GHG EMISSION REDUCTION IN THE AGRICULTURE OF LATVIA: THE REALITY AND OPPORTUNITIES

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ABSTRACT

At present in Latvia, agriculture is the second-largest source of greenhouse gas (GHG) emissions, accounting for 24.2% of the total amount of GHG emissions in the country. Besides, agricultural activity tends to increase in Latvia from year to year, which also contributes to the increase in agricultural GHG emissions. A number of GHG emission reduction measures are being implemented in the agriculture of Latvia for a long period, e.g. biogas production, the inclusion of legumes in crop rotation and fertilisation planning. To date, however, there is a lack of scientific substantiation that could determine the potential for GHG emission reduction measures, the efficiency of the measures as well as whether some extra measures are needed so that Latvia could meet its international obligations. The paper analyses 17 measures having GHG emission reduction potential by employing Marginal Abatement Cost Curves (MACC). The research resulted in constructing MACCs for five the most typical groups (clusters) of agricultural holdings. The analysis allows concluding that there are a number of GHG emission reduction measures that are cost efficient, as the implementation of the measures generates extra economic benefits for farmers (higher crop yields, less fertilisers used etc.), and costs and the potential for GHG emission reduction are considerably affected by the type (cluster) of agricultural holdings. The research findings give an opportunity for policymakers to design a more precise and effective climate policy for agriculture.

Keywords: *GHG emissions, MACC, reduction measures, agriculture, farm typology*

INTRODUCTION

To achieve and maintain the sustainable development of agriculture in Latvia, a larger focus has to be placed on climate-friendly practices that considerably contribute to greenhouse gas emission reduction. At present in Latvia, agriculture is the second-largest source of GHG emissions, accounting for 24.2% of the total amount of GHG emissions in the country [1]. Besides, agricultural activity tends to increase in Latvia from year to year, which also contributes to the increase in agricultural GHG emissions. Such a trend in agricultural GHG emissions indicates the environmental impact of agriculture in terms of GHG emissions becomes more intense, and the introduction of GHG emission reduction measures in agricultural practices could become necessary in order to maintain and ensure the sustainable development of agriculture in the future. Such considerations determined the research aim – to assess opportunities for introducing climate-friendly agricultural practices in Latvia in the context of greenhouse gas emission reduction. However, reducing agricultural GHG emissions is a complicated problem. It is determined by the source of GHG emissions, which is mainly the feed fermentation process in the intestines of animals (CH_4); in 2015, it accounted for 31.3% of the total agricultural emissions. Fertiliser application (N_2O) and organic soil use (N_2O, CO_2) made up 60.5%, while manure management (CH_4; N_2O) comprised 7.2% of the total [1]. Farms must change the farming practices, which could raise the efficiency of the factors of production and/or reduce the release of emissions; the goal of such measures is to reduce relative GHG emissions per unit of agricultural output. The most frequently used kind of analysis to examine GHG emission reduction measures is the so-called marginal abatement cost curve, which is a histogram that compares the measures according to GHG emission reduction potential and measure introduction and maintenance costs.

A marginal abatement costs curve (MACC) is the most widely employed method for assessing GHG reduction measures that allows assessing the measures according to GHG emission reduction potential and costs per unit of CO_{2eq}. MAC curves are used in France [2], Ireland [2], [4], Great Britain [5] as well as in other countries. Overall, one can find that the approaches and solutions are diverse [2], [3]. In general, a MACC is a very useful instrument for analysis of GHG emission reduction measures. The task of the research was to integrate the cluster approach into a MAC curve for Latvia in order to assess GHG emission reduction measures, which would allow identifying both the GHG emission reduction potential and the specific costs more accurately.

MATERIALS AND METHODS

Typology of agricultural farms in Latvia in the context of GHG emission reduction

Before beginning performing the assessment of GHG emission reduction measures, it was assumed that the various types of agricultural holdings and the development level of the holdings affected the GHG emission reduction potential and the cost efficiency of introduction of the measures at the farm level. A typology of agricultural holdings in Latvia was developed in order to incorporate this assumption into calculations. Farm Accountancy Data Network (FADN) farms (n=1000, 2014) were used to develop the typology. The initial typology was developed by applying cluster analysis. First of all, out of an initial set of farm indicators (171) that were identified based on an analysis of variance, there were selected those being statistically significant for cluster analysis. In a result, 22 statistically significant indicators, which were employed in the cluster analysis, were acquired.

The number of farm clusters was identified employing the Elbow method – it was three. The K-means clustering, which uses Euclidean distance, was also applied in the cluster analysis. Based on cluster centre coordinates, there were identified the three clusters of agricultural holdings. In this way, the three different clusters of agricultural holdings were identified in the result of clustering the FADN farms.

