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EVALUATION OF LONG-TERM ENERGY POLICY PROPOSITIONS FROM THE PERSPECTIVE OF THEIR IMPACT ON AGRICULTURE, LAND USE, LAND USE CHANGE AND FORESTRY SECTOR

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TABLE OF CONTENTS

ABBREVIATIONS

AL – agricultural land
CAP – Common Agricultural Policy
EC – European Commission
EGD – European Green Deal
EU – European Union
GHG – greenhouse gases
HCS – "Hugs, *carrots* and *sticks*" approach
LULUCF – Land Use Land Use Change and Forestry
NECP2030 – Latvian National Energy and Climate Plan 2030
RES – renewable energy resources
RV – activity direction
UAA – utilised agricultural area

1. Aim and context of the study

1.1. European Green Deal

On 11 December 2019, the European Commission (EC) announced its Communication on the European Green Deal, which is going to serve as a roadmap for making the EU economy sustainable. Sustainability will be achieved by turning climate and environmental problems into new opportunities in all areas of policy, and by ensuring that these changes are just and inclusive of every individual [1].

Actions in agricultural sector are going to be of critical importance to ensure transition to carbon neutral and sustainable development. The goal of the Common Agricultural Policy (CAP) is to achieve a traceable development, and From Farm to Fork strategy will become an essential factor in achieving the EU climate, environmental and biodiversity goals [2]. CAP provides that at least 40% of the budget will be allocated for climate change mitigation between 2021 and 2027. The European Commission is on the course of launching CAP in 2022 ensuring that EU member states honour the goals encompassed in the EGD and From Farm to Fork strategy when elaborating their national agricultural and land use plans. These plans should respect the principles of practice of precise agriculture, organic agriculture, agroecology, agroforestry, and animal welfare.

Support schemes in these plans should include support to farmers that is based on the goal of achieving environmental and climate targets, through facilitating carbon sink in soil and an improved practice of using fertilisers with the aim of reducing water pollution. To achieve higher environmental and climate standards organic farming will be facilitated and use of chemical pesticides, fertilisers and antibiotics will be reduced through innovative technologies and solutions.

1.2. Circular economy

Circular economy is promoted as a sustainable development model the essence of which is keeping the value of products, materials and resources in the economy for as long as possible while simultaneously reducing consumption of raw materials and volume of waste, and thus reducing environmental impact [3]. From Farm to Fork strategy will be essential for successful implementation of the concept of circular economy [2], as one of its central goals is to reduce environmental impact of food by changing the principles of transport logistics, food storage, packaging and reducing food waste. Policy measures / activities in the NECP2030 RV 8 and RV 9 have been assessed from the point of view corresponding the principles of circular economy.

1.3. Bioeconomy and biotechonomy

One of the biggest challenges is effective use of resources. Sustainable and climate neutral development can only be ensured through broader and more rational and effective use of bioresources. Bioeconomy provides analysis and allows planning all of that. Bioeconomy is part of economy where renewable natural resources (plants, animals, microorganisms, etc.) are used in a sustainable and well-thought production process to produce food and feed, industrial products and energy. Agriculture, fishery, food industry, forestry, timber industry, pulp and paper industry, as well as energy are all areas of bioeconomy. Latvia's bioeconomy potential is significant: the share of the traditional areas of bioeconomy – agriculture, forestry, fishery, food production and timber industry – constitutes approximately half of the added value of all producing industries. It is almost six times as much as the next biggest contributor – production of metals and metal products [4]. Biotechonomy makes a step further by analysing and providing opportunity to plan the use of bioresources for the production of products with high added value and in high demand [5].

2. METHODOLOGY

To carry out this analysis data sources about agri-environmental indicators, land use and land use change are available when planning changes in the state of environment in agriculture and LULUCF sectors. Significant financing has been identified for most of the RV 8 activities / measures, therefore it can be anticipated that NECP2030 activities are going to have significant impact on the development of the sector.

Both RV 8 (agriculture) and RV 9 (LULUCF) and the potential impact of activities and policy measures is assessed from the point of view of the type of activity ("hugs, carrots, sticks" approach) – literature analysis has served as basis for assessment whether the activities can be efficient enough to reach the NECP2030 goals.

However, such an approach does not in itself mean that implementing these activities corresponds the principles of low carbon development, circular economy and bioeconomy. The aim of this analysis is to establish whether:

- Most essential indicators are available, which allow drawing conclusions about the necessity of activities and how adequate they are to achieve the goals;
- Benchmarks exist for various parameters that have critical influence on sustainable development of the agriculture sector and that can serve as a point of reference to establish trends and whether country indicators are or are not acceptable.

2.1. Framework for measuring progress

The framework for measuring progress in agriculture sector stems from the EC Communication about agri-environmental indicators and indicators reflecting the state of environment in the land use, land use change and forestry sector [6] and the EC Communication about the statistical information required to measure the integration of environmental factors into the Common Agricultural Policy (CAP) [7]. The requirement to measure the progress is also set out by the EC Communication on elaboration of agri-environmental indicators for the monitoring and evaluation of the EU CAP development [8].

2.2. Data sources

On availability of data for measuring environmental indicators in Latvia – data is available that has been included in the Forecasting of Development and Elaboration of Policy Scenarios for Agricultural Sector for 2050 (LASAM) research, Eurostat data, and data that has been used for assessing the progress of achieving environmental and climate goals so far. The main variables allowing to draw conclusions about the progress towards environmental and climate goals are CO_2 sink in land use and agriculture, as well as changes in the area (ha) of different categories of land. Data about the use of nitrogen, emissions, and sink, use of forest land and CO_2 emissions is well available and comparable covering an extensive period of time.

Data on the use of nitrogen fertilisers and nitrogen sink has a special role: nitrogen has 298 times bigger impact factor than CO_2. Nitrogen is also the main type of fertiliser to increase agricultural productivity, and better productivity is associated with a more intense use of mineral fertilisers, therefore special attention is paid to indicators associated with nitrogen.

One of reference indicators is gross nitrogen balance in kilograms on a hectare of land used in agriculture, which reflects the ratio between nitrogen that has been used to fertilise the land and the volume of nitrogen fixation. Eurostat and European Environment Agency data about nitrogen use and gross nitrogen balance has been used in analysis to establish whether any correlation exists between gross nitrogen balance and other indicators – input in agricultural land (euro per ha), GDP per capita, used nitrogen per 100 000 inhabitants and other indicators.

2.3. Reference literature on the NECP2030 topics covered by Activity Direction 8 and Activity Direction 9

References to sources that explain the essence of agricultural activities and their potential impact on environmental indicators are used to outline the substance and aim of each activity under RV 8 of the NECP2030. A series of publications on topics that coincide with the activity directions of NECP2030 RV 8 prepared by the Latvian University of Agriculture (LLU) and Ministry of Agriculture (MoA) represents an example of such source of reference. The material has been prepared by LLU scientists and it has informative purpose. It serves as reference material, as a handbook with examples about key environmental aspects of agricultural activity. References to each specific source have been added in the text of analysis of each sub-direction of RV 8.

2.4. Assessing NECP2030 activities

NECP2030 RV 8 and RV 9 activities have been assessed both by applying "hugs, carrots and sticks" approach and by evaluating critically important indicators, and by drawing conclusions about the influence of policies and activities on environmental indicators. Insight into the current state of affairs of each of the activity directions is provided, the context of activity directions and the set goals is explained, key challenges and risks to achieving ENCP2030 goals are identified.

2.5. Data availability

EU Member States (MS) are obliged to prepare and submit data about emissions and emission sink to the European Commission. For this purpose MS prepare GHG inventory report regularly [9]. National GHG inventory report contains data on GHG emissions in 1) energy sector, 2) industrial processes sector, 3) agriculture sector, 4) land use, land use change and forestry (LULUCF) sector, and 5) waste sector. With respect to the LULUCF indicators MS are obliged to report emissions and CO2 sink, and should not allow double accounting of CO2 sink units if the sink has taken place in more than one sector at the same time.

Following data sources have been used on GHG emissions and emission sink in agriculture and LULUCF sectors:

1. Eurostat;
2. European Environmental Agency;
3. Latvia's National GHG emission Inventory report and carbon dioxide sink (in accordance with the UN FCCC reporting mechanism).

3. ANALYSIS OF NECP2030 POLICY MEASURES

3.1. RV 8 – Effective use of resources and reduction of GHG emissions in agriculture (12 activity groups)

Data and progress of EU Member States in reducing GHG emissions in agriculture sector should be viewed in the context of the EC Communication (COM2006)508) on establishing agri-environmental indicators (within the framework of the Common Agricultural Policy of the EU) as the principles included in the Communication are the ones to consider when forming agricultural policy, which respects environmental aspects of agricultural activity [8]. NECP2030 activities in agriculture sector should be assessed from the point of view of these principles as well – how and to what extent are the activities included in NECP2030 RV 8 going to facilitate reaching the set goals.

The EU is developing its agriculture sector within the framework of Common Agricultural Policy (CAP). Inclusion of environmental issues into CAP is a dynamic process, which requires permanent monitoring and control. Agri-environmental indicators are the main control instrument that allows assessing whether agricultural activity respects EU environmental and climate goals. Agri-environmental indicators serve several political goals [8]:

1) Ensure availability of information about the current situation and changes in agricultural environment;
2) Reflect the impact of agriculture on environment;
3) Assess the impact of agricultural and environmental policy on environmental management of farms;
4) Influence decisions pertaining to agriculture and environment;
5) Provide information to society about relations between agriculture and environment.

A system of indicators has been created for the sake of data feasibility and traceability, that reflects the development of CAP including interaction with environment and climate [10]. The main task of the coordinated system of agri-environmental indicators is to show the main positive and negative environmental impact of agriculture, and reflect the regional differences in economic structures and nature conditions in a broader EU context [11]. The EU Strategy for the Baltic Sea Region also takes note of the role of sustainable agriculture in protecting the Baltic Sea environment [12].

