AGRICULTURAL GHG EMISSION AND MITIGATION MEASURES IN LATVIA

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Abstract. In Latvia the production resource – land is not exploited efficiently, and there is a large potential for land to be used in efficient agricultural production. National task is set for the next years in Latvia to retain agricultural land for agricultural production, in order to efficiently manage approximately 2 million ha. The agricultural sector is an important source of nitric oxide (N_2O), methane (CH_4) and carbon dioxide (CO_2) emissions. Increasing agricultural production is expected to increase the greenhouse gas (GHG) emissions in Latvia. Emissions depend on the specialization and the farm grown products. Quantifying emissions from different specialization farms can identify the main sources of emissions and make decisions to reduce them.

Keywords: agricultural production, greenhouse gas, accounting tools.

Introduction

According to the Intergovernmental Panel on Climate Change (IPCC) data, agricultural production and forestry are one of the key sources of greenhouse gas (GHG) emissions. These economic activities contribute to 30 % of the total GHG emissions in the world. Depending on the structure of national economies, these emissions range from a few percent (1 % in Jordan, 6 % in the USA and 10 % in the European Union (EU)) up to half (48 % in Brazil) and even more (91 % in Chad) of the total emissions [1; 2]. A change in the use of land is a source of GHG emissions, as the amount of accrued CO_2 decreases by reducing the unfarmed area and logging forests [3]. In order not to contribute to further climate change, according to the European Commission's Roadmap 2050, a target has been set to reduce GHG emissions from agriculture by 42-49 % from the emission level of 1990 until 2050 [3].

Latvia's Rural Development Programme 2014-2020, approved by the European Commission, declares development pathways which are necessary for the economic development of Latvia's rural areas and which are controversial at the same time. While seeking a solution to the efficient use of Latvia's land resources, a target has been set to exploit 2 mln ha of agricultural area (AA) until 2020 [4]. According to a detailed research, the reintroduction of an additional 275 thou ha of agricultural area in agricultural production is economically feasible [5]. The Rural Development Programme of Latvia also envisages supporting the introduction of GHG emission neutral or reductive agricultural practices [4] in order to achieve the binding GHG emission target for Latvia until 2020. The reintroduction of an additional AA in agricultural production results in more GHG emissions from agriculture. Latvia is allowed to increase its GHG emissions by 17 % until 2020, compared with 2005, in the industries not included in the EU GHG emissions trading system [6]. Latvia's agriculture is the second largest source of GHG emissions, accounting for 22 % of the total emissions in 2012 [7].

Overview of GHG emissions in different agricultural sectors is needed to ensure that the goals are met. Real measurements of pollution from agricultural activity are actually impossible; therefore, the emissions emerging from: 1) cultivating the AA and from soils due to the release of nitrous oxide (N_2O); 2) the gastrointestinal tract of ruminants, as methane (CH_4) is released during the process of fermentation and 3) manure, as methane (CH_4), ammonia (NH_3) and nitrous oxide (N_2O) are released, are calculated employing a GHG emission calculator (GHGEC). The GHGEC – a tool of management of economic processes will help rural policy makers and farm mangers make decisions based on the IPCC emission calculation guidelines. The most appropriate model for Latvia's situation can be identified by using the data obtained and comparing various farm specialisations and the kinds of their production cycles. The quantitative value of GHG emissions produced can be found for the case if the utilised agricultural area (UAA) is increased.

The research object of the present research is GHG emissions produced by Latvia's agriculture and the research subject is the quantification of GHG emissions produced by agriculture at farm level in Latvia. The research aim is to analyse the main sources of emissions from agricultural activity and to identify the most appropriate emission calculator (GHGEC) for Latvia. Based on the aim, the following research tasks have been set: 1) to calculate the crop and livestock sector development indicators and GHG emissions correlations; 2) to calculate a potential increase of GHG emissions from exploiting an additional AA; 3) to assess and select the most appropriate GHGEC for Latvia's agricultural holdings.

