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Review

Air Emissions from Agriculture in Austria and Romania

ANDERL M.*

Umweltbundesamt,Spittelauer Lände 5, 1090 Viena, Austria

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Abstract

A comparative picture of the trends in GHG emissions during 1990 – 2007 in Austria and Romania, within EU – 27 tendencies context, with accent on agriculture sources is presented. The green house gases (GHG) emissions from agriculture in EU – 27 during 1990 and 2007 are mainly represented by methane (CH_4) nitrous oxide (N_2O) and ammonia (NH_3). In Austria, all sectors have a decreasing tendency during the analyzed interval. In Romania, during analyzed interval, the GHG emissions from Romanian sector agriculture had the same decreasing tendency. The main driving force in methane and nitrous oxide decrease, in both studied situations (Austrian and Romanian agricultural sectors, respectively), is the declining number of animals. Concerning the ammonia emissions, the decrease was the result of improvement in different sectors: housing, storage, spreading, and animal diets.

Keywords: greenhouse gases, industry, methane, nitrous oxide, ammonia

1.Backgrounds

The air emissions from agriculture in Austria are monitored by the National Reporting System of Austria. Umweltbundesamt is the national entity with overall responsibility for emission reporting. In Romania, the authority responsible for the monitoring of the air emissions is the National Agency of Environmental Protection (ANPM). The National Inventory System Austria (NISA) is based on several connections with different areas, including both Austrian air emissions inventory and quality management system. It is based on a team of in-house sectorial experts with links to external data and expertise and supported by ISO 17020 certification ensuring independency of judgment [4].

* Corresponding author.
Tel.: 0043 313045955; Fax: 0043 313045959
e-mail: michael.anderl@umweltbundesamt.at

The overview of the green house gases (GHG) emissions from agriculture in Austria during 1990 and 2007, mainly represented by methane (CH_4) and nitrous oxide (N_2O) reveals a decrease from 9.2 Mt CO_2-eq in 1990 to 7.9 Mt CO_2-eq in 2007, meaning 14.13% decreasing tendency (fig. 2). Their share is about 9% of Austria's total GHG emissions.

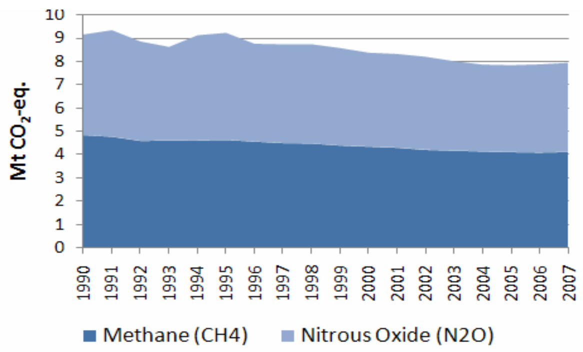

Figure 1. GHG emissions from Austrian agriculture

The sub sectors of the agriculture in Austria are divided in: enteric fermentation, which occupies 41% of the segment; manure management, 22%; agricultural soils, 37% and no fields where agricultural residues are burn (fig. 2). All sectors, meaning enteric fermentation, manure management, and agricultural soils have a decreasing tendency during the analyzed interval (fig. 3).

In Romania, during analyzed interval, 1990 – 2007 [6], the GHG - emissions represents 9.3% of total EU emissions. The agricultural sector share is 9.2% total GHE and in EU - 27 0.4%. During 1990 – 2007 the GHG Emissions from Romanian Sector Agriculture (EU-27) decreased by 20% (fig. 4, 5, 6).

