STUDY OF THE EVOLUTION OF GREENHOUSE GAS EMISSIONS AT THE NATIONAL LEVEL FROM THE CATTLE AND PIG FARMING SECTOR

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Abstract: *Agriculture is considered to be a major source of greenhouse gas emissions. The main activity of gas generation is livestock farming, especially cattle and pig farming, according to many studies conducted internationally. The main greenhouse gases are water vapors, methane, carbon dioxide, ammonia. Methane emitted in the atmosphere is considered to be more harmful than carbon dioxide, accelerating the global warming phenomenon. Methane emissions from the livestock sector result from metabolic processes and manure. Ammonia is another gas resulting from the growth of animals that, in high concentrations, affect the health of the population, the animals and the environment. Ammonia emissions are influenced by factors such as animal feed composition, temperature, humidity, livestock shelter, etc. Greenhouse gases are the main cause of global warming, an international problem for which solutions are still being sought. The phenomenon of global warming implies serious environmental, population and animal effects, and agriculture is one the cause of the rise in annual average temperature. This is why the emphasis is on identifying sources of air pollution and ways to mitigate the adverse effects of the agricultural sector. The purpose of this study is to estimate emissions into the air at national level in the cattle and pig breeding sector. The official data provided by the National Institute of Statistics was used to carry out this study. Based on these data, emissions were estimated for each calendar year between 1990 and 2016, and then the results were interpreted to track the evolution of gas emissions from this sector. It has been noted that Romania has experienced a regression in livestock farming nationwide according to the data provided by the National Institute of Statistics therefore the amount of greenhouse gas emissions from the zootechnical sector is significantly diminishing.*

Key words: *greenhouse gas emissions methane, ammonia, cattle and pig farming*

INTRODUCTION

Global warming is a global problem. Given that the effects of this phenomenon of increasing annual average temperatures are increasingly felt, solutions are being sought for the reduction of greenhouse gases, one of the major causes of the challenge of global warming

GHG emissions of livestock production have enormous global relevance.[3]The highest NH_3 emissions in Europe in agriculture are due to livestock breeding (80-90%). In relation to these emissions, although it varies from one country to another, the following can be noticed: 30-40% of NH_3 emissions result from the animals being stationed in shelters and outside perimeter (farms, yards); 10-20% of total NH_3 emissions come from storing animal manure; [4]

During this study we intend to estimate the amounts of NH_3, N_2O, NO, N_2 emissions generated over a 26-year period at national level from animal farming, taking into account several factors.

Here are five main sources of emissions related to livestock farming and manure management: animal feed (PM), manure generated in closed and open areas (NH_3, PM, NMVOCs); storage of fertilizers (NH_3, NO, NMVOC); (NH_3, NO, NMVOCs) and excreta deposited during grazing (NH_3, NO, NMVOCs)[1].

Once emitted, NH3 can rapidly react with acidic compounds found in the atmosphere, N compounds can impact ecological balance, biodiversity, and water systems. Deposition back onto soil, vegetation, or water usually occurs within a matter of days and thus in relatively close proximity to the emission source. Once deposited, N can impact soil acidity, forest productivity, terrestrial ecosystem biodiversity, stream acidity, and coastal productivity.[2]

MATERIAL AND METHODS

The official data on the number of animals registered at national level during the years 1990-2016 were collected from the website of the National Institute of Statistics

For the estimation of emissions from livestock farming and animal manure management, emission modeling was used using a series of equations and emission factors. The EMEP / EEA guide has taken over the model used to calculate the amounts of nitrogen compounds. This guide has been developed to provide information on how to carry out inventories of gas emissions from all areas of activity(agriculture, wood processing, food industry, etc).The National Environmental Protection Agency promotes these guides, thus proving that this guide is compiled in accordance with all laws in the field of environmental protection. The formulas presented in Table 1 are the formulas used according to ENEP / EEA guidelines for this study. These refer to the amount of greenhouse gases produced under certain conditions such as: N added in bedding, kg/animal/yr for cattle is 6 and for swine is 0,80, $EF_{NH3\ house,\ slurry}$ are similar in both animals to 0.2 , $EF_{NH3\ house,\ solid\ is}$ between 0,19 and 0,21; Housing period is 180 day for cattle and 365 days for ; $f_{min} =$ 0,1 etc.

Table 1.

