Estimation of Methane (CH_4) Emission by Ruminants due to Enteric Fermentation -A Preliminary Study in Sri Lanka

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Abstract
Methane emission of ruminants due to enteric fermentation is an important subcategory considered globally under the agriculture sector greenhouse gas emissions. A preliminary study was undertaken to estimate the CH_4 emission due to enteric fermentation of ruminants in different production systems in Sri Lanka. Further it was aimed to use the emission data as a tool to develop future research on appropriate adaptation and mitigation strategies. Animal population statistics during the period from 2003 to 2014 were obtained from the Departments of Census and Statistics. Emissions from enteric fermentation were calculated using the guidelines given in Intergovernmental Panel on Climate Change (IPCC 2006) for tier 1 National Greenhouse Gas Inventories. Total CH_4 emission from cattle through enteric fermentation was highest ($P<0.05$) in low country dry zone (385.19 Gg) compared with the coconut triangle (138.93 Gg). Total CH_4 emission from enteric fermentation was 96.01 Gg for the low country wet zone and intermediate zone while up and mid country showed the lowest ($P<0.05$) value of 89.79 Gg. Results reveal that, estimated values are mainly related ($R^2=0.96$) to the herd size in different zones. Further, in the low country dry zone, majority of herd composed of indigenous, zebu and their crosses with low number of productive and higher number of unproductive animals including bulls. Due to extensive management system, poor quality of forages, and occasional use of draught power lead to high maintenance requirement in animals. Therefore higher CH_4 emission was estimated compared to other production systems. In contrast, mid and up country consisted pure European breeds and their crosses reared mainly under intensive management system. Therefore CH_4 emission estimated to be lowest due to low mobility. When considering the CH_4 emission from buffaloes, low country dry and intermediate zones showed highest values (126.22 Gg) due to the existence of highest numbers of buffaloes. Contributions of goat and sheep were negligible due to their low body size and low population.CH_4 emission values estimated in this study will be helpful in improving the emission estimates for future greenhouse gas inventories to be produced in the country as well as to use as a tool to develop future research.

Keywords: Enteric fermentation, Greenhouse gas inventory, IPCC Tier 1, Methane
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Introduction

Globally, the livestock sector contributes 18 percent of greenhouse gas emissions in the world. Methane is the second most important manmade greenhouse gas (GHG) after carbon dioxide (CO_2).

At global scale, greenhouse gases emitting activities are agricultural, waste management, and energy uses. In ruminants there are two ways that CH_4 can be released to the atmosphere, enteric fermentation and emissions from manure handling.

Methane is produced as a part of the normal digestive process in ruminants. During digestion, microbes resident in an animal's digestive system ferment feedconsumed by the animal. Among domesticated animal types, ruminants are the major emitters of methane because of their unique digestive system. Livestock sector contributes significantly to global warming through GHG. Livestock contribute also 80% of all agricultural non-CO_2 emissions and it will lead to serious environmental problems (Havic, *et al.* 2014). Methane emission from Asia in 2000 was 107Tg. India was.32.9Tg. China is the largest emitter at 38.4Tg. Emissions from manure and enteric fermentation in animals represent the largest source of methane emission in Asia (Streets *et al.*, 2003).

However, there is a need to collect more information on enteric methane emission from ruminants in Sri Lanka. Further our aim was to make the emission data as a tool to develop future studies.

Methodology

Data collection

Animal population data were obtained from the Department of Censes and Statistic Department.

Determination of methane amount

Emissions were calculated by applying the equations in 2006 IPCC guidelines for National Greenhouse Gas Inventories. Default emission factors are provided for developed and developing countries separately for the different regions of the country. Emissions were calculated by applying an emission factor to the number of animals of each livestock type in the country to produce a total for enteric fermentation. Default emission factors are provided for developed and developing countries with more regional details. Default emission factors were provided by region and for three different climate regimes. Simple multiplication of populations by emission factors produced emissions estimates.

Enteric fermentation Emissions from a livestock category

Tier 1 method was used to estimate emissions. To estimate total emission selected emission factors are multiplied by the animal population and summed.

Emissions = $EF\ (T) * [N\ (T) / 10\ 6$

Where:

Emissions = Methane emissions from enteric fermentation, Gg CH_4 yr^{-1}

$EF_{(T)}$ = emission factor for the defined livestock population, kg CH_4 $head^{-1}$ yr^{-1}

$N_{(T)}$ = the number of head of livestock species/ category T in the country

T = species/category of livestock

Total emissions from livestock enteric fermentation

Total $CH_{4\ Enteric} = \sum i\ Ei$

Where:

Total CH4 Enteric = total methane emissions from enteric fermentation, Gg CH4 yr-1

Ei = is the emissions for the i th livestock categories and subcategories

Results and Discussion

Out of four ruminant production systems identified by FAO total methane emission from enteric fermentation was significantly ($p<0.05$) higher in low country dry zone and intermediate zones (LCDZ and IZ) (385.19 Gg from 2003 – 2014), due to the presence of highest number of animals as well as the poor quality feeding conditions. Total methane emission from coconut triangle (CT) was 138.93 Ggwhile 55 Gg was produced by the cattlebelong to low country wet zone.(LCWZ) Due to the presence of large number of exotic animals, as well as associated with better quality feeding, Up and mid country showed the lowest emission ($p<0.05$) as 89.79Gg.

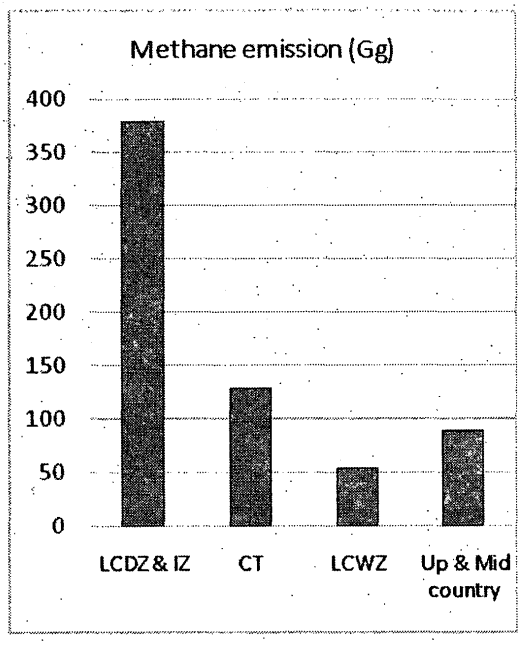

Figure 1: Methane emission in four livestock production systems

When considering the CH_4 emission from enteric fermentation of buffaloes, highest value for the low country dry zone and intermediate zones was nearly 120 Gg. Then Coconut triangle, low country wet zone and up country – mid country were respectively.

Methane emission from goat and sheep were negligible compared to other two species due to their small body size and low population.

When considering the total methane emission from all ruminant species during the period 2003 - 2014 there was no constant trend. The emission values were inconsistent mainly due to the changes in the population of ruminants in different zones. Due to extensive type of management and occasional use of draught power lead to high maintenance requirement due to generally poor quality of forages. Therefore higher CH_4 emission was estimated compared to other production systems. In contrast, mid and up country consisted pure

European breeds and their crosses reared mainly under intensive management system.

CH_4 emission values estimated in this study will be helpful in improving the emission estimates for future greenhouse gas inventories to be produced in the country as well as to use as a tool to develop future research.

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