# GREENHOUSE GAS EMISSIONS FROM ENTERIC FERMENTATION AND MANURE MANAGEMENT IN EU COUNTRIES

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***Abstract***
*Agricultural activities contribute to the emissions of greenhouse gases through a variety of different processes. Enteric fermentation and manure management are discussed in this paper. Emissions per capita reported in the agriculture were 0.948 tonnes of $CO_2$-equivalent of greenhouse gases in 2007 at EU-27 level. This represents 9.2 % of total emissions, decreased from 11 % in 1990. As a comparison, GHG emission of fuel combustion is 7,680 t $CO_2$ eq. per capita out of which 1.933 t CO2 eq. per capita belongs to the transport sector, but the GHG emission of international aviation 0.279 t $CO_2$ eq. per capita and international maritime transport 0.343 t $CO_2$ eq. per capita is calculated separately. Agricultural emissions account for almost 14% of total emissions at global level. Agriculture is the most important source of two powerful gases, nitrous oxide ($N_2O$) and methane ($CH_4$), which account for around 8.15 % and 7.34 % of total European emissions respectively. Between 1990 and 2007 carbon dioxide ($CO_2$) emission was reduced by 4.84 %, nitrous oxide emission by 27.14 and methane emission by 31.15%, while emission of fluorinated gases increased by 31.06%.*

**Key words*:*** Climate change, enteric fermentation, manure management

## INTRODUCTION

The emission of greenhouse gases from the agricultural activities includes $CH_4$ emission from enteric fermentation and manure management and $N_2O$ emission from manure management and agricultural soils. Methane is produced in herbivores as a by-product of enteric fermentation, a digestive process by which carbohydrates are broken down by micro-organisms into simple molecules for absorption into the bloodstream. Both ruminant animals (e.g., cattle, sheep) and some non-ruminant animals (e.g., pigs, horses) produce $CH_4$, although ruminants are the largest source since they are able to digest cellulose, a type of carbohydrate, due to the presence of specific microorganisms in their digestive tracts. The amount of $CH_4$ that is released depends on the type, age, and weight of the animal, the quality and quantity of the feed, and the energy expenditure of the animal. $CH_4$ is also produced from the decomposition of manure under anaerobic conditions. These conditions often occur when large numbers of animals are managed in a confined area (e.g., dairy farms, beef feedlots, and swine and poultry farms), where manure is typically stored in large piles or disposed of in lagoons. During storage of manure, some manure nitrogen is converted to $N_2O$. Emissions of $N_2O$ related to manure handling before the manure is added to soils are included in this source category. Manure-related $N_2O$ emissions from soils are considered agricultural soil emissions.

## MATERIALS AND METHODS

The biosphere is a strong determinant of the chemical composition of the atmosphere. A rich variety of carbon, nitrogen, and sulphur gases are emitted and absorbed by the biosphere. This has been true since the existence of the biosphere, but there is evidence that the expanding human use and alteration of the biosphere for food, fuel and fibre is contributing to increasing atmospheric concentrations of GHG. The dominant gas of concern in this source category is carbon dioxide ($CO_2$), methane ($CH_4$) and nitrous oxide ($N_2O$). Non-methane volatile organic compounds are emitted in significant quantities from biomass burning. The calculations of the emissions are based on methods described in the IPCC Reference Manual (IPCC, 1995) and the Good Practice Guidance (IPCC, 2001a). The emissions of $CH_4$ and $N_2O$ from manure management are given in CRF Table 4.B (a) and 4.B (b).

**METHANE EMISSIONS FROM ENTERIC FERMENTATION IN DOMESTIC LIVESTOCK**

Methane is produced in herbivores as a by-product of enteric fermentation, a digestive process by which carbohydrates are broken down by micro-organisms into simple molecules for absorption into the bloodstream. The amount of released methane depends on the type, age, and weight of the animal, the quality and quantity of the feed, and the energy expenditure of the animal. The type of digestive system also has a significant influence on the rate of methane emission. Ruminant animals have the highest emission of methane as results of methane-producing fermentation within the rumen. The main ruminant animals in EU are cattle, sheep and goats. Pseudo-ruminant animals, like horses and monogastric animals, like swine have relatively lower methane emissions because much less methane-producing fermentation takes place in their digestive systems (IPCC, 1995; 2001b).