Materials and methods

The present research employed the publicly available data of the Central Statistical Bureau (CSB), the European Statistical Bureau (Eurostat) and the Rural Support Service (RSS). It also analysed Latvia's National Inventory Reports (LNIR). To achieve the aim and execute the tasks, the research employed secondary information being summarised and published by the EU's and Latvia's scientists regarding GHG emissions of agricultural origin. The calculations of GHG emissions from the crop and livestock industries are based on the guidelines and methodologies provided by the IPCC GPG 2000. For dairy farms, the emissions of CH_4 from the process of fermentation in gastrointestinal tracts of milk cows and the emissions of CH_4 and N_2O from the management of manure are calculated based on the Tier 2 methodology. The emissions of N_2O from soils are calculated based on the IPCC guidelines and Latvia's National Inventory Reports, employing the Tier 2 methodology. The key economic indicators of agricultural holdings, used for calculating emissions, are available in databases; yet, data on nitrogen balance have to be additionally collected. Such data are not collected in Latvia.

The source of variable emissions from crop farming is fertilisers worked in arable land, and the GHG emissions are a function of:

- sown and fertilised area;
- intensity of fertilisation and the choice of the right production function;
- fertilisation technologies used.

The distribution of variable emissions from crop farming by crop group was calculated based on the consumption of nitrogen fertilisers for various crop groups. The calculations were performed:

1. using data on the output of crops and the consumption of nitrogen fertilisers. The approximate consumption of nitrogen fertilisers in 2012 and the expected one for 2020 were calculated in proportion to crop output differences;
2. distribution of variable GHG emissions from soils by crop was calculated in proportion to the distribution of N fertilisers by crop group.

Livestock farms specialised in milk and meat production produce N_2O and CH_4 emissions accounting for 80-90 % of their total emissions. Livestock farms have an opportunity to reduce their total emissions by replacing their fertilisers with organic manure. However, given the fact that the number of livestock per ha of cropped UAA is insufficient in Latvia, the opportunity of organic fertilisation does not exist in all territories. Certain forage production standards will be set for livestock farms in the future, as the release of CH_4 emissions is directly associated with the portion and composition of feed. Research studies prove a considerable increase in emissions if livestock is fed with low quality feed [8].

The third significant source of GHG emissions on farms relates to livestock manure management. Yet, there are activities that reduce emissions, but their introduction depends on the initiative of rural businessmen. For instance, the souring of manure, anaerobic treatment and other activities can considerably reduce the emissions of NH_3, CH_4 and N_2O [9].

An analysis of emissions for selected livestock industries was performed based on output in the industry, as it is associated with the quantity of feed consumed and the number and productivity of livestock.

Results and discussion

1. GHG emission changes in crop and livestock sectors

The consumption of nutrients (N) by crop farms for the purpose of increasing the efficiency of UAA in Latvia in 2012 rose by 52 % in comparison with the base year. A reasonable and effective use of N reduces emissions from other N compounds and would significantly reduce total emissions.

Scientific research studies point not only to the gains from GHG emission reductions through effective use of N but also to economic gains [10]. An increase in the output of crops at the same time contributes to the total emissions from agriculture. Changes in the indicators are shown in Figure 1.

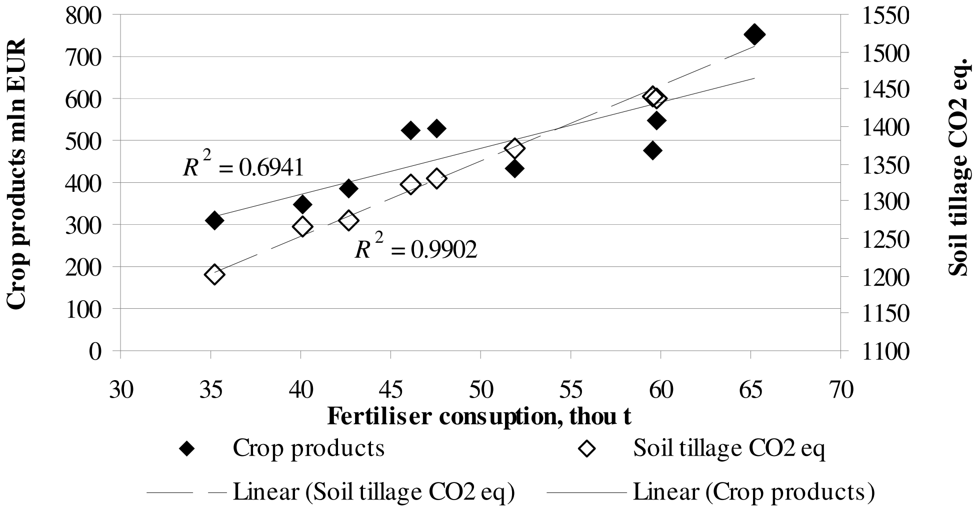

Fig. 1. **Crop production and GHG emissions in Latvia**

Over the analysis period, the GHG emissions from soil tillage rose by 27 % and reached 1521.93 thou t of CO2. The correlation coefficient value 0, 99 indicates a very strong growth in GHG emissions through fertilizers. Correlation analysis of the livestock sector development indicators does not appear as close link between production volumes and emissions. Correlations are shown in Figure 2.

