

METHANE EMISSION FROM ANIMAL PRODUCTION IN POLAND: SCALE AND POTENTIAL COSTS

Summary

The animal production is responsible for almost 1/5 world greenhouse gases emissions (without taking into account the vapor of water emission). The aim of this paper was to analyze the literature data in the field of studies on methane emissions from animal husbandry (including manure management), to estimate the total scale of the emission in case of Poland and the size for different kinds of typical farms as well as the approximate cost analysis of this emission in case of "methane" tax implementation. It was found that depending on the price scenario (4.07-30 euro Mg⁻¹ CO₂eq) costs of methane emission from animal production are widely different and can reach even over 190 million euro in scale of whole Poland. Comparing the methane emission from pigs production (0.35 million tonnes / year) with the one from cows breeding (6.348 million tonnes / year) a huge disproportion between those values is clearly visible. Methane emission from pigs production is in fact more than 18 times lower.

Key words: animal production, pigs, cows, methane emissions, costs, Poland

EMISJA METANU Z PRODUKCJI ZWIERZĘCEJ W POLSCE: SKALA ORAZ POTENCJALNE KOSZTY

Streszczenie

Hodowla zwierzęca jest odpowiedzialna za blisko 1/5 światowej emisji gazów cieplarnianych (bez uwzględnienia emisji pary wodnej). Celem niniejszej pracy była analiza danych literaturowych w zakresie badań emisji metanu z hodowli zwierzęcej (z uwzględnieniem zagospodarowania nawozów naturalnych), oszacowanie jej ogólnej skali dla Polski oraz wielkości dla różnych wielkości typowych farm jak również przybliżona analiza kosztów tej emisji w przypadku wprowadzenia podatku „metanowego”. Stwierdzono, że w zależności od scenariusza cenowego (4,07-30 euro Mg⁻¹ CO₂eq) koszty emisji metanu z produkcji zwierzęcej bardzo różnią się od siebie i mogą osiągnąć nawet ponad 190 mln euro rocznie w skali Polski. Porównując wielkość emisji metanu z produkcji tuczników (0,35 mln Mg/rok) z emisją z hodowli krów (6,348 mln Mg/rok) wiadać ogromną dysproporcję tych wartości. Emisja metanu z produkcji tuczników jest bowiem ponad 18 razy niższa.

Słowa kluczowe: produkcja zwierzęca, świnie, krowy, emisja metanu, koszty, Polska

1. Introduction

If not taken into account the amount of water vapor as a greenhouse gas (GHG), methane is the main gas, apart from the CO₂, which has an influence on the greenhouse effect. Although its emission is much smaller than carbon dioxide, according to different sources the CH₄ molecule affects 20 to 60 times stronger on the greenhouse effect than CO₂ molecule. Global methane emission in a worldwide scale has been estimated at the level of 6.4 billion tonnes of the CO₂ equivalent [1]. This represents nearly 24% of a global GHG emission to the atmosphere.

The EU has introduced the fees for member states for carbon dioxide emission. For many sectors of Polish economy (steel, energy, cement, etc.) these charges will result in a sharp deterioration in the profitability of production, and in consequence the closure of the plants and increase of prices of manufactured goods (inevitable increase in electricity prices will hit particularly hard Polish consumers). However, for several years, not only in the EU but also in many countries of the world, it has been talking more widely about the need to introduce common charges for emission of other greenhouse gases - just as it has been done in case of CO₂ emission. Meanwhile the share of methane emission in greenhouse gases (GHG) is classified

just after CO₂ and is estimated to be 15-20% of the world production [2] [3]. Agriculture apart from petrochemical industry, municipal landfills and coal mines is the largest emitter of methane in the global economy [US EPA 2006]. Needless to add, however, that compared with the previously mentioned industry and utilities, it is agriculture that may get the hardest hit by charges imposed due to the low profitability of agricultural production, and - due to fragmentation - a relatively small investment potential.

Especially in case of Poland, the possibility of taxation of animal production by the fees for methane emission can (of course depending on the payments amount of) in extreme cases, lead to the collapse of the level of livestock in the country. Since 2008, the strong exchange rate of PLN and a large pork import to the country caused a strong reduction in the number of pigs. In case of additional fees for methane emission it can be expected that the national farms will be in a much worse economic situation compared with farmers in Western Europe, because in contrast to the amount of subsidies - tax rates for methane probably will be at the same level throughout the EU.

However it does not seem, that in the world scale the methane emission from a livestock production would significantly reduced. The research shows that demand for meat and milk continuously increases and therefore produc-

tion will double by 2050 [4]. It proves that the problems related to GHG emission from animal production will increasingly grow. It is therefore necessary to take indispensable actions to determine the costs of livestock production in case of the introduction of charges for methane emission also from agriculture.

The aim of this paper was to analyze the literature data in the field of studies on methane emissions from animal husbandry (including manure management), to estimate the total scale of the emission in case of Poland and the size for different kinds of typical farms as well as the approximate cost analysis of this emission in case of "methane" tax implementation.