Formulas used in this study[5]

Nr.Crt	Types of gas	Formulas
1	NH_3	$E_{MMS\_NH3} = (E_{yard} + E_{build\_slurry} + E_{build\_solid} + E_{storage\_NH3\_slurry} + E_{storage\_NH3\_solid}) \times 17/14$
2	NO_2	$E_{MMS\_NO2} = (E_{storage\_NO\_slurry} + E_{storage\_NO\_solid}) \times 46/14$
3	N_2O	$E_{N2O} = E_{storage\_slurry\_N2O} \times 44 / 28 + E_{storage\_solid\_N2O} \times 44 / 28$
4	N_2	$E_{MMS\_N2} = E_{storage\_slurry\_N2} + E_{storage\_solid\_N2}$
5	$E_{storage\_slurry}$	$E_{storage\_slurry} = E_{storage\_slurry\_NH3} + E_{storage\_slurry\_N2O} + E_{storage\_slurry\_NO} + E_{storage\_slurry\_N2} = mm_{storage\_slurry\_TAN} \times (EF_{storage\_slurry\_NH3} + EF_{storage\_slurry\_N2O} + EF_{storage\_slurry\_NO} + E_{Fstorage\_slurry\_N2})$
6	$E_{storage\_solid}$	$E_{storage\_solid} = E_{storage\_solid\_NH3} + E_{storage\_solid\_N2O} + E_{storage\_solid\_NO} + E_{storage\_solid\_N2} + E_{storage\_solid\_effluent\_N} = mm_{storage\_solid\_TAN} \times (EF_{storage\_solid\_NH3} + EF_{storage\_solid\_N2O} + EF_{storage\_solid\_NO} + EF_{storage\_}$

		solid_N2 + $EF_{storage\_effluent\_N}$)

RESULTS AND DISCUSSION

According to the information published by the National Institute of Statistics, during the 26 years (1990-2016), 79153033 cattle and 179957387 pigs were recorded in Romania. Since 1990 (the year when most animals were recorded), Romania experienced a regression period, reaching 2049713 cattle in 2016, or 4707719 registered portions.
The main factors that have contributed to the reduction of the number of animals at national level are economic in nature.

Table 2

Number of animals registered during 1990-2016

Nr. Crt	**Years**	**Cattle**	**Swine**
1	1990	5380780	12003384
2	1991	4355300	10954100
3	1992	3683100	9852400
4	1993	3596782	9262066
5	1994	3480803	7758110
6	1995	3496255	7959539
7	1996	3434869	8234464
8	1997	3235390	7096477
9	1998	3142668	7194126
10	1999	3051149	5848360
11	2000	2870415	4797357
12	2001	2799817	4446828
13	2002	2877803	5058161
14	2003	2897082	5145448
15	2004	2808061	6494666
16	2005	2861671	6622302

17	2006	2933596	6814605
18	2007	2818983	6564907
19	2008	2683611	6173682
20	2009	2512296	5793415
21	2010	2001105	5428272
22	2011	1988939	5363797
23	2012	2009135	5234313
24	2013	2022408	5180173
25	2014	2068888	5041788
26	2015	2092414	4926928
27	2016	2049713	4707719
28	Total	79153033	179957387

The number of pigs at national level gradually decreased until 2001, and after this period the number of pigs registered increased slightly over the next 7 years, as can be seen in Fig.1

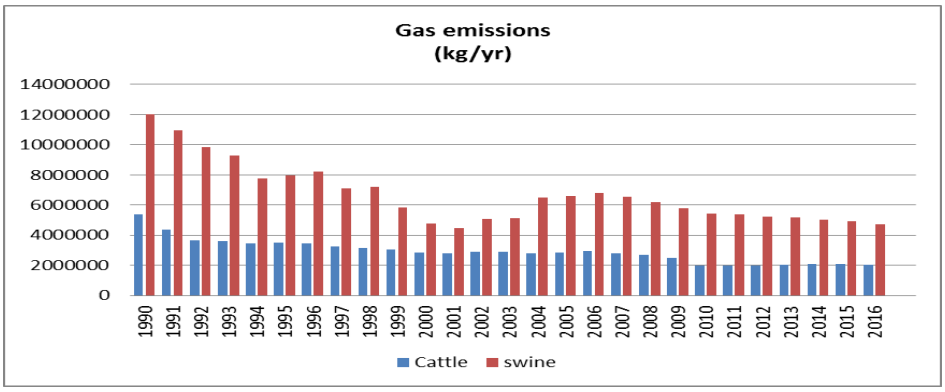

Fig.1 Gaseous emissions from swine and cattle

The emissions of NH_3, N_20, N0, N_2 shown in Table 3 and Table 4 resulting from the increase in the number of animals were influenced by several factors such as: Housed period, days (180 for cattle, 365 for pigs); N added in bedding, kg / animal / yr (6 for cattle, 0.80 for pigs), the amount of nitrogen in the consumed food, etc.

The amount of NH_3 emissions at national level is 55882415,22 kg lower than in 1990, the number of pigs declining significantly during this period.

Table 3.

Gaseous emissions from pigs.

