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ROMANIA'S AGRICULTURE POLLUTER EFFECTS *vs.* POTENTIAL CONTRIBUTION TO A CLIMATE CHANGE RESILIENT ECONOMY

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Abstract

The paper aims to assess the pollution level of Romania's agriculture, with emphasis on emissions of carbon gases, by analyzing the structure, trends and estimates of indicators projected in medium and long terms, according to the actual policies and targets for moving to a competitive low carbon economy in 2050. Romanian agriculture has not proved to be very intensive in terms of greenhouse gases pollution compared to the energy sector, however, being the second pollutant sector of economy, is one factor that contributes significantly to overall emissions mainly due to emissions of the livestock sector and of synthetic fertilizers use. Analysis shows potentials in 'greening' the economy in Romania, given the trends of massive reduces of emissions of greenhouse gases over the last two decades. It also underlines the crucial importance to reduce the statistics on polluting effects of agriculture provided by the potential expressed and growing of the Romanian forestry sector.

Key words**:** *agriculture, carbon gases emissions, climate change, resilient economy.*

INTRODUCTION

Scientific research confirms that global warming is the result of direct or indirect human activities (combustion of fossil fuels, land use change etc.) that produce excess greenhouse gases i.e. carbon dioxide (CO_2), methane (CH_4) nitrous oxide (N_2O), hydro-fluoro-carbons (HFCs), perfluorocarbons (PFC), sulfur hexafluoride (SF_6), that cause changes in the composition of the global atmosphere and natural variability of clime [1]. Their production will involve a substantial impact, although unequally, on natural resources, respectively, on soil, water, air and biodiversity, also creating a biological pressure on food security.

Climate change is a major challenge for agriculture and rural development in Romania, given that agriculture is both an emitter of greenhouse gases and therefore should contribute to the goals of climate change mitigation Europe 2020, and that is extremely vulnerable to climate change because the capacity of the rural area to provide an adequate supply of food to provide services to ecosystems, to support growth and to provide a safe living for rural communities directly depends on weather conditions.

At international level there is a large political and institutional mobilization to prevent possible risks that options for increasing productivity, as an immediate response to the signaled process that they will propagate on the natural environment, in terms of global warming. The Report on the environment, prepared annually by the European Environment Agency [3], signals the need to increase resource efficiency and preservation of natural capital elements key strategic continued through the Framework Agreement of the EU in 2014, outlining targets in the medium term in 2030 included three pillars: reduce greenhouse gas emissions by at least 40%, compared to 1990, increase by at least 27% of both energy savings and, respectively, the share of energy produced from renewable sources. The agricultural sector is one of the factors responsible to meet global demand that will be exerted by demographic pressures that FAO projected increase of 70% by 2050, by providing food, fiber and energy quantitatively and qualitatively adequate. Recent FAO estimates also point out that emissions of greenhouse gases s from agriculture, forestry and fishing sectors has doubled in the last 50 years and, without

measures taken by authorities, could increase further to 30% by the year 2050 [4].

Pursuing the achievement of the goals, a long-term 'Roadmap' established targets percent reduction in emissions of greenhouse gases by 2050 compared to 1990 levels, the growth of renewable energy and energy efficiency based on the use of new resources, boosting resource productivity and decoupling economic growth from natural resource use and environmental impact, while ensuring ecological system resilience [6]. Achieving long-term strategic vision depends on meeting short and medium-term targets. Both objectives, to adapt to climate change and to reduce greenhouse gases, are important challenges for Romania, but also an opportunity, supported in part by the new rule of EU funds to encourage researches and investments compatible with the objectives of climate change policies.

In this context, the paper aims to assess the level of pollution in Romania's agriculture, with emphasis on emissions of greenhouse gases by analyzing the structure indicators and trends and estimates projected in medium and long terms, according to the relevant policies and targets.

MATERIALS AND METHODS

The study approaches an investigation into the pollution resulted from the main activities Romania's agriculture, focusing on the assessment of carbon emissions eq., based on the analysis of structural indicators and trends of the national statistics [5]. As well, based on FAO data there are presented the expected medium to long-term projections in line with the policies and the relevant objectives.

RESULTS AND DISCUSSIONS

Agricultural sector is the second largest provider of greenhouse gases polluting in Romania, after the energy sector (Fig. 1).

