Central Statistical Bureau of Latvia

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"Modernization of Agricultural Statistics"
(08441.2017.008-2018.0215)

Latvia

Final Report

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1 Executive summary

The Final Report of EU Grant Agreement "Modernisation of Agricultural Statistics" (08441.2017.008-2018.0215) includes description of the project activities in line with the activities foreseen in the grant agreement as well as summarises the implementation of the activities foreseen with regard to the objectives.

The project was started in 3 July 2018 and lasted for 24 months. Its main aim was the improvement of methodological processes of acquisition of agricultural statistics, to successfully implement and carry out principles of producing new integrated farm statistics according to the European Union Strategy for Agricultural Statistics for 2020 and in the future and Regulation (EU) 2018/1091 of the European Parliament and of the Council, as well as guaranteed statistics within the framework of ESS agreement. This is needed to monitor related policies, especially community's policy on agriculture and rural development, as well as environmental policy and policy that is aimed to adjustment to climate changes and reduction of its consequences, EU land use policy and sustainable development goals.

Activity 1: Within the framework of "Improvement of methodological processes for implementation of the new Integrated Farm Statistics (IFS)", a register survey was organized, where farms on which there is no information available in administrative data sources and which are not surveyed since Agricultural Census 2010 were surveyed, to update information of Statistical Farm Register (hereinafter – SFR). Information from the new administrative data sources was analysed – databases of State Revenue Service (SRS) and Register of Enterprises of the Republic of Latvia, to look for new data sources for provision of statistical information on persons employed in agriculture. Methodology and results of research are reflected in this report.

Activity 2. "Gross Nutrient Balances (GNB) Calculation in Accordance with ESS Agreement on Nutrient Budgets, Adapted for Latvian Situation" includes the study of methodology, identification of data sources, revision of updating coefficients to be used for the GNB calculations, including possibility to use new additional coefficients. An analysis of the current balance for the 2018 and suggestions for possible improvement and optimization of GNB calculations methodology, according to the situation of Latvia, have also been included in this report.

Activity 3. "Participation in seminar on modernisation of agricultural statistics" includes information about participation in the workshop "Modernisation of agricultural statistics", that was organized by Statistics Poland and Statistical Office in Olsztyn as a part of the project "Modernisation of agricultural statistics" and took place in Olsztyn (Poland). Experience gained and activities planned are reflected in the report.

2 Introduction

Aiming to modernise acquisition of data and improve quality of agricultural statistics, Central Statistical Bureau of Latvia (CSB) is participating in this Eurostat grant project, thus aiming to ensure timely and efficient adaptation to changes in EU legislations on agricultural statistics.

The Grant project "Modernisation of Agricultural Statistics" includes three activities:

> **Activity 1:** "Improvement methodological processes for implementation of the new Integrated Farm Statistics (IFS)". The main objective of the action is to get ready for implementation of new IFS Regulation, including updating of SFR and testing of possibility to use new data sources for data provision of Agricultural Census 2020.
>
> **Activity 2:** "Calculation of Gross Nutrient Balances (GNB) in accordance with ESS Agreement on Nutrient Budgets, adapted for situation in Latvia". The main goal of this activity is to ensure fulfilment of ESS Agreement on Nutrient Budgets by providing basis of nutrient budgets calculations made by Latvia itself.
>
> **Activity 3:** "Participation in seminar on modernisation of agricultural statistics". The main objective of the activity is to exchange good practises, opportunities and plans related to the modernisation of agricultural statistics in EU.

Further sections of the report describe aims reached, tasks and main conclusions of each activity. The project was implemented in line with the activities planned and the goals set for the project were met.

3 Activity 1: Improvement of methodological processes for implementation of new Integrated Farm Statistics (IFS)

3.1 Introduction

The main objective of the action is to get ready for implementation of the new Integrated Farm Statistics Regulation, including updating of Statistical Farm Register and testing of the possibility to use new data sources for data provision of AC 2020.

Specific objectives:

1. Provision of a good basis for AC 2020, updating of SFR information about holdings on which no information is available in administrative data sources and which have not been included in statistical surveys since AC 2010.

2. Development of methodology used for evaluation and confirmation of data on holdings not covered by administrative registers in annual crop and livestock statistics, Agricultural Census 2020, as well as integrated farm surveys after 2020.