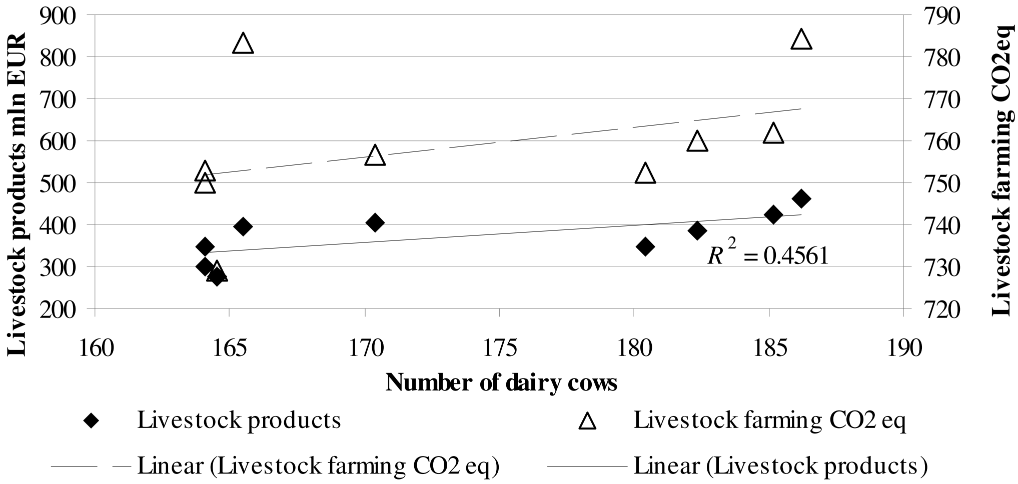

Fig. 2. **Livestock production and GHG emissions in Latvia**

The increase in the output of the livestock sector has not caused a significant increase in emissions. The dairy sector has increased its output by 11 % in the analysis period, reaching an output of 870.06 thou t of milk in 2012, while the emissions produced by this sector decreased by 5 % to 511.31 thou t CO_2. The other livestock sector presented slight increases in emissions owing to increases in the number of livestock.

2. GHG emission increase potential

Based on the information summarised by the Rural Support Service [11] and a detailed analysis of uses of UAA, the additional quantity of crops to be produced was calculated. By exploiting the UAA, which was declared for the single area payment scheme (SAPS) [11], more intensively and efficiently, additionally 275 thou ha, of which 52 thou ha are unameliorated, with an agricultural land qualitative estimate of more than 25 points, could be reintegrated in agricultural production. The reintegrated area could increase the output of crops, compared with 2012, from 12 % (grain, rapeseed) to 17 %

(potatoes, fresh biomass from meadows/pastures) [12]. The necessary quantity of fertilisers and the additional GHG emissions produced by every crop were calculated in proportion to the additional AA reintegrated in production. The results are summarised in Table 1.

Table 1

Total crop output potential and variable GHG emissions in Latvia in 2020

Crops	Output in 2012, thou t	GHG emissions in 2012, thou t of CO_2	Additional			Total output, thou t	GHG in 2020 thou t of CO_2
			ha	incl. unameliorated, ha	output, thou t		
Cereals	2124	737.56	87197	16394	334	2799	971.88
Rapeseed	303	212.24	17399	3268	46	373	260.84
Potatoes	538	11.59	6276	1014	146	881	18.95
Maize	553	42.46	3769	563	131	849	65.11
Grasses and green forage and silage crops sown in arable land	721	12.86	61756	11718	1292	898	68.65
Meadows, pastures	167	1.34	98820	19098	833	478	36.66
Vegetables	161	4.77	0	0	0	195	5.76
Total	x	1022.83	275217	52055	x	x	1427.85

In case the additional 275 thou ha are reintegrated in agricultural production, the variable GHG emissions from crop farming will increase by 39 % in 2020, compared with the level of 2012. The increase from the base year could reach 80 %. In addition to the emissions emerging from exploiting histolysis soils to produce crops (constant emissions are equal to 490 thou t CO_2, at the level of 2012), emissions from the UAA will amount to 1917 thou t CO_2.

