METHANE FROM ENTERIC FERMENTATION OF LIVESTOCK IN LATVIA

Lilija DEGOLA[1], Aiga TRŪPA[1], Elita APLOCIŅA[1], Laima BĒRZIŅA[1, 2]
[1]Latvia University of Agriculture, [1]Agrobiotechnology Institute, [2] Faculty of Information Technologies
Liela street 2, LV3001, Jelgava, Latvia
Emails: lilija.degola@llu.lv, aiga.trupa@llu.lv, elita.aplocina@llu.lv, laima.berzina@llu.lv

Abstract. *Latvia reports emissions from cattle (including dairy cows), sheep, swine, goats, horses, rabbits, and fur-bearing animals. Emissions from poultry enteric fermentation have not been estimated. According to 2006 IPCC Guidelines methodology for enteric fermentation calculation from poultry are not developed. However methane emission from poultry is calculated below in the Manure management category. Cattle are the largest source of enteric methane emissions (95.2% from total methane emissions from enteric fermentation) in Latvia. In 2013, dairy cattle produced 64.5% and non-dairy cattle – 30.7% of methane emissions. Emission from sheep made 2.1%, swine – 1.7%, horses – 0.6%, and goats – 0.2% of the total emission from enteric fermentation. In 2013, methane emissions from enteric fermentation of domestic livestock increased by 0.11 Gg or 3.6%, if to compare with 2012. This is caused by the increase of the number of all livestock, excepting goats and horses. The number of non-dairy livestock increased up to 5.7% in 2013. Since 1990 generally due to evident fall of the number of livestock emissions methane emmisions decreased by 64.9%.*

Key words: *methane, enteric fermentation, livestock.*

INTRODUCTION

Naturally occurring greenhouse gases consist of water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and ozone (O_3). Carbon dioxide, CH_4 and N_2O have a direct global warming effect, and their concentrations in the atmosphere are the result of human activities. Methane makes up 7.9% of all emissions. The major sources include landfills, natural gas systems, enteric fermentation (dairy and beef cattle primarily), and coal mining. According to the Intergovernmental Panel on Climate Change (IPCC), methane is more than 20 times as effective as CO_2 at trapping heat in the atmosphere. The concentration of CH_4 in the atmosphere the past two centuries has increased by 143%. Methane from enteric (microbial) fermentation represents 20% and manure management 7% of the total CH_4 emitted. Ruminants (beef, dairy, goats, and sheep) are the main contributors to CH_4 production [1],[3] Ruminant livestock can produce 250 to 500 L of methane per day. The ruminant animal is unique because of its four stomach compartments: reticulum, rumen, omasum and abomasum. The rumen is a large, hollow muscular organ where microbial fermentation occurs. The function of the rumen as a fermentation vat and the presence of certain bacteria promote the development of gases. These gases are found in the upper part of the rumen with CO_2 and CH_4 making up the largest portion: hydrogen 0.2%, oxygen 0.5%, nitrogen 7.0%, methane 26.8%, carbon dioxide 65.5%. The proportion of these gases is dependent on rumen ecology and fermentation balance. Typically, the proportion of carbon dioxide is two to three times that of CH_4, although a large quantity of CO_2 is reduced to CH_4 [3].

MATERIALS AND METHODS

Emissions from enteric fermentation of domestic livestock in Latvia have been calculated by using the IPCC Tier 1 and Tier 2 methodologies presented in the *2006 IPCC Guidelines*. Methane emissions from enteric fermentation for sheep, swine, goats, horses, rabbits and fur-bearing animals have been calculated with the IPCC Tier 1 methodology by multiplying the number of the animals in each category with the IPCC default emission factor of the respective livestock category as shown in *2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC Guidelines*. Volume 4, Chapter 10): The default emission factors as for developed countries according to *2006 IPCC Guidelines (2006 IPCC Guidelines*. Volume 4, Chapter 10) were used to calculate methane emissions from enteric fermentation for sheep, swine, goats, horses, rabbits and fur-bearing animals (Table 1). As default IPCC or national emission factors for rabbits and fur-bearing animals are not available, the Norwegian (Greenhouse gas emission in Norway 1990-2011, National inventory report, 2013, p. 238) emission factor for fur-bearing animals and Russian emission factors for rabbits were used for emission calculations similarly by neighbouring countries.