3. Evaluation of possibility to use information regarding labour force in agriculture available in the State Revenue Service to provide data for Agricultural Census and future integrated farm surveys for the IFS Regulation module "Labour Force and Other Gainful Activities" in accordance with the quality requirements of the Regulation.

Agricultural Statistics Section of the CSB maintains and regularly updates the Statistical Farm Register, which is used as a basis in the elaboration of a framework of agricultural surveys and the selection of holdings, as well as for the publication of data. Development of SFR started in 1997 and is regularly maintained since 1999. The basic unit of SFR is the agricultural holding. For updating of the register administrative data sources are used, for example, from State Land Service, Agricultural Data Centre, Rural Support Service, data and information from statistical agricultural surveys. However, SFR contains holdings on which there is no information available in these sources. To restore register data for holdings on which there is no information in administrative data sources and which were not included in statistical surveys since AC 2010, within the framework of the project, the CSB organized survey basing on the list of indicators defined in Regulation (EU) 2018/1091 of the European Parliament and of the Council, which corresponds to information of Agricultural Census 2020.

To reduce respondent burden, possibilities of the use of new administrative sources in provision of agricultural statistics were examined – data of the State Revenue Service, etc. Possibilities to track change of owners of agricultural holdings using data of Enterprise Register of the Republic of Latvia were assessed.

3.2 Project status

3.2.1 Updating of SFR information about holdings on which no information is available in administrative data sources

Information from SFR is regularly updated using information both from statistical surveys and administrative data sources. Main statistical sources used in updating of SFR information are statistical surveys – agricultural censuses and farm structure surveys, other statistical surveys, special register surveys and telephone interviews, as well as Statistical Business register. Main administrative sources used for updating SFR are National Real Estate Cadastre Information System of State Land Service, Population Register of the Office of Citizenship and Migration Affairs, State Address Register Information System, Livestock and Herd Register of Agricultural Data Centre (ADC) and Integrated Administration and Control System (IACS) of Rural Support Service, Milk Producers Register of ADC, Slaughterhouse Electronic Reporting System of ADC and Organic Farming Statistics Information System of ADC. The scheme below shows the process of SFR updating based on administrative and statistical data sources.