NECP2030 says agriculture and use of other land are emission-intensive activities, and significant part of GHG emissions occur where GHG emission reduction is difficult to implement [13]. Agriculture sector in Latvia is the second biggest GHG emission source after energy sector accounting for 24.6 per cent (2017) of the total volume of emissions [14]. Thus, emission reduction in agriculture sector is critically important to achieve reduction of the overall national GHG emissions (-6% in 2030, compared to 2005). 60% of GHG emissions in agriculture sector come from agricultural soil, 32% from animal digestive fermentation processes. 7% of emissions come from manure management, but other sources (use of carbamide, liming) are less relevant as they constitute less than 1% of the sector's emissions each. Emissions from agriculture sector in Latvia are illustrated in Figure 1 [14].

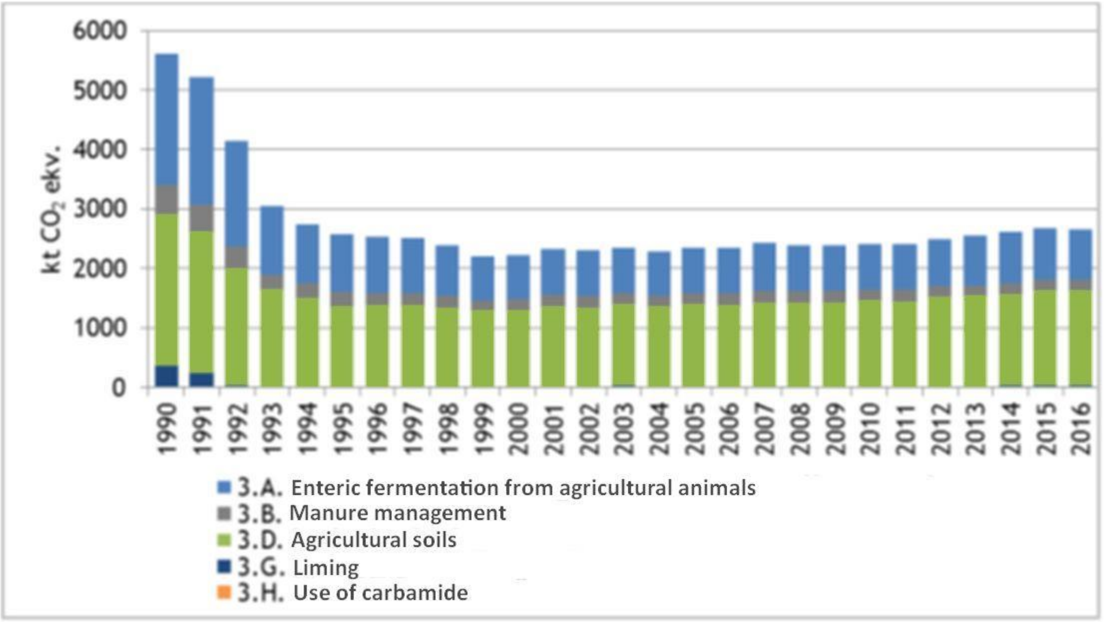

Figure 1. Agriculture sector emissions in Latvia from 1990 till 2016 (kt CO_2 equivalent) (screenshot from LVĢMC 2018 GHG Inventory summary).

EU MS have differing agricultural intensity, investment (input) in utilised agricultural area (UAA), use of fertilisers, productivity, income (revenue). There are also differences in nitrogen balance: the difference between how much nitrogen is emitted in agriculture and how much is fixated. Level of economic development characterised by GDP also differs.

Agricultural activity data points towards correlation that in those EU Member States where high intensity farming dominates, nitrogen emissions have decreased while they have increased significantly in the Baltic States. For example, nitrogen emissions have decreased in the Netherlands and Germany while increasing in countries with traditionally lower intensity farming. Thus, nitrogen emissions in Latvia have increased 2.7 times since 2002 while 2.3 times in Estonia and 1.3 times in Lithuania. Comparing total GHG emissions in agriculture sector in 1990 (5616 kt CO_2 equivalent) and in 2017 (2782 kt CO_2 equivalent), volume of GHG emissions in Latvia has decreased by half. This can possibly be explained by the fact that the intensity of farming was still higher in 1990, but agriculture sector experienced changes after 1991, which resulted in much lower farming intensity and rapid decrease of GHG emissions during the following 10 years.

It is characteristic to Latvia along with Lithuania and Estonia as well as several Central and Eastern European countries, which joined the EU in 2004, that agricultural land is managed by low and medium intensity farms (expressed by input in euro per hectare of UAA). Situation is illustrated by Figure 2 – Latvia, Lithuania and Estonia are EU Member States with the lowest ratio of intensive farming (4.1%, 3.7% and 4.4% respectively), while The Netherlands, Belgium, Germany and France have the highest ratio of intensive farming among the EU Member States.

Of countries that are similar to Latvia in terms of territory, Denmark has the highest ratio of intensive agriculture. The most radical differences however, are with The Netherlands, where the ratio of high, medium and low intensity farming is inversely proportional to the situation in the Baltic States, the share of high intensity farming constituting 88.4% of UAA [15].

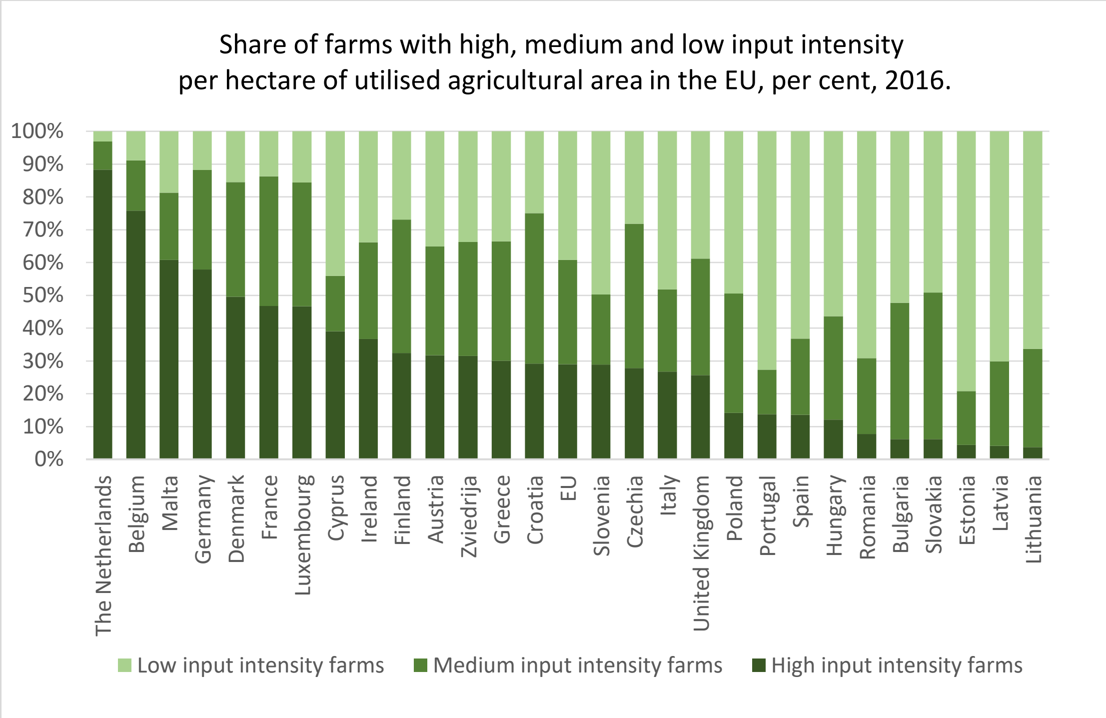

Figure 2. Ratio of farms with high, medium and low intensity input per hectare of Utilised Agricultural Area (UAA) in EU countries in 2016, expressed as per cent of total UAA (Eurostat data, [aei_ps_inp]).

Latvia's agriculture sector GHG emissions have increased by 16.7% in 2017 compared to 2005. Increase of emissions during this period of time has been stimulated mainly by growth of crop production indicators as sown area and fertiliser use has increased [14].

3.2. Special role of nitrogen

It was indicated earlier that nitrogen has a special role among agri-environmental indicators: not only it is the most widely used fertiliser for increasing agricultural productivity, it also has significantly higher environmental impact than other types of GHG emissions – one kilogram of nitrogen oxide (N_2O) is equivalent to 298 kilograms of carbon dioxide (CO_2) [16]. NECP2030 also points out that management of organic soils and use of nitrogen fertilisers are key sources of GHG emissions related to agricultural tillage [13]. When in water nitrogen facilitates eutrophication and worsening of water quality not only in direct proximity of UAA, but also in those water bodies where the contamination gets with the stream – in inland lakes, the Riga Gulf, and the Baltic Sea. To decrease eutrophication processes in the Baltic Sea The Convention on the Protection of the Marine Environment of the Baltic Sea Area (the Helsinki Convention) restricts activities that are related to the use of nitrogen compounds also in agricultural activities [17] [18]. Latvia ratified the Convention in 1994.

Concentration of nitrogen compounds in the Baltic Sea has been decreasing gradually since 1994 although remaining seasonally high in its Southern part, and risk of eutrophication remains [19]. The desired benchmark level was not reached in 2017 yet (see Figure 3) with most of nitrogen contamination originating from agriculture sector [20].