The amount of emissions produced in the production process has to be calculated in order to identify the low-emission management model for livestock and crop farming.

3. Use of an emission calculator to calculate GHG emissions

Calculating GHG emissions for a farm may have several purposes. It depends on the further use of calculations of emissions. More than 14 calculation tools/GHGECs [13] have been developed and are available, and they might be classified into four groups by purpose: 1) ones promoting the understanding of emissions – simple in use, no need for preliminary knowledge, with limited capabilities, they reveal general emission sources and do not offer solutions; 2) ones keeping data records – they describe and examine the current situation in detail, determine precise amounts of emissions and could compare emission amounts among farms/countries. They are used by policy and decision makers, as well as by crop and livestock farmers; 3) ones for project evaluation – they calculate project implementation gains from a reduction of emissions in the production process. Such tools are used in quota trading industries and in agriculture; 4) ones for product certification – they calculate the amount of emissions released per unit of products produced. They compare products in terms of amount of emissions released in their production. Such tools do not consider territorial differences.

One of the EU strategic goals is to introduce low carbon farming in practice. To keep such agricultural practices, international standards have to be complied with [14-17] by bringing them in line with environmental footprint methods [18] and the EnviFood protocol [19] adopted by the European Commission. The emission calculation methodology has to be in accordance with the IPCC guidelines used in producing annual LNIR reports.

Based on the criteria set, five most appropriate GHGECs were selected out of the analysed ones: Cool Farm Tool [20]; CLA CAML Calculator [21]; Cplan Carbon Calculator [22]; Farm Carbon Calculator [23] and Carbon Calculator [24] and evaluated for their consistency with conditions in Latvia.

At the first stage of use of GHGECs in Latvia at the farm level, the emissions from the production process will be calculated using the same methodology. The results obtained will be used in shaping farm support policies and for analyses of production cycles with the purpose of reducing the total emissions produced by agriculture. At the second stage, the GHGECs may be used by farms or for certifying products in the single low carbon farming system.

The GHGEC Carbon Calculator was selected for calculating GHG emissions for farms in Latvia. This tool was developed for the needs of agricultural holdings in the EU-28. Its calculations are performed using Microsoft Excel. Entering and processing data in it does not require special preliminary knowledge. Its quantified data identify pollution sources from: fuels, fermentation in the gastrointestinal tract of animals, manure, land tillage and fertilisation, production and farm buildings, exploitation of machinery and circulation of N on farms. In addition, emissions from a change in land use on farms can be calculated as well.

The data obtained are calculated per ha of the farm UAA (tonnes of CO_2-equivalent/ha UAA) and per unit (tonnes of CO_2-equivalent/tonnes of products) for five key agricultural products produced on the farm. The remaining products of the farm are combined into one category – other products. The calculation is performed for one production cycle or one year. The next stage of the research will focus on case studies of five characteristic farms identified in a cluster analysis in various Latvia's regions.

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Conclusions

1. The sources of GHG emissions from agricultural production are land tillage, fermentation in the gastrointestinal tract of animals and manure, accounting for 22 % of the emissions in Latvia; an increase of 16 % was observed in 2012 in comparison with the base year.
2. A target has been set to exploit up to 2000 thou ha AA in agricultural production, increasing the total cropped area by 18 %.
3. The GHG emissions from the crop industry increased by 27 % in the analysis period and reached 152.93 thou t CO_2, while those from dairy farming deceased by 5 %, totalling 511.31 thou t CO_2.
4. In case the additional 275 thou ha are reintegrated in agricultural production, the variable GHG emissions from crop farming will increase by 39 % in 2020, compared with the level of 2012.
5. The GHGEC Carbon Calculator is used to calculate GHG emissions at the farm level in order to identify the main sources of GHG emissions and to achieve a reduction per unit of agricultural product.