Table 1

Default methane emission factors from Enteric Fermentation

Livestock category	EF (kg CH_4 head^{-1} yr^{-1})
Sheep	8
Swine	1.5
Goats	5
Horses	18
Rabbits	0.59
Fur-bearing animals	0.1

Table 2

Methane emissions (Gg) from Enteric Fermentation by livestock category, 1990-2013

Year	Dairy cattle	Non-dairy cattle	Sheep	Swine	Goats	Horses	Rabbits	Fur-bearing animals	Total, CH_4
1990	52.92	33.96	1.32	2.10	0.03	0.56	0.11	0.03	91.02
1991	51.52	31.98	1.47	1.87	0.03	0.54	0.13	0.03	87.57
1992	44.85	24.88	1.32	1.30	0.03	0.51	0.12	0.03	73.03
1993	32.6	12.28	0.91	0.72	0.03	0.47	0.10	0.03	47.14
1994	29.67	8.97	0.69	0.75	0.04	0.48	0.09	0.02	40.72
1995	28.34	9.21	0.58	0.83	0.04	0.49	0.09	0.02	39.60
1996	27.24	8.89	0.44	0.69	0.04	0.46	0.08	0.02	37.87
1997	27.16	8.07	0.33	0.64	0.04	0.42	0.06	0.01	36.73
1998	25.37	7.23	0.24	0.63	0.05	0.40	0.06	0.01	33.98
1999	21.53	6.47	0.22	0.61	0.04	0.34	0.04	0.01	29.25
2000	21.55	6.04	0.23	0.59	0.05	0.36	0.07	0.01	28.90
2001	22.39	6.39	0.23	0.64	0.06	0.35	0.09	0.01	30.16
2002	21.69	6.81	0.25	0.68	0.07	0.33	0.08	0.01	29.93
2003	21.02	7.43	0.31	0.67	0.08	0.28	0.09	0.01	29.87
2004	20.39	6.86	0.31	0.65	0.07	0.28	0.08	0.01	28.66
2005	20.69	7.42	0.33	0.64	0.07	0.25	0.06	0.01	29.48
2006	20.68	7.43	0.33	0.63	0.07	0.24	0.05	0.02	29.45
2007	20.84	8.45	0.43	0.62	0.07	0.23	0.06	0.02	30.71
2008	20.05	8.17	0.54	0.58	0.06	0.24	0.03	0.02	29.69
2009	19.67	8.37	0.57	0.56	0.07	0.23	0.03	0.02	29.50
2010	19.71	8.57	0.61	0.58	0.07	0.22	0.02	0.02	29.80
2011	19.79	8.68	0.64	0.56	0.07	0.21	0.02	0.02	29.98
2012	20.14	9.19	0.67	0.53	0.07	0.20	0.02	0.02	30.84
2013	20.62	9.80	0.68	0.55	0.06	0.19	0.02	0.02	31.95
Share of total % in 2013	64.50%	30.70%	2.10%	1.70%	0.20%	0.60%	0.10%	0.10%	100.00%
2013 versus 2012	+2.40%	+6.60%	+1.40%	+3.50%	-5.30%	-1.80%	+4.30%	0.00%	+3.60%

The Tier 2 methodology has been used for cattle, because emissions from cattle make the biggest part of total agricultural sector methane emissions. With the Tier 2 methodology methane emissions have been calculated as in the Tier 1 methodology, but the emission factors (EF) for dairy cattle and non-dairy cattle has been calculated according to *2006 IPCC Guidelines (2006 IPCC Guidelines*. Volume 4, Chapter 10): Feed digestibility (DE) 65% is used in calculation according average value represented in the *2006 IPCC Guidelines*, because detailed information on feed digestibility are not available in the country yet. The calculation of GE is strongly based on the milk production and fat content in milk.

RESULTS AND DISCUSSION

Methane (CH_4) is emitted as a by-product of the normal livestock digestive process, in which microbes resident in the animal's digestive system ferment the feed consumed by the animal. This fermentation process is also known as enteric fermentation. Ruminant livestock (cattle, sheep and goats) are primary source of methane emissions. The amount of enteric methane emitted is driven primarily by the number and size of domestic animals, the type of digestive system, and the type and amount of feed consumed (IPCC GPG, 2000). Latvia reports emissions from cattle (including dairy cows), sheep, swine, goats, horses, rabbits, and fur-bearing animals (Table 2). Emissions from poultry enteric fermentation have not been estimated. According to 2006 IPCC Guidelines methodology for enteric fermentation calculation from poultry are not developed. However methane emission from poultry is calculated below in the Manure management category.