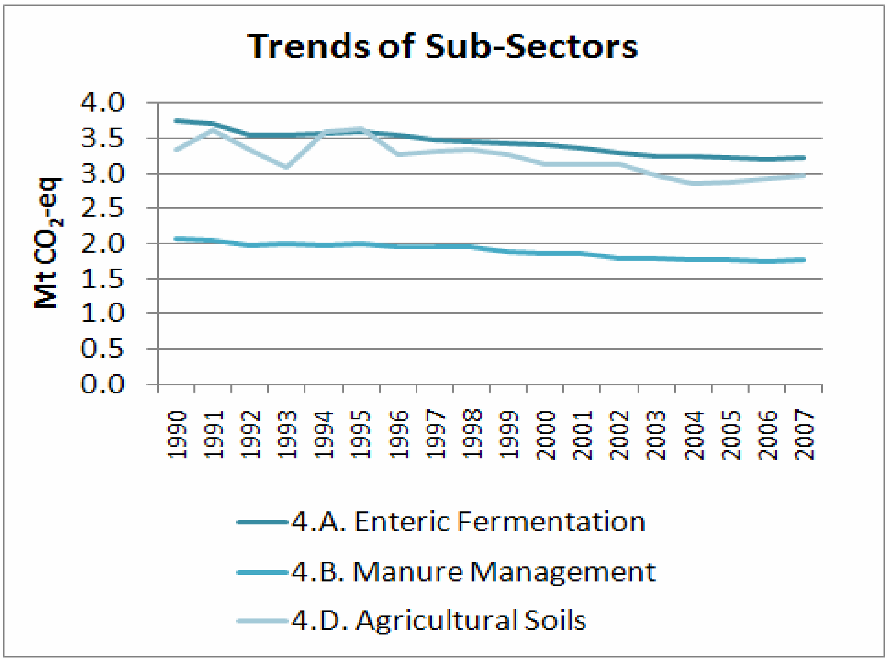

Figure 2. The share of sub sectors

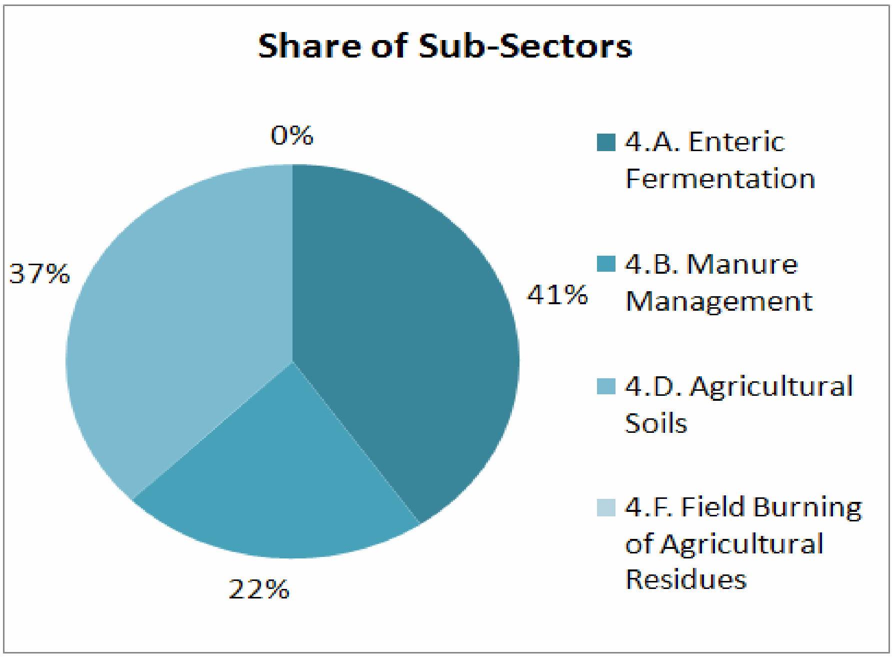

Figure 3. The trends of sub sectors

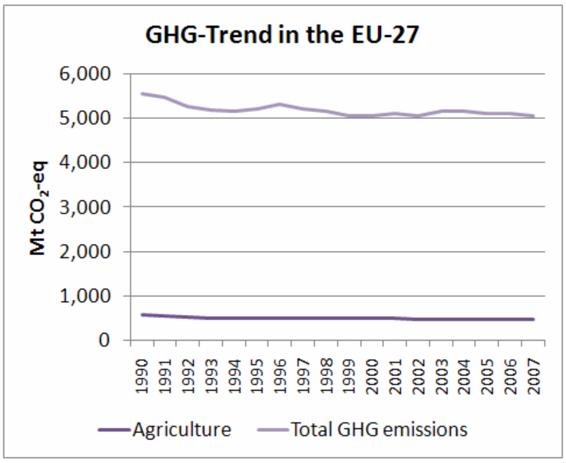

Figure 4. The GHG trend in the EU - 27

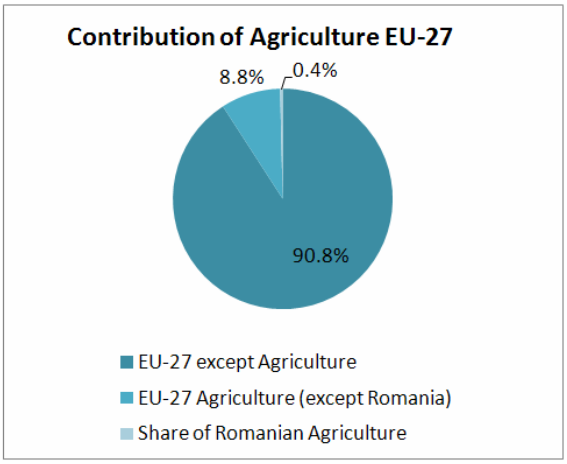

Figure 5. The contribution of agriculture in EU

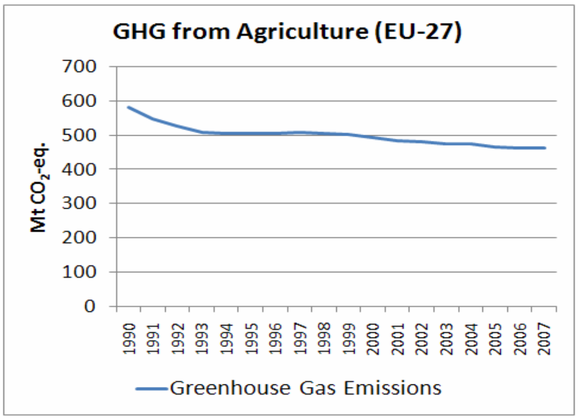

Figure 6. The GHG emissions in Romania

The Romanian contribution (fig. 7) of total, composed of N_2O and CH_4 expressed in CO_2 eq, is 56% and 44%, respectively. According to EEA 2009, it has the following structure (fig. 8): for N_2O - 6% solid storage and dry lot, 6% animal production, 26% direct soil emissions, 17% indirect soil emissions, and for CH_4 – sheep 3%, cattle 31%, swine 6%, other 5% [6].