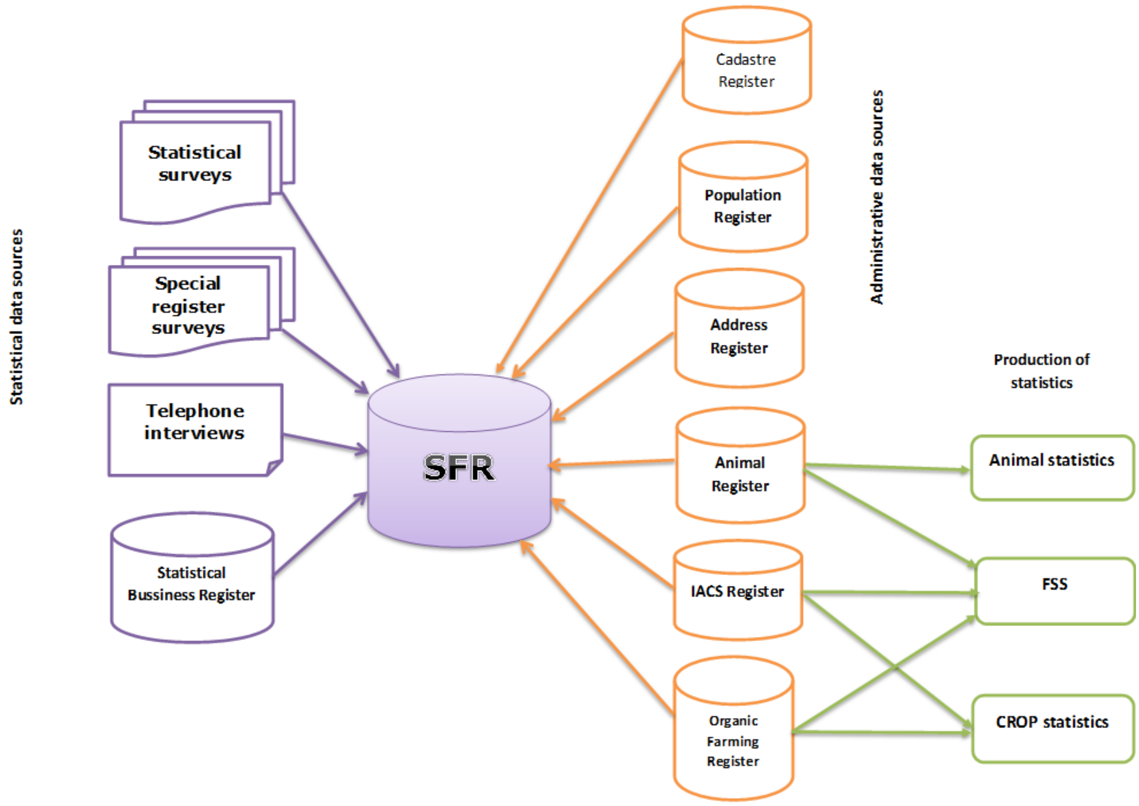

Figure 3.1: Process of SFR updating based on administrative and statistical data sources

To obtain information on agricultural holdings, on which there is no information available in administrative data sources, the survey "Activity of agricultural holdings in 2019" (questionnaire 1-agricultural holding) was organized.

Table 3.1: Survey organisation

Survey population	The unit of the survey is the holding and the framework of the survey was made of CSB SFR information, to include agricultural holdings, on which there is no information available in administrative data sources and which were not included in statistical reports since 2010. In the result 20 895 holdings were selected from SFR, of which 12 155 holdings were included in the sample. See description of the sample in Annex 3.1. An agricultural holding is a single unit, both technically and economically, which has a single management, and which conducts agricultural activities, either as its primary or secondary activity. The definition of agricultural holdings complies with the definition set by the EU and is compatible with the one in IFS 2020.

Survey design	**Questionnaire** 1-agricultural holdings "Activities of agricultural holdings in 2019" was worked out and approved by the Cabinet. The questionnaire meets requirements of IFS 2020 and annual crop and livestock production surveys (Annex 3.2). **Methodology** developed, and methodological guidelines for interviewers (available only in Latvian) worked out. **The reference period** of the survey was 1 July 2019, but depending on the information to be obtained, it may vary. The reference period of the main groups of characteristics are: – for use of utilised agriculture area – crop year 2019 or 12-month period from 1 July 2018 to 30 June 2019, – for number of livestock – 1 July 2019, – crop yield and livestock production obtained – 2019, – for labour force – 1 July 2018 to 30 June 2019, – for respondent identification indicators - 1 July 2019. For **data collection** purposes, the unified data collection system ISDAVS CASIS of the CSB was used. There were 2 different types of application: – application for face-to face interviews – CAPI. The application was installed on the interviewers' laptops, – application for telephone interviews – CATI.
Data collection	Based on the information available in SFR and State Land Service, agricultural holdings were selected and holding lists have been drawn up. The survey was conducted by CSB interviews using CAPI and CATI. They took place in the CSB Telephone Interview Centre in Preiļi. 40 CAPI interviewers were engaged in the survey, who surveyed 59.8 % or 7.2 thousand agricultural holdings and 10 CATI interviewers, who surveyed 40.2 % or 4.9 thousand agricultural holdings. Data collected was launched in August 2019 and finished in December.

Data processing and validation	Interviewers performed both data collection and data entry, as well as primary control, because data entry applications contain around 200 logical and mathematical controls. Once the survey was completed, repeated data control was carried out in the CSB central office, and data were re-verified at the level of holdings. If it was necessary, the employees responsible contacted the holders or managers to update the information.

Table 3.2: Response rate

	Number of holdings	In per cent
Sample size	12115	**100**
Information acquired:	9318	**76.9**
Questionnaires filled in	6992	75.0
Are not engaged in agriculture – no land and livestock	2326	25.0
Information was not acquired:	2797	**23.1**
Was not met	2262	80.9
Refusal	535	19.1

Main results

15.7 thousand active agricultural holdings, on which no information is available in administrative data sources, total land area in 2019 comprised 123.1 thousand ha, of which utilised agricultural area occupied 72.9 thousand ha (Table 3.3).