At EU level, Romania recorded the largest overall decline in greenhouse gas emissions from agriculture, with 53% between 1989 and 2011 [8]. While greenhouse gas emissions from agriculture in the EU-28 have fallen by about 23.1% from 1990 to 2012, the agricultural sector has cut emissions faster than carbon gases eq. emissions at macroeconomic level. The reduction of agricultural emissions at EU-28 is mainly due to the decrease in the number of animals, the improvements in good agricultural practice, the decreasing use of nitrogen fertilizers and the better management of natural fertilizers.

Romania has the fifth lowest share of greenhouse gas emissions compared to EU-28 agricultural output as a whole and by its main components - methane (CH4), nitrous oxide (N2O) and dioxide carbon (CO2) [2]. This is mainly due to the high percentage of subsistence agriculture as a result of the restitution of agricultural land and the ownership of the land after the fall of the communist regime. Because of financial constraints, these farmers who practice subsistence farming face difficulties in the mechanization effort.

At the same time, however, due to the low share of livestock production, restricted rice growing areas (both with potential sources of CH4) and the relatively low use of nitrogen-based inorganic fertilizers, the chances of increasing productivity in agriculture are limited.

According to data provided by the NIS, the total quantities of CO_2 equivalent emissions estimated from agriculture in 2005 accounted for 20.95 thou. Gg and decreased to 18.94 thou. Gg in 2011.

In comparison, removals of greenhouse gases emissions from land use and consumption sectors forests (LULUCF) (amounts of CO_2, CH_4 and N_2O) were estimated at -25.3 thou $GgCO_2$ eq. in 2011, up from -17.9% averaged over the period 2000-2006 to -20.2% on average in 2007-2011.

In the period 2000-2006, emissions from agriculture represented 14% of total net greenhouse gases emissions (the amounts of CO_2, CH_4 and N_2O in Gg CO_2 equivalent), including LULUCF, following a slight increase from 2007 -2011, the share of 15%.

Animal production sector was the main source of CH4 emissions from agriculture, both from enteric fermentation of livestock and from manure management.

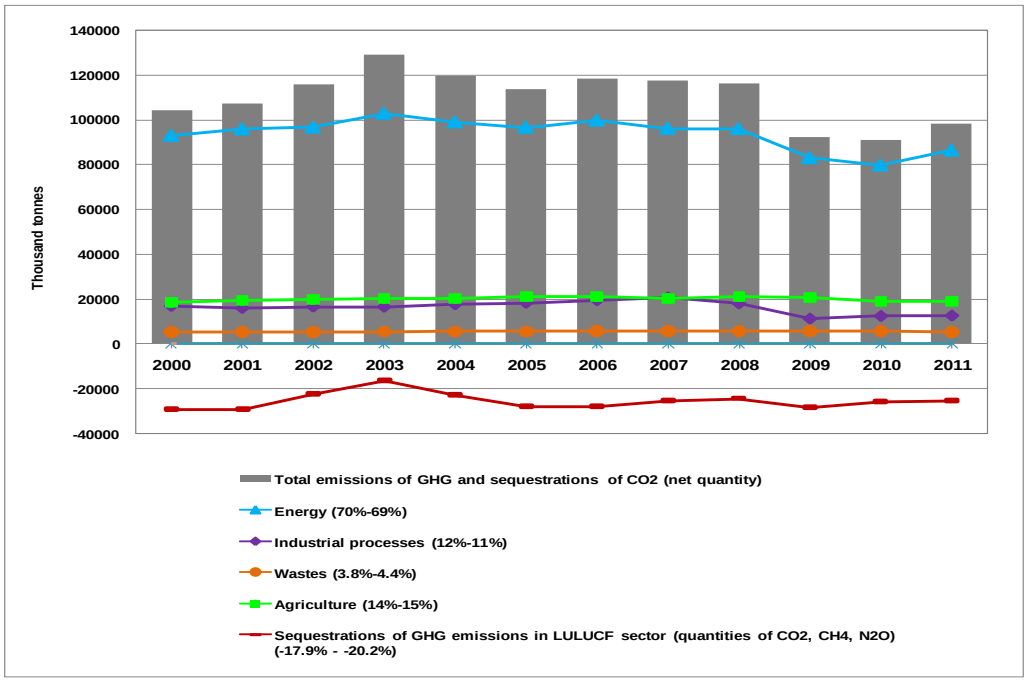

Fig.1. Greenhouse gas emissions in Romania, with effect on economy sectors, 2000-2011
Source: [5] (www.insse.ro).