Nr. Crt	**Years**	**Swine**	**NH_3** [to/year]	**N_20** [to/year]	**N0** [to/year]	**N_2** [to/year]
1	1990	12003384	88767,699	323,271	87,058	1465,678
2	1991	10954100	81008,010	295,012	79,448	1337,555
3	1992	9852400	72860,693	265,341	71,457	1203,031
4	1993	9262,066	68495,041	249,443	67,176	1130,948
5	1994	7758110	57372,951	208,939	56,268	947,307
6	1995	7959539	58862,564	214,363	57,729	971,903
7	1996	8234464	60895,695	221,768	59,723	1005,473
8	1997	7096477	52480,028	191,120	51,469	866,518
9	1998	7194126	53202,164	193,749	52,177	878,442
10	1999	5848360	43249,925	157,506	42,417	714,116
11	2000	4797357	35477,523	129,200	34,794	585,783
12	2001	4446828	32885,283	119,760	32,252	542,982
13	2002	5058161	37406,227	136,224	36,685	617,629
14	2003	5145448	38051,734	138,575	37,318	628,287
15	2004	6494666	48029,502	174,912	47,104	793,034
16	2005	6622302	48973,398	178,349	48,030	808,619
17	2006	6814605	50395,522	183,528	49,425	832,100
18	2007	6564907	48548,949	176,804	47,614	801,611
19	2008	6173682	45655,753	166,267	44,776	753,840
20	2009	5793415	42843,594	156,026	42,018	707,407

21	2010	5428272	40143,280	146,192	39,370	662,821
22	2011	5363797	39666,473	144,456	38,902	654,949
23	2012	5234313	38708,910	140,968	37,963	639,138
24	2013	5180173	38308,533	139,510	37,570	632,527
25	2014	5041788	37285,145	135,783	36,567	615,630
26	2015	4926928	36435,730	132,690	35,734	601,605
27	2016	4707719	34814,630	126,786	34,144	574,838
28	Total	179957387	1330824,972	4846,557	1305,197	21973,771

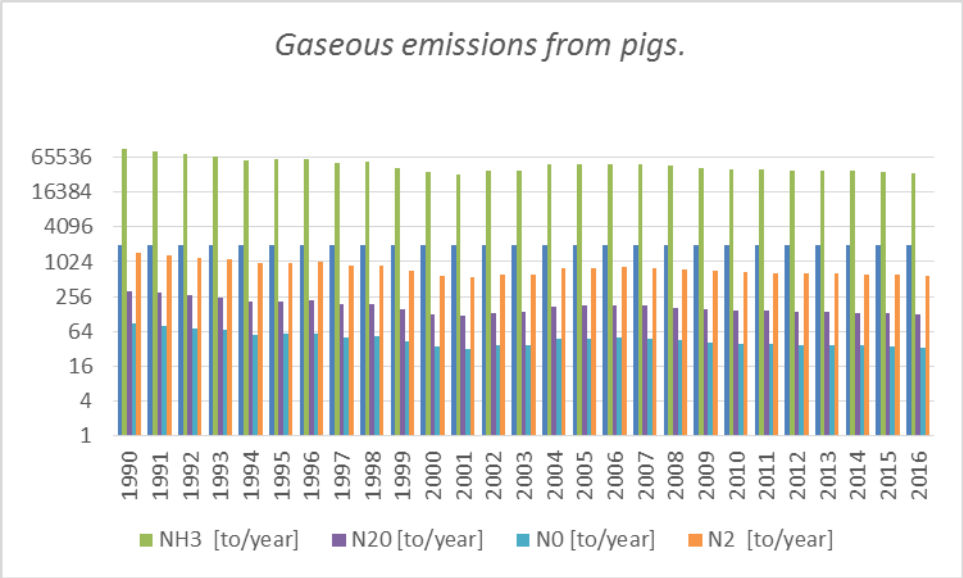

Fig2 . Gaseous emissions from pigs.

In Table 4 on the emissions of gas from cattle breeding the quantities of NH_3, N_20, N0, N_2 fluctuate according to the number of registered cattle. Quantities of gases with nitrogen compounds gradually decrease from 1990 to 2016 by 116242570.1 NH3, 1039863.455 N20, 141799.562 NO, 2426100 N2. This result is environmentally friendly, but it is a disadvantage from the point of view of agriculture.

Table 4.

