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**EVALUATION OF THE GREENFEED SYSTEM FOR
METHANE ESTIMATION FROM GRAZING DAIRY
COWS**

A thesis presented in partial fulfilment of the requirements for
the degree of

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In

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ABSTRACT

Ruminant methane (CH₄) production contributes ~32% of New Zealand's total greenhouse gases (GHG) and a reduction in emissions is required under the Kyoto Protocol. Under this agreement, New Zealand has pledged to either reduce, or take responsibility for the GHG emissions above those in 1990. GHG emission factors used for inventory need to be accurate, reliable and applicable to animals grazing in New Zealand. Furthermore, identification and implementation of mitigation strategies also depends on accurate and reliable methods for measuring CH₄ emissions.

Current techniques to measure CH₄ have to compromise between accuracy and applicability. Respiration chambers are accurate, but do not represent a grazing environment, whilst the Sulphur Hexafluoride (SF₆) technique can be used at grazing, but has more variation than the chambers. Consequently, a new technique known as the Greenfeed system, has been developed to measure CH₄ from grazing animals. The evaluation of this technique applied to grazing animals, with minimal interference from humans, and its evaluation is reported here.

In the first experiment, CH₄ measurements were compared from the Greenfeed system with respiration chambers and the SF₆ technique using six dry dairy cows fed a silage-based diet. Intakes were measured and were approximately at maintenance levels and feeding regimens were similar throughout. The mean CH₄ production (g CH₄/d) ± standard deviation (Murray *et al.*, 2001) from the Greenfeed unit (150 ± 20.2) was higher and more variable than those from the respiration chambers (134 ± 9.8) and the SF₆ technique (128 ± 8.7). Similarly, the CH₄ yield (g CH₄/kg dry matter intake (DMI)) ± SD was higher from the Greenfeed unit (24.0 ± 3.2) than the respiration chambers (21.9 ± 1.6) or the SF₆ technique (20.5 ± 1.4). Correlations between CH₄ production by individual animals using the Greenfeed system and either respiration chambers or the SF₆ technique were weak ($r = -0.36$ and 0.13 , respectively).

The second experiment successfully implemented two Greenfeed units on-farm with 24 lactating cows, including four with rumen fistulae, and evaluated their behavioural interactions and estimated CH₄ production. Seventeen of the 24 cows (approximately 70%) visited the Greenfeed units, but this could be increased by training so most cows visit. An attractant/reward was used to encourage cows into the units and the cows preferred the Lucerne pellets to the Grain pellets. The mean CH₄ production measured using the Greenfeed units were 340.3 ± 61.8 g CH₄/d, suggesting about 21.3 g CH₄/kg DMI (based on calculated feed intakes). It appears that 14 days are needed for cows to get used to the Greenfeed units, and extending estimates (for five further weeks) did not reduce the variance in CH₄ emissions values within cows.

This research has shown that the Greenfeed system seems adequate for estimating CH₄ production of a whole herd. Further estimates are required before standard operating procedures can be determined and that confidence can be placed in the accuracy of CH₄ estimates.

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Dedicated in loving memory to my Mum

Christine Anne Garnett

3rd September 1950 to 24th February 2009

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LIST OF ABBREVIATIONS

% Percent

A

μM Micromole
ADF Acid detergent fibre
ATP Adenosine triphosphate
ADP Adenosine diphosphate

B

BCS Body condition score

C

C2 Acetate
C3 Propionate
C4 Butyrate
CH₄ Methane
CO₂ Carbon dioxide
CV Coefficient of variation

D

d Day
DM Dry matter
DMI Dry matter intake
DOMI Digestible organic matter intake
Dr Doctor

E

Ei Emissions intensity
ERUCT Emissions from Ruminants Using a Calibrated Tracer Technique

F

FACE Free air carbon dioxide enrichment

G

g Gram

GE	Gross energy
GEI	Gross energy intake
GHG	Greenhouse gas
GWP	Global warming potential
H	
H ₂	Hydrogen gas
H ⁺	Hydrogen ion
HFC	Hydrofluorocarbon
I	
Inc.	Incorporated
IPCC	Intergovernmental Panel on Climate Change
K	
Kg	Kilogram
Km	Michaelis constant
L	
LULUCF	Land-use, land-use change and forestry
M	
MAF	Ministry of Agriculture and Forestry
ME	Metabolisable energy
MJ	Megajoule
mV	Millivolt
N	
n	Number
N ₂ O	Nitrous oxide
NAD ⁺	Nicotinamide adenosine dinucleotide oxidised
NADH	Nicotinamide adenosine dinucleotide reduced
NIWA	National Institute of Water and Atmospheric Research
NDF	Neutral detergent fibre
O	
O ₂	Oxygen gas
OM	Organic matter
OMD	Organic matter digestibility
OMI	Organic matter intake

P

PFC Perfluorocarbon
pH Power of hydrogen

R

RRT Rumen retention time

S

SD Standard deviation
SSS Soluble sugars and starch
SF₆ Sulphur hexafluoride

T

TCA Tricarboxylic acid
™ Trademark

U

UNFCCC United Nations Framework Convention on Climate Change
US United States

V

VFA Volatile fatty acid