The FADN includes only the farms that are economically active – commercial farms – that produce their products for the market, and such farms account for about 45% of the total farms in Latvia. The three clusters of FADN farms did fully represent the situation in Latvia. For this reason, the three clusters identified in the cluster analysis were supplemented with two more clusters – organic farms and home farms – that, overall, gave a more complete insight into the situation with the farms in Latvia. To obtain the characteristics of organic farms, the present research used the FADN database, as part of the organic farms was included in the Farm Accountancy Data Network, as well as the database of the Food and Veterinary Service (FVS). However, to acquire data on home farms, the present research used the database of the Central Statistical Bureau (CSB). In the result, based on 2015 data, the cluster analysis identified the following five clusters of agricultural holdings in Latvia:

- Cluster 1 – intensive mixed specialization farms that keep their livestock indoors (n=286);
- Cluster 2 – intensive cereal farms (n=110);
- Cluster 3 – medium-large mixed specialization farms that graze their livestock (n=20797);
- Cluster 4 – organic farms (n=3473);
- Cluster 5 – home farms (n=57130).

To acquire comprehensive characteristics of the farm clusters, the following information sources were used:

the Eurostat database; CSB annual statistics (for 2015); data specially requested from the CSB, which were not publicly available; survey data on agricultural holdings in Latvia (the structure of agricultural holdings in 2013); FADN data (for 2014); results of a survey of agricultural holdings conducted within the present research in 2015 (n=50); an expert evaluation.

Development of a MACC and the selection of GHG reduction measures. The IPCC methodology for emission calculation was employed to develop a MACC. More about the development of a MACC has been reported earlier [6]. The current costs of technological services in Latvia or in a situation if the services and technologies were not available in Latvia, the information on the closest neighbouring countries were used to calculate the costs of introduction of the GHG reduction measures. Totally, 17 measures were selected; part of the measures had been already introduced in practice, as it was required by the current government policy (fertilisation planning, maintenance of amelioration systems, nitrogen fixation (introduction of legume plants in crop rotation) and the promotion of biogas production) or by the specifics of business and the type of farm (precision fertiliser application, direct incorporation of organic manure into soil, liming acidic soils, conservation tillage, growing crops for green manure, feed ration planning, feed quality enhancement, intensive grazing (frequent cattle rotation from pasture to pasture) and an extended grazing season). However, some of the measures are new and little known in Latvia (use of nitrification inhibitors, growing permanent grasses in organic arable soils, feed enrichment with fats, separation of liquid manure, intensive grazing (frequent cattle rotation from pasture to pasture) and an extended grazing season).

RESULTS

In a marginal abatement cost curve (MACC) for GHG emissions, the vertical axis represents marginal abatement costs per 1 tonne of GHG emissions reduced (EUR t^{-1} CO_{2eq}), and the horizontal axis shows emission reduction potential for each measure in a 14-year period, i.e. from 2017 to 2030.

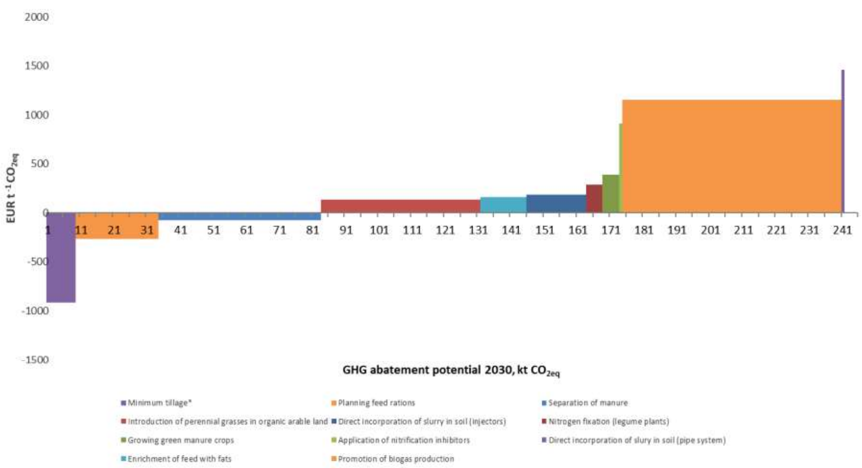

Fig. 1. MACC for Cluster 1 (intensive mixed specialization farms that keep their livestock indoors)

The results obtained show that Cluster 1 farms have large GHG emission reduction potential, as potentially ten various measures, of which four are cost-efficient (marginal costs are negative), could be introduced on the farms of this cluster. This means that the introduction of the measures results in additional gains (e.g. lower fertiliser consumption, higher yields). Part of the measures are cost-efficient, as the costs of reducing GHG emissions are not high, whereas the others are cost-inefficient, as their costs are too high and require large investments and innovative technologies or machinery, as well as limit agricultural production. Cluster 1 has very significant GHG emission reduction potential – 38% of the total potential for the agriculture of Latvia. This could be explained by the specifics of the cluster – intensive agricultural animal production, a good opportunity to attract investments and a relatively small effect of the investments on average cost. An average farm of this cluster could potentially reduce GHG emissions by 9251 t CO_{2eq} up to 2030.