Methane ($CH_4$) is produced by the fermentation of feed and generally, the higher the feed intake, the higher is the methane emission. Feed intake is positively related to animal size, growth rate, and production (e.g., milk production, wool growth, or pregnancy). The amount of methane emitted by a population of animals is calculated by multiplying the emission rate per animal by the number of animals. To reflect the variation in emission rates among animal types, the population of animals is divided into subgroups, and an emission rate per animal is estimated for each subgroup. Types of population subgroup are recommended by the IPCC Guidelines for National Greenhouse Gas Inventories.

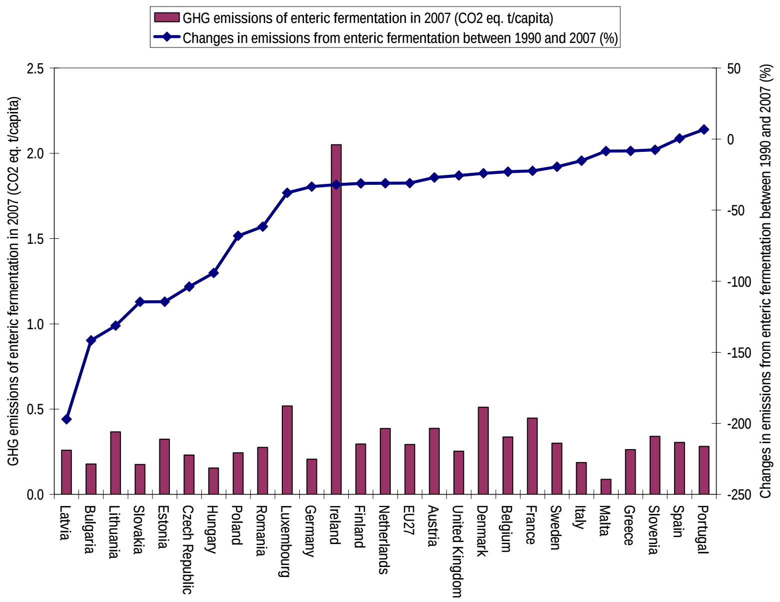


Figure 1: GHG emissions of enteric fermentation in 2007 ($CO_2$ eq. t/capita) and changes in emissions between 1990 and 2007 (%) (Data are from dataservice.eea.europa.eu)

In some countries of EU, the dairy cattle population is comprised of two well-defined segments: high-producing improved varieties in commercial operations; and low-producing cows managed with traditional methods. These two segments are evaluated separately by defining two dairy cattle categories. However, the dairy cattle category does not include cows kept principally to produce calves. Low productivity multi-purpose cows should be considered as non-dairy cattle. Emission data of average milk production of dairy cattle are expressed in terms of kilograms of whole fresh milk produced per year per dairy cow, and can be obtained from country-specific reports. Two or more dairy cattle categories are defined, the average milk production per cow is required for each category. Reduction of methane from enteric fermentation, still require substantial research efforts and practical experience before they could become general practice (CEC, 2009ab). Some of the most relevant measures, such as those linked to the nitrogen cycle are closely related to measures aiming at controlling nitrates and ammonia emissions and thus produce a range of substantive environmental benefits.

