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Evaluation of methane measuring techniques

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Evaluation of different techniques to quantify methane emissions from South African livestock

Industry Sector: Cattle And Small Stock

Research Focus Area: Sustainable Natural Resource Utilization

Research Institute: University Of Pretoria

Researcher: Dr JL Linde Du Toit

The Research Team

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Year Of Completion : 2018

Aims Of The Project

- To measure methane emissions from livestock using the SF6 technique
- To measure methane emission from livestock using the handheld laser methane detector (LMD) technique
- To compare the results of the SF6 and the LMD techniques

Executive Summary

The need to verify greenhouse gas inventories demands the development of high throughput, economical yet accurate short-term measurement techniques, such as the laser methane detector (LMD). The aim of this project was to compare methane (CH_4) emission rates as measured by the LMD to the sulphur hexafluoride tracer gas (SF_6) technique from lactating dairy cows grazing pasture and to evaluate the practicality of the LMD measurement protocol under grazing conditions in the temperate coastal region of South Africa. Methane production was determined from six lactating Jersey cows on pasture using both techniques. The data generated by the LMD had a superior daily repeatability compared to the SF_6 technique in the present study. A higher between-cow coefficient of variation (CV) (0.6 vs. 0.4) from the LMD compared to the SF_6 technique was observed and this was ascribed to the sensitivity of the LMD to ambient conditions, animal movement while grazing and time of measurement. Methane production as

measured by the SF_6 technique (348 g/d) was higher ($P<0.05$) compared with the LMD technique (82.6 g/d).

Results from this study indicated that the LMD yielded approximately a 70% lower average daily CH_4 production when compared to the SF_6 techniques under the experimental conditions and daily CH_4prediction models using the same animals and dry matter intakes. The lack of a third measuring technique and a standardized LMD methodology makes an accurate comparison between techniques and published data difficult. Both the SF6 and the LMD methods are viable methods to evaluate differences between mitigation options, for ranking of animals for selection purposes and to identify differences between dietary treatments. More research is needed before new techniques such as the LMD can be employed to determine absolute CH_4 daily emissions which can be up scaled for inventory purposes.

Popular Article

Measuring Methane From Livestock

Recently, methane has been reported as the most abundant organic trace gas in the atmosphere. The radiative forcing of methane (CH_4) is significantly higher than carbon dioxide (CO_2) and it is estimated that CH_4 has a global warming potential of 28 compared to CO_2 with an atmospheric half-life of 12.4 years[1]. Enteric production of CH_4 from ruminant livestock production systems is one of the major sources of agricultural greenhouse gas emissions globally. The relatively short atmospheric half-life of CH_4 makes it the main target in livestock greenhouse gas mitigation protocols. Methane is also an important indicator of livestock productivity as it is associated with the conversion of feed into animal product *i.e* meat, milk or fibre.

Methane is produced in the rumen by methanogenic bacteria as a by-product of the fermentation process. Ruminal fermentation by rumen microbes result in the formation hydrogen (H_2). Accumulation of excessive amounts of H_2 in the rumen negatively affects the fermentation rate and growth of some microbial consortia which will reduce feed intake and production of animals. Methanogens therefore reduce carbon dioxide (CO_2) to methane (CH_4) and water (H_20) thereby capturing available hydrogen and sustaining a favorable fermentation environment in the rumen[2]. Methane is exhaled or belched by the animal and accounts for the majority of emissions from ruminants. Methane also is produced in the large intestines of ruminants and is expelled in much smaller volumes compared to ruminal methane.

There are a variety of factors that affect CH_4 production in ruminant animals, such as: the physical and chemical characteristics of the feed, the feeding level and schedule, the use of feed additives to promote production efficiency, and the activity and health of the animal[1]. Reductions in greenhouse gas emissions from livestock can be achieved through a range of CH_4 mitigation strategies and more efficient livestock production systems through improved genetics and management.

Regardless of the mitigation strategy imposed, any reduction in enteric methane production must be quantified and for this to be achieved, accurate baseline emissions data are essential[1]. There are currently many techniques available to researchers to quantify CH_4 emissions from livestock each with specific applications and challenges. These techniques vary from tracer and capsules for individual ruminants to whole farm systems. The development of baseline emission data can also be achieved through modeling, employing specific livestock and environmental activity data to estimate emissions. One of the main challenges of the majority of the measurement techniques is the lack of “real time” emissions from grazing ruminants under natural conditions. There is a need to develop measuring techniques and methods which can be standardized, is relatively low-cost and which can deliver reliable, feasible and repeatable assessments of emissions from grazing livestock.

The Sulphur hexafluoride (SF_6) technique and spot sampling lasers are two of the techniques which shows promise to measure CH_4 emission from grazing livestock. Researchers recently compared these two techniques in a pasture dairy production system in the Western Cape province of South Africa. It was found that the spot sampling with the laser could be useful for purposes such as selective animal breeding and comparing between different mitigation strategies, where the requirement is for relative emission data but not necessarily daily methane production. This trial highlighted the need to develop specific operational standards when employing methane quantification techniques under natural conditions in order to minimize variation and environmental interference when recording measurements.

Strategies to reduce greenhouse gas emissions and to increase farm productivity are likely to remain vague, random and possibly inefficient without the development of standardized, accurate and reliable CH_4 measurement techniques[1].

References

1. Hill, J., McSweeney, C., Wight, A.G., Bishop-Hurley, G. and Kalantar-zadeh, K., 2016. Measuring methane production from ruminants. Trends in Biotechnology, Vol. 36 (1).
2. Goopy, J., Chang, C. and Tomkins, N., 2016. A Comparison of Methodologies for Measuring Methane Emissions from Ruminants. In: Methods for Measuring Greenhouse Gas Balances and Evaluating Mitigation Options in Smallholder Agriculture. Editors: Todd S. Rosenstock, Mariana C. Rufi no Klaus Butterbach-Bahl, and Eva Wollenberg Meryl Richards. Springer International Publishing AG Switzerland.

Please contact the Primary Researcher if you need a copy of the comprehensive report of this project – Linde du Toit on linde.dutoit@up.ac.za

Cattle and Small Stock, Natural Resource Utilisation

2018, CSS, duToit, Online, UP

Methane and nitrous oxide from beef cattle manure

Dairy ranching for beef and milk

DEADLINES for RESEARCHERS 2021

Proposals for 2021: TBC
Progress reports: 28 Jan 21
Final reports: 29 Jan 21 Final includes comprehensive report and popular article

COMMITEE MEETINGS for 2021

RMRDSA CSS Planning - TBC
Project Committee - TBC
Pork Planning - TBC

Calendar

< Apr 2021 >

Sun	Mon	Tue	Wed	Tur	Fri	Sat
				1	2	3
4	5	6	7	8	9	10
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PORK Priority Areas

Cattle & Small Stock Programmes

1 Sustainable natural resource utilisation

2 Improvement of Livestock production and forage

3 Management of agricultural risk to create a resilient Red Meat sector

4 Sustainable health and welfare for the Red Meat sector

5 Enhancement of production and processing of Animal Products

6 Consumer and market development of the Red Meat sector

7 Commercialisation of the emerging sector