Table 3.3: Land use

	Area, ha
Total land area	123 115
Utilised agricultural area	22 422
owned	2 481
granted for use	882
rented	683
Arable land	3 337
Orchards and berry fields	2.48
Kitchen garden[1]	882
Meadows and pastures utilised	683

[1] Kitchen garden - various crops grown in one field (vegetables, herbs, potatoes, some berry shrubs, etc.) only for consumption of persons living in the holding and that cannot be separated, which does not exceed 0.2 ha

Unutilised agricultural area	12 316
Wood	73 099
Other land	15 277

Results of the survey show that 3206 thousand ha were occupied by sown area, which is 14.3 % of utilised agricultural area. In the structure of crops, cereals are most important, occupying1475 ha, forage crops – 570 ha and potatoes – 704 ha (Figure 3.2).

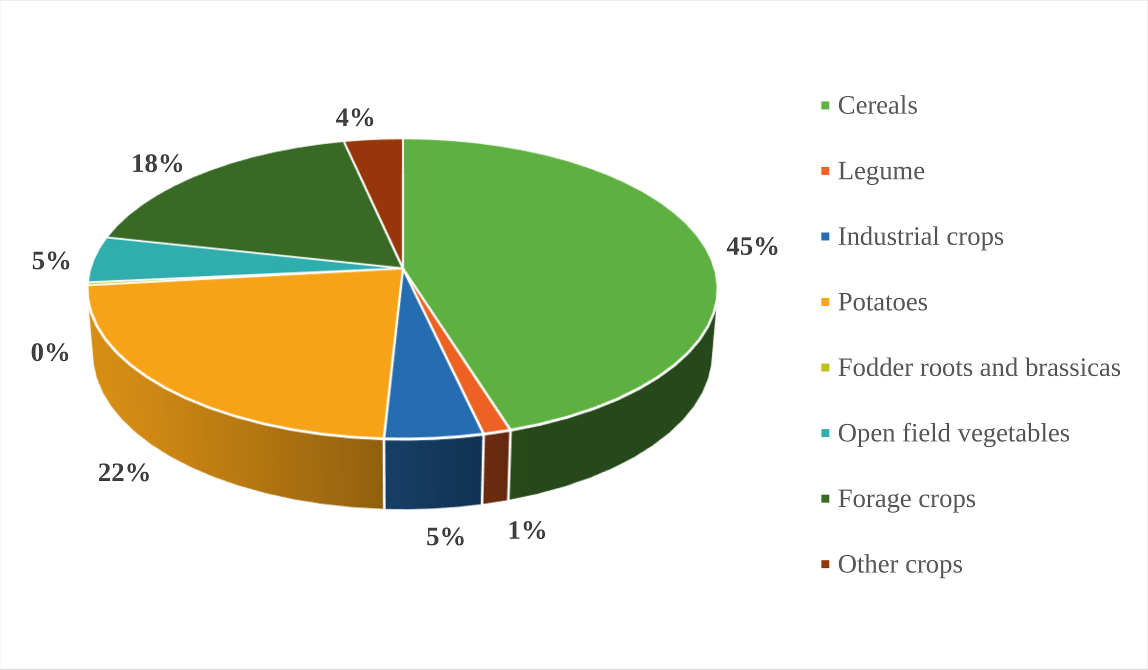

Figure 3.2: Structure of sown area of agricultural crops; 2019

As a result of the survey, SFR information was updated for 12 115 agricultural holdings on which there was no information available in administrative data sources, which ensured a more qualitative framework for Agricultural Census 2020, excluding inactive farms.

Results of the survey were used to elaborate an assessment methodology of the impact of agricultural holdings on which there is no information available in administrative data sources, on annual agricultural survey results, where holdings of these groups are not surveyed.

Even though the share of holdings on which there is no information available in administrative data sources is 20.7 % of the total number of agricultural holdings in Latvia (75.8 thousand), they manage only 1.1 % of total utilised agricultural land in the country (1959.4 thousand ha). According to the results of the survey, holdings are small. Holdings on average manage 2.2 ha of agricultural area (Figure 3.2), which is almost 12 times less than in the country.