Gaseous emissions from cattle

Nr. Crt	Years	Cattle	NH_3 [to/year]	N_20 [to/year]	N0 [to/year]	NO_3 [to/year]
1	1990	5380780	187770,374	1679,724	229,053	3918,957
2	1991	4355300	151984,714	1359,599	185,399	3172,074
3	1992	3683100	128527,288	1149,758	156,785	2682,494
4	1993	3596782	125515,090	1122,812	153,110	2619,626
5	1994	3480803	121467,832	1086,606	148,173	2535,156
6	1995	3496255	122007,052	1091,430	148,831	2546,410
7	1996	3434869	119864,896	1072,267	146,218	2501,701
8	1997	3235390	112903,777	1009,995	137,726	2356,415
9	1998	3142668	109668,104	981,050	133,779	2288,884
10	1999	3051149	106474,412	952,481	129,883	2222,228
11	2000	2870415	100167,428	896,061	122,190	2090,595
12	2001	2799817	97703,806	874,022	119,184	2039,177
13	2002	2877803	100425,244	898,367	122,504	2095,976
14	2003	2897082	101098,013	904,385	123,325	2110,017
15	2004	2808061	97991,492	876,596	119,535	2045,181
16	2005	2861671	99862,293	893,331	121,817	2084,227
17	2006	2933596	102372,224	915,784	124,879	2136,611
18	2007	2818983	98372,632	880,005	120,000	2053,136
19	2008	2683611	93648,623	837,746	114,238	1954,541
20	2009	2512296	87670,330	784,266	106,945	1829,768
21	2010	2001105	69831,554	624,687	85,184	1457,455
22	2011	1988939	69407,004	620,889	84,666	1448,594
23	2012	2009135	70111,773	627,194	85,526	1463,303
24	2013	2022408	70574,955	631,337	86,091	1472,970

25	2014	2068888	72196,944	645,847	88,070	1506,823
26	2015	2092414	73017,919	653,191	89,071	1523,957
27	2016	2049713	71527,803	639,861	87,253	1492,857
28	Total	79153033	2762163,592	24709,303	3369,450	57649,133

Figure 3 shows the emissions of NH_3, N_20, N0, N_2 emissions from bovine breeding activity during the period 1990-2016.

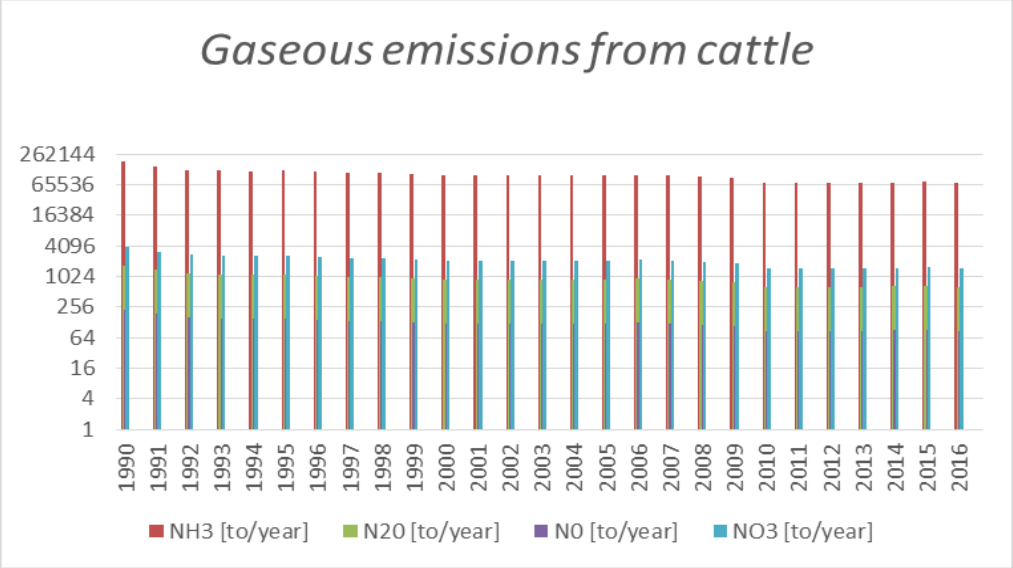

Fig. 3 Gaseous emissions from cattle

CONCLUSIONS

In this study we followed the evolution of gas emissions (NH_3, N_20, N0, N_2) from the activity of cattle and swine farming in the period 1990-2016, using a series of equations and emission factors from the EMEP / SEE guide.

According to the obtained results, more than 79.150.000 cattle and more than 179.950.000 swine were recorded at national level in the studied period. Cattle and swine farms have emitted approximately4092988,564 to NH_3, 29555,860 to N_20, 4674,647 to N0, 79622, 904 to NO_3.. Cattle farming contributes 6.26% more to environmental pollution than pig farming.

Even if gas emissions have decreased significantly over the last period, due to the persistence of these gases in the atmosphere and their environmental effects, the following are recommended for the reduction of gas emissions: implementing animal nutrition management; housing animals in naturally ventilated; covering the areas where manure is stored; compliance

with the annual land application times of manure; production of biogas and its energy recovery in cogeneration.

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