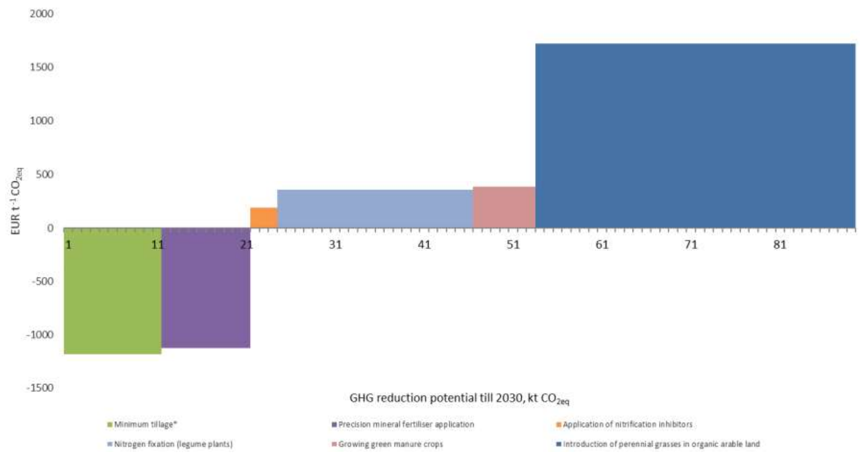

Fig. 2. MACC for Cluster 2 (intensive cereal farms)

Six measures, of which two are cost-efficient, could be potentially introduced on Cluster 2 farms. A large GHG emission reduction could be achieved owing to growing permanent grasses in organic arable soils, growing green manure crops and nitrogen-fixing legume plants, yet these measures are economically inefficient and involve considerable production limitations and lower profits. Cluster 2 farms are intensive and very large ones, which have introduced many GHG reduction measures based on business considerations and often were not aware of the positive effects of the measures on GHG emission reduction. Cluster 2 farms would account for 12% of the total GHG reduction potential if an average farm introduced the measures, thereby producing less 7311 t CO_{2eq}.

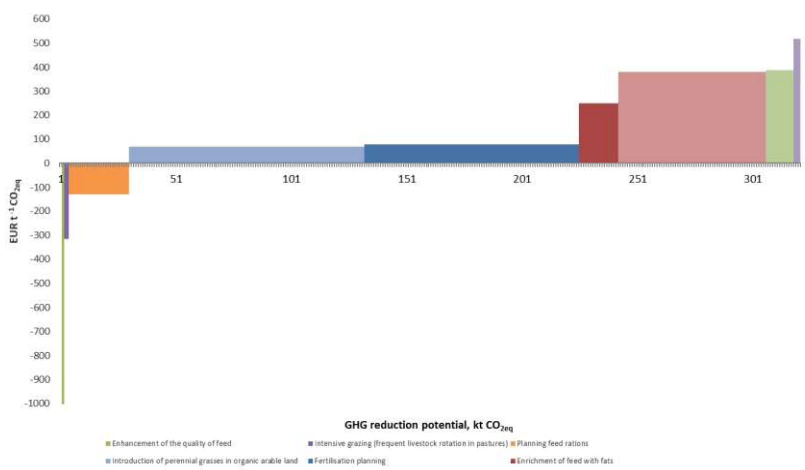

Fig. 3. MACC for Cluster 3 (medium-large mixed specialization farms that graze their livestock)

Nine measures could be potentially introduced on Cluster 3 farms, which are considered to be typical and most represented in Latvian agriculture. Of the nine measures, four are cost-efficient and mainly suitable for the livestock industry, as they relate to livestock feeding enhancement – planning feed rations and enhancing feed quality – resulting in significant increases in livestock productivity and GHG emission reductions up to 700 CO_{2eq} ha^{-1}/animal, as well as to pasture management. A large reduction in GHG emissions could be achieved if growing permanent grasses in organic arable soils and planning fertiliser application rates; besides, the measures are cost-efficient for such farms. However, such measures as feed enrichment with fats and growing nitrogen-fixing legume plants and green manure crops create relatively large GHG emission reduction effects, yet their introduction is cost-inefficient. As mentioned above, Cluster 3 is the most typical one for agriculture in Latvia; accordingly, the cluster contains most of the commercial farms. Overall, the contribution of Cluster 3 to the GHG reduction potential is the most significant – 45%; however, compared with Clusters 1 and 2, the contribution of an average farm of this cluster is considerably smaller, reaching 99.1 t CO_{2eq}.