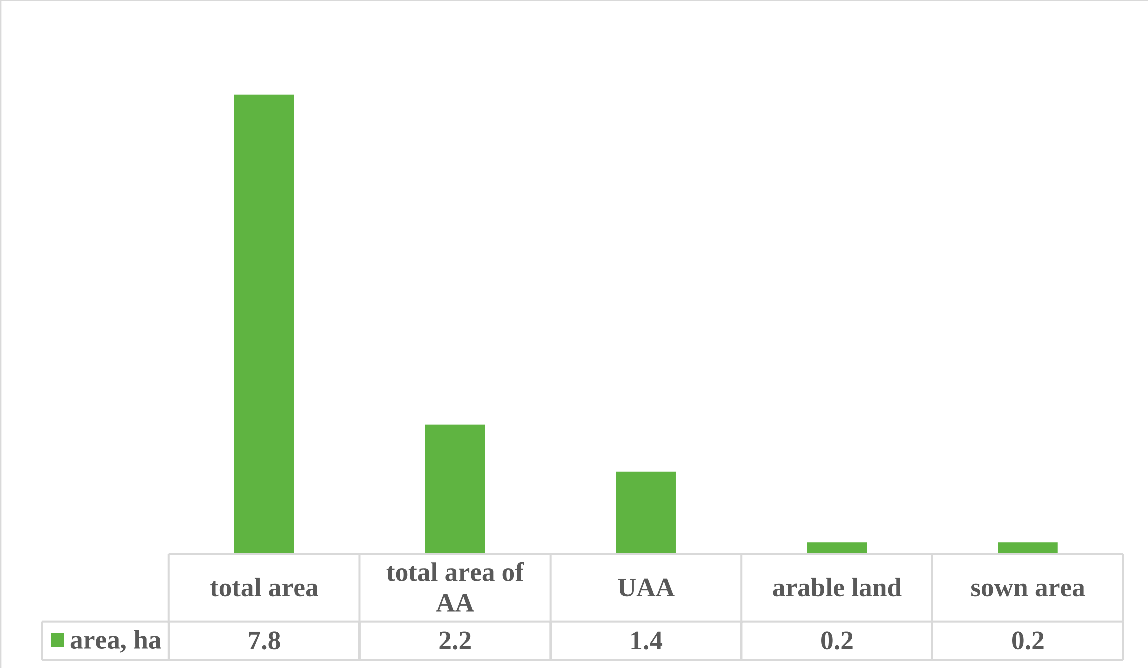

Figure 3.3: Average size of surveyed agricultural holdings

When assessing the impact of these agricultural holdings for the total agricultural production in the country, the areas of crops and number of livestock traditionally bred in Latvia for own consumption were analysed. These are not always registered in administrative data sources and production is used for own consumption.

Most often cultivated crops are potatoes, vegetables (open field and green house), fruit trees and berry shrubs, as well as kitchen garden. Variation coefficient for these crops is up to 10 %, which shows high incidence in the respective range of respondents. Even though crop areas comprise 42 % of seedlings in the structure, they are cultivated by a small number of respondents.

Statistical data on the number of livestock, except for pigs, is ensured using data on livestock from Animal Register of Agricultural Data Centre. Also laying hens, rabbits and beehives are kept for own consumption, which are not always registered in Animal register.

To assess the impact of the survey "Activity of agricultural holdings in 2019" and elaborate an algorithm for carrying out future assessment, information from annual crop and livestock statistical survey and administrative data were analysed.

Annual crop production and livestock production surveys include agricultural holdings for whom crop standard output and livestock standard output (SO) is 1500 euros and more, impact of smaller holdings is assessed according to information of administrative data sources.

Annex 3.4 includes variation coefficients.

For assessment of impact, data comparison and mathematical method of approximate assessment (benchmarking method) were used.

Data analysis results show that economic activities that are carried out by holdings, on which there is no information available in administrative data sources, have a small impact and mainly affect only the volume of production for own consumption.

Annual statistical information on crop area is acquired in the result of annual Crop survey. Annual survey includes agricultural holdings with SO>1500 EUR. To acquire information on all Latvia, aggregation is carried out, which is based on IACS and AC and FSS information:

- for holdings on which information is available in administrative data sources, but their SO<1500, data are used on crop areas registered in IACS database,
- for holdings on which there is no information available in administrative data sources, the latest FSS data are used for aggregation, which in the future it will be possible to replace with the model elaborated as a result of the Modernisation project.