References

1. UNFCCC 2012 GHG Emission Profiles. [online] [31.01.2015]. Available at: http://unfccc.int/ghg data/ghg data unfccc/ghg profiles/items/3954.php
2. Van der Werf G., Morton D. C., DeFries R. S., Olivier J. G. J., Kasibhatla P. S., Jackson R. B., Collatz G. and Randerson J. CO2 emissions from forest loss. Nature Geoscience 2, 2009, pp.737-738.
3. EC. Communication from the commission to the European parliament, the council, the European economic and social committee and the committee of the regions. A Roadmap for moving to a competitive low carbon economy in 2050. In: Commission E (Hrsg.), COM/2011/0112. European Commission, Brussels, 2011.
4. Lauku attīstības programma 2014.-2020.gadam (Rural Development Programme 2014-2020). 2014. 142 p. (In Latvian).
5. Latvijas Lauksaimniecības universitāte (LLU). Zemes ekonomiski efektīva, ilgtspējīga un produktīva izmantošana lauksaimniecības un mežsaimniecības produkcijas ražošanai (Latvia University of Agriculture.Economically Efficient, Sustainable and Productive Use of Land for Producing Agricultural and Forestry Products). 2014. Jelgava, 204 p. (In Latvian).
6. Decision No 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. 2009.

7. Latvia's National Inventory Report. Latvian Environment, Geology and Meteorology Centre. 2014. 568 p.
8. Meale S. J., McAllister T. A., Beauchemin K. A., Harstad O. M., Chaves A. V. Strategies to reduce greenhouse gases from ruminant livestock. Acta Agric. Scan. Sect. A. Anim. Sci. 2012. 62: pp. 199-211.
9. Sindhöj B. E., Rodhe L. Examples of Implementing Manure Processing Technology at Farm Level. Baltic Forum for Innovative Technologies for Sustainable Manure Management. 2013. 56 p.
10. Oenema O. Economic Cost of Nitrogen Management in agriculture. TFRN-5 in Paris 2011. [online] [01.02.2015]. Available at:http://www.clrtap-tfrn.org/node/94
11. Lauku atbalsta dienests (RSS) Lauku reģistra _IS datu bāze uz 2013.gada 1.martu (Rural Support Service. Field Register IS database as of 1 March 2013). (In Latvian).
12. Pilvere I., Nipers A., Upite I. Agricultural land-use potential and investment required in Latvia. Proceedings of International conference "Engineering for rural development", 2014, Jelgava, Latvia, pp. 459-465.
13. Report of Greenhouse Gas Accounting Tools for Agriculture and Forestry Sectors. Technical Guidelines and Scientific Methods for Entity-Scale Greenhouse Gas Estimation, 2012. USDA. [online] [31.01.2015]. Available at: http://www.usda.gov/oce/climate_change/techguide/Denef_et_al_2012_GHG_Accounting_Tools_v1.pdf
14. Product Life Cycle Accounting and Reporting Standard. World Resources Institute and World Business Council for Sustainable Development, USA, 2011. 154 p.
15. ISO 14040. Environmental management - Life cycle assessment -- Principles and framework, International Organisation for Standardisation, 2006.
16. ISO 14044. Environmental management -Life cycle assessment -- Requirements and guidelines, International Organisation for Standardisation, 2006.
17. ISO/TS 14067. Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quantification and communication, 2013.
18. EC. Commission Recommendation of 9 April 2013 on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations. Official Journal of the European Commission. Publications Office of the European Union, 2013, Luxembourg.
19. Food SCP RT. ENVIFOOD Protocol, Environmental Assessment of Food and Drink Protocol, European Food Sustainable Consumption and Production Round Table (SCP RT), Working Group 1, Brussels, Belgium, 2013. [online] [01.02.2015]. Available at: http://www.food-scp.eu/files/ENVIFOOD_Protocol_Vers_1.0.pdf
20. Hillier J., Walter C., Malin D., Garcia-Suarez T., Mila-i-Canals L., Smith P. A farm-focused calculator for emissions from crop and livestock production. Environmental Modelling & Software, 2011. pp. 1070-1078.
21. CLA CALM Calculator. [online] [01.02.2015]. Available at: http://www.calm.cla.org.uk/
22. Cplan Carbon Calculator. [online] [01.02.2015]. Available at: http://www2.cplan.org.uk/
23. Farm Carbon Calculator. [online] [01.02.2015]. Available at: http://www.cffcarbon calculator.org.uk/
24. Bochu J.L., Metayer N. Development of Carbon Calculator to promote low carbon farming practices – User guidance manual for the Carbon Calculator. Deliverable to EC-JRC-IES by Solagro, 2013. 67 p.