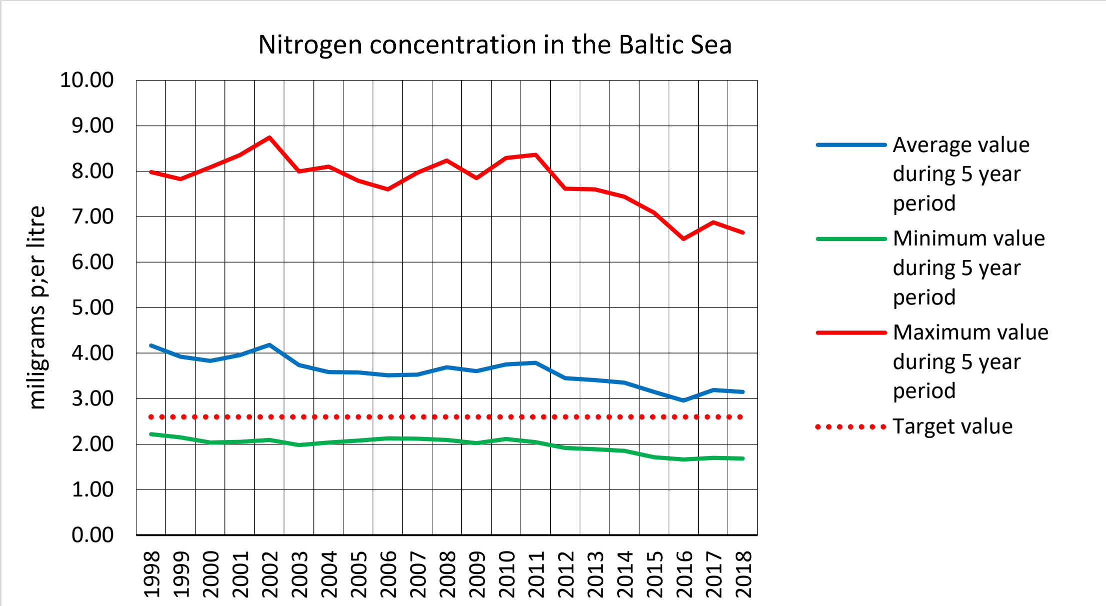

Figure 3. Nitrogen concentration in the Baltic Sea in milligrams per litre (Umweltbundesamt data).

Gross nitrogen balance as an indicator reflects the potential excess nitrogen or deficit in agricultural land. The balance is calculated between nitrogen, which is added to the agriculture system and nitrogen, which is taken out of the agriculture system. The calculation is done in kilograms of nitrogen per hectare of UAA annually.

The input side of the balance counts mineral fertiliser application and manure excretion as well as atmospheric deposition, biological fixation and biosolids (compost, sludge and sewage) input. The output side of the balance represents the removal from grassland (grazing and mowing) and the net crop uptake (removal) from arable land. The gross nitrogen balance takes an “extended soil” surface (or “land” surface) as the system boundary, meaning that it also includes nitrogen losses from animal housing and manure management (e.g. storage) systems [21].

When calculating changes in trends indicators over a longer period of time should be taken into account to avoid having extreme weather influence the calculation for a particular year. This indicator ranks Latvia and other Baltic States at the bottom end of the graph of EU countries with a comparatively good gross nitrogen balance (see Figure 4) [21]. If normalised per 100 000 inhabitants this indicator places Latvia in the middle of the graph with medium-high results (see Figure 5).

To illustrate the existing correlation between indicators or to demonstrate that there is no correlation between indicators, a group of countries were selected from among the EU Member States and included in the reference group for analysis, according to the following criteria: 1) high and low GDP per capita; 2) significant differences in the ratio of high, medium and low-intensity agriculture; 3) differing number of inhabitants; 4) differing volume of used nitrogen; 5) differing input in UAA. Following 11 countries were selected according to the criteria: Belgium, Denmark, Estonia, Finland, France, Germany, Latvia, Lithuania, The Netherlands, Sweden, United Kingdom.

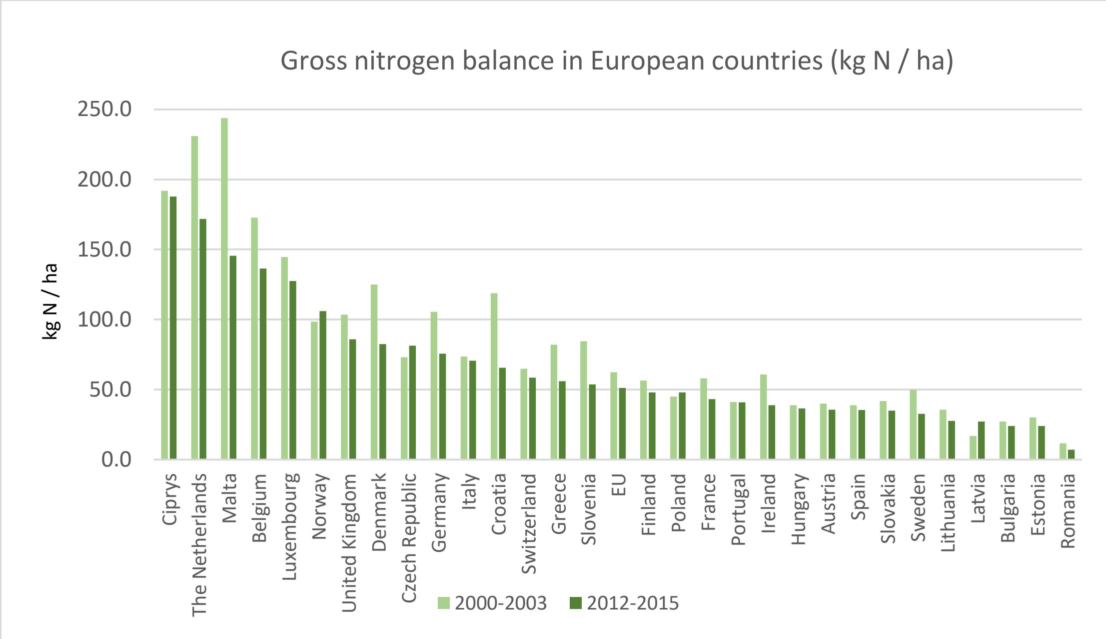

Figure 4. Gross nitrogen balance in European countries in kilograms of nitrogen per hectare of UAA (European Environment Agency, Eurostat [aei_pr_gnb]).

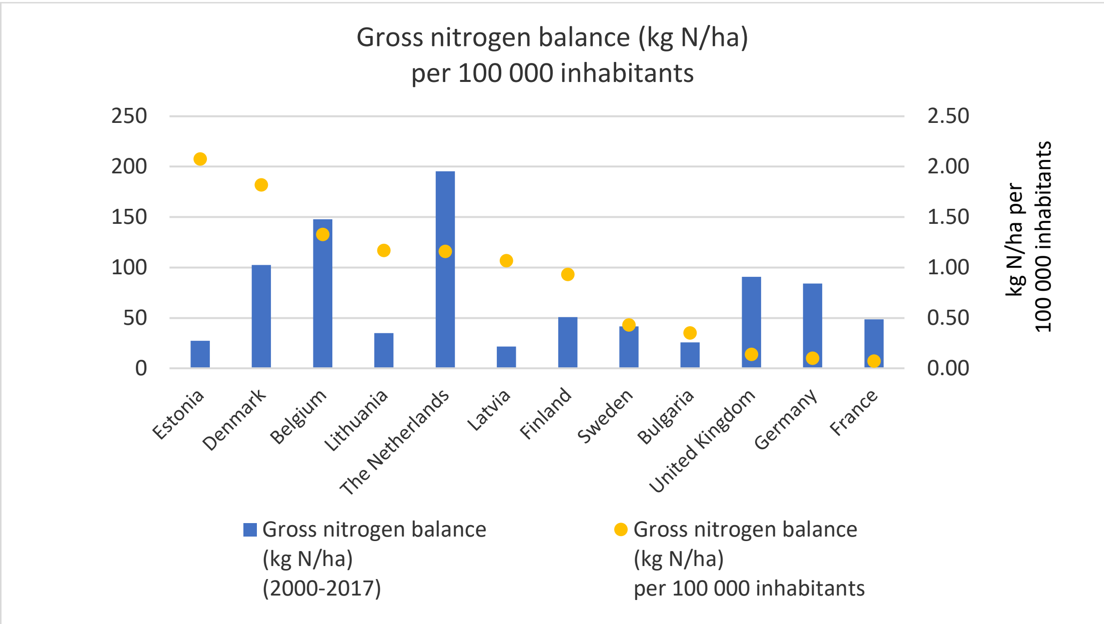

Figure 5. Gross nitrogen balance in kilograms of nitrogen per hectare per 100 000 inhabitants.

EU countries have differing input per hectare of UAA. Absolute figures expressed per 100 000 inhabitants allow drawing conclusion that indicators place countries in slightly different order than if placed according to nominal data. Differences are significant: for example, in The Netherlands and in Belgium input indicators are high both in absolute figures and per 100 000 inhabitants, while input in the Baltic States per 100 000 inhabitants is proportionally higher although absolute figures are low (see Figure 6). One could intuitively draw conclusion that there is correlation between this indicator and the level of welfare (GDP per capita), however regression analysis provided further on refutes such an assumption (see Figure 11).