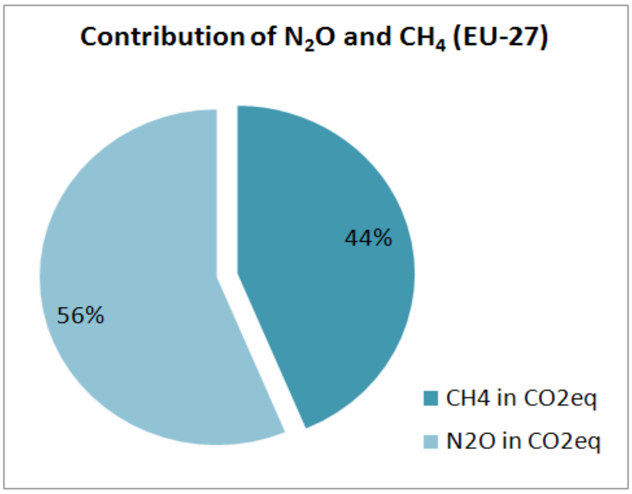

Figure 7. The Romanian contribution in N_2O and CH_4

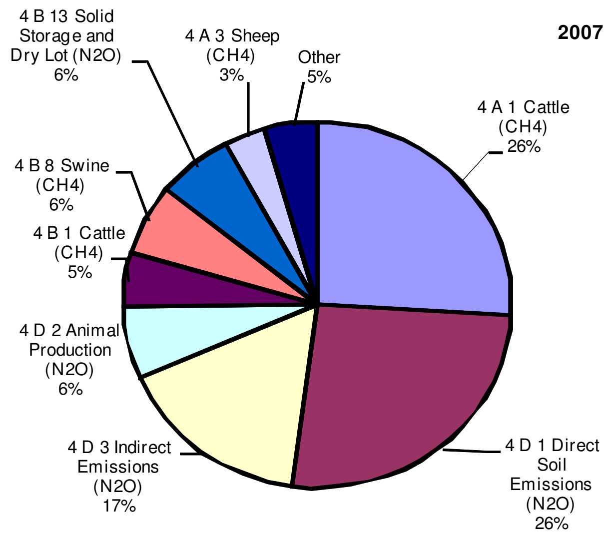

Figure 8. The structure of Romanian contribution to the total emissions expressed in CO_2 eq

The general conditions and policies affecting GHG emissions in the EU are the following [5]:

- Beginning with 2003, the reform of Common Agricultural Policy (CAP) introduced the production-based subsidies, and direct support to farmers;
- Milk quota system settled the fixed milk production;
- Agro-environment programmes (extensification measures, organic farming);

- Nitrates Directive (with essential role in preventing water pollution);
- Integrated Pollution Prevention and Control (IPPC) Directive (control techniques according BAT);
- National Emission Ceilings (NEC) Directive;
- The description of the economies in transition, the break down of the economic system of the new member states in the early 1990ies.

2.The Enteric Fermentation Source for Air Emissions

The microbial conversion of cellulose in the digestive tracts of ruminants (fig. 9) releases methane (CH_4).

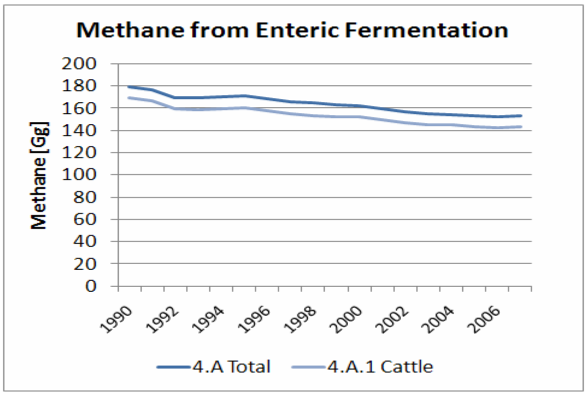

Fig. 9. The methane emissions from enteric fermentation

IPCC Tier 2 method based on the feed intake (GE) was put into practice in order to obtain the needed data, and following results were obtained [2, 5]:

$$EF = \frac{GE * Y_m * 365}{55.65}$$

where Ym = methane conversion rate

The feed intake is estimated on the basis of feed energy requirements of the representative animals.

- Cs data on average weight, weight gain, feed digestibility.
- Choose feeding situation: stall/pasture/grazing etc.
- One important input parameter is the yearly milk yield: high-yield cows need high-energy feed.

The Austrian Inventory reveals decreasing tendency of methane releasing in cattle (tables 1, 2). The main driving force is the declining number of animals.

Almost all emissions in livestock (93%) are caused by cattle farming [5], the feed-intake data based on national studies reveals a decrease by 16% from 1990-2007, with the main driver represented by decreasing cattle numbers (dairy: -42%, and non-dairy: -12%).

Table 1. The picture of the CH_4 emissions in CO_2 eq from Enteric Fermentation resulted from cattle rearing agricultural sector, in the EU-27

Member State	**CH_4 emissions (Mio t CO_2 equivalents)**		**Share 2007**	**Change 1990-2007**
	1990	2007	(%)	(%)
EU-27	**150.3**	**119.9**	**100.0%**	**- 20%**
France	27.9	25.7	21.5%	- 8%
Germany	20.4	15.6	13.0%	-23%
United Kingdom	13.5	11.7	9.8%	-13%
Italy	10.0	8.7	7.2%	-14%
Poland	13.9	8.5	7.1%	-39%
Spain	6.5	8.3	6.9%	28%
Ireland	8.4	8.1	6.8%	- 4%
Netherlands	6.8	5.6	4.7%	-17%
Romania	8.0	4.5	3.7%	- 44%
Belgium	3.9	3.3	2.8%	- 14%
Austria	3.6	3.0	2.5%	-16%
Sweden	2.7	2.4	2.0%	-12%

