

EMISSION OF GREEN HOUSE GASES FROM MANURE MANAGEMENT OF CATTLE AND BUFFALOES IN ROMANIA

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Abstract

The paper aimed to present the evolution of green house gases emissions from manure management at cattle and buffaloes, during the period 1989 -2014 in Romania. It is based on the statistical data provided by National Institute of Statistics. The data have been processed into the following indicators: cattle and buffaloes livestock, number of dairy cows and buffaloes, milk yield. All categories included in this study were in accordance with IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2006, chapter 11, Agriculture and used parameters in equations have national values (gross energy intake, digestible energy, VS). After all the calculations to see that the green house gases emission trend from manure management was descending due to the decrease in the number of animals, but in the last period (2010-2014), emission of GHG seems to have an ascending trend.

Key words: buffaloes, cattle, emission, green house gases, manure management

INTRODUCTION

Animal waste is a major source of anthropogenic greenhouse gases emissions, most of which is methane and nitrous oxide. Regarding methane, manure resulting from rearing of economic interest animal species contributes with 5-10% of the total emissions [3].

The natural degradation of animal waste during storage leads to the release of methane into the atmosphere, as a result of the anaerobic degradation of organic matter. These emissions result especially from pigs (38%), cows (21%) and poultry (9%) manure [5]. The same author estimates that, in France, out of about 60 million tons of the total annual methane emissions, over 20% result from manure management.

Nitrous oxide (N₂O) accounts for approximately 5% of total greenhouse gases from human activity. This compound is naturally occurring in the atmosphere, as part of the nitrogen global cycle, and it also has a

wide variety of natural sources. A number of human activities, such as: agriculture, fossil fuel combustion, waste water management and industrial processes increase the amount of nitrous oxide in the air. These molecules remain in the atmosphere for 114 years until they are removed by rain or destroyed by various chemical reactions at this level. The contribution of nitrous oxide to global warming is about 300 times higher than that of carbon dioxide.

MATERIAL AND METHODS

The primary data used in this report were provided by the National Institute of Statistics [6], by the statistical yearbooks on "Agriculture and Forestry", time series 1989 ÷ 2014.

Data from NIS [6] until 2003, show livestock units grouped on larger categories, so it was necessary to extrapolate the past animal subcategories which appear in this study and for which there are official data available for 2004-2014. In this respect, it was considered the reference year for extrapolation, 2004.

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At this year level, based on the total cattle livestock, were calculated the percentages of the other categories and subcategories, the percentages of cattle, with all subcategories, and the percentages of buffaloes, with their subcategories. Thus, buffaloes occupies 1.2% of the total cattle livestock, and, in this category, dairy female buffaloes represents 0.89% of the total cattle, and the “other buffaloes” subcategory is 0.31% of the total cattle. In cattle subcategory, calves for veal represents 10.03% of the total cattle, young calves for breeding less than 1 year old is 15.3% of the total cattle, young breeding calves 1-2 years old is 7.97% of the total cattle, breeding bulls are 0.34% of the total cattle, heifers – 5.83% of the total cattle, dairy cows – 55.79% of the total cattle, males and females for beef – 1% of the total cattle, and draft cattles are 1.94% of the total cattle.

There were kept the same percentages for whole 1989-2003 period because they are sensitive similar, given that certain subcategories move pretty quickly from one subcategory to another. The long service categories, such as dairy cows, breeding bulls, draft cattle, dairy female buffaloes, have similar percentages for the entire time series, and the livestock structure is not changing, even if the numeric livestock registers sudden drops. Most buffaloes livestock is found in households that do not slaughter youth for beef, but keep it in order to exploit their milk production. Draft cattle are also private property only at the household level.

The methane emission from manure management was calculated using *method 2* from the IPCC 2006 [2]; national data are available for GE (gross energy intake, MJ /day), DE (digestibility of the feed in percent), VS (volatile solid excretion per day on a dry-organic matter basis, kg VS /day) for each species and subcategory, by also using default values (B_0 - maximum methane producing capacity for manure produced by livestock category T, m^3CH_4/kg VS excreted, and MCF - methane conversion factors for each manure management system S by climate region k, %).

For the calculation of methane emissions from animal waste management systems, equations 10.22., 10.23 and 10.24 of the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2006 were used [2].

In the calculation of (UE*GE) fraction, urinary energy expressed as a fraction of the gross energy was made based on the equation developed by Hoffmann and Schiemann, 1980 [1]:

$$\text{Urine Kcal (\% of GE)} = 3.30 + 0.233 x_1 + 0.016 x_2 - 0.00002 x_2^2 \pm 0.7$$

X_1 = the GP (crude protein) content of the ration (% of dry matter);

X_2 = body weight (in kg).

X_1 value is calculated based on an extremely simple algorithm consisting in reporting the crude protein amount to the amount of dry matter in the ration, expressing the result as a percentage. The amount of protein and dry matter in the ration are essential parameters in calculating its structure, and the values for each type of fodder can be taken from the tables with the chemical composition and nutritional value of various forage categories [4].

Thereafter, the result is converted into MJ (1 kcal = 239 MJ) to enter in the equation 10.24.