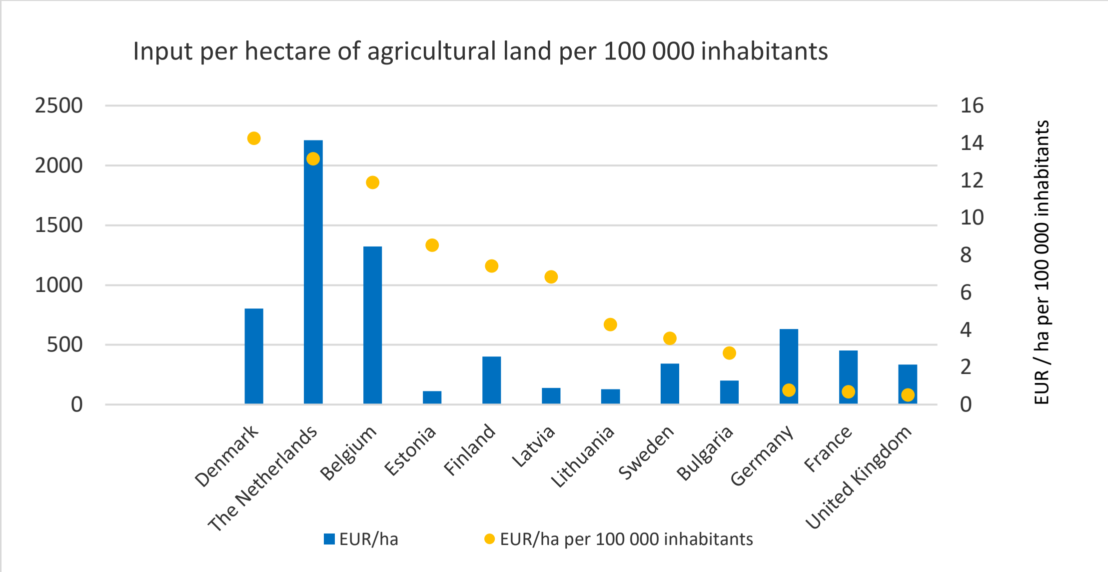

Figure 6. Input per hectare of UAA per 100 000 inhabitants.

In absolute figures the Baltic States are among EU countries that consume nitrogen fertiliser least. However, the correlation of input in euro per hectare of UAA and gross nitrogen balance Latvia's indicators are on average worse than in countries with higher ratio of high-intensity agriculture (Figure 7).

	Gross nitrogen balance	Investment in utilised agricultural area	Ratio between gross nitrogen balance and investment in utilised agricultural area
	(kg N/ha)	(EUR/ha)	(kg N/EUR)
The Netherlands	195	2 213	0,0882
France	49	454	0,1073
Belgium	148	1 322	0,1117
Sweden	42	343	0,1213
Finland	51	403	0,1257
Denmark	103	803	0,1276
Germany	84	632	0,1328
Latvia	22	139	0,1563
Estonia	28	113	0,2434
United Kingdom	91	336	0,2700
Lithuania	35	128	0,2725

Figure 7. Gross nitrogen balance (kg/ha), input in UAA (EUR/ha) and the ratio between gross nitrogen balance and input (kg N/EUR).

It is assumed that countries with GDP per capita below 18 000 EUR are low GDP countries and countries with GDP per capita over 27 000 EUR are high GDP countries (see Figure 8). When comparing gross nitrogen balance by groups of countries ranked by GDP per capita, one can conclude that in the group of countries with high GDP per capita there is no pronounced correlation between GDP per capita and gross nitrogen balance. In countries with low GDP per capita gross nitrogen balance is similar – it is lower and similar in all four countries with low GDP (Bulgaria, Estonia, Latvia, Lithuania), which is illustrated by Figure 9.

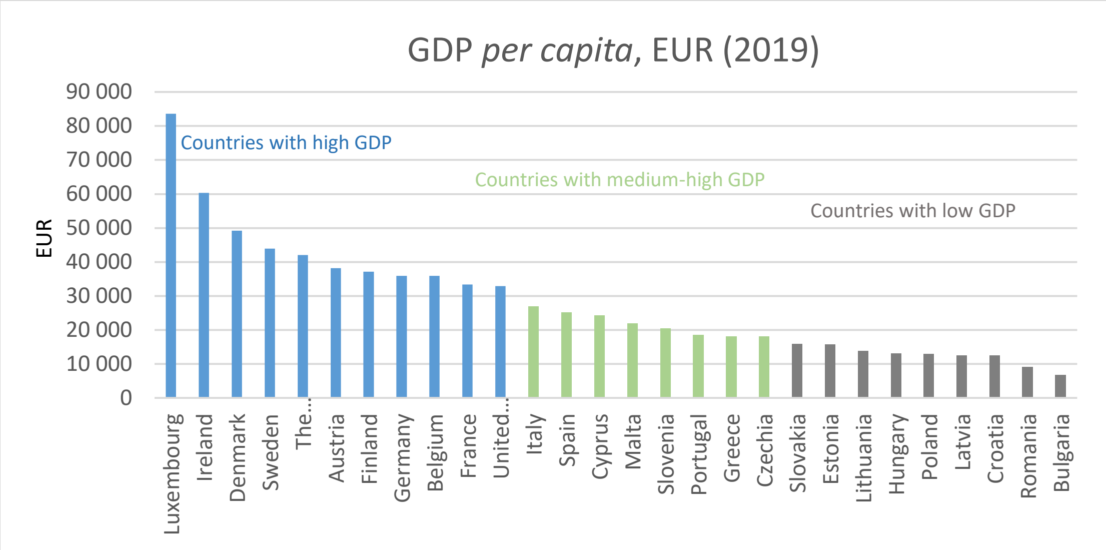

Figure 8. GDP per capita of EU countries, EUR, 2019 (Eurostat).

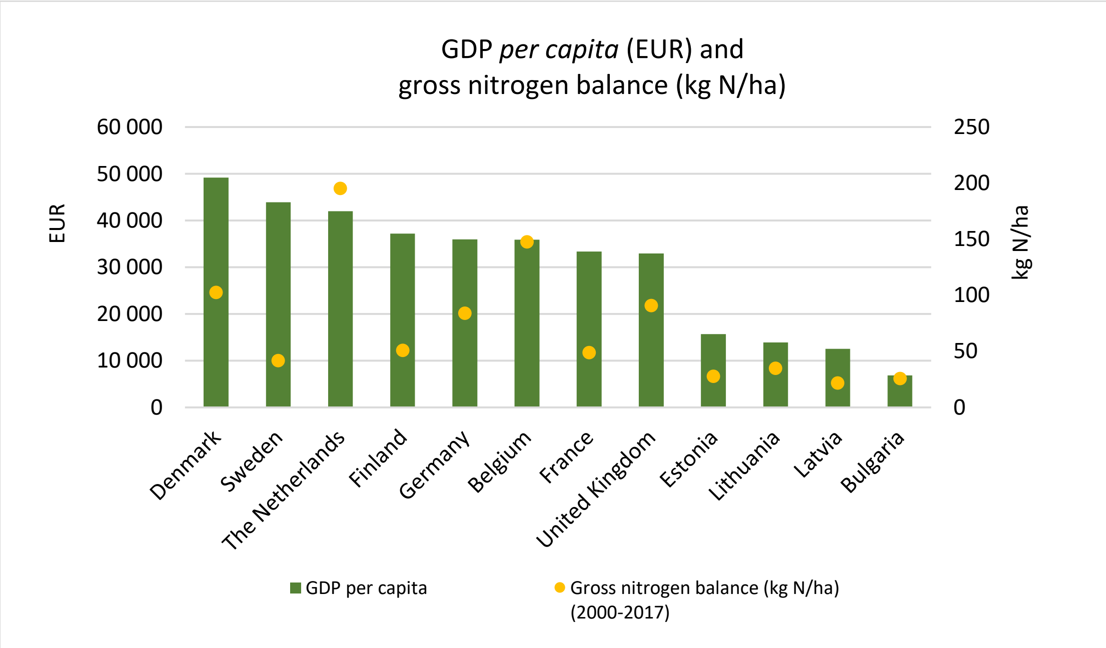

Figure 9. Gross domestic product per capita and gross nitrogen balance (Eurostat, European Environment Agency).

Regression analysis was used to establish whether there is any correlation, if at all, between GDP per capita, input in UAA and use of nitrogen. First, regression analysis shows that among the countries in the reference group there is high correlation between input in UAA and nitrogen balance: the higher the input, the higher the intensity of agricultural production and the nominally worse nitrogen balance (Figure 10).

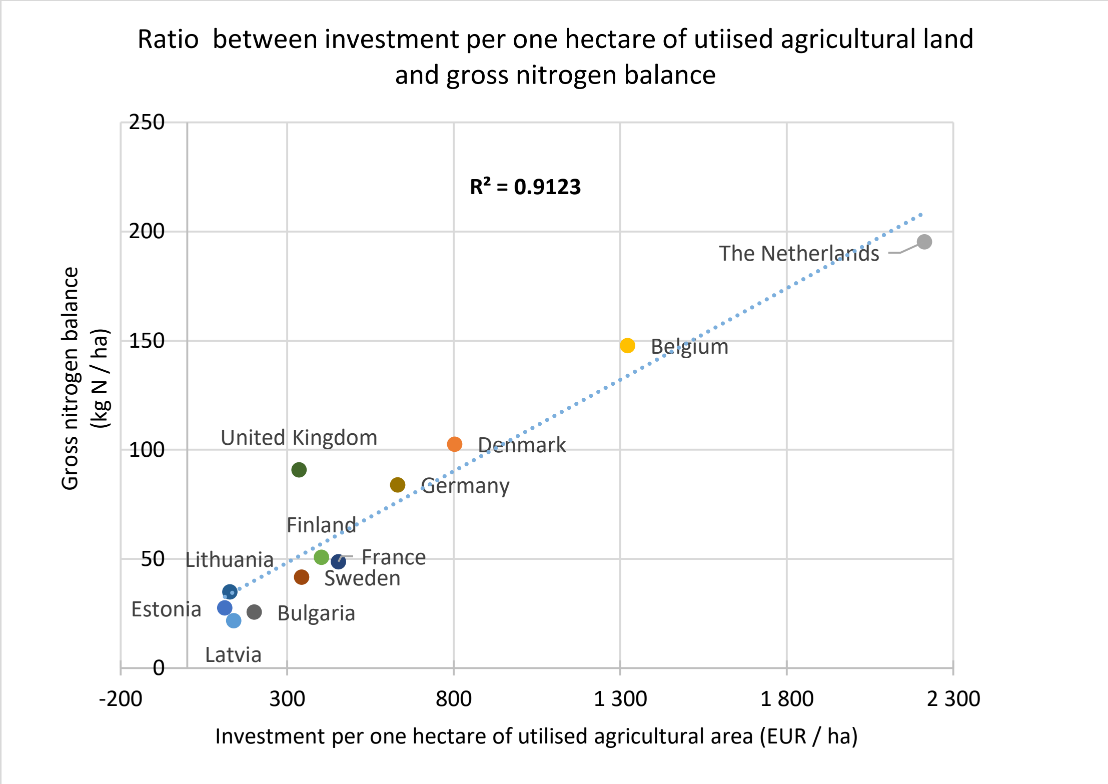

Figure 10. Ratio between input in UAA and gross nitrogen balance.