Table 2. The picture of the CH_4 emissions in CO_2 eq from Enteric Fermentation resulted from sheep rearing agricultural sector, in the EU-27

Member State	CH_4 emissions (Mio t CO_2 equivalents)		Share 2007	Change 1990-2007
	1990	2007	(%)	(%)
EU-27	**20.7**	**15.9**	**100.0%**	**-23%**
Spain	4.3	4.0	25.5%	-5%
United Kindom	4.4	3.4	21.1%	-23%
France	2.3	1.8	11.4%	-21%
Greece	1.4	1.4	8.7%	2%
Italy	1.5	1.4	8.7%	-6%
Romania	1.6	0.9	5.6%	-45%
Ireland	1.0	0.7	4.4%	-33%
Portugal	0.6	0.7	4.3%	22%
Germany	0.6	0.4	2.7%	-23%
Bulgaria	1.3	0.3	1.7%	-80%
Netherlands	0.3	0.2	1.5%	-20%
Hungary	0.3	0.2	1.4%	-34%

The milk production aims the increase of animal performance (milk yield per cow) by reduction of dairy cow numbers in the dairy sector due to the fixed milk quota in the EU and lower emissions per kg milk.

Feeding is improved by optimization of energy and protein supply, using less roughage, more concentrate, which lead to lower CH_4 emissions from enteric fermentation.

The possible conflicts may appear from:

- Minimum amount of roughage required (health & animal welfare)
- Carbon food print of concentrated feed
- Ecological side effects e.g. the maintenance of the cultural landscape.

The manure management source category is described by a series of particularities. CH_4 and N_2O emissions are released in the stalls and the storage facilities [1]. Emissions depend on animal excretions, type and duration of manure storage, etc. The National Volatile Solid (VS) rates and nitrogen excretion data can be estimated from feed intake or obtained from country specific studies. The IPCC Tier 2 method requires detailed information on animal characteristics and the manner in which manure is managed [5].

The key sources and trends of the Manure Management according to Austrian Inventory are the following:

- Cattle, CH_4 - Share 0.5%, trend -22.9%; N_2O - Share 0.9%, trend -13.2%
- Swine, CH_4 - Share 0.5%, trend: -9.0%.

Emission trends are the result of structural changes, rationalisations and an improved efficiency of the agricultural production. The main driving force of descendant evolution is the decrease in livestock (fig. 10).

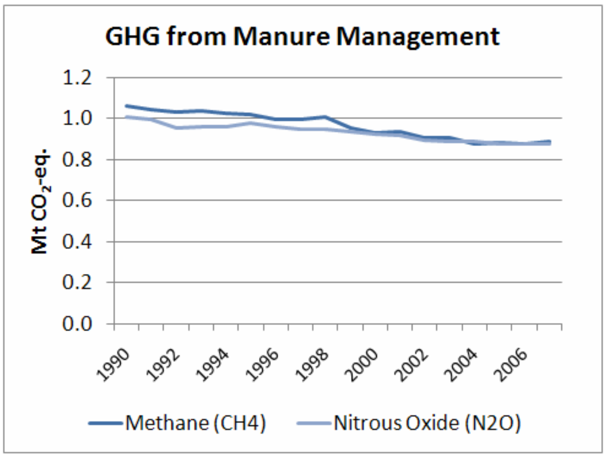

Fig. 10. The GHG emissions from manure management

The animal waste management system takes into consideration both low and high CH_4 emission sources, as treatment options for slurry and N_2O emissions [2,5].

