# Methane emissions from pregnant and lactating ewes fed different intakes of high quality pasture: the third measurement period

MAF Technical Paper No: 2011/94

Report prepared for Ministry of Agriculture and Forestry
By AgResearch (MAF AG_INVENT-27)
August 2008

Authors: TW Knight, S Hoskin, G Molano, SV Maclean, DS Villacorta

ISSN 2230-2794 (online)
ISBN 978-0-478-38750-6 (online)

November 2011

Ministry of Agriculture and Forestry
Te Manatū Ahuwhenua, Ngāherehere

BIOSECURITY NEW ZEALAND

NEW ZEALAND FOOD SAFETY AUTHORITY

## Disclaimer



## Publisher

Ministry of Agriculture and Forestry
PO Box 2526
Pastoral House, 25 The Terrace
Wellington 6140
www.maf.govt.nz

Telephone: 0800 008 333
Facsimile: +64 4 894 0300

agresearch

Farming, Food and Health. **First**

*Te Ahuwhenua, Te Kai me te Whai Ora. Tuatahi*

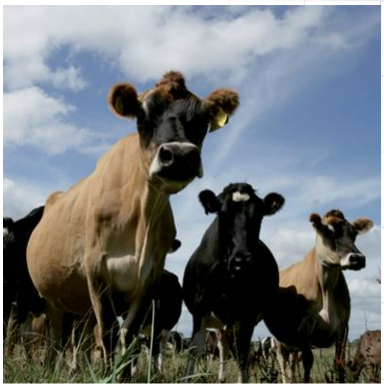
# Methane emissions from pregnant and lactating ewes fed different intakes of high quality pasture: the third measurement period

**MAF AG-INVENT-27**

August 2008

2020 SCIENCE

*New Zealand's science. New Zealand's future.*



# Methane emissions from pregnant and lactating ewes fed different intakes of high quality pasture: the third measurement period

**August 2008**

TW Knight, S Hoskin, G Molano, SV Maclean, DS Villacorta
AgResearch Grasslands

# Table of Contents

## 1. Summary

Ten dry Romney two tooth ewes and 10 pregnant ewes with single foetuses had their methane ($CH_4$) emissions measured in calorimeters at 122-132 days of gestation. Freshly cut perennial ryegrass was fed twice daily at 1 X energy maintenance to the dry ewes and the pregnant ewes were fed at 2 X energy maintenance. The ewes were fed their respective diets for 8-14 days before the $CH_4$ emissions were measured. Quality of the ryegrass was measured daily using NIRS and the true dry matter content of the ryegrass was determined by drying samples for 16 hr at 105 C°. The organic matter digestibility of the ryegrass was 72% and the crude protein content was low (15%). The pregnant ewe had significantly higher $CH_4$ emissions /day than the non-pregnant ewes (24.4 vs 20.5 ± 1.00 g $CH_4$ /day, $P < 0.01$), but lower $CH_4$ emissions /kg DMI ($P < 0.05$) than the non-pregnant ewes (21.2 vs 24.6 ± 1.32 g $CH_4$ /kg DMI). When the data were combined with the data from the previous two measurement periods, regression analyses showed there was a positive relationship ($P < 0.001$) between $CH_4$ emissions /day and DMI, with DMI accounting for 56% of the variation in $CH_4$ emissions /day. In contrast there was a negative relationship ($P < 0.001$) between $CH_4$ emissions /kg DMI and the DMI ($R^2$ = 48%). These results confirm that $CH_4$ emissions per unit of intake decreases with increasing intake and that a more accurate estimate of $CH_4$ emissions per day can be obtained by including DMI into a regression equation, rather than multiplying DMI by a constant value as is used in the Green House Gas inventory.