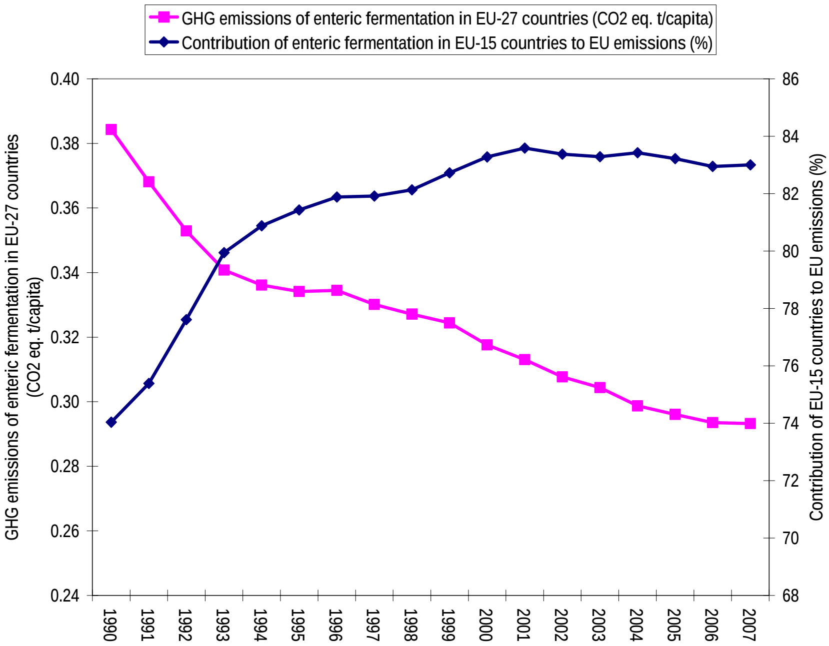


Figure 2: GHG emissions of enteric fermentation in EU-27 countries ($CO_2$ eq. t/capita) and contribution of EU-15 countries to EU emissions (%) (dataservice.eea.europa.eu)

In the period of 1990-2007, methane emissions from enteric fermentation decreased by 31.1% in EU-27 countries, which represent 0.293 tons $CO_2$ eq. per capita. Considering the GHG emissions of enteric fermentation in 2007, Ireland produced 2.050 tons of $CO_2$ eq. per capita (Figure 1). This is nearly six times more than the average of EU-27 countries. Large reductions occurred in Latvia, Bulgaria, Lithuania, Slovakia, Estonia, Czech Republic and Hungary, while Spain and Portugal increased GHG emission from enteric fermentation (Figure 3). As results of transition in East European countries, reduction in GHG emission was very fast between 1990 and 1993. The contribution of EU-15 member states countries to the GHG emission of EU increased until 2001 (Figure 2).

## METHANE AND NITROUS OXIDE EMISSIONS FROM MANURE MANAGEMENT

This section presents a brief overview of the key factors affecting methane and nitrous oxide (N2O) emissions from these sources. Methane emissions from manure management are usually smaller than enteric fermentation emissions, and are principally associated with confined animal management facilities, where liquid manure is handled (IPCC, 1995). Methane is produced from the decomposition of manure under anaerobic conditions. These conditions often occur when large numbers of animals are managed in a confined area (dairy farms, beef feedlots, swine and poultry farms), where manure is typically stored in large piles or disposed of in lagoons. During storage, some manure nitrogen is converted to nitrous oxide. Emissions of $N_2O$ before the manure is added to soils are included in this category, while manure-related $N_2O$ emissions from soils are considered as agricultural soil emissions. Improved manure and slurry storage, processing and application techniques are technically feasible measures for reducing methane and nitrous oxide emissions. In regions with high animal densities, volumes of slurry and manure are high and the installation of anaerobic digestion plants is particularly effective in reducing emissions. Anaerobic digestion is the natural process of biological degradation of organic material in the absence of air. Anaerobic digester is a man-made system that uses this process to treat different types of organic waste and produce biogas. The biogas can be converted into heat and/or electricity. The process reduces gaseous emissions from the input material, while at the same time delivering valuable renewable energy.

In the period of 1990-2007, methane and nitrous oxide emissions from manure management decreased by 22.3 % in EU-27 countries, which represent 0.177 tons $CO_2$ eq. per capita. Considering the GHG emissions of manure management, Ireland and produced 0.589 tons $CO_2$ eq. per capita in 2007 (Figure 3). This is 233% more than the average of EU-27 countries. Large reductions occurred in Latvia, Slovakia, Bulgaria, Lithuania, Estonia, Czech Republic and Hungary, while Cyprus, Denmark and Spain increased GHG emission of manure management between 1990 and 2007. Reduction in GHG emission was very fast between 1990 and 1993 mostly as results of transition in East European countries. The contribution of EU-15 member states countries to the GHG emission of EU increased until 2003 (Figure 4).

