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GREEN HOUSE GASES EMISSIONS FROM NONRUMINANTS

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Abstract

The paper aimed to present the evolution of green house gases emissions from entheric fermentation and manure management at nonruminants Romanian livestock during the period 2014 -2017. The emissions are based on the data provided by National Institute for Statistics. The data have been processed into the following indicators: nonruminants livestock, number of: breeding females (sows), swine youth categories as piglets (under 20 kg and 20-50 kg), fattening swine, breeding swine, horses, for entheric fermentation. For manure management were including two poultry categories: broilers and adult laying chickens. All categories included in this study were in accordance with IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2006, and parameters used in equations have national values (gross energy intake, digestible energy, EF, MS, N_{ex}). The researchproved that the green house gases emission trend from entheric fermentation and manure management were descending, due to the decrease in the number of animals, and due to conversion to sustainable agriculture sustained by government subsidies for environmental measures.

Key words: *greenhouse gas, emissionss, entheric fermentation, manure management, nonruminants*

INTRODUCTION

Methane from enteric fermentation is the product of microbial activity from the animal rumen. The amount of methane produced in the enteric fermentation is positively correlated with the animal live weight, production and thus the quantity and quality of food intake in order to achieve the production concerned. In conditions of normal feed, methane is 15-30% of the total ruminal gas (a mixture of carbon dioxide, methane, hydrogen, nitrogen, etc.). The proportion of these gases varies according to feed nature and the fermentation intensity. The production of ruminal methane is not directly proportional to the consumed feed digestibility. Feed with high digestibility form less methane per unit of caloric energy consumed, than those with lower digestibility (Cristea, 1985) In other words, if the energy intake have higher value, the amount of methane from enteric fermentation will be higher.

On the other path, 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 (IPCC, 2006).

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. The methane emissions from entheric fermentation and manure management is higher in cold season due to value of food ratio which contains more energy from feed used and more manure quantity kept on platform than in grazing season.

Nitrous oxide (N_2O) 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.

In agriculture, sources of nitrous oxide pollution are represented by the use of synthetic fertilizers and manure management. Soil management is the main source of pollution, accounting a total of approx. 72-74% of the total emissions, while the degradation of animal waste from species of economic interest contributes with approx. 5%.

MATERIALS AND METHODS

The primary data used in this report were provided by the National Institute of Statistics, EUROSTAT and FAOSTAT.

To estimate the methane emissions from entheric fermentation and manure management, livestock'sdata have been corrected with the "days of exploitation" factor that is specific to each subcategory of use within species. This correction factor refers to the number of days in a year, during which the animal is exploited and it is applied to youth categories. The correction of the livestock was made based on the following relation:

$$\text{AAP} = \text{Days of life} * \left(\frac{NAPA}{365}\right) \quad (1)$$

where:

AAP = average annual population;

NAPA = number of animals produced annually.

The methane emission from manure management was calculated using method 2 from the IPCC 2006; national data are available for GE, DE and EF. The methane emission was calculated based on equations 10.19, 10.20, 10.21 of the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2006:

$$Emissions = EF_{(T)} * \frac{N_{(T)}}{10^6}$$

where:

Emissions= methane emissions from enteric fermentation, Gg CH_4/year;

$EF_{(T)}$= emission factor for the defined livestock population, kg CH_4 / head/ year;

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

T= species or category of livestock.

$$\text{Total } CH_{4\ ENTERIC} = \sum_i E_i$$

where:

Total $CH_{4Enteric}$= total methane emissions from enteric fermentation, Gg CH_4/year;

E_i= the emissions for the i^{th} livestock categories and subcategories.

$$EF = \left[\frac{GE * \left(\frac{Ym}{100}\right) * 365}{55.65}\right]$$

where:

EF= emission factor, kg CH_4/head/year;

GE= gross energy intake, MJ/head/year;

Ym= methane conversion factor, per cent of gross energy in feed converted to methane;

55.65 (MJ/kg CH4) = the energy content of methane.

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

$$N_2O_{D(mm)} = \left[\sum_S \left[\sum_T \left(N_{(T)} * Nex_{(T)} * MS_{(T,S)}\right)\right] * EF_{3(S)}\right] * \frac{44}{28}$$

where:

$N_2O_{D(mm)}$ = direct N_2O emissions from manure management in the country, kg N_2O/year;

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

$Nex_{(T)}$= annual average N excretion per head of species/category T in the country, kg N/animal/year;

$MS_{(T,S)}$ = fraction of total annual nitrogen excretion for each livestock species/category T that is managed in manure management system S in the country;

$EF_{3(S)}$ = emission factor for direct N2O emissions from manure management system S in the country, kg N_2O-N/kg N in manure management system S;

S = manure management system;

T = species/category of livestock;

44/28 = conversion of (N_2O-N)(mm) emissions to N_2O (mm) emissions.

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.

$$Nex_{(T)} = N_{rate(T)} * \frac{TAM}{1000} * 365$$

where:

$Nex_{(T)}$ = annual N excretion for livestock category T, kg N/animal/year;

$N_{rate(T)}$ = default N excretion rate, kg N/1000 kg animal weight/day (table 10.19 IPCC, 2006);

$TAM_{(T)}$ = typical animal mass for livestock category T, kg/animal.

Table 3 indicates the N_{ex} values after applying equation 10.30.