Second, high GDP per capita does not necessarily have direct correlation with input in used agricultural area (Figure 11).

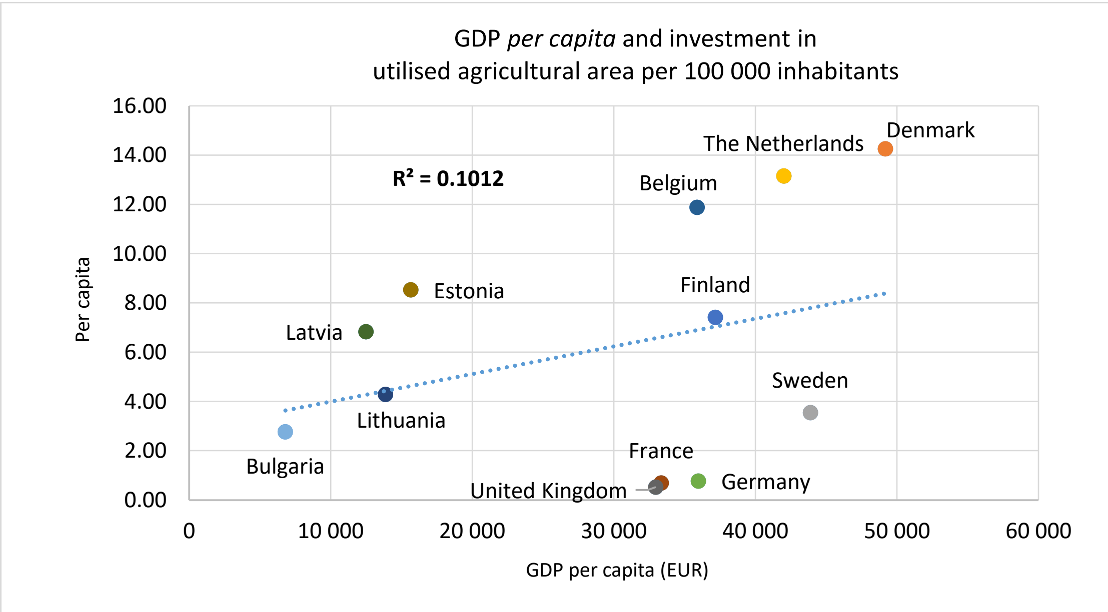

Figure 11. Correlation between GDP per capita and input in UAA.

Third, regression analysis shows no correlation between GDP per capita and volume of nitrogen per one euro invested in UAA (Figure 12).

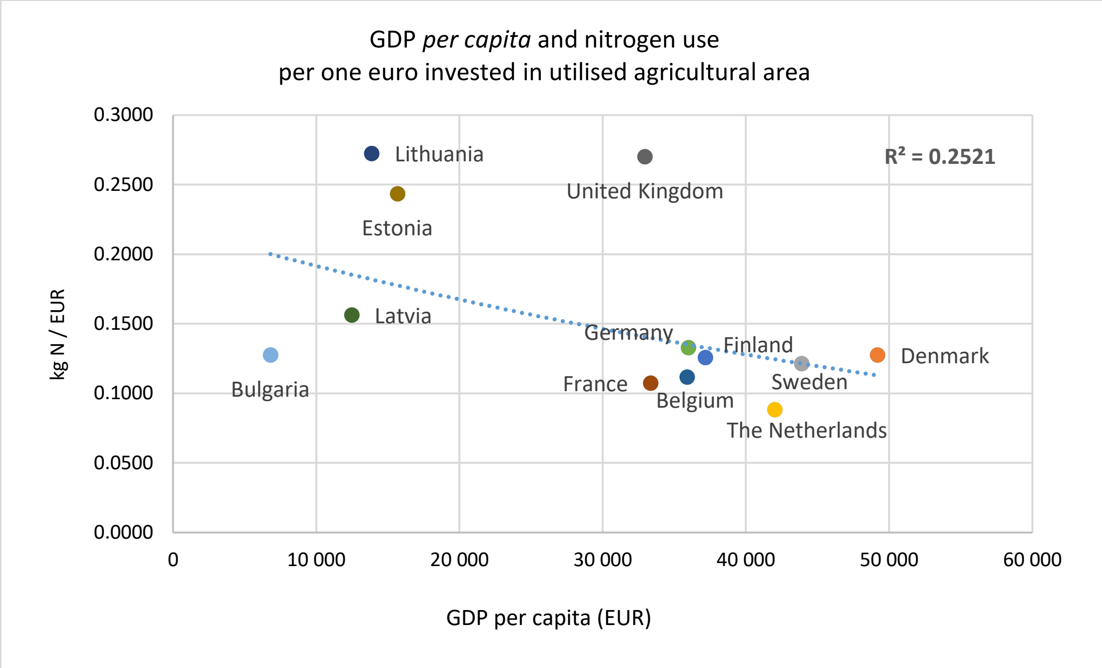

Figure 12. GDP *per capita* and use of nitrogen per one euro invested in UAA.

NECP2030 policy measures and activities under RV 8 activity direction are analysed further.

RV 8.1. Facilitate and support precise use of mineral fertiliser

Different agrotechnical methods and agricultural equipment is used to manage land and make it more fertile. Use of mineral fertilisers is a set of coordinated actions, where possibilities that information technologies provide in planning and disseminating doses of mineral fertiliser are implemented, for example, by using GPS, various sensors, software, specially developed applications, purposefully equipped dispensers and other technological solutions [22].

Precise use of mineral fertiliser has three main purposes (see Figure 13):

1) economic: reduce cost of using mineral fertiliser;

2) agronomic: maintain and increase crop productivity while not reducing the quality of soil;

3) environmental: reduce loss of mineral elements, especially nitrogen and nitrogen oxide emissions into the environment.

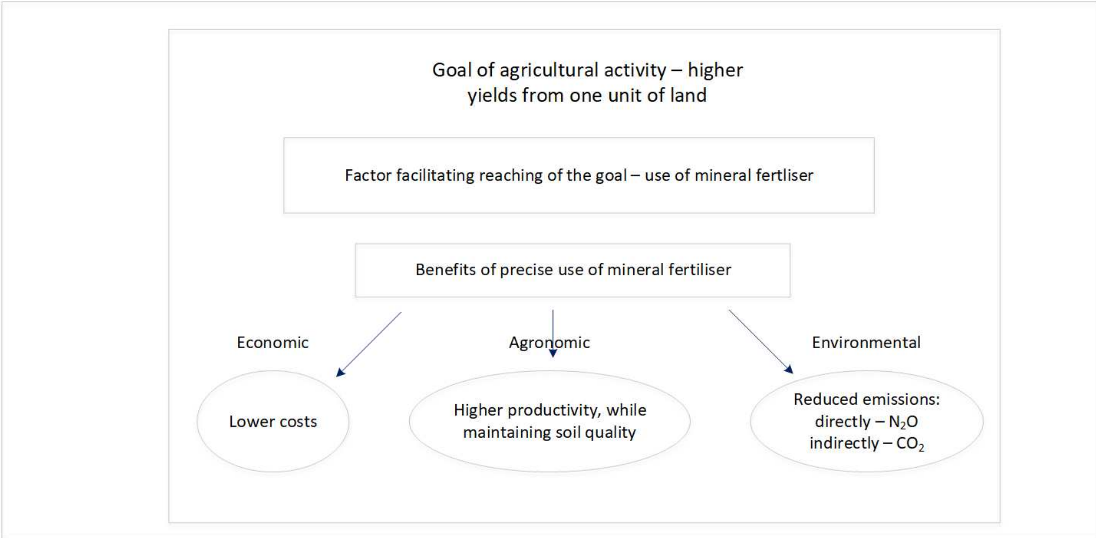

Figure 13. Purpose of precise use of mineral fertiliser.

Plants usually cannot consume all nitrogen that is incorporated in the soil. Certain competition exists between nitrogen consumers in the soil (plants, bacteria, mushrooms, etc.), nitrogen of organic and non-organic origin is subject to influence of microorganisms in the environment. Loss of nitrogen can occur during this process: it can leach from the soil in the form of nitrates and ammonia, but part of nitrogen present in the water transforms into nitrogen oxide (N_2O) and evaporates as emissions into the atmosphere. In addition, indirect CO_2 emissions occur by operating agricultural equipment and machinery to disperse mineral fertilisers and lime. Use of innovative technologies and technological solutions (like optimising the navigation route of agricultural machinery and the process of dispersing fertiliser) provides opportunity to reduce both the actual volume of required nitrogen fertiliser as well as fuel used to incorporate fertiliser into the soil, thus reducing CO_2. Emission reduction effect occurs from the reduction of use of nitrogen fertiliser. Studies in Latvia indicate that effectiveness of use of nitrogen significantly increases and the volume of used nitrogen decreases by 8% if precise use of fertiliser is applied [22]. CO_2 emissions decrease as the volume of used fuel decreases due to optimal planning of area management routes.