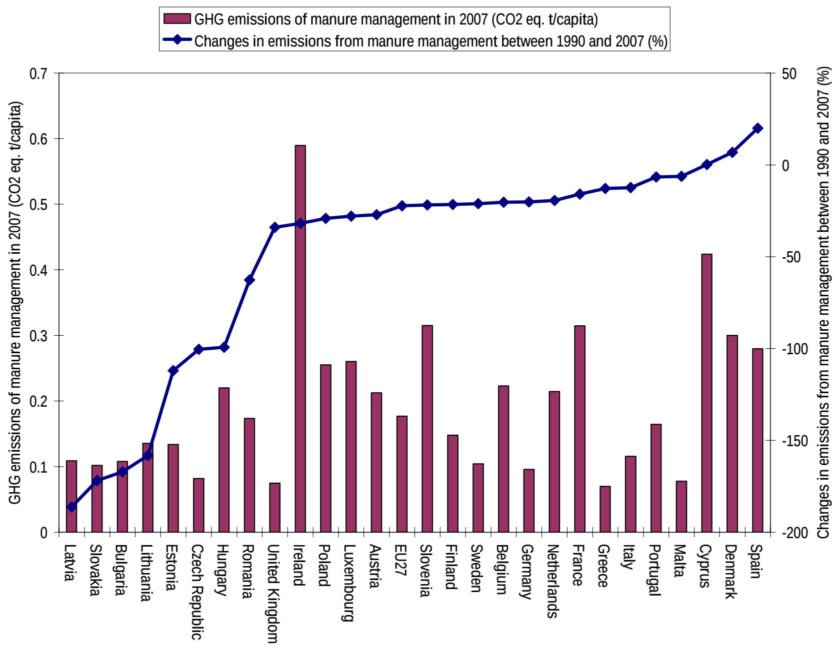


Figure 3: GHG emissions of manure management in 2007 ($CO_2$ eq. t/capita) and changes in emissions between 1990 and 2007 (%) (Data are from dataservice.eea.europa.eu)

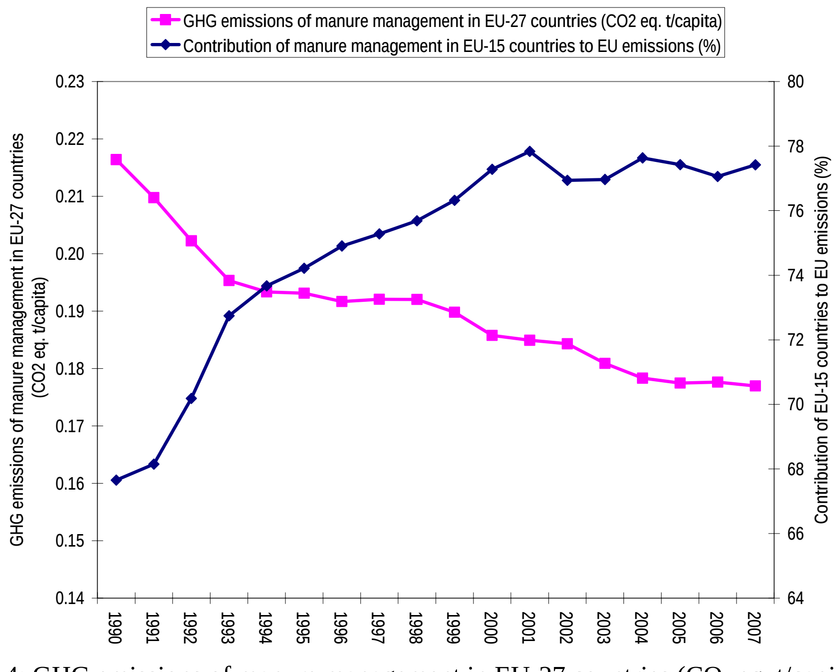


Figure 4: GHG emissions of manure management in EU-27 countries ($CO_2$ eq. t/capita) and contribution of EU-15 countries to EU emissions (%) (dataservice.eea.europa.eu)