The low CH_4 emission factors are: grazing, solid systems, composting and anaerobic digesters (biogas production). The high CH_4 emissions are produced by: liquid systems (slurry), anaerobic lagoons, deep litter (bedding) collected for more than one month. The treatment options for slurry include the anaerobic digestion of slurry and mechanical separation of solids (slurry separation) together with composting of solids.

The Austrian Inventory methodology takes into consideration the computing of nitrogen oxide according to the formula [2]:

$$N_2O = \Sigma\ [Animal(T) * Nex(T) * AWMS(T)] * EF\ (AWMS)$$

The nitrogen excretion country specific values calculated by Austrian experts on the basis of feed intake data:

- dairy: depending on milk yield [2]
- non-dairy, swine and other animals: N ex values elaborated by the Fachbeirat für Bodenfruchtbarkeit, BMLFUW [5].

Concerning the N_2O from solid manure Storage and grazing in the EU-27, the emission trends are the result of structural changes, rationalizations and an improved efficiency of the agricultural production [1].The main driving force in the EU-27 is the declining number of animals (tables 3 and 4).

Table 3. N_2O from Pasture. Range and Paddock Manure

Member State	CH_4 emissions (Mio t CO_2 equivalents)		Share 2007	Change 1990-2007
	1990	2007	(%)	(%)
EU-27	36 918	29 099	100.0%	-21%
France	8 593	7 440	25.6%	-13%
United Kindom	4 980	4 270	14.7%	-14%
Greece	3 383	3 379	11.6%	0%
Ireland	2 802	2 680	9.2%	-4%
Romania	2 871	1 660	5.7%	-42%
Spain	1 366	1 620	5.6%	19%
Italy	1 736	1 570	5.4%	-10%
Germany	1 821	1 475	5.1%	-19%
Portugal	662	755	2.6%	14%
Belgium	936	735	2.5%	-21%
Netherlands	1 449	603	2.1%	-58%
Bulgaria	1 539	492	1.7%	-68%

Table 4. N_2O emissions from Swine

Member State	CH_4 emissions (Mio t CO_2 equivalents)		Share 2007	Change 1990-2007
	1990	2007	(%)	(%)
EU-27	28 071	28964	100.0%	0%
Spain	5 329	8 521	29.4%	60%
France	4 206	5 044	17.4%	20%
Germany	2 727	2 593	9.0%	-5%
Poland	2 208	2 489	8.6%	13%
Italy	1 432	1 395	4.8%	-3%
Belgium	1 350	1 252	4.3%	-7%
Netherlands	1 140	1 082	3.7%	-5%
Portugal	1 087	1 047	3.6%	-4%
Romania	1 716	965	3.3%	-44%
Hungary	1 997	921	3.2%	-54%
Denmark	448	749	2.6%	67%
United Kingdom	1 119	717	2.5%	-36%

The low N_2O emission factors are: liquid systems (slurry), anaerobic digesters (biogas production), anaerobic lagoons. The high N_2O emissions are produced by solid storage system, and grazing. Grazing produces high N_2O emission factors, but no emissions from storage and spreading [3].

3.Emissions from agricultural soils

The anthropogenic N input into agricultural systems increases processes of nitrification and denitrification. The direct soil emissions are represented by nitrous oxide produced and emitted directly in agricultural soils.

The following sources can be distinguished:

- Synthetic and organic fertilisers
- Biological nitrogen fixation
- Crop residue decomposition
- Sewage sludge application
- Cultivation of organic content soils (histosoils)

The indirect soil emissions are represented by nitrous oxide.

4.Athmospheric deposition of NO_x and NH_3

These pollutants are emitted from agricultural system and transported off - site. The fertilization enhances production of N_2O. Nitrogen enters ground and surface waters, rivers, wetlands, riparian areas and coastal ocean, and enhanced biogenic production of N_2O (nitrification, denitrification) was observed during treated interval.

The decrease in N_2O emissions from agricultural soils is mainly due to a decrease in the use of mineral and organic (manure) fertilizers (tables 5 and 6).

The reduction of N-losses is the most straightforward strategy for prevention of pollution. The avoidance of N surplus can be achieved by efficiency improvements of nitrogen uptake by crops leads to lower fertilizer consumption on agricultural land [5].