Use of mineral fertiliser is associated with increasing yields per one unit of utilised agricultural area. In Latvia too, the forecast increase of yields is at least partially related to technological innovation, but to a larger extent it is related to a more intensive use of mineral fertilisers [23]. The projected increase of yield productivity in 2050 is 69% compared to 2018 (growth from 3.41t/ha to 5.76 t/ha). Therefore, the implementation of RV 8.1 activities is of high importance in the context of limiting GHG emission growth.

NECP2030 RV 8.1. activity aims at elaborating rules for Cluster 2 (high intensity grain farming) farms, which constitute 0.1% of all farms, manage 9% of agricultural land (AL), manage 30% of all wheat and 10% of all rape areas nationwide with the total affected area of 65 478 hectares [13].

As the activity will target farms that manage an essential part of AL and since 3.2 million euro financing is projected to implement the activity, it can be anticipated that it is going to have a positive effect on GHG reduction including reduction of CO_2 emissions in agriculture sector.

RV 8.2. Facilitate fertilisation planning

Although fertilisation planning is not a new kind of activity planning methods can still be updated and used in practice on a broader scale. NECP2030 RV 8.2. encompasses such activities. The purpose of crop fertilisation plan is to ensure getting an economically beneficial yield while maintaining crop quality, soil fertility, and avoid loss of feed elements and environmental pollution. Plan is needed to facilitate the protection of water and soil from nitrate pollution, e.g., direct or indirect leakage of nitrogen compounds (any chemical substance or product containing nitrogen, except for gaseous nitrogen) into water or soil given such leakage threatens or can threaten human health, harms or can harm natural resources, water ecosystem and biodiversity [24].

Introduction of methods of precise use of nitrogen in a farm is a set of activities comprising soil absorption mapping, soil sampling and analysis, planning and calculation of fertiliser doses, and installation of equipment. Full-cycle technologies of precise use of nitrogen are seldom used in Latvia as they are associated with additional costs.

NECP2030 RV 8.2. activity aims at elaborating regulations for GHG emission reduction for Cluster 3 farms, which are medium-size farms with mixed portfolio of agricultural activity, which put farm animals on pasture, which constitute 25.4% of the total number of farms, and manage 46.2 per cent of agricultural land with the total affected area of 245 675 hectares [13].

Significant (9.8 million euro) financing is projected to implement the activity of RV 8.2., and it can be anticipated that it is going to have a positive effect on GHG emission reduction in agriculture sector.

RV 8.3. Facilitate and support direct incorporation of organic fertiliser into soil (liquid manure transportation via a hose system or a barrel and incorporation into soil through injectors)

The purpose of this activity is to reduce loss of nitrogen when dispersing liquid organic manure on the soil or incorporating it into the soil in farms that have liquid manure and / or slurry storage or biogas stations [25].

Manure dispersed on the field must be incorporated into the soil as soon as possible as 50 to 60% of ammonia evaporates during the first 12 hours after being dispersed. Loss of ammonia decreases if liquid manure is dispersed during crop growth and while plants are still under 20 cm in height. Government Regulations No. 834 (23.12.2014) "Requirements Regarding the Protection of Water, Soil and Air from Pollution Caused by Agricultural Activity" state that bedding manure should be incorporated into the soil within 24 hours after having been dispersed, but liquid manure and slurry – within 12 hours [25].

Research done in Denmark gives evidence that total loss of nitrogen (NH_3 and NH_4) is circa 2-3% when using disc injector and 20-35% when spraying. Direct injection service providers in Latvia estimate the loss during direct injection slightly higher at 5-7%, but also point out that the efficiency of use of liquid manure is in practice lower with loss of nitrogen being as high as 50%. The volume of evaporated ammonia is influenced by the content of dry matter in fertiliser. If it is 6% evaporation from liquid manure is by approximately 20% higher than if the volume of dry matter is 2%.

Research results in neighbouring countries reveal that the average decrease of nitrogen loss with disc injector is 70-80%, while being 35% when using tube rods. Efficiency of incorporation can also be affected by incorporation speed, wind velocity, soil moisture, precipitation, time of the day (evaporation is lower in the morning than in the afternoon). Also, loss is significantly smaller if plants are 60cm high and tube rods are used [25].

This activity targets Cluster 1 farms (high intensity farms with mixed specialisation), which keep their livestock (farm animals) predominantly inside, which constitute 0.3% of all farms, raise 23.5% of all cattle, 66.4% of all dairy cows, 88.3% of all poultry and 90.4% of all pigs in the country, with the total affected area of 8 868 hectares.

Approximately 10 million euro funding is projected to implement the activity of RV 8.3., and it can be anticipated that it is going to have a positive effect on agricultural practice and all the subsequent impacts.

RV 8.4. Biological dairy farming (emissions reducing dairy farming)

Biological products are produced by pursuing natural methods of agricultural management – not using chemically synthesised substances, like pesticides and mineral fertilisers. Healthy, natural soil with diverse flora and fauna is a precondition for such farm management, where productivity is achieved by stimulating natural life processes in the soil. Healthy and rich soil that is able to resist pests and diseases on its own is the basis for biological agriculture [26].

To continue developing biological dairy farming there is need to increase the ratio of biological dairy products to ensure that consumers have broader choice of dairy products and access to healthy food. Informing consumers about the benefits and positive qualities of biological milk and dairy products, and positive influence of human health (for example, by implementing EU information and facilitation programme for biological products, with EU and national co-financing) is essential. Local market for biological raw milk and its products should be expanded, looking for new potential places of trading possibly closer to the consumer, while at the same time maintaining open the possibility of buying biological produce in biologically managed farms [26].

Activities should therefore be implemented, which provide support in terms of technical upgrading, innovation, new products, elaboration of methods, processes and technologies, improving quality systems. It is essential that formation of new producers and cross-sector organisations, short food supply chains and participation of farmers in EU support programmes is facilitated with the ultimate goal of achieving growth in the biological farming and processing sector [26].

The purpose of this activity is to elaborate regulatory framework to ensure that 17% of the total number of dairy cows in 2020, 21% in 2025 and 22% in 2030 are part of biological dairy farming category with the total number of cows part of biological dairy farming reaching 33 352. It is anticipated that the ratio of dairy cattle will be increasing incrementally by one per cent annually until 2030.

94.3 million euro financing from EU structural funds and state budget is marked for the implementation of this activity, and it can be assumed that it is going to have positive effect on sustainable development of agriculture sector.

RV 8.5. Facilitate planning of feed rations

The purpose of planning feed rations is to optimise nutrient content in the feed ration according to the needs of agricultural animals, their weight, productivity, age, sex and reproductive status. A balanced and wholesome diet improves animal health and increases productivity [27]. The NECP2030 activity will cover more than 90% of all dairy cows and improve results of agricultural activity.

It should be noted that this activity is not estimated to have an environmental impact – it aims at a more optimal cattle farming and increasing milk yields. An indirect influence is possible through increasing herd reproductive rate and decreasing the number of dairy cattle required to produce the desired milk yield, thus also decreasing GHG emission volume from cattle farming.

The purpose of the activity of NECP2030 RV 8.5. is to elaborate rules for Cluster 1, 3 and 4 farms, covering 31 408 dairy cows. Cluster 1 covers high intensity farms with mixed specialisation, which keep their cattle mostly indoors, and which constitute circa 0.3% of all farms and breed 66.4% of all dairy cows. Cluster 3 covers medium size farms with mixed specialisation, which put farm animals on pasture, constitute 25.4% of all farms and breed 20.7% of all dairy cows. Cluster 4 covers biological farms, which constitute 4.2% of all farms and breed 7.5% of all dairy cows [13].

4.7 million euro financing from EU structural funds and state budget is marked for the implementation of this activity, and it can be assumed that it is going to have positive effect on development of agricultural methods and application in dairy farming.

RV 8.6. Facilitate feed quality improvement

The purpose of this activity in the context of common goals of the NECP2030 is to decrease methane (CH_4) emissions from farming as cattle farming is one of the biggest sources of methane emissions. This activity can have the best effect in conjunction with RV 8.5. (planning of feed rations).

Cows, sheep and goats lose 2-12% of gross feed energy or 89-12% of digestible energy with methane. Loss of methane can reach 3-7% of gross feed energy in high intensity (conventional) cattle farming. Most of research on emissions is dedicated to dairy cows as they produce at least 50% more CH4 emissions per animal than any other groups of cattle. Calves start emitting methane only at approximately 4 weeks of age when their digestive tract begins to digest feed fibres. Fermentation and emission of methane depends on the development of calf's pancreas [28].

The quality of cattle feed, level of concentrates, digestibility of feed and feed rations are all mutually interrelated and have direct influence on the production of intestinal methane (CH_4) in the rumen. The quality b of roughage significantly influences methane production: if digestibility of roughage is low, then the volume of methane increases. Increasing the quality of roughage facilitates uptake of feed and decreases the time it spends in the rumen, thus stimulating a more effective use of energy in the further processes of feed digestion and proportionally decreasing the energy that is converted into methane [28].

The activity aims at elaborating regulations to cover Cluster 3, Cluster 4 and Cluster 5 farms covering 20 300 dairy cows in total. Cluster 3 (medium-size mixed specialisation, put agricultural animals on pasture) farms constitute circa 69.8% of all farms and breed 20.7% of all dairy cows. Cluster 4 (biological farms) cover 4.2% of all farms and breed 7.5% of all dairy cows. Cluster 5 (backyard farms) cover 4.2% of all farms and breed 5.4% of all dairy cows [13].

No indication of potential financing for this activity was indicated in the NECP2030 version, which was published in January 2020, however, EU structural funds were mentioned as the potential source of financing.