2. Material and Methods

In order to estimate the methane emission in national scale and its costs for farms it was based on the data of Central Statistical Office regarding the livestock amount. To calculate the amount of methane emitted in animal production and in manure management have been used the factors from National Inventory Report prepared for the United Nations Framework Convention on Climate Change and the Kyoto Protocol [5]. This report was made in National Centre for Balancing and Emission Management (KOBiZE) for the Ministry of the Environment.

In order to estimate the methane emissions costs for farms, the following variants of the analyzed size of the livestock production were taken into account:

- farms 50, 250 and 800 ha corresponding (at the reference 0.8 LSU - Livestock Unit ha⁻¹) to livestock 40, 200 and 640 LSU;
- for each farm it has been adopted a variant of production of dairy cattle and pigs due to the fact that these production lines are the most common. When converting methane emission from particular animals into LSU under the regulation [6], the following indicators have been adopted: 1 cow = 1 LSU, 1 porker = 0,14 LSU.

Converter 0.8 LSU ha⁻¹ of farmland is at much lower level than seen in Western European countries with intensive animal production. It is also lower than those found in studies of Malaga-Toboła et al. [7], which stood average at 1.14 LSU ha⁻¹ agricultural land (livestock was average at the 1.14 LSU ha⁻¹ LSU) or 100-170 LSU ha⁻¹ obtained in studies of Sawa [8]. However, the value of 0.8 LSU ha⁻¹ was adopted on the basis of the tendency to decrease the number of livestock in Poland and after consultations with experts from Poznan branch of the Institute of Technology and Life Sciences. The lower cast is also advantageous from the viewpoint of ecology because less intensive livestock production less charged environment.

The cost of methane emissions was calculated in a way that 1 tonne of CH₄ is equivalent to 21 t of carbon dioxide equivalent (CO₂eq) [9]. The average price for CO₂ emission for first 5 months of 2013 was calculated at the level of 4.07 EUR Mg⁻¹ according to exchange data from trading at European Energy Exchange [10].

Three price scenarios were assumed while cost calculation of methane emission:

- current price 4.07 euro Mg⁻¹ (average from January-May 2013);
- 15 euro Mg⁻¹ that is price, which EC wants to reach in order to increase the CO₂ impact on the investment policy

of the enterprises and to decrease the production of energy absorption;

- price of 30 euro Mg⁻¹, which may be obtained in the worst scenario, if EC moves 900 million allowances to emission from the beginning of this year started III phase ETS (European Trading System Committee) to its end (2018-2020).

Based on the report of the Ministry of Environment and KOBiZE [9] and the IPCC 1997 report [11] for methane emission calculation from animal waste were adopted the factors at the level of 13.76 kg CH₄/animal/year for cows and 2.39 for pigs CH₄/animal/year. In case of intestine methane emission that is from digestive systems of animals, the data from Ministry of Environment and KOBiZE [9] were used and adopted emission factor 1.5 kg CH₄/animal/year for porkers and 97.358 kg CH₄/animal/year for dairy cows.

3. Research results

3.1. Cumulative emission

Summary statement of cumulative emission for cows and pigs in Polish scale are shown in Table 1 and 2.

The results in Table 1 clearly show that based on IPCC indicators, the amount of intestinal emission in cows breeding is more than 5.5 times higher than the emission from cattle excrement. Noteworthy is total emissions in CO₂eq - it is in fact close to 6.5 million tonnes of carbon dioxide equivalent. It is more than 3% of the amount of CO₂ emissions assigned to Poland by the European Commission. Counting this number in the analyzed scenarios of different prices for CO₂ emission the value for each scenario varies between about 26 million up to over 190 million annually.

Table 1. Methane emission and costs for the analyzed scenarios in national scale for cows

PIGS	Unit thousands of units	Value 2626
Intestinal emission CH ₄	kg/unit/year	97.358
CH ₄ emission from excrement	kg/unit/year	17.76
Total intestinal emission CH ₄	Mg/year	255662
Total CH ₄ emission from excrement	Mg/year	46638
Total intestinal emission in CO ₂ eq	mln Mg/year	5.369
Total emission from excrement in CO ₂ eq	mln Mg/year	0.979
Total emission in CO ₂ eq	mln Mg/year	6.348
Costs		
I scenario (4.07 €/Mg CO ₂ eq)	mln Eur	25.838
II scenario (12 €/Mg CO ₂ eq)	mln Eur	76.180
III scenario (30 €/Mg CO ₂ eq)	mln Eur	190.449

Table 2. Methane emission and costs for the analyzed scenarios in national scale for pigs

PIGS	Unit thousands of units	Value 4280.9
Intestinal emission CH ₄	kg/unit/year	1.5
CH ₄ emission from excrement	kg/unit/year	2.39
Total intestinal emission CH ₄	Mg/year	6421
Total CH ₄ emission from excrement	Mg/year	10231
Total intestinal emission in CO ₂ eq	mln Mg/year	0.135
Total emission from excrement in CO ₂ eq	mln Mg/year	0.215
Total emission in CO ₂ eq	mln Mg/year	0.350
Costs		
I scenario (4.07 €/Mg CO ₂ eq)	mln Eur	1.423
II scenario (12 €/Mg CO ₂ eq)	mln Eur	4.196
III scenario (30 €/Mg CO ₂ eq)	mln Eur	10.491

It is also worth to notice that in the obtained results the IPCC indicators related to emission from livestock excre-

ment tend to be somewhat understated. In Poland, since - in contrast to Western European countries dominates the production of manure, not slurry. However, the observations carried out in a number of farms in Poland have shown often very careless placement of stored manure heaps, especially the lack of piles compaction. As a result, due to the availability of small quantities of air comes to raise of the temperature inside the pile up to 30-40°C, which arises ideal conditions for mesophilic methane fermentation. This topic is the subject of a more extensive research currently at the Poznan University of Life Sciences and will be analyzed in other publications.