The nitrogen input must meet crop demand, and appropriate technique must be adopted:

- Optimized timing of fertilizer application
- Low trajectory application techniques
- Slow release mineral fertilizers
- Reduction of mineral fertilizer input (organic farming).

Table 5. N $_2$O emission from direct soil emission

Member State	CH_4 emissions (Mio t CO_2 equivalents)		Share 2007	Change 1990-2007
	1990	2007	(%)	(%)
EU-27	155 584	120 739	100.0%	-22%
France	26 776	22 174	18.4%	-17%
Germany	22 757	19 950	16.5%	-12%
Poland	14 373	11 015	9.1%	-23%
UnitedKindom	14 469	10 855	9.0%	-25%
Spain	10 106	9 975	8.3%	-1%
Italy	9 581	8 694	7.2%	-9%
Netherlands	4 674	4 868	4.0%	4%
Romania	9 971	4 629	3.8%	-54%
Hungary	4 626	3 251	2.7%	-30%
Denmark	4 231	2 956	2.4%	-30%
Sweden	3 174	2 919	2.4%	-8%
Czech Republic	4 573	2 550	2.1%	-44%

Table 6. N $_2$O emission from indirect emission

Member State	CH4 emissions (Mio t CO2 equivalents)		Share 2007	Change 1990-2007
	1990	2007	(%)	(%)
EU-27	100 373	75 946	100.0%	-24%
France	20 582	17 748	23.4%	-14%
United Kindom	10 797	7 982	10.5%	-26%
Spain	7 515	7 911	10.4%	5%
Italy	8 118	7 527	9.9%	-7%
Germany	6 693	5 676	7.5%	-15%
Poland	5 988	4 559	6.0%	-24%
Romania	7 091	3 561	4.7%	-50%
Netherlands	4 975	3 124	4.1%	-37%
Greece	3 591	2 613	3.4%	-27%
Denmark	3 743	2 401	3.2%	-36%
Hungary	3 344	2 249	3.0%	-33%
Czech Republic	3 620	1 803	2.4%	-50%

5.Ammonia Emissions

The ammonia emissions [5] are produced from different sources (fig. 11): housing (area polluted with urine and faeces, e.g. tied vs. loose housing systems), storage (farmyard manure, tanks, lagoons), fertilizer application (manure spreading, mineral fertilizer application).

The contribution of agriculture represents more than 90% [5] of total ammonia EU-27 emissions (fig. 12). The decrease in NH_3 emissions is mainly due to a decrease in livestock (table 7) and the use of fertilizers (table 8).