RV 8.7. – Reduction of indirect NO_2 loss through improved maintenance of drainage systems in agricultural land

The purpose of this activity is to elaborate regulations that would relate to all clusters of farms covering approximately 100 000 hectares of land in total. Land drainage is a land improvement that decreases the negative impact of climate conditions and facilitates sustainable use of natural resources.

Under Latvia's climatic conditions introduction of drainage systems ensures uptake of excess moisture from used agricultural areas laying ground for rational and economically justified agricultural activity. Drainage systems decrease soil moisture and the level of groundwater allowing effective tillage, crop sowing, fertiliser spreading, using of plant protection products and crop harvesting. Uptake of excess moisture from agricultural fields facilitates crop development and ensures higher and smoother crop yields compared with undrained fields [29].

Regular renovation and maintenance of drainage systems requires financing. 230 million euro from public sector sources (state budget, EU funds, etc.) have been invested in renovation and maintenance of drainage systems since 2007. Maintenance of state and state importance drainage systems are financed from state budget. Financing has increased over recent years maintenance works, however, have covered only approximately 10% of the total length of water drainage systems and 25% of the total length of protective dams. Although drainage system maintenance works should be planned according to requirements for drainage system usage and maintenance, actual work in Latvia is done not according to the need, but according to the available financing [29].

Approximately 500 million euro financing from EU structural funds and state budget has been marked for the implementation of this activity, and it can be anticipated that the activity is going to have positive impact on sustainable development of agriculture sector provided that activities in other NECP2030 RV 8 activity groups that are related to fertilisers being incorporated into soil and leaching from soil into water are implemented successfully, preventing, for example, leaching of nitrogen fertiliser into water bodies.

RV 8.8. Facilitate integration of legumes in crop rotation to facilitate nitrogen uptake

Legumes create symbiotic relations with bacteria in the soil, which significantly increases uptake of atmospheric nitrogen in soil, and ensures nitrogen storage in the soil for the crop, thus decreasing the need for additional nitrogen in the following season. Legumes as an interculture ensure accumulation of mineral nitrogen compounds in the biomass during Autumn and Winter period thus decreasing the leaching risk. Incorporating this biomass in Spring just before sowing the next crop improves the crop's supply with nutrients and decreases the need for additional fertiliser. The amount of mineralised nitrogen during vegetation period can reach 60 kg per hectare [30].

Integration of legumes in crop rotation is one of five land fertility improving activities along with the maintenance of drainage systems, liming of sour soils, minimal tillage and growing of green manure crops [31].

Regulations will be elaborated for Cluster 1, Cluster 2 and Cluster 3 farms, which together constitute 26% of all farms in Latvia and cover 172 331 hectares or 70% of all agricultural land [13].

As the activity is aimed at farms managing a significant share of agricultural land and 95.6 million euro financing has been marked for this purpose from EU structural funds, state budget and private sources it can be anticipated that implementation of this activity is going to have impact on agriculture sector.

RV 8.9. Create a map of peat soils on agricultural land

Belonging of a soil the group of organic soils has significant impact on the volume of emissions during production of agricultural products. For example, average amount of GHG emissions from agricultural production on non-organic soils (other soils) was 2 tons of CO2 equivalent per 1000 euro worth of produce in Latvia in 2016. Situation differs with hydromorphic soils where GHG emissions per 1000 euro worth of produce correspond 21.9 tons of CO2 equivalent. Creation of peat soil map will facilitate a more effective planning of use and management of soil [32].

Soil mapping with special attention dedicated to the mapping of peat soils shall be looked at in the context of land use and possible land use change assessing whether land use change is beneficial from the point of view of GHG reduction. If the use of land is changed from agriculture to forestry emissions from this soil are no longer regarded as emissions from agriculture, and emissions from organic soils of forest are not calculated currently. Considering that emissions from organic soils are significant, and not all the agricultural land is used for agricultural production, such land use change would provide opportunity to reduce agricultural emissions. Methodology of calculation of GHG emissions can change in the future, and it can turn out that change of land use is not beneficial from GHG emission reduction any more [32].

The activity would result in an elaborated agricultural soil map. No impact on environment is anticipated, but impact on agriculture sector would be indirect through providing information to farmers about the distribution of specific soils, which allows better planning of tillage considering specific characteristics of soils. 450 000 euro of state budget funding has been marked for the implementation of this activity.

RV 8.10. Support and facilitate broader use of undersowing in cereal sowings

Undersowing is used to enhance the positive effect of plant rotation and to improve the quality of crop yield by decreasing the viability of several varieties of weeds most widespread in agriculture [33]. Activity aims at elaborating regulations to ensure a more widespread use of undersowing in agricultural management as using undersowing increases nitrogen sink [34].

New opportunities to decrease the negative effects of agricultural activity on environment open up with the improvement of growing technologies of plants sown as undersowing, as well as with variating the density of sowings, choosing correct sowing time for specific crop varieties, considering soil fertility indicators and field conditions [35]. Such farm management is especially important in the context of developing biological farming [36].

Supply of nitrogen is the key factor in increasing cereal yield. When growing cereals and using legumes as undersowing, the required nitrogen can be supplied for free as it is absorbed from the atmosphere. In practice, however, it is often difficult to keep the balance in competition between the basic crop (traditionally – one of the Summer cereal varieties) and undersown plant (usually a mix of legumes and grasses) according to the factors required for crop development. As a consequence, the yield from the fields with undersowing is smaller than from the fields without undersowing. At the same time soil without undersowing becomes less fertile as the crops do not absorb atmospheric nitrogen, and thus does not contribute to nitrogen fixation and better growth of subsequent crops.

Biological fixation of nitrogen closely correlates with the biomass of plants – the bigger the biomass of legumes, the more nitrogen is fixated from the atmosphere. It means that farmers should think about ensuring good growth conditions also for the legumes sown as undersowing to ensure sufficient legume biomass.

The activity will relate to 17 500 hectares of agricultural land. No financing has been marked for the implementation of this activity, but EU structural funds and state budget have been indicated as the potential sources of financing.

RV 8.11. Support and facilitate use of green fallow prior to sowing winter crops

Green fallow is used to improve soil fertility and an effective control of weeds by introducing fallow in the rotation scheme of several (usually 5 to 6) fields.

The activity aims at elaborating regulations to ensure that the green fallow prior to winter crop sowing increases nitrogen sink. The activity would cover 100 858 hectares of agricultural land. No precise amount of financing has been indicated, but state budget and EU structural funds are identified as the potential sources in the NECP2030 version as of January 2020.

RV 8.12. Support development of innovative technologies and solutions to facilitate resource efficiency, GHG emission reduction and increase CO2 fixation in agriculture

Resource efficiency is one of eight areas, which will have to implement the principles incorporated in the Low Carbon Development Strategy. The activity provides that funding from EU structural funds and other sources will be used for following activities: 1) Support research, technology development and demonstration projects to increase resource efficiency, reduce GHG emissions and increase CO_2 fixation in agriculture, including public procurement, which is able to function under market conditions; 2) Support development of new technologies and innovative solutions to increase resource efficiency, reduce GHG emissions and increase CO_2 fixation in agriculture, including public procurement, which is able to function under market conditions; 3) In-kind support to facilitate mutual cooperation of between commercial enterprises, higher education institutions and research organisations state and municipal institutions, NGOs and other stakeholders to implement innovative solutions in agriculture with the purpose of increasing resource efficiency, reduce GHG emissions and increase CO_2 fixation in agriculture [13]. State budget and EU structural funds have been identified as the source of financing, but the amount of financing has not been marked at the beginning of 2020.

3.3. Main conclusions about agriculture sector

It can be concluded that use of nitrogen as an important fertiliser in Latvia does not provide the desired result. Latvia is among EU member states with the lowest ratio of high and medium intensity farming, and increasing agricultural productivity is associated with a more intense use of fertiliser and land tillage. Raising agricultural productivity by increasing use of fertilisers is a development trajectory associated with risks.

As nitrogen is a critically important fertiliser element, which facilitates growth of the mass of agricultural crops, a more intense use of fertiliser will increase the presence of nitrogen compounds in the soil and in the atmosphere and leaching into water thus having negative impact on environment.

From such a point of view activities included in NECP2030 RV 8 are directed towards decreasing negative impact on environment of the agriculture sector. However, the goals of increasing productivity and increasing income in the agriculture sector create risks that it may not be enough with the activities included in the NECP2030 for achieving the desired environmental goals. Eight out of 12 activity groups can be identified as a *stick*, eight as a carrot, and four – as hugs. From this perspective balance has been maintained between positive stimuli and compulsory activities.

4. RV 9 – SUSTAINABLE USE OF RESOURCES, REDUCTION OF GHG EMISSIONS AND CO2 FIXATION IN LAND USE, LAND USE CHANGE AND FORESTRY SECTOR

Data about emissions in the land use, land use change and forestry (LULUCF) sector reveals a trend that the volume of CO_2 fixated in the sector has been decreasing since 1994 (Figure 14). Reasons for this are associated mainly with forest land where the structure of varieties of trees and their age has changed due to natural causes and due to forest management [13].