## 2. Introduction

The previous measures of methane ($CH_4$) emissions (Knight et al 2008a) when the ewes were 80-90 of pregnancy for the ewes with single foetuses has shown that when both the pregnant ewes and the non-pregnant ewes were fed at 1 X energy maintenance there was no difference in $CH_4$ emissions per day (19.2 vs 18.7 ± 0.36 g $CH_4$ /day) or in the $CH_4$ emissions per kg DMI (25.4 vs 25.2 ± 0.50 g $CH_4$ /kg DMI). However, when the $CH_4$ measurements were made when the pregnant ewes were 98-108 days of gestation and fed at 1.5 X energy maintenance and the non-pregnant ewes were fed at 1 X energy maintenance the pregnant ewes had significantly higher $CH_4$ emissions /day (22.5 vs 16.4 ± 0.77 g $CH_4$ /day) but significantly lower ($P < 0.05$) $CH_4$ /kg DMI (21.1 vs 23.3 ± 0.95 g $CH_4$ /kg DMI) compare with the non-pregnant ewes.

The over all aim of the project is to;

- To determine the $CH_4$ emissions per kg dry matter intake (DMI) from a group of ewes as they go through pregnancy and lactation when fed fresh pasture intakes which are typical for high producing farms
- Compare these $CH_4$ emission values to a cohort of non-pregnant ewes (Dry ewes) fed at 1 X energy maintenance

The aim of the results presented in this report is to compare the $CH_4$ emissions from the ewes at 122 - 132 days of gestation and fed 2 X energy maintenance with non-pregnant ewes fed at 1 X energy maintenance.

# 3. Methods

## 3.1 Animals

The 10 Romney ewes pregnant with single foetuses (Singles) and the 10 non-pregnant (Dry) Romney ewes have been described previously (Knight et al 2008a) and had $CH_4$ emissions measured at 70-80 and 98-108 days of gestation. In this third measurement of $CH_4$ emissions the Singles ewes were 122-132 days of gestation. These ewes plus the 2 spare ewes from each treatment returned from pasture to pens in the animal house at Agresearch Grasslands on 7 July. Dry ewes were fed freshly cut perennial ryegrass pasture at 1 X energy M while the Single ewes were fed at 2 X energy M. The ewes remained in the pens for 4 days, and then the ewes were placed in individual metabolism cages for at least 4 days before entering the calorimeters for 2 days. The ewes continued to be fed their respective diets while in the metabolism cages and calorimeters.

Refusals for each ewe were accumulated over the 2 days they were in the calorimeter and at the end of the period the refusals were collected and weighed. Ewes were weighed immediately before they entered the pens from pasture, and before they entered and after they were released from the calorimeters. The mean of the latter liveweights are presented in this report.

Pasture for the ewes was cut in the mid-afternoon and half of the diet was fed at 16.00 hr and the rest was stored in a chiller to be fed at 09 00 hr the next morning. The maintenance requirements of the ewes were calculated using equations from the Australian Feeding Standards (1990) using the initial liveweight in each period and a pasture metabolisable energy (ME) content of 11.0 MJ / kg DM. The Single ewes were given an additional pasture allowance of 1.7 MJ ME / day for the foetus. Ewes in each group were fed an allowance calculated from the average liveweight of the group using the liveweight on the day the ewes entered the pens.

## 3.2 Measurement of CH4 emissions

Since there were 8 calorimeters and 20 ewes, 4 ewes from each group were randomly selected for the first 2 days $CH_4$ measurement (Replicate 1), followed by 2 from each group (Replicate 2) and then 4 from each group (Replicate 3). Problems with the calorimeters while $CH_4$ emissions from Replicate 2 were being measured meant the ewes stayed in the calorimeters an extra day. Once the $CH_4$ emissions had been measured over the 2-3 days the ewes were released into a paddock and a new replicate entered the calorimeters.