The N_2O emissions from animal waste were calculated according to equation 10.25, of IPCC 2006.

The nitrogen excretion (N_{ex}) was calculated according to the equation 10.30 of IPCC 2006 (table 18), using N_{rate} (table 10.19, the IPCC guide) as default value, and national values for animal live weight.

For $EF_{3(S)}$, the emission factor for direct N_2O emissions from the S manure management system, kg N_2O-N/kg N of the S manure management system, were used default values of the IPCC guide, listed below:

- Pasture/paddock for bovines (cattle and buffaloes) – 0.002
- Pasture/paddock for sheep, goats, horses – 0.001
- Daily spreading (all species) – 0
- Solid storage (all species) – 0.005
- Anaerobic lagoons (all species) – 0

- Sludge/liquid (all species) – 0.005
- Poultry with/without bedding – 0.001
- Pit storage – 0.002

For the calculation of each GE (gross energy intake) value, based on the exploited species and category, an average ration was considered, both in summer and in winter. The ration can provide the necessary maintenance (allow normal operation of the animal body, at basal metabolism level, providing vital functions), and the need to develop productions for cattle, buffaloes. It should be made clear that the data provided by the National Institute of Statistics do not make the difference between exploitation systems (intensive, semi-intensive, extensive, subsistence), between the exploitation (farms or individual households) and their size, as well as between various management types (occurring depending on the farm size, species and categories of animal exploited), and as a result, the values of energy gross intake (GE) have been established linking the nutritional requirements of each exploitation species and category with the nutritional content of the rations and the average recipes that are considered (expert's opinion) to ensure the productions of the official data (NIS).

When calculating the calorificity of the energy gross intake of each recipe or ration, were considered the algorithm according to Stoica, 1997 [4].

RESULTS AND DISCUSSIONS

Figure 1 shows the dynamics of methane emissions from manure management, for cattled aged under 1 year and between 1-2 years

For these cattle categories, with all default subcategories, there is a descending trend of methane emissions from manure management, although in 2005-2007, all categories registered increased emission, due to increased animal livestock. However, the increase is not significant and does not influence the emissions general descending trend, per total analysed period.

Figure 2 shows the dynamics of methane emissions from manure management for cattle aged 2 years and over, and Figure 3 for buffaloes.

Just like to the previous categories for which we described the trend for methane emissions from manure management, the same emissions decrease is also registered for these subcategories, in general, with the same increase specific to 2005-2007 (most likely, due to the increase of animals number included in these categories).

Currently, the emissions are registering a slightly increasing trend, due to a slight increase of animals number included in these cattle categories.

Direct nitrous oxide emissions from manure management for cattle (figures 4 and 5) and buffaloes (figure 6) show a descending trend.

Regarding the direct nitrous oxide emissions for cattle and buffaloes, they registered a descending trend for the whole period, for two reasons: first, the livestock decrease, and secondly, due to the expansion of less polluting manure management systems, the organization of manure platforms, practicing rational grazing, etc.

Direct emissions have registered the highest decreases for *young breeding cattle under 1 year* and *young breeding cattle aged 1-2 years* categories, together with the *calves for veal* category. The lowest fluctuation of direct nitrous oxide emissions was registered for young cattle for slaughter aged 1-2 years.

Regarding the subcategory *cattle aged 2 years and over*, as we expected, decreasing emissions of nitrous oxide from manure management are more pronounced for dairy cows, on the one hand due to livestock decrease, as well as due to the modernization of farms and rearing technologies, as well as due to environmental protection legislation applied in animal husbandry.

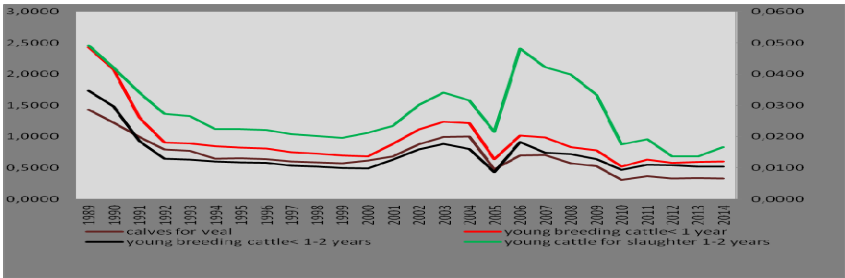


Fig. 1 The dynamics of CH₄ emissions from manure management, for cattle aged under 1 year and cattle aged 1-2 years

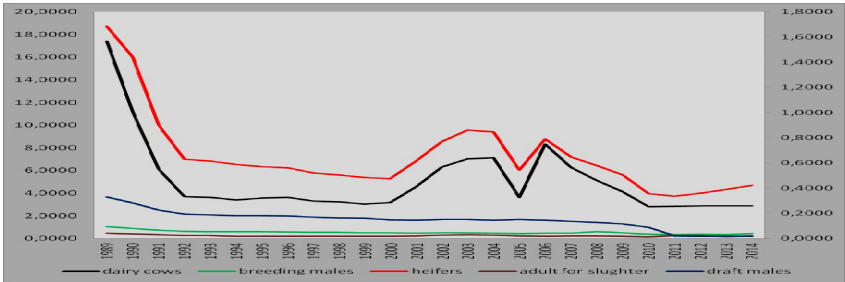


Fig. 2 The dynamics of CH₄ emissions from manure management, for cattle aged over 2 years