Comparing the methane emission from pigs production (0.35 million tonnes / year) with the one from cows breeding (6.348 million tonnes / year) a huge disproportion between those values is clearly visible. Methane emission from pigs production is in fact more than 18 times lower. It means considerably lower cost in all of the analyzed scenarios.

3.2. Emission costs for analyzed farms

Summary of the emission amount from analyzed farms and the cost in different price variants for CO₂ emission are shown in Table 3 (for cows production) and Table 4 (for pigs production).

Table 3. The size of methane emission and costs for analyzed farms with cow production

Farm area	50	250	800	ha
LSU	40	200	640	units
Livestock	40	200	640	units
Intestinal emission CH ₄	97.358	97.358	97.358	kg/unit/year
CH ₄ emission from excrement	17.76	17.76	17.76	kg/unit/year
Total intestinal emission CH ₄	3.894	19.472	62.309	Mg/year
Total CH ₄ emission from excrement	0,710	3,552	11,366	Mg/year
Total emission in CO ₂ eq	96,7	483,5	1547,2	Mg/year
Costs				
I scenario (4.07 €/Mg CO ₂ eq)	394	1968	6297	Eur/year
II scenario (12 €/Mg CO ₂ eq)	1160	5802	18566	Eur/year
III scenario (30 €/Mg CO ₂ eq)	2901	14505	46416	Eur/year
I scenario	1692	8462	27077	PLN*/year
II scenario	4990	24948	79835	PLN*/year
III scenario	12474	62371	199587	PLN*/year

* 1 Euro-4.30 PLN

Table 4. The size of methane emission and costs for analyzed farms with pig production

Farm area	50	250	800	ha
LSU	40	200	640	units
Livestock	286	1429	4571	units
Intestinal emission CH ₄	1.5	1.5	1.5	kg/unit/year
CH ₄ emission from excrement	2.39	2.39	2.39	kg/unit/year
Total intestinal emission CH ₄	0.429	2.143	6.857	Mg/year
Total CH ₄ emission from excrement	0.683	3.414	10.926	Mg/year
Total emission in CO ₂ eq	23.3	116.7	373.4	Mg/year
Costs				
I scenario (4.07 €/Mg CO ₂ eq)	95	475	1520	Euro/year
II scenario (12 €/Mg CO ₂ eq)	280	1400	4481	Euro/year
III scenario (30 €/Mg CO ₂ eq)	700	3501	11203	Euro/year
I scenario	408	2042	6536	PLN*/year
II scenario	1204	6022	19270	PLN*/year
III scenario	3011	15054	48174	PLN*/year

* 1 Euro - 4,30 PLN

The results obtained for the 1st scenario which is the lowest price for CO₂ emissions (4.07 euro Mg⁻¹) appear not

to be a heavy burden for cow farms. Another situation occurs in case of the third scenario, because then the cost of methane emission may have been strongly felt by the farm. Taking into account the fact that intestinal emission is 5.5 times higher than the emission from excrement, in its limitation we should look for savings. Research related to diet modification can lead to a considerable savings in case of methane emission new taxation by the European Commission.

Significantly lower values of emission costs for analyzed farms were obtained in case of pigs for slaughter (tab. 4).

Calculated amounts of the produced methane have shown that in case of pigs is dominant the emission from excrement, not from intestines. In this case, the greatest savings in possible charges for emission can be found through the rational manure and slurry: composting or biogas plants construction.

It was also found that for the analyzed farms, with the same LSU cast the methane emission from pigs production and their manure management is nearly 5-fold lower compared to the cows breeding. It means that pig producers are at a lower level of risk of deterioration of the profitability of production in case of taxation on methane emissions than cattle breeders.

4. Conclusions

1. Depending of the price scenario (4.07-30 euro Mg⁻¹ CO₂eq) costs of methane emission from animal production are widely different and can reach even over 190 million euro in scale of whole Poland.
2. Comparing the methane emission from pigs production (0.35 million tonnes / year) with the one from cows breeding (6.348 million tonnes / year) a huge disproportion between those values is clearly visible. Methane emission from pigs production is in fact more than 18 times lower.
3. The greatest opportunities for reducing methane emission in case of cows lie in limitation of enteric emissions, which can be mainly achieved by modification of the diet.
4. The indicators of methane emission from excrement used by the IPCC seem to be partly underestimated in case of Poland due to the fact that the majority of animal waste is produced in the form of manure, which can generate huge methane emissions during improper storage.

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