The N_2O emissions from manure management (production and storage) and through agricultural land use, mainly arise due to des-nitrification that occurs after application of inorganic fertilizer or manure.

Some of N_2O and CH_4 emissions derive from field burning of agricultural residues, being also a source of NOx (oxides of nitrogen) and CO emissions.

As well, agriculture is an important source of reduction in carbon emissions through its biological capacity to sequester CO_2 and due to the availability of unproductive agricultural land that can be forested.

Nevertheless, forests have the most important role in isolating and absorption carbon emissions. This is represented in Romania by large estimated sequestration quantities of CO_2 equivalent that systematically contribute substantially to reducing the carbon balance in agriculture and other sectors.

In the structure of CO_2 equivalent in agriculture, the emissions of CH_4 from enteric fermentation of animals occupy the major share in total emissions of Romanian agriculture, which in 2012 shared 59%, followed by emissions from N_2O, accounting for 29% (Table 1).

Table 1 Carbon eq. gases emissions from agricultural activities: structure, trends and projections

Activity / Element (Gg)	**1990**	**2005**	**2007**	**2012**	**2030**	**2050**
Enteric fermentation (CO_2eq) of CH_4	12,670	6,636	6,902	5,394	6,545	6,121
Manure management CO_2eq)	4,522	3,087	3,116	2,568	3,155	3,011
Rice (CO_2eq) of CH_4	235	20	48	66	34	33
Synthetic fertilizers (CO_2eq) of N_2O	4,940	1,931	1,714	1,872	1,427	1,436
Crop residues (CO_2eq) of N_2O	1,235	1,303	630	916	1,153	1,163
Organic soils cultivation (CO2eq) of N_2O	123	123	123	123	123	123
Energy use (CO_2eq)	3,793	683	842	1,512	1,512	1,512
Total CO_2 eq. emissions of agric. (Gg)	27,635	13,834	13,434	12,568	14,066	13,517

Source: FAOSTAT, 2015 [7]

Substantial CO_2 emissions of N_2O equivalent were as well estimated after the use of synthetic fertilizers, with a 17.9 share, in 1990, but with a declining trend, down to 14.9%, in 2012, followed by emissions from manure management, which had, however, an

increasing trend, respectively, from 16.4% to 20.4%.

Emissions from agricultural crop residues, although with a smaller share, recorded a volume increase of 4.5% in 1990 to an average of 8% in 2005-2012.

Compared to the CO_2 equivalent in 1990, it was observed a decrease by 57.4 % of the emissions from enteric fermentation, by 62 % of emissions from synthetic fertilizer and 80 % of the energy used in agricultural emissions of methane. It stresses that, in total greenhouse gases emission trends in agriculture has been a positive trend indicated by the decrease of 54.5% in 2012, compared to 1990 emissions, favored by:

- decline trend of livestock;
- reducing rice acreage (a potential source of methane emissions);
- reducing intensive agriculture, in particular by reducing fertilizer applications based inorganic nitrogen.

According to FAOSTAT, total CO_2 eq. emissions projections of agriculture show an increase of 1.7 % compared to 2005, but by 2030 will decrease by 49% compared to 1990, and by another two percent by the target year 2050.

Medium-term projections indicate a possible increase in CH_4 emissions by 5.6 percent compared to 1990, while in long term, down from 1.3 percent in 2030.

Meanwhile, projections for N_2O emissions show a decrease of 2.6 percent compared to 1990 and further to 1 percent by 2050.

Given the significant contribution agriculture's emissions of the emissions from animal enteric fermentation, has been analyzed the situation regarding the evolution of emissions from livestock activities in the period 1990-2012 and the medium effects and long-term effects of the forecasted developments according to FAO data, for the target years 2030 and 2050.

The results consist in gases greenhouse in the livestock sector: structure, trends and projections, corresponding to the data of the Table 2, presents an obvious feature of developments in 1989-2012 period, showing a general downward trend in emissions of methane from animal enteric fermentation of CO_2 equivalent, coupled with the reduction of the animal categories. i.e. cattle, by -68%, sheep & goats, by -40% and pigs, by -54%.