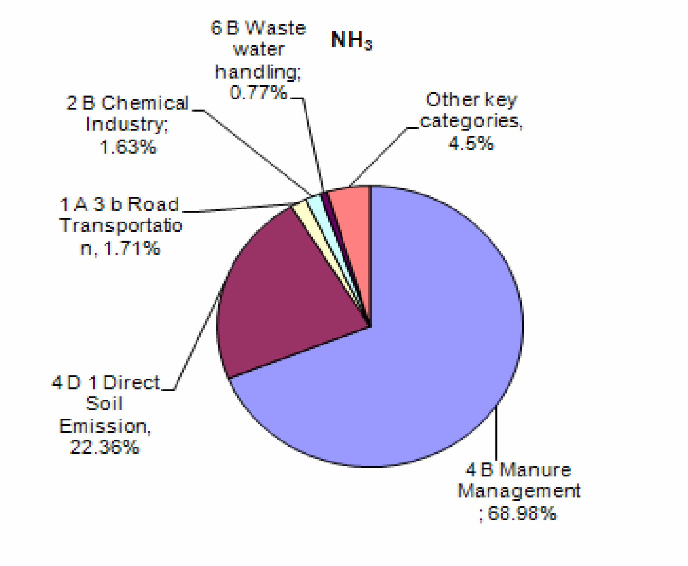

Fig. 11. The ammonia emissions 2006 EU-27 function of sources

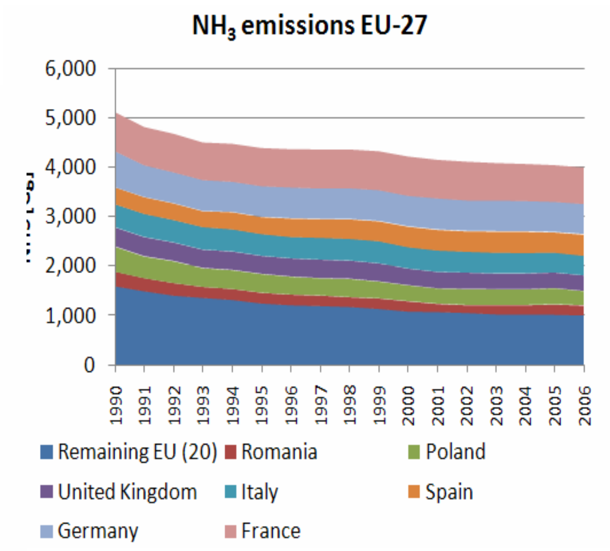

Fig. 12. The ammonia emissions 2008 EU-27

Table 7.NH_3 emissions 4.B Manure Management

Issue	NH_3 (Gg) 2006	Share 2006 (%)	(%)
EU-27	2756.9	100%	NE
France	569.1	21%	-7%
Germany	494.4	18%	-20%
United Kindom	251.1	9%	-15%
Italy	219.4	8%	-18%
Poland	206.4	7%	
Romania	156.5	6%	
Spain	133.1	5%	37%
Netherlands	109.4	4%	-51%
Ireland	100.4	4%	-2%
Hungary	66.7	2%	
Czech Republic	60.0	2%	
Denmark	58.8	2%	-33%

Table 8. NH_3 emissions from direct soil emission

Issue	NH_3 (Gg) 2006	Share 2006 (%)	Change 1990-2006 (%)
EU-27	894.8	100%	NE
Spain	257.0	29%	16%
Italy	165.4	18%	-12%
France	148.5	17%	-5%
Germany	95.7	11%	6%
Poland	73.3	8%	
United Kindom	34.8	4%	-40%
Portugal	24.6	3%	-8%
Denmark	22.4	3%	-43%
Hungary	12.3	1%	
Belgium	9.2	1%	
Romania	9.1	1%	
Austria	7.8	1%	-3%

The decrease of the ammonia emissions from agriculture was the result of improvement in different sectors [5]: housing (reduced area polluted with urine and faeces, but with potential conflicts in animal welfare, species-appropriate husbandry), storage (covered tank with straw cover, plastic foil cover, natural crust), spreading (low trajectory application techniques - band spreading, sleih foot application, slurry injection) and animal diets (N - input, according to the animal‘s requirements).

6.Conclusions

- The air emissions from agriculture in EU – 27 are monitored by the national reporting systems, in Austria – Umweltbundesamt, and in Romania - National Agency of Environmental Protection, respectively.
- During 1990 – 2007, the green house gases emissions are mainly being represented by methane and nitrous oxide. In Austria they recorded a decrease from 9.2 Mt CO_2-eq in 1990 to 7.9 Mt CO_2-eq in 2007, meaning 14.13% decreasing tendency. Their share is about 9% of Austria‘s total GHG emissions.
- During the same analyzed interval, the Romanian contribution of total GHE from agriculture, is mainly composed of N_2O and CH_4 and expressed in CO_2 eq, is 56% and 44%, respectively. The GHG - emissions represents 9.3% of total EU emissions. The agricultural sector share is 9.2% total GHE and in EU - 27 0.4%. During 1990 – 2007 the GHG Emissions from Romanian Sector Agriculture (EU-27) decreased by 20%
- The methane and nitrous oxide decrease, in EU - 27 during analyzed interval in Austria and Romanian agricultural sectors, particularly, is the declining number of animals.
- Contrarily, the ammonia emissions, decreased due to the improvement in different sectors: housing, storage, spreading, and animal diets.

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