Ministry for Primary Industries
Manatū Ahu Matua

EVALUATION OF THE GREENFEED METHANE MEASUREMENT SYSTEM

A summary Report to MPI and NZAGRC funded by the New Zealand Government in support of the Global Research Alliance on Agricultural Greenhouse Gases

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Background

Enteric methane (CH_4) emissions from livestock farming constitutes a large proportion of New Zealand GHG emissions, a consequence of the major role played by pastoral farming in the economy. In the past, the inventory and mitigation research of enteric CH_4 emissions in New Zealand have been based mainly on the SF_6 tracer technique. This technique is appropriate for estimating mean CH_4 emissions from a group of animals, but lacks accuracy to rank individuals for emissions. Alternatively, findings from standardised and accurate respiration chambers cannot easily be extrapolated to free-ranging situations. Recently, the GreenFeed^{TM} system (C-Lock Inc, Rapid City, South Dakota, USA) has been proposed as a new method for estimating daily CH_4 emissions from free-ranging ruminants. The GreenFeed system potentially offers a lower cost option for estimating cow/herd emissions than the labour intensive SF_6 methodology and the accurate but artificial respiration chamber method. To test whether the GreenFeed system could be an option for use under grazing herd situations, a two part study was undertaken. The first part assessed how CH_4 measurements taken using the GreenFeed system compared with those obtained from the SF_6 and respiration chamber methods. The second part studied the behavioural characteristics of grazing cows using the system.

Evaluation

The first study was conducted under controlled indoor conditions at AgResearch Grasslands (Palmerston North, New Zealand) using non-lactating cows fed the same amount of silage, twice daily at restricted intakes. Restricting intakes avoided confounding effects of intake variation, and methane emissions were determined using GreenFeed, SF_6 and respiration chambers. Preliminary results and conclusions presented here are specific to the experimental conditions, and showed that:

- Mean estimates of CH_4 production from individual animals were not significantly different for the 3 measurements, and mean (± SD) values (g CH_4/d) were 146.2 ± 42.47 (GreenFeed), 133 ± 10.6 (Chambers) and 130.5± 9.9 using SF_6. Hourly CH_4 emission data from all animals, pooled within a hypothetical 24-h period, yielded a high correlation (r = 0.89) between GreenFeed and respiration chamber measurements.
- Differences in CH_4 emissions between animals were small, and although ranking of individuals differed for the three methods, more data are needed before GreenFeed can be assessed for the identification of high and low emitting animals. Based on the preliminary data in this study, GreenFeed is suitable for estimating emissions from groups of animals, although the larger variability associated with the GreenFeed system under the feeding regime used here, needs to be understood and addressed.
- Cow interaction with the GreenFeed unit and other cows in the group, plus the timing, number and duration of animal visits to the GreenFeed system influenced the accuracy and variability of emission estimates.
- Animal visits lasting around 7 min seem to be associated with the most accurate and least variable CH_4 emission estimates.
- The mean ± SD values for CO_2 emissions (g/cow/d) were 5082 ± 453 from GreenFeed and 5123 ± 247 from Chambers.

A separate study conducted by DairyNZ (Hamilton) evaluated the behaviour of grazing dairy cows in early lactation in the presence of the GreenFeed units. This study elucidated the requirements for applying the technique on farm, especially with regard to chute design (allowing single animal access to the units) and the movement of the Greenfeed system between paddocks. This study showed that:

- Some cows required training in order to visit the GreenFeed units; this was achieved by placing a small amount of pelleted feed in the chute leading to the units, and in the feeding station (where breath was sampled for methane analysis). Visits per cow were highly variable; but once individuals became accustomed to it, most had to have their access restricted.
- There was no preference for either grain-based or lucerne-based pelleted feed.
- Two types of chutes were evaluated - to limit only one animal accessing the GreenFeed system at a time - both performed well, although the 'sled' chute required less physical work than the 'gate' chute.
- Significant pasture damage was observed around the GreenFeed units; this was not unexpected as soils in spring in the Waikato are characteristically close to field capacity.
- Mean daily methane emissions per cow (± SD) were 339 ± 47.8 g/day with coefficients of variation of individual animals over the 35 d period ranging from 5 to 12%.
- Estimated feed dry matter intakes (DMI, obtained using energy metabolism algorithms) and an assumed CH_4 yield (21 g/kg DMI) were used to calculate an 'expected' CH_4 emissions of 331 g/day.

Recommendations

Results from these preliminary studies suggest that the GreenFeed system shows considerable promise as an automated method for obtaining CH_4 emissions from a group of lactating cattle managed on a typical dairy farm in New Zealand. This initial study suggests that the absolute values generated by the GreenFeed system are slightly higher and more variable than those obtained by the SF_6 technique techniques and respiration chambers, but the variance may have been affected by the low intakes and rapid feed consumption conditions of the indoor evaluation. Further studies are required to evaluate the accuracy of the GreenFeed system, in particular sensitivity to changes in feeding regimes, the effect of herd size, number and length of visits and duration of the measurement period all need to be assessed. Future studies should involve indoor and grazing stages, with animals fed at feeding levels appropriate to the range of conditions faced by grazing animals in New Zealand. The accuracy and precision of the GreenFeed system for estimating CH_4 emissions from cattle requires further definitive evaluation both indoors and at grazing.

It is recommended for future evaluation studies:

- Grazing studies should involve dairy cows at contrasting stocking rates (herbage allowances). This should involve simultaneous estimation of feed intakes and especially animal production measurements. Parallel estimation of emissions using the SF_6 tracer technique need to be taken.
- Grazing trials are required to determine the optimal number of cows per GreenFeed unit and/or number of units for defined groups of cows. This should be undertaken in conjunction with development of cow training procedures to increase the rate and extent of GreenFeed use.
- Indoor evaluation should compare the GreenFeed system against the standard respiration chambers and SF_6 techniques and should involve forage-fed animals at different feeding frequencies and quantities. These studies are necessary to refine the

current emission algorithms which have been obtained from North American studies using diets and feeding situations that are not typical of those in New Zealand.

- Data from existing and future trials needs to be scrutinised in order to understand and improve measurement accuracy at both the individual and herd level.
- Applying GreenFeed principles for CH_4 emission measurements under free-ranging situations needs to be considered for other ruminant species. A priority task for New Zealand would be to assist in the development of units suitable for sheep.
- Research will benefit from international collaboration, to share information and accelerate the science.

A copy of the full report is available from the authors below,

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