Table 2. Emissions of gases greenhouse in the livestock sector: structure, trends and projections

Category	Element	1989	1990	2005	2006	2007	2012	2030	2050
Bovines	Thousand heads	6,416	6,291	2,808	2,862	2,934	1,989	2,781	2,571
	Gg of CH_4	442	445	228	234	239	163	229	211
	Gg of CO_2eq	9,282	9,345	4,791	4,913	5,011	3,430	4,808	4,439
Sheep and goats	Thousand heads	17,288	16,452	8,086	8,298	8,405	9,770	8,002	7,674
	Gg of CH_4	135	129	63	64	65	74	62	59
	Gg of CO_2eq	2,836	2,700	1,317	1,351	1,366	1,563	1,302	1,249
Swine	Thousand heads	14,351	11,671	6,495	6,622	6,815	5,364	6,710	6,656
	Gg of CH_4	22	18	10	10	10	8	10	10
	Gg of CO_2eq	452	368	205	209	215	169	211	210

Source: FAOSTAT, 2015 [7]

The data in Table 3 shows the evolution of the net quantities of emissions / sequestration from LULUCF (Gg CO_2 eq.) in the period 1990-2012 (selected years). Medium-term projections indicate an increase in 2030 compared with 2012 levels, of the number of cattle, by 12.6 percent, and pigs, by 11.5 percent, leading to increased CO_2 emissions equivalent, respectively, by 14.8 percent, and 11.5 percent.

Accordingly, sheep & goats will decrease by 10.7 percent, coupled with a decrease of emissions by 9.7 percent.

In the long term, by 2050, it is forecasted a decrease in all categories of animals.

Table 3. Sequestration of carbon eq, gases emissions in the LULUCF sector: structure and trends

	1990	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Forest areas	172	-1,378	-12,412	-12,410	-12,409	-12,407	-12,406	-12,404	-12,402
Cultivated area	1,155	1,155	1,155	1,155	1,155	1,155	1,155	1,155	1,155
Biomass burnings	294	31	250	882	406	30	46	867	949
Total utilized agricultural area	1,621	-192	-11,007	-10,374	-10,848	-11,222	-11,205	-10,382	-10,298

Source: FAOSTAT, 2015 [7]

Compared with the target year 2030, the cattle will decrease by 3.3 percent, with 2 percent sheep and goats and pigs by 0.5 percent.
Equivalent CO_2 emissions from enteric fermentation of animals evolve accordingly, so that the cumulative drop of the categories of animals for which projections were made will be 6.4 percent.
There is noted a substantial increase in net removals of emissions / sequestration of greenhouse gases by total agricultural land use in the period 2005-2012, compared to 1990, respectively, from 1,621Gg CO_2 equivalent to -10,298 in 2012.
The major contribution to improving the carbon balance in Romania, showing a particular natural isolation capacity and absorption of emissions that forests have, offsetting emissions from soil cultivation and biomass combustion.
It has been estimated a substantial increase of forest absorption, accounting for -12,402 Gg CO_2 equivalent in the year 2012, compared to 172 Gg CO_2 equivalent in 1990.

CONCLUSIONS

Agriculture, the second pollutant sector of economy, contributes to overall greenhouse gases mainly due to emissions of the livestock sector and of synthetic fertilizers use.
Analysis shows potentials in ‘greening’ the economy in Romania, given the trends of massive reducing of greenhouse gases emissions over the last two decades. It also underlines the crucial importance to reduce the statistics on polluting effects of agriculture provided by the potential expressed and growing of the Romanian forestry sector.
Medium-term projections on FAO data indicate an increase of CO2 emissions, up to the year 2030, of 11.5-14.8 percent due to swine and cattle growth, while decrease of emissions by 9.7 percent coupled with a sheep & goats herds decrease by 10.7 percent.
In the long term, it is forecasted a decrease in all categories of animals, leading to cumulative drop of CO2 eq. emissions from enteric fermentation of animals of 6.4 percent by target year 2050.
A desirable vision for Romania in medium and long terms in its efforts to combat the negative climate effects is to become a low carbon dioxide economy resilient to climate change which has integrated its policies and actions in a smart, 'green' and inclusive economic growth.

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