (0.05)
Average	**0.29** (0.07)	**0.04** (0.02)	**0.01** (0.05)
Previous MAF trials	**0.9**	**0.18**	**0.00**

EF3 for cattle urine and dung in this study was lower than the average from previous MAF trials

Results and discussion

- The lower EF3 for urine in this study could be due to relatively dry conditions during the current two study periods (supported by simultaneous soil moisture analyses)
- Similar relativity might be expected for dung
- This suggests that the EF3 from dung obtained from this study might have been lower than expected

Conclusions

- The dung EF3 was less than one fifth of that of the urine EF3
- EF3 values were mainly affected by differences in soil moisture and climatic conditions between the regions
- Soil drainage class did not have a consistent effect on EF3 values for dung

Conclusions

- The average EF3 for cow urine, cow dung and sheep dung were estimated at 0.29%, 0.04% and 0.01% of excreta N applied, respectively
- These results support a disaggregation of EF3 between animal urine and dung to improve accuracy of the N_2O inventory