## DISCUSSIONS

Hungary, Slovakia, Lithuania, Czech Republic, Romania, Poland, Estonia and Bulgaria have paid a high price for the challenging data in reduction of GHG emissions of enteric fermentation as their animal production went back in a similar scale and these countries are contributing to less and less to world total food and agricultural production. According to FAO statistics, EU-27 countries produced 26.3% of total world meat production in 1980 and this has reduced to 15.4% in 2008 (Figure 5). Contribution of EU countries to total world total milk production was close to 35% at the beginning of the 1980s and now it is close to 22% (Figure 6). Hungary produced more than 1% of meat and this number has reduced to 0.31%. According to FAO statistics, Hungary produced 0.56% of total world milk production in 1980 and this has reduced to 0.26% in 2008. To ensure adequate food supplies, produce row material for industry and energy sector, preserve the countryside and provide a reasonable living for agricultural and related populations we need Europe 2020 strategy focused on smart growth to foster knowledge, innovation and education in agriculture, where the employment rate is low and the acquisition of skills to fight against poverty is difficult.

Farming influences climate change mainly by producing two powerful greenhouse gases (i) methane from livestock digestion processes and stored animal manure, nitrous oxide from organic and mineral nitrogen fertilisers. Human-induced emissions in agriculture have a high degree of uncertainty as farming activities are very diverse and involve a wide range of biological processes, which naturally emit GHG. Behind the overall picture, there are considerable variations in the national situations (Figure 7). Large reductions occurred in Latvia, Bulgaria, Slovakia, Lithuania, Czech Republic, Estonia, Romania and Hungary, while Spain increased GHG emission of agriculture between 1990 and 2007. Per capita GHG emission of agriculture was highest in Ireland and produced four times more than the mean value of EU-27 countries in 2007. Reduction in GHG emission was very fast between 1990 and 1994, mostly as results of transition in East European countries. The contribution of EU-15 member states countries to the GHG emission of EU increased until 2000 (Figure 8).

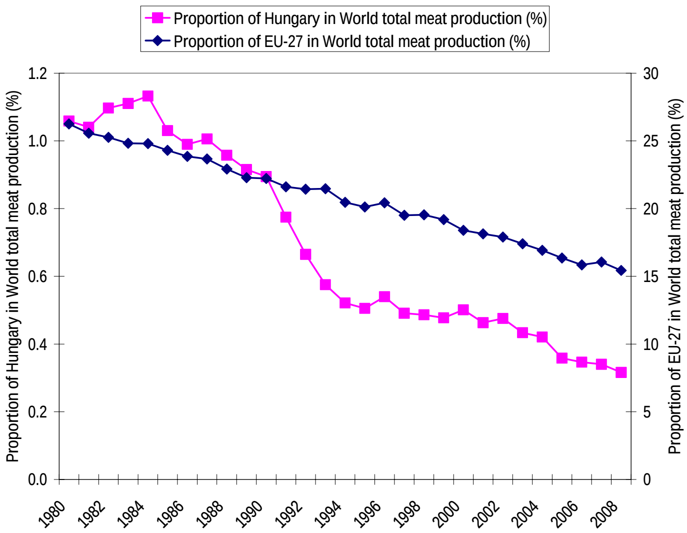


Figure 5: Contribution of Hungary and EU-27 countries to total production of meat

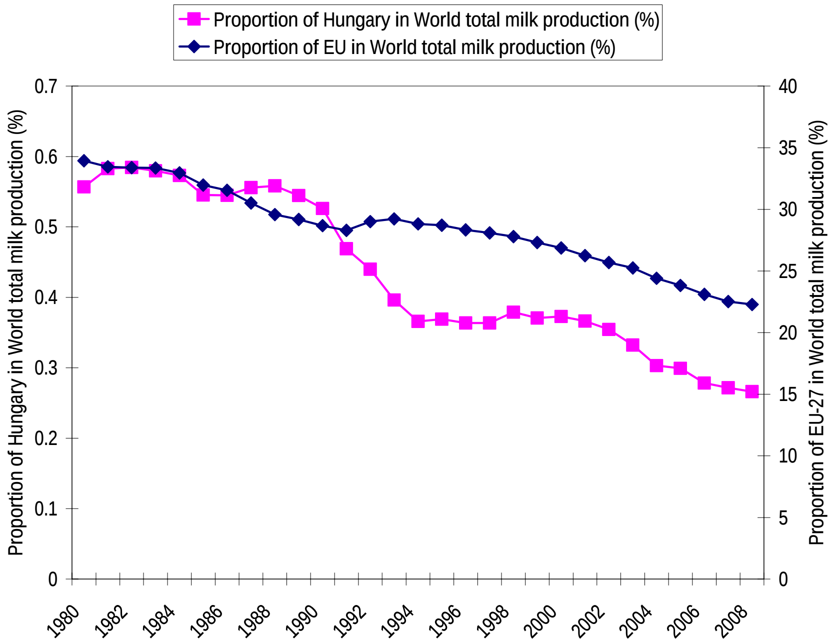


Figure 6: Contribution of Hungary and EU-27 countries to total production of milk