## 3.3 Pasture samples

Samples of the newly planted perennial ryegrass were collected the day the ewes entered the pens, the day they entered the metabolism cages and the day before and each day the ewes were in the calorimeters. Rapid estimates of the dry matter (DM) content of the pasture were made by drying a weighed sub-sample for 20 min in a micro-wave oven. This was used to indicate the weight of fresh feed to prepare for the ewes. A second weighed sub-sample was dried at 105 C° for 16 hr to determine true DM and a third sample was sent for analyses of nutrient content by Infrared Reflectance Spectrophotometry (NIRS; Corson et al. 1999). The refusals collected over the two days each ewe was in a calorimeter were weighed and dried at 105 C° for 16 hr to determine DM and sent for analyses of nutritional composition by NIRS (data not included here). The botanical composition was determined on a fresh perennial ryegrass sample collected on the 14 July and on the refusals from one Single ewe (number 74) collected the next day.

## 3.4 Statistical analyses

All data were analysed by analyses of variance (GenStat, 2005) with pregnancy status being the main factor. The chamber number and the order the ewes entered the calorimeters (Replicates) were included as factors but only stayed in the model if they were significant. Regression analyses were conducted to investigate the relationships between DMI and $CH_4$ emissions per day and per kg DMI using the combined data from this measurement and the two previous measurements.

# 4. Results

## 4.1 Pasture quality

The perennial ryegrass sward used in this period was the same one that was used in the second measurement but it had deteriorated with noticeable dead and decaying plant material in the base of the sward. A sample collected on 14 July for botanical composition indicated 17.8% dead material, 49.5% leaf and 32.7% stem. The DM content was low because of the rain either before or during the cutting of the feed each day. Compared with the feed in the two earlier measurement periods the digestibility and metabolisable energy content was lower and the neutral detergent fibre (NDF) and acid detergent fibre (ADF) contents were higher. The crude protein content was also slightly higher than in the previous measurement periods.

**Table 1:** Mean (±SD) nutrient composition measured by NIRS or oven drying at 105 C° in the case of DM, of samples collected daily from the pasture fed to the ewes over the period the $CH_4$ emissions were being measured in the calorimeter. Samples were collected for the 8 days the replicates of ewes were put in the calorimeters and from the day before ewes the first entered the calorimeter.

| | **Third period** |
|---|---|
| **DM%** | 14.8 ± 2.39 |
| **Ash%** | 9.4 ± 0.55 |
| **NDF%** | 52.9 ± 2.31 |
| **ADF%** | 28.2 ± 0.79 |
| **Lignin%** | 3.3 ± 0.43 |
| **CP%** | 15.2 ± 1.10 |
| **Lipid%** | 2.5 ± 0.47 |
| **SSS%** | 11.5 ± 1.46 |
| **OMD%** | 72.5 ± 1.98 |
| **ME** | 10.8 ± 0.35 |

DM = dry matter; NDF = neutral detergent fibre; ADF = acid detergent fibre; CP = crude protein; SSS = soluble sugars and starch; OMD = organic matter digestibility; ME = metabolisable energy. All the values are expressed as a proportion of DM except ME, which is in MJ / kg DM.

## 4.2 Liveweights

The initial liveweights for the Single and Dry ewes when they returned from pasture to the pens were similar but after the 8-14 days of differential feeding up to and over the time the ewes were in the calorimeters the liveweight of Single ewes were higher ($P < 0.001$) than that of Dry ewes (Table 2).

**Table 2**: Mean (±SED) liveweights, feed intakes, refusals and $CH_4$ emissions /day and /kg DMI, in the third measurement period for Single ewes (ewes with one foetus) fed at 2.0 X energy maintenance and Dry ewes were fed at 1 X energy maintenance.

| | **Third measurement** | | | |
|---|---|---|---|---|
| | **Dry** | **Singles** | **SED** | **Probability** |
| Initial wt# (kg) | 42.6 | 45.0 | 1.49 | ns |
| Calorimeter wt (kg) | 43.0 | 49.8 | 1.26 | <0.001 |
| DMI (kg/day) | 0.844 | 1.171 | 0.055 | <0.001 |
| Feed offered (kg DM/day) | 0.872 | 1.631 | 0.035 | <0.001 |
| Refusals (g DM/day) | 28 | 461 | 33.0 | <0.001 |
| $CH_4$ g/ day | 20.7 | 24.4 | 1..00 | =0.002 |
| $CH_4$ g/kg DMI | 24.6 | 21.2 | 1.32 | =0.02 |