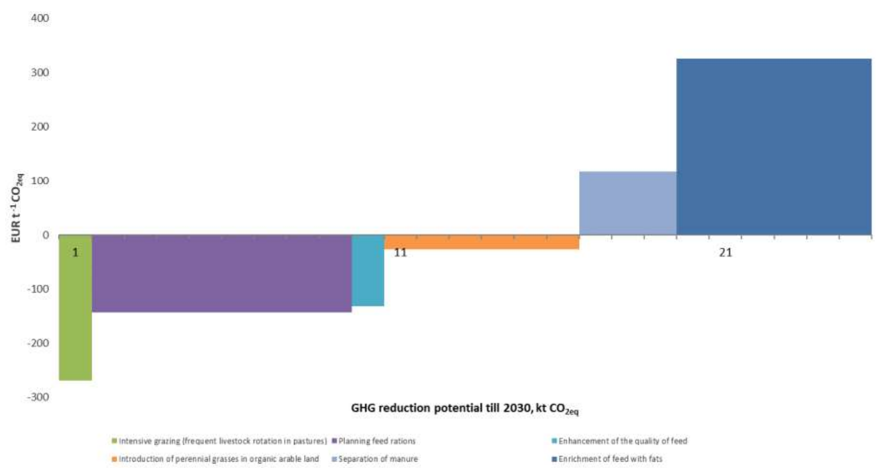

Fig. 4. MACC for Cluster 4 (organic farms)

The research results showed that the expansion of the application of smart and appropriate organic farming techniques should be also promoted, as a number of GHG emission reduction measures related to livestock farms have to be introduced on organic farms as well, thereby creating additional positive effects on climate and agricultural efficiency. Organic farms are traditionally considered to be environment- and climate-friendly, yet the potential for an average farm equals 62 t CO_{2eq}. The proportion of Cluster 4 in the total GHG reduction potential is 3.4%.

Fig. 5. MACC for Cluster 5 (household plots)

Home farms have the smallest GHG emission reduction potential, which is logical because such agricultural holdings are small and manage a few hectares of agricultural land, thereby playing no essential role in agricultural production. Nevertheless, despite this fact, also this group of farms could introduce some GHG emission reduction measures that are cost-efficient. The GHG reduction potential for an average farm is only 2.1 t CO_{2eq}, and the cluster's contribution to the total potential for agriculture is only 1.4%.

Overall, a detailed assessment of GHG emission measures allows concluding that Latvia has some GHG emission potential. There are a number of measures that are cost-efficient, as their introduction provides additional economic gains to farmers (higher yields, lower fertiliser consumption etc.). In order that such measures are introduced in practice, it is important to educate farmers in relation to the measures. The measures are as follows: precision fertiliser application, liming acidic soils, conservation tillage, feed ration planning, feed quality enhancement and rotational grazing. Part of the GHG emission reduction measures are cost-efficient, which means that farmers have to take into account additional expenses for the introduction of the particular measures. The other measures are cost-inefficient, as their introduction involves additional investments or production limitations, which result in losses for the farmers.

CONCLUSION

1. The cluster approach uses typical farms that better characterise the agricultural reality. The use of typical farms contributes to taking specific farming conditions (e.g. herd size, farming intensity degree, solvency, investment effects on production cost etc.) into consideration in calculations.

2. The inclusion of home and organic farms in the MACC facilitates communication with farmer organisations, as it shows the opportunities for each typical farm group to take part in GHG emission reduction.

3. At the same time, one has to be aware that the integration of GHG reduction measures into agricultural policies often involves financial stimuli, and the cluster approach reduces the potential discrimination in the use of the stimuli.

4. It has to be noted that the GHG reduction measures set for the farms of Clusters 4 and 5 are cost-efficient and contribute to both economic growth and overall sustainability.

5. However, it has to be considered that the cluster approach for agricultural holdings could be employed in relation to not only climate policies but also the Common Agricultural Policy.

6. An important challenge for Latvian agriculture is to raise land use efficiency; from this perspective, the development of a typology of farms for the purpose of more accurate policies is only at the stage of development.

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