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 horses – 0.001
- Daily spreading (horses) – 0
- Solid storage (horses, poultry) – 0.005
- 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 caloricity of the energy gross intake of each recipe or ration, the following equivalences were considered (Stoica, 1997):

1 g crude protein = 5.72 kcal; 1 g crude fat = 9.5 kcal; 1 g crude fiber =4.79; 1 g SEN (non-nitrate extractable substances) = 4.17 kcal.

The GE calculation formula is (Stoica, 1997):

GE (kcal/kg) = 5.72·GP + 9.5·GB + 4.79·CelB + 4.17·SEN, where: GE = gross energy intake; GP = crude protein; GB = crude fat; CelB = crude fibers; SEN = non-nitrate extractable substances.

The rations were established according to the equation above, and the values of crude protein, crude fat, crude fiber and non-nitrate extractable substances were taken from the tables with the feed chemical composition (Stoica, 1997).

The percentage of digestible energy (DE%) of raw energy is calculated by applying the cross-multiplication rule, according to the following relation: DE % = (DE/GE) x 100.

RESULTS AND DISCUSSIONS

The values used for calculation of methane emission from enteric fermentation are presented in Table 1.

Table 1. The values used for calculation of methane emission from enteric fermentation

SPECIFICATION	AAP (thousands head)				GE (MJ/day)	DE (Mj/day)	Ym	EF	Days of life
	2014	2015	2016	2017					
Piglets < 20 kg	133.22	122.20	120.55	114.28	8.18	6.7	13.00	6.97	56
Piglets 20-50 kg	346.84	344.20	324.06	305.70	13.49	11.7	13.00	11.50	75
Fattening pigs	441.60	431.94	412.73	389.35	46.86	40.66	13.00	39.96	100
Boars	7.07	5.600	6.10	5.80	45.32	39.3	13.00	38.64	365
Sows	343.61	374.60	361.20	342.00	45.34	37.7	13.00	38.66	365
Horses	524.74	503.46	541.23	511.19	225.79	121.84	2.50	37.02	365

Table 2. CH_4 emissions from entheric fermentation

SPECIFICATION	Emissions of CH_4 (Gg)			
	2014	2015	2016	2017
Piglets < 20 kg	0.929	0.852	0.841	0.797
Piglets 20-50 kg	3.989	3.959	3.727	3.516
Fattening pigs	17.644	17.259	16.491	15.557
Boars	0.273	0.216	0.236	0.224
Sows	13.284	14.482	13.964	13.221
Horses	19.428	18.640	20.038	18.926

The number of animals has decreased in the analyzed period from 5.041.7thousand pigs in the year 2014 to 4441.1 thousand heads in the year 2017, and the methane emissions following the same descendent trend. The methane emission trend from enteric fermentation is descending due, on the one hand, to the decrease in the number of animals, and on the other hand, due to the technological improvements at farms level and genetic improvements, at animal level. The data used for calculation of N_2O emissions from manure management are presented in Table 3.

Table 3. The values used for calculation of N_2O emissions from manure management

SPECIFICATION	N_{ex} kgN/head/ year	Management system (MS)						
		Pasture	Daily spread	Solid storage	Anaerobic lagoons	Pit storage<1m	Poultry with bedding	Poultry without bedding
Piglets < 20 kg	2.3506			0.2	0.45	0.35		
Piglets 20-50 kg	5.8765			0.3	0.4	0.3		
Fattening pigs	22.0825			0.15	0.45	0.4		
Boars	45.333					1		
Sows	20.9875			0.2	0.44	0.36		
Horses	54.75	0.7		0.3				
Laying hens	0.53874		0.25					0.75
Broilers	0.8833		0.23				0.77	

Table 4. N_2O emissions from manure management

SPECIFICATION	Emissions of N_2O (Gg)			
	2014	2015	2016	2017
Piglets < 20 kg	0.0127	0.0116	0.0115	0.0109
Piglets 20-50 kg	0.0639	0.0634	0.0597	0.0563
Fattening pigs	0.2125	0.2079	0.1986	0.1874
Boars	0.0010	0.0008	0.0009	0.0008
Sows	0.0444	0.0484	0.0467	0.0442
Horses	0.3837	0.3682	0.3958	0.3738
Laying hens	0.0271	0.0277	0.0259	0.0199
Broilers	0.0040	0.0043	0.0043	0.0058

The nitrous oxide emission from poultry manure recorded for the *broilers* subcategory an almost constant trend (although the regression line shows a slight decrease in emissions, due to a better poultry manure management, dissolution of large poultry complexes), but in the last year recordered an increase trend, due to market request for this type of meat. For the *laying chickens* subcategory, direct nitrous oxide emissions from manure management are placed descending trend, due to laying chickens decrease number. The N_2O emission decreased during the analysed period, due to livestock decrease, as well as due to the organization of these livestocks in farms and complexes that practice manure management systems, in accordance with the legislation on environmental protection and on polluting emissions reduction.

CONCLUSIONS

These significant emissions decreases are not only due to the decrease of animal livestock, but also due to cancellation of rearing this species in individual households (there is a trend to give up rearing pigs in the households, but it is also a tradition), on the one hand due to the economy (the price of pork is affordable, compared to beef price, for example), on the other hand, because of feed which if it's not produced by the same farmer/landowner, may be less affordable when they are purchased from a different producer (there were dry years when the produced feed were preserved for animal feeding).

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