Cattle are the largest source of enteric methane emissions (95.2% from total methane emissions from enteric fermentation) in Latvia. In 2013, dairy cattle produced 64.5% and non-dairy cattle – 30.7% of methane emissions. Emission from sheep made 2.1%, swine – 1.7%, horses – 0.6%, and goats – 0.2% of the total emission from enteric fermentation. In 2013, methane emissions from enteric fermentation of domestic livestock increased by 0.11 Gg or 3.6%, if to compare with 2012. This is caused by the increase of the number of all livestock, excepting goats and horses. The number of non-dairy livestock increased up to 5.7% in 2013. Since 1990 generally due to evident fall of the number of livestock emissions methane emmisions decreased by 64.9% (Table 2). There has been a lot of research conducted in Europe, Canada, Australia, and the U.S. on strategies to reduce methane emissions from dairy and beef operations. The main focus has been on nutritional strategies, especially cows grazing pasture. Some dietary practices that have been shown to reduce CH_4 include the addition of ionophores, fats, the use of high quality forages, and the increased use of grains [1]-[4]. These nutritional strategies reduce CH_4 through the manipulation of ruminal fermentation, direct inhibition of the methanogens and protozoa, or by a redirection of hydrogen ions away from the methanogens. Relatively new mitigation options have been investigated and include the addition of such additives as probiotics, acetogens, bacteriocins, organic acids, and plant extracts (i.e. condensed tannins). For the long term approach, genetic selection of cows that have improved feed efficiency is a possibility. The following gives more detail about some of the strategies that reduce CH_4: 1) Increasing the efficiency in which animals use nutrients to produce milk or meat can result in reduced CH_4 emissions. This can be accomplished by feeding high quality, highly digestible forages or grains. However, the emissions produced in producing and/or transporting the grain or forage should be considered. 2) Rumen modifiers such as ionophores improve dry matter intake efficiency and suppress acetate production, which results in reducing the amount of hydrogen released. In some of the published research, CH_4 has been reduced by 10%, however the effect of the ionophores have been short-lived in respect to CH_4 reduction [6]. More research on the continued use of ionophores for this purpose is needed. 3) The grinding and pelleting of forages can reduce emissions by 40%, however the costs associated with this practice may be prohibitive. 4) Dietary fats have the potential to reduce CH_4 up to 37% [5]. This occurs through biohydration of unsaturated fatty acids, enhanced propionic acid production, and protozoal inhibition [1],[2]. The effects are variable and lipid toxicity to the rumen microbes can be a problem. This strategy can affect milk components negatively and result in reduced income for the producer. There are several novel approaches to reducing CH_4 that are not very practical at this point. An example would be the defaunation of the rumen. Removing protozoa has been demonstrated to reduce CH_4 emissions by 20% [1],[2]. There may be opportunities to develop strategies that encourage acetogenic bacteria to grow so they can perform the function of removing hydrogen instead of the methanogens. Acetogens convert carbon dioxide and hydrogen to acetate, which the animal can use as an energy source. There is also research being conducted to develop a vaccine, which stimulates antibodies in the animal that are active in the rumen against methanogens. The problems with some of these mitigation strategies to reduce CH_4 are potential toxicity to the rumen microbes and the animal, short-lived effects due to microbial adaptation, volatility, expense, and a delivery system of these additives to cows on pasture [1],[2].

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CONCLUSION

1. Cattle are the largest source of enteric methane emissions (95.2% from total methane emissions from enteric fermentation) in Latvia.

2. In 2013, dairy cattle produced 64.5% and non-dairy cattle – 30.7% of methane emissions of the total emission (31.95 Gg) from enteric fermentation.

3. In 2013, methane emissions from enteric fermentation of domestic livestock increased by 0.11 Gg or 3.6%, if to compare with 2012.

4. Since 1990 generally due to evident fall of the number of livestock emissions methane emmisions decreased by 64.9%.

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