Methane emissions from grazing red deer hinds measured using the SF_6 tracer technique

Dr Simone Hoskin, Massey University

Dr Marie Krause, AgResearch Ltd

Dr Harry Clark, AgResearch Ltd

Ms Natasha Swainson, MSc student Massey University

December 2003 (Revised)

Executive Summary

The primary objective of this project was to measure methane output from grazing red deer using the SF_6 technique to provide data that will improve/verify the New Zealand national inventory of ruminant methane emissions. A secondary objective was to investigate the potential of forage herbs chicory and plantain for mitigation of methane emissions by grazing red deer.

Twenty four red deer (20 hinds and 4 castrated stags) were used in this experiment, which included methane measurements on two occasions from deer grazing perennial ryegrass-based pasture (n=12), chicory (n=6) and plantain (n=6). The first measurement consisting of five 24 hour periods took place in early March and the second measurement in late May. Voluntary intake was estimated using the double alkane procedure, the first time this technique has been used both for farmed deer in the grazing situation and for pure forage herb swards.

Conditions in March were extremely dry for the Manawatu region, and irrigation was unavailable. Hinds produced 68.2 ± 13.7 g (mean ± standard deviation) of methane daily when grazing mature ryegrass pasture, 65.3 ± 13.0g when grazing chicory and 48.3 ± 19.3g when grazing plantain in March. This represents a 4% reduction in total methane production on chicory and a 29% reduction on plantain. On average, deer consumed 1802 g of dry matter daily on pasture, 2614 g on chicory and 2533 g of dry matter daily on plantain. This resulted in an average methane production per kg dry matter intake of 38.5 g for pasture, 25.5 for chicory and 17.8 for plantain. This represents a 34% reduction in methane produced per unit intake for chicory and a 54% reduction in methane produced per unit intake for plantain compared with conventional pasture.

In May, when the drought had eased, hinds produced 74.7 ± 19.4 g (mean ± standard deviation) methane daily on pasture, 71.7 ± 10.0 g on chicory and 64.7 ± 25.9 g on plantain representing a 4-15% reduction in total methane

production when grazing herbs compared with grass-based pasture, which was similar to March. Daily dry matter intake averaged 2268 g on pasture (up 20% from March), 6029g on chicory (up 230% from March) and 1999g on plantain (down 10% from March). Chicory was found to have a particularly low alkane content during May, which most likely caused the overestimation of feed intake by 2-3 times what is biologically realistic. These intakes resulted in chicory apparently reducing methane production per unit intake by 67% and plantain apparently reducing methane production per unit intake by 13% compared with pasture. However, these results are a function of the intake measurements and should be interpreted with much caution.

These preliminary results appear to indicate that deer produce approximately 60% more methane per kg dry matter intake than sheep and cattle grazing similar pasture. However, this relies on the accuracy of the technique used for determining feed intake of grazing animals on which comparisons between species are made. The alkane technique has not been validated for use in deer, although this work is in progress at Massey University. Given the uncertainty around these original methane measurements from grazing deer, an indoor trial was conducted in August with individual, accurate feed intake determination, using 12 hinds from the grazing study. This trial showed that deer fed ryegrass-based pasture produced 22.3g methane per unit feed intake. This is similar to the figures used for the national methane inventory for adult sheep and dairy cattle, 20.9g and 21.6g methane per unit feed intake, respectively.

These preliminary results also highlight the potential use of forage herbs for natural, sustainable, nutritional strategies for mitigation of methane production in farmed deer. However, the results presented here are obtained from a small number of animals. Before any firm conclusions regarding emissions from red deer can be drawn these results need to be validated with controlled feeding studies.