# Weighed on 7 July 2008.

## 4.3 Feed allowances and DMI

Single ewes were offered almost twice the daily pasture allowance of the Dry ewes and this resulted in the expected significant difference in DMI between Single and Dry ewes (Table 2). The difference in DMI was not as large as expected because Single ewes had almost 20 times the refusals of Dry ewes. This much higher rate of refusals from Single ewes could partially be explained by the lower quality of the perennial ryegrass sward compare to the earlier trials. The botanical composition of the refusals collected on 15 July from one Single ewe contained 41.6% dead material and the proportion of stem had deceased from 32.7% to 7.8%. However, the refusals also contained 50.7% leaf, which was a similar proportion to the fresh pasture sample. This suggests the high rate of refusals in the Single ewes could be due to the small frame size of these two-tooth Romney ewes. These small ewes may have reached the upper limit of volume of intake and they possibly could not consume any more of the feed that was on offer. This would make the next measurement of $CH_4$ emissions of these ewes after lambing when they will be fed at 3 X energy maintenance a very difficult proposition.

### 4.4 CH4 emissions

The Single ewes fed at 2.0 X energy M had $CH_4$ emissions /day that were significantly higher than for Dry ewes fed at 1 X energy M (24.4 vs 20.5 ± 1.00 g $CH_4$ /day, $P < 0.01$; Table 2). In contrast, $CH_4$ emissions /kg DMI was 14% lower ($P < 0.05$) for Single than for Dry ewes (21.2 vs 24.6 ± 1.32 g $CH_4$ / kg DMI).

## 5. Discussion

Single ewes at days 122 to 132 days of pregnancy and fed 2 X energy M had 19% higher $CH_4$ emissions /day than Dry ewes, but the $CH_4$ emissions /kg DMI were 14% lower than for Dry ewes. These data were similar to the second measurement taken when the Single ewes were 98-108 days of pregnancy and fed at 1.5 X energy M. In that measurement, Single ewes had a 37% higher $CH_4$ emissions /day, but 9% lower $CH_4$ emissions /kg DMI.

These results support the hypothesis that the $CH_4$ emissions /kg DMI decreases with increasing DMI. The regressions between $CH_4$ emissions /day and /kg DMI and DMI for the three measurements periods combined are given below.

1) $CH_4$ emission g/day = 9.62 + 12.14 (DMI); $R^2$ = 55.8%

±1.27 ±1.42

$P < 0.001$ $P < 0.001$

2) $CH_4$ emissions g/kg DMI = 32.28 – 9.97 (DMI); $R^2$ = 47.8%

± 0.1.74 ± 2.13

$P < 0.001$ $P < 0.001$

These regressions are very similar to the ones calculated form the data for the first two measurement periods (Knight et al 2008a) and to previous trials where the $CH_4$ emissions have been measured using the calorimeters (Knight et al 2008b).

## 6. References

Corson D. C, Waghorn G. C, Ulyatt M. J, and Lee J (1999) NIRS: Forage analysis and livestock feeding. *Proceedings of the New Zealand Grassland Association* 62, 127-132.

GenStat (2005) GenStat for Windows. Release 8.1. Eighth Edition. VSN International Ltd., Oxford.

Knight T. W., Clark, H., Molano, G. Maclean, S. V. and Villacorta, D. S. (2008a) Methane emissions from pregnant and lactating ewes fed different intakes of high quality pasture: the first two measurement periods. Report to MAF August 2008.

Knight T. W., Clark, H., Molano, G. Maclean, S. V. and Villacorta, D. S. (2008b) Methane emissions from sheep fed different intakes of high quality pasture. Report to MAF August 2008.

Standing Committee on Agriculture (SCA) (1990) Ruminants, Feeding Standards for Australian Livestock. CSIRO Publications, Australia.