Results of the survey "Activity of agricultural holdings in 2019" (Annex 3.4) show that in agricultural holdings on which there is no information available in administrative data sources, a wide range of agricultural crops is cultivated which is consumed in the holding. Areas of these crops are small and their impact on total areas is also small, however, there are some crops whose area takes up more than 2 % of total crop area in Latvia, for example, potatoes, vegetables, orchards and berry shrubs, greenhouses, fodder roots and cabbages, nectar crops, etc.

According to results of the survey, in holdings on which there is no information available in administrative data sources, potatoes, vegetables, fruit trees and berry shrubs in open field and greenhouses are always cultivated, and there are always meadow and pasture areas, kitchen gardens. To acquire precise statistical information on crop areas in Latvia in the future, within the framework of the project crops were defined and their share was calculated, which in the future will be used in adjustment of crop area.

Table 3.4: Aggregation coefficients of agricultural crop area

Crop	Aggregation coefficients of agricultural crop area
Meadows and pastures	2.75
Potatoes	3.14
Open field vegetables	1.86
Orchards and berry shrubs, total area	7.81

Since 2008 information on the number of animals in Latvia is provided from ADC Animal register. The number of pigs is an exception. It is obtained within Livestock survey as there is no information on the number of fattening pigs available in ADC Animal register, according to requirements of the Regulation (EC) No 1165/2008 of the European Parliament and of the Council of 19 November 2008 concerning livestock and meat statistics.

Results of the survey "Activities of agricultural holdings in 2019" (Annex 3.4) show that in some cases livestock are not registered in LDC Animal register. The number of these livestock is rather small almost in all livestock groups and their share does not exceed 2 % (Table 3.5). Exception are goats, ducks, geese, turkeys, rabbits and beehives where the share of unregistered animals in the total number may reach even 17.5 %.

Table 3.5: Analysis of data on number of livestock

	Number of livestock (survey results)	Total number of livestock (1.07.2019)	In per cent of total livestock	Total number of livestock (1.01.2020)	In per cent of total livestock
Cattle	437	411273	0.11	395757	0.11
Calves under 1 year	162	112870	0.14	108398	0.15
Young bovine animals, 1-2 years	46	68483	0.07	64701	0.07
Cattle over 2 years	230	229923	0.10	222659	0.10
Of which dairy cows	211	143506	0.15	138624	0.15
Pigs	279	315632	0.09	314483	0.09
Piglets below 2 months	17	52585	0.03	58631	0.03
Piglets 2 to 4 months	71	82749	0.09	87787	0.08
Breeding sows	4	22520	0.02	23335	0.02
Breeding boars	0	415	0.00	440	0.00
Fattening pigs, total	187	144408	0.13	133169	0.14
Young pigs	0	12955	0.00	11121	0.00
Sheep	464	131917	0.35	100285	0.46
Goats	404	13888	2.99	12094	3.34
Poultry	38937	3780603	1.04	5729353	0.68
Laying hens	34576	3186252	1.10	3242989	1.07
Broilers	806	506656	0.16	2336849	0.03
Ducks	1482	10011	17.38	8426	17.59
Geese	604	4895	14.08	3827	15.79
Turkeys	442	4874	9.98	4527	9.77
Other poultry (quails, pheasants, etc.)	1025	67913	1.53	132733	0.77
Rabbits	5328	39370	15.65	31530	16.90
Beehives	3594	96627	3.86	106690	3.37

These groups of animals traditionally are bred in Latvia for own consumption and seasonal pattern may be observed in the number of animals – during the winter period the number of animals is smaller than in in summer. To obtain precise statistical information on the number of animals in Latvia in the future, within the framework of the project, the share of unregistered animals was determined, which in the future will be used for adjustment of the number of animals.

Table 3.6: Number of animals outside of Animal register

	Average number of livestock	Aggregation coefficients of the number of livestock
Goat mothers and new goats over 1 year	8896	2.47
Other goats	4094	4.49
Ducks	9219	16.08
Geese	4361	13.86
Turkeys	4701	9.41
Other poultry (quails, pheasants, etc.)	100323	1.02
Rabbits	35450	15.03
Beehives	101658	3.54

3.2.2 Study of new administrative data

Aiming to find out possibilities to provide data on labour force in agriculture for the IFS module "Labour Force and Other Gainful Activities", within the project two administrative registers that until now were not used for agricultural statistics were studied:

- State Revenue Service (SRS) databases,
- Register of Enterprises (RoE) of the Republic of Latvia.