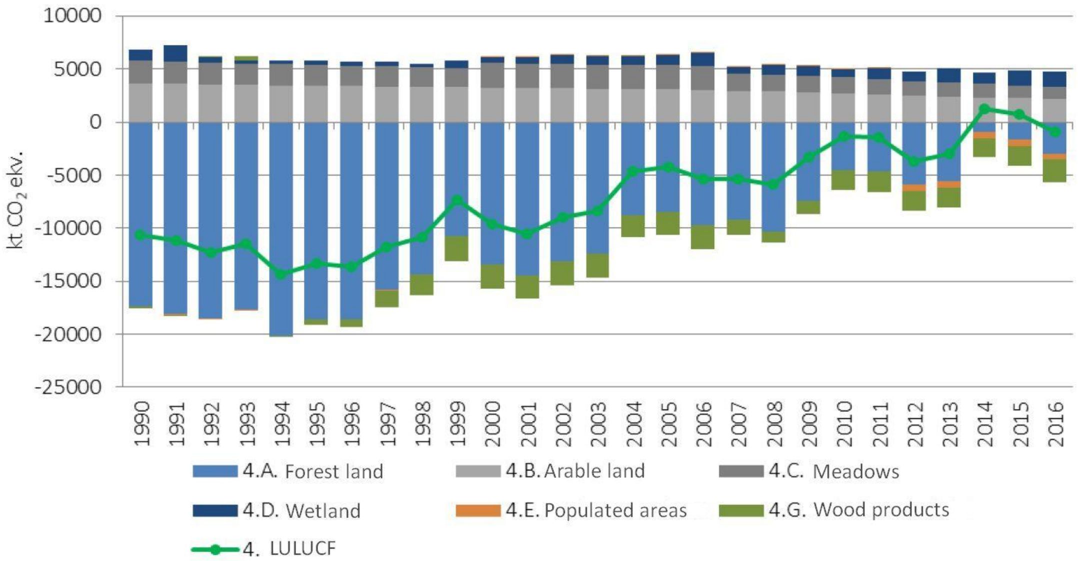

Figure 14. Latvia's actual net fixation of GHG emissions and CO_2 in 1990-2016 (kt CO_2 equivalent) (NECP2030 data and visualisation).

A separate set of activities in NECP2030 is dedicated to LULUCF sector. It has 12 groups of activities encompassing 14 activities in total. Figure 15 lists activity subgroups and identifies the activities according to the *hugs, carrots and sticks* principle and reflects whether a particular activity has impact on environment.

	Activities (by type)					Environmental impact according to SIEA	
Sphere of Activity	Activity group	Activities, in total	A (*hugs*)	B (*carrots*)	C (*sticks*)	Activity group has Positive / Negative impact	Activity group has No impact

RV 9. Sustainable use of resources and reducing GHG emissions and increasing CO2 sequestration in land-use, land use change and forestry sector	12	14	5	10	1	4-8, 11	1-3, 9, 10, 12
RV 9.1 When planning forestry sector development ensure that the total area of forests does not become smaller		1	1	0	0		No
RV 9.2 Support creation of new orchards		1	1	0	0		No
RV 9.3 Improve forest growth and the quality of forest stands in naturally afforested areas		1	0	1	0		No
RV 9.4 Facilitate replacement of unproductive forest stands with low carbon fixation		1	0	1	0	Positive	
RV 9.5 Facilitate renewal of forest stands destroyed by natural disasters		1	1	0	0	Positive	
RV 9.6 Facilitate care felling of young-growth stands		1	0	1	0	Positive	
RV 9.7 Improve the quality of forest land and land used in forestry		2	1	2	0	Positive	
RV 9.8 Facilitate recultivation of historic peat extraction sites by choosing the most appropriate recultivation method		2	1	1	0	Positive	
RV 9.9 Facilitate use of timber in construction industry		1	0	1	0		No
RV 9.10 Facilitate the principle of cascading in the use of timber and biomaterials		1	0	1	0		No
RV 9.11 Increase forest stand productivity by 25% by 2050 compared to 2018		1	0	1	1	Positive	
RV 9.12 Support development of innovative technologies and solutions to facilitate resource efficiency, GHG emission reduction, increase CO2 fixation in forestry activities		1	0	1	0		No

Figure 15. Activity groups of the LULUCF sector and their identification according to type of activity (*hugs, carrots and sticks*).

The goal of NECP2030 policies is to achieve a situation when LULUCF sector contributes to the reduction of climate change. Conclusions of the European Council "About the Framework for Climate and Energy Policy till 2030" (FCEP2030) sets out that the EU will reduce its GHG emissions at least by 40% and this reduction will cover 100% of EU emissions including the LULUCF sector.

4.1. Accounting principles

EU LULUCF Regulation [37] provides that each Member State must ensure that after applying the accounting rules listed in the Regulation and using the flexibility options no net GHG emissions occur in the Member State's LULUCF sector – the total CO_2 fixation in the sector is not smaller than the sector's GHG emissions.

From the point of view of data accessibility EU Member States are obliged to prepare and maintain accounting that reflects GHG emissions and CO_2 fixation, which occurs in land accounting categories referred to in Article 2 of the LULUCF Regulation [37]. Member States are obliged to keep complete and correct registry with all data that is used in emission accounting. GHG emissions and CO_2 fixation may not be accounted for twice – GHG emissions and CO_2 fixation, which occurs in several categories must be accounted for in one category only. Statistically GHG emissions and CO_2 fixation, which occurs from land that is changed into forest land, arable land, wetlands, residential areas and other types of land, shall be accounted as belonging to the category into which it has been changed 20 years after the change has taken place. For example, GHG emissions and CO_2 fixation, which occurs from grassland that is changed into arable land will be accounted for as arable land 20 years after the change took place.

Member States should indicate all changes in carbon savings for each land accounting category that have occurred in carbon sinks referred to in the LULUCF Regulation. Those carbon savings' changes in carbon sinks may be excluded from accounting, where carbon sink is not the source, except for cases when the sinks are above-land biomass and felled wood products in managed forest land.

Following principles should be taken into consideration in LULUCF accounting according to Article 6, 7 and 8 of the LULUCF Regulation:

1) GHG emissions and CO_2 fixation in deforestation and afforestation accounting categories is summed. To fulfil the non-emission requirement CO_2 fixation resulting from afforestation should be higher than GHG emissions resulting from deforestation, or emissions that have occurred in this accounting category have to be covered by additional fixation in the required amount in other accounting categories.

2) GHG emissions and CO_2 fixation in managed arable land and grassland is calculated vis-à-vis the total level of GHG emissions and CO_2 fixation in 2005-2007.

To fulfil the non-emission requirement total GHG emissions and CO_2 fixation (during the period of 2021-2025 and 2026-2030) in managed arable land and grassland categories should not exceed the total level of GHG emissions and CO_2 fixation in 2005-2007, or emissions that have occurred in this accounting category have to be covered by additional fixation in the required amount in other accounting categories.

3) Generating forest management related GHG emission units or CO_2 fixation units is calculated against a reference level calculates according to certain rules. To achieve non-emission requirement forest reference level must be reached in forest accounting category, or emissions that have occurred in this accounting category have to be covered by additional fixation in the required amount in other accounting categories.

4.2. Accounting rules for afforested land and deforested land

EU Member States register GHG emissions and CO_2 fixation, which has occurred in an afforested and deforested land during time periods 2021-2025 and 2026-2030 as total GHG emissions and CO_2 fixation each year.

Member States can transfer arable land, grassland, wetland populated areas and other land from a category that has been changed into forest land (afforested land) the category, which is forest land that will stay forest land 30 years (instead of 20) after having been changed. In other words – exception clause of the 30-year transition period refers to afforestation activity, but in the case of deforestation 20-year period laid down in Paragraph 3 of Article 5 of the LULUCF Regulation is applied. Application of this value (30-year period, that is) instead of the default value has to be properly justified in the GHG report submitted by states under the obligations of the UN Framework Convention on Climate Change (UNFCCC) reporting mechanism in accordance with the guidelines of the Intergovernmental Panel on Climate Change.

4.3. Accounting rules for managed arable land, managed grassland, managed wetlands

Member States register total GHG emissions and CO_2 fixation that has occurred in managed arable land and managed grassland. GHG emissions and CO_2 fixation from land that has been changed into managed arable land and managed grassland of from this category into other categories is also accounted for under these categories. Afforested and deforested land does not fall under this rule as it is accounted for in a separate category of its own.

GHG emissions and CO_2 fixation is calculated from total GHG emissions and CO_2 fixation that has occurred during the period of 2021-2025 and 2026-2030, by deducting the value that has been obtained by multiplying by five the average annual GHG emissions and CO_2 fixation coming from the managed arable land and grassland of the Member State in the basis year in 2005-2007. Thus, total CO_2 fixation and GHG emissions in each five-year period is compared with the average total CO_2 fixation and GHG emission volume in 2005-2007 multiplied by five.

4.4. Main conclusions about the LULUCF sector

According to the inventory report submitted by Latvia under the UNFCCC reporting mechanism the biggest reduction of CO_2 fixation in Latvia has taken place and continues in forest management sector. Although the total forested area in Latvia has doubled compared with the first half of the 20th century, and the total wood stock in the forest has increased almost three times [38], CO_2 fixation has experienced a pronounced trend of decreasing between 1994 and 2014 stabilising and fluctuating at around zero balance after 2015. This situation illustrates that the age and variety structure of the wood stock has changed in favour of an increasing ratio of old or very young trees and less valuable tree varieties. Several of the 12 activity groups of the NECP2030 activity direction RV 9 are related to increasing wood stock and correction of the structure of wood varieties although the impact from these activities would be felt with delay as forest needs to be planted and has to have some time to grow.

Authors of this analysis are of the opinion that a risk exists of Latvia not being able to sustain positive CO2 fixation balance as the NECP2030 RV 9 policy measures pertaining to forest management activities (RV 9.1, RV 9.3, RV 9.4, RV 9.11, see Figure 15) aimed at increasing the wood stock and changing its structure and which have the best potential of changing the current CO2 fixation reduction trend are not of compulsory nature – so called *hug* and *carrot* type activities dominate, which do not imply any obligations or duties. In other words – there are no measures among the NECP2030 activity cluster 9 (RV 9) policy instruments that would not only create opportunities and ensure availability of financing, but would also imply obligation to exercise forest management model, which allows satisfying the commercial interests of forest owners [39] [40], but would also ensure that Latvia fulfils its NECP2030 LULUCF sector obligations.

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