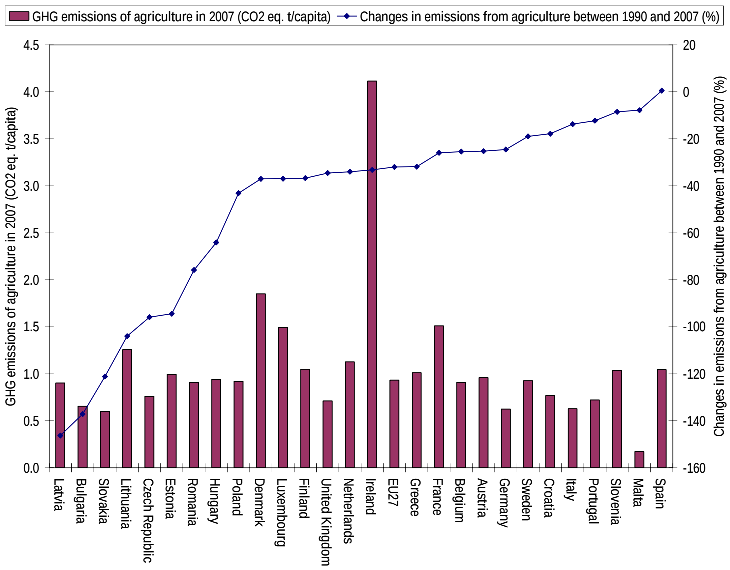


Figure 7: GHG emissions of agriculture in 2007 ($CO_2$ eq. t/capita) and changes in emissions between 1990 and 2007 (%) (Data are from dataservice.eea.europa.eu)

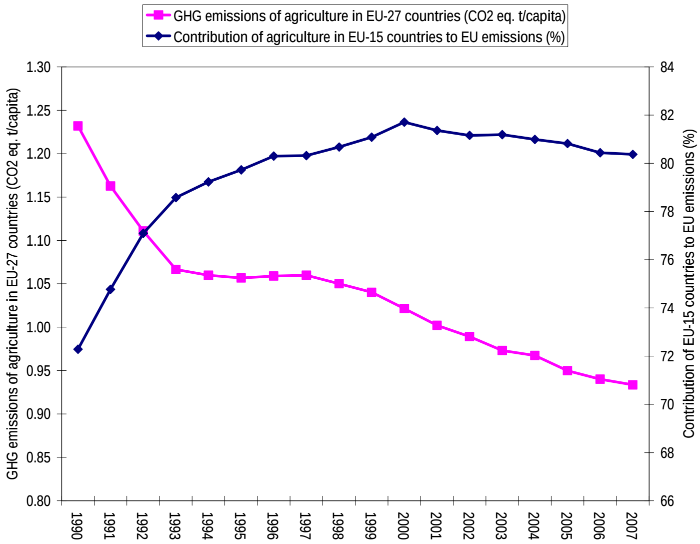


Figure 8: GHG emissions of agriculture in EU-27 countries ($CO_2$ eq. t/capita) and contribution of EU-15 countries to EU emissions (%) (dataservice.eea.europa.eu)

Agricultural activities also release carbon dioxide from fossil fuel use in buildings, equipment and machinery for field operations, which account for around 1% of $CO_2$ emissions of all sectors. Following the IPCC Guidelines for National Greenhouse Gas Inventories reporting scheme these emissions are not accounted in the 'agriculture' category but are included in the 'energy' inventory (IPCC, 1995). Further agriculture-related emissions, such as those from the manufacturing of fertilisers and animal feed, are included in the inventory on industrial processes.

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