As IFS regulation requires information on labour force in agriculture, SRS databases on hours worked by employees of agricultural enterprises as well as legislation on procedure under which enterprises provide the respective information to the SRS were studied.

As of 1 July 2013, employers are obliged to submit information on profession of employees and hours worked to the State Revenue Service. This is foreseen by amendments to Cabinet Regulation No. 827 of 7 September 2010 "Regulations Regarding Registration of Persons Making Mandatory State Social Insurance Contributions and Reports Regarding Mandatory State Social Insurance Contributions and Personal Income Tax" (regulation No. 827). Regulations foresee that an employer, of which taxpayer of micro-enterprise, when registering each employee in SRS, provides information on employees and simultaneously indicates occupational code (occupation, profession, speciality), according to the Classification of Occupation. But regulations also foresee a set of exclusions when profession and working time are not to be indicated.

Within the framework of the project, working time of persons employed was analysed. According to Annex 3 of Cabinet Regulations, employer must indicate the following information on the employee:

- total hours worked by employee in a month, summing hours worked in main job and in secondary job,
- total hours worked by employee in a month, without breaking down hours by professions if change of profession took place,
- overtime hours worked by employee are included in total hours worked.

In turn, information on hours worked by employee is not to be indicated on those:

- who are employed by employer only on the basis of enterprise agreement,
- to whom regulations of Part I of Article 148 of Labour Law concern - following principles of health and safety at work, as well as ensuring sufficient rest, may not be related to situations, when, following the nature of the respective work or occupation, length of working time is not measured or determined previously, or it may be determined by employees themselves. In cases mentioned registration of working time is not to be carried out.

Special regulations for organizing working time may be related especially to the following persons:

- leading administrative employees or other persons with autonomous power of decision,
- persons working in family,
- employees carrying out obligations in religious ceremonies in churches and religious communities.

Tax payers of micro-enterprises do not have to submit information on hours worked by micro-enterprise employees a month, as it is not foreseen by Cabinet Regulation No. 819 of 31 August 2010 "Regulations on tax declaration of micro-enterprises and order of its submission".

Within the framework of the project, the number of employed in enterprises that were included in Farm Structure Survey 2016 was analysed. The study covered SRS information on period from 1 July 2015 to 30 June 2016 meeting the reference period of FSS 2016. As the responding unit in the SRS differs from the unit used in statistics (agricultural holding), an algorithm was worked out to link SRS data with SFR and the data available in SRS were compared to FSS 2016 results. Registration number in RoE and identity codes of the employees were the key identifiers used.

From SRS database those enterprises were selected to whom agriculture is primary or secondary activity and that are registered in SRS and have provided information on employees. In line with the FSS 2016 data, there were 162.6 thousand persons employed in agriculture, while SRS showed 64.2 thousand people fewer.

5004 enterprises were included in Farm Structure Survey 2016 (FSS 2016) and provided information on employees both to SRS and FSS 2016. In these enterprises SRS data on the number of persons employed at holding level was analysed. However, using only NACE code of the enterprise (agriculture sector), it is not possible to acquire precise information on enterprises occupied in agriculture. As compared to information acquired from the survey, where it is asked only about persons employed in farm works on the holding, in the SRS database all employees of the enterprise are registered (Table 3.7).

Table 3.7. Number of employed in enterprises – SRS vs FSS 2016

Economic size class, SO thousand EUR	Number of enterprises	UAA, thousand ha	Number of employed, thousand		Weighted number of employees[2], thousand	
			SRS	FSS 2016	SRS	FSS 2016
Total	5004	1063.9	51.2	26.8	64.1	29.3
500 and more	252	324.8	12.1	6.9	12.2	6.9
100-499.9	1247	463.5	12.3	8.0	12.4	8.1
50-99.9	863	127.1	3.6	3.5	3.9	3.5
25-49.9	765	68.8	6.1	2.7	6.2	2.8
15-24.9	514	31.9	2.1	1.6	2.2	1,7
4-14.9	769	30.7	8.9	2.2	10.7	2.6
up to 3.9	503	15.2	5.0	1.3	14.7	3.1
0	91	1.8	1.0	0.5	1.9	0.6

As it is shown by data in table 3, about 40 % of persons employed in enterprise are not employed in agriculture. As detailed analysis of professions of employees was not carried