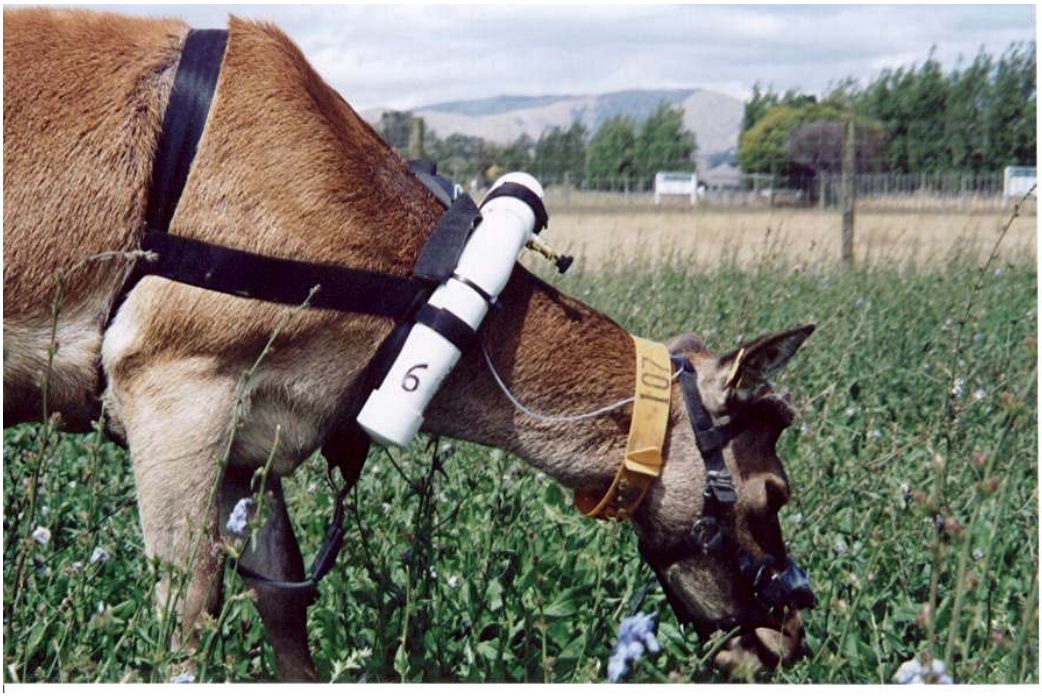

Figure 1. Red deer equipped with methane collection gear, grazing chicory in early March.

Introduction

Deer numbers in New Zealand have more than doubled in the last 10 years and methane emissions from deer in 2000 accounted for approximately 4% of enteric methane emissions. This compares with <2% in 1990, the base year for the Kyoto Protocol. The rate of increase in deer numbers recorded since 1990 is projected to continue in the next decade and methane emissions from deer could then account for almost 10% of total enteric methane emissions. Importantly emissions from deer could account for almost 50% of the projected excess emissions over the 1990 total.

In the official national inventory, emissions per unit of feed intake from deer are estimated using New Zealand SF_6 data obtained from sheep and cattle. In the national methane inventory the mean value for adult sheep and adult dairy cattle are 20.9g and 21.6 g of methane per kg dry matter intake and so an average of these two values 21.3 g of methane per kg dry matter intake is used (Clark et al 2003). The literature contains some references to the methane output of deer kept indoors but to date no measurements anywhere in the world have been obtained from grazing deer. There are therefore no data with which to assess the adequacy of the sheep and cattle data for predicting methane output from grazing deer.

The use of forage herbs chicory and plantain in pasture mixes is increasing, particularly for farmed deer due to perceived, and in some cases proven, production and health advantages. Research at DEXCEL with dairy cattle has highlighted the potential of tannin-containing legumes to reduce methane emissions per unit milk production. However, the effect of forage herbs on methane production in grazing ruminants has yet to be elucidated.

The goal of this project was primarily to measure methane output from grazing red deer using the SF_6 technique to provide data that will improve/verify New Zealand national inventory of ruminant methane emissions. A second objective was to initiate research into the potential for forage herbs for mitigation of enteric methane production.

Conclusions

- It is likely that deer produce similar quantities of methane per unit feed intake to cattle and sheep.
- Differences in measurements of methane production from grazing and housed deer on the same diet have been observed, but cannot be explained given current knowledge. However, this is likely to be due to inaccuracies in the alkane technique used to estimate feed intake in the grazing situation, and to behavioural differences between housed and grazing deer.
- Validation of the alkane technique for use in deer grazing grass-based pastures and alternative forages is required.
- These preliminary results highlight the potential use of forage herbs for mitigation of methane production in farmed deer. However, before any firm conclusions regarding reducing methane emissions from red deer using alternative forage species can be drawn these results need to be validated with controlled feeding studies.