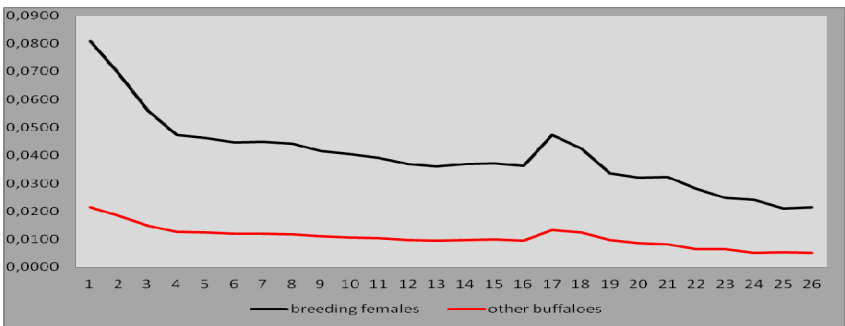


Fig. 3 The dynamics of CH₄ emissions from manure management, for buffaloes

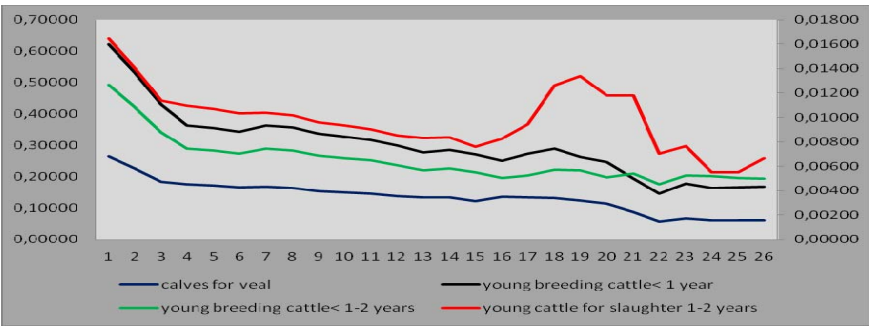


Fig. 4 The dynamics of direct N₂O emissions from manure management, for young cattle under 1 year and aged 1-2 years

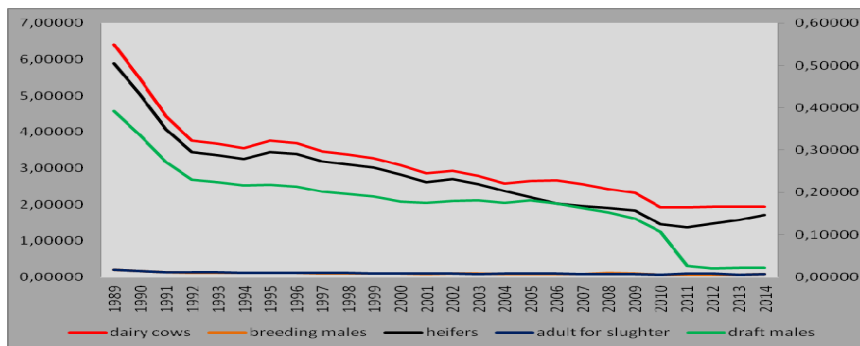


Fig. 5 The dynamics of direct N_2O emissions from manure management, for young cattle aged over 2 years

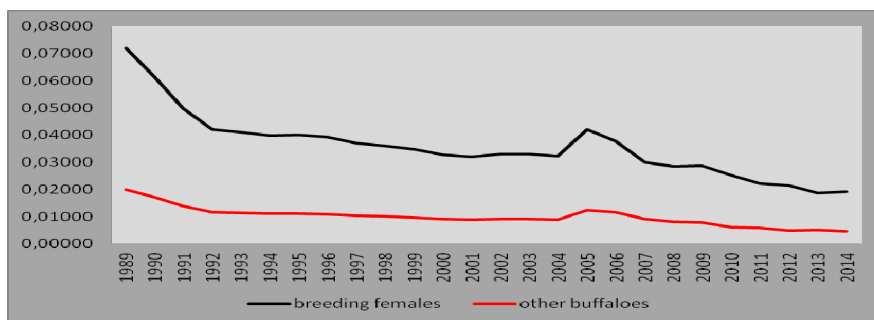


Fig. 6 The dynamics of direct N_2O emissions from manure management, for buffaloes

CONCLUSIONS

Although it seems that, lately (2010-2014), the methane emission from manure management tends to increase, in reality, emissions have closer, almost constant values, which indicates that there were not significant changes during the above period in animal husbandry sector, either in terms of animals number, or as manure management system.

The N_2O emission decreased during the analysed period, due to cattle and buffaloes livestock decrease, as well as due to the organization of these livestock in different size farms that practice manure management systems, in accordance with the legislation on environmental protection and on polluting emissions reduction.

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