Methane and nitrous oxide from beef cattle manure

10/25/2018

Direct manure methane and nitrous oxide emissions from a commercial beef feedlot in South Africa.

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

Title	Initials	Surname	Highest Qualification
Prof	WA	van Niekerk	PhD
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Dr	L	Stevens	PhD

Year Of Completion : **2017**

Aims Of The Project

- To identify the on-farm manure management system employed in a typical commercial beef feedlot in South Africa
- To determine the methane emissions from manure in a commercial beef feedlot
- To determine the nitrous oxide emissions from manure in a commercial beef feedlot

Executive Summary

Methane And Nitrous Oxide Emission From Pen Surfaces In A Commercial Beef Feedlot In South Africa

Global warming has become a worldwide concern in recent years. The release of Greenhouse gasses (GHGs) have brought about rapidly changing climate conditions the world over, GHGs produced by various industry sectors are being investigated, researched and laws put in place to limit the production of GHGs wherever possible. This includes the agricultural sector where extensive animal husbandry has increased the global carbon footprint and environmental pollution.

The International Panel of Climate Control (2006) has three Tiers that estimates methane (CH_4) values, one of the main GHGs, from the use of default values to the use of more complicated models and experimental data to improve the accuracy of reporting. This study investigated the contribution of manure GHGs emissions to livestock emissions focussing on intensive beef feedlot manure emissions. At present in South Africa, these values are only roughly estimated and are only available on an IPCC Tier 2 level. Gaseous emissions from livestock waste, specifically beef cattle waste, are affected by a variety of external factors (atmospheric temperature, humidity, soil conditions, ration consumption and manure management practices) as well as internal factors, (ration digestibility, nutrient absorption and gut health).

The objective of the study was to achieve an understanding of the gaseous emissions, specifically methane (CH_4) and nitrous oxide (N_2O), from beef cattle feedlot pen surfaces from a commercial beef feedlot in South Africa as influenced by diet and season, using the closed chamber method of gas collection over the three prominent seasons experienced in Mpumalanga, South Africa. The sampling of these various factors would lead to more accurate reporting, conforming to Tier 3 methodology results.

Random pen surface and emissions samples were taken from three pens per each feedlot ration fed. The results indicated significant differences in soil/manure characteristics, but little effect on ultimate CH_4 and N_2O emissions from the pen surface were found across treatments. Similar results were observed for the rangeland manure analysed and manure emissions from manure management practices at the feedlot. Ambient temperature had a tendency ($p<0.10$) to affect CH_4 and N_2O emissions with higher temperatures resulting in higher emissions but. Overall soil and manure characteristics were affected by diet treatments and seasonal variation. It must be noted that the lack of significant differences in gas emissions in the present study could have been due to sampling error. The gas emissions observed did show a trend between treatment levels and manure management practices within the feedlot, with the effluent dams and manure piles recording the highest CH_4 emissions over each of the measured seasons. The CH_4 emissions varied between seasons within the feedlot, rangeland and manure management practices, but a level of significance was never observed even though manure characteristics observed significant differences. The N_2O emissions observed no set trend between areas measured on the feedlot. The varying values, and negative values obtained may indicate sample error, or a general uptake of N by soil or microorganisms (Chantigny *et al*., 2007; Li *et al*., 2011).

In conclusion, it was found that manure characteristics are affected by season and diet characteristics which tended to have an effect on the rate of CH_4 and N_2O emissions from the manure, although not significantly.

Popular Article

Feedlot Greenhouse Gas Study Analyses Emissions From Pen Surfaces And Manure Management

By CJL Du Toit

Researchers from the University of Pretoria spend time at a commercial beef feedlot in Mpumalanga, South Africa to gain a better understanding of the greenhouse gas emissions originating from feedlots pen surfaces and manure.

Why are GHG emissions important to agriculture?

In agriculture and livestock production systems the three main greenhouse gases (GHG) include methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2). Greenhouse gases impact the environment through their ability to trap heat which depends on their capacity to absorb and re-emit infrared radiation and the atmospheric life time of the different gasses. Increasing atmospheric concentrations of GHG caused by fossil fuel combustion, industrial activities, land use change and agricultural activities contributes to changes in global temperatures and rainfall patterns which could impact directly on agricultural and livestock production.

Accurate estimation of GHG from anthropogenic sources is an increasing concern given the current and potential future reporting requirements for GHG emissions. Research measuring GHG emission fluxes from feedlot surfaces and manure management has been very limited and this was the first research project on the topic under South African conditions.

Livestock manure and GHG emissions

Livestock manure is a source of nutrients and can be used for various purposes including soil amendments to improve fertility and productivity and the generation of green energy. The main GHG emitted by manure are CH_4 and N_2O. Methane is produced during anaerobic decomposition of organic matter and N_2O is emitted during nitrification and de-nitrification processes. Feedlot manure GHG emissions is influenced by a variety of factors including manure management (pile, anaerobic lagoon, rangeland), manure application (fertilization of rangeland, composting, bio-fermentation), temperature, aeration, moisture and the sources of nutrients in the manure which is in part caused feed inefficiencies. Emission is also influenced by animal factors in the feedlot such as stocking density which will influence the amount of manure deposited, feed intake and digestibility, animal type and age.

What did the researchers do?

Following an extensive review of current literature on GHG emission flux quantification from pasture, cropping and livestock enterprises it was decided to adopt closed static chambers as the measurement methodology. The aim of the study was to determine the effect of feedlot ration and season on the GHG emissions from manure at different sites within in a commercial feedlot operation. Chamber bases were randomly installed at each manure management site (rangeland, pen surface, manure piles and water catchment lagoons) during each season. The seasons were classified as wet and hot (WH), dry and cold (DC) and dry and hot (DH).

Gas samples were drawn from the chambers during mid-day at four time intervals within a 40 min measuring period and analysed using a gas chromatograph to determine average CH_4 and N_2O fluxes.

What did the researchers learn?

The method employed resulted in large variation within results sets mainly due to difficulty in sealing the chambers bases especially in the pen surfaces which were extremely compacted. The random placement of chambers also caused variation in results as some chambers had a higher manure density and factors such as soil and manure moisture varied between different locations within each pen. The results yielded an average pen surface manure CH4 emission factor of 449 g/head/year which was 50% lower compared to feedlot manure emission factors previously calculated of 870 g/head/year using IPCC (2006) based models. The N_2O emissions measured from pen surfaces (10.95 g/head/year) were much lower than previously calculated or reported emission factors in literature varying from 54.8 to 2555 g N_2O/ head/year. Within the whole manure management system on the feedlot CH_4 emissions from the water catchment dams were the highest followed by manure piles, feedlot pen surfaces and manure deposited on rangeland. Although no statistical differences were found between the different seasons the wet and hot season produced the highest overall CH_4 emissions and the dry and cold season produced the highest N_2O emission across all manure management sites.

Managing GHG emissions from manure

The mitigation of GHG emissions from manure management in livestock operations is the topic of many research projects globally. Identified mitigation strategies are already being used by producers but new techniques and fine-tuning of existing options will lead to new and improved alternatives which can be tailored to country or regions specific production systems. The mitigation of GHG emissions from livestock production systems can be complicated as a strategy that reduces one emission may increase the other. Manure emissions can be reduced through two main actions namely input (providing of organic matter e.g. feeds) and manure management. Overfeeding of nutrients such as nitrogen (N) will result in an increase in the amount of N excreted in manure which will lead to increased N_2O emissions. To reduce GHG emission from manure producers will have to use feeding regimes that will maximise feed efficiency and reduce nutrient wastage. The management of on-farm manure can also be tailored to reduce GHG emissions and the effect of production systems on the environment. The time of manure application to soil and rangeland is important to reduce emissions. Producers should avoid spreading manure when soil is are wet as this will increase CH_4 emissions and attempt to reduce the storage time of manure on the farm. The use of technologies such as covered lagoons, digesters, aeration of manure and composting has all been employed to reduce CH_4 emissions from manure.

On-going research

There is a need to develop standardised research methodology protocols, for both on-farm and laboratory experiments, which will make it possible to compare mitigation strategies and research results between different studies. Researchers are also attempting to understand the interplay of CH4 and N2O as it seems that the processes that produce these GHG are related.

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

2017, CSS, duToit, Online, UP

< Does short duration grazing work in grasslands?

> Evaluation of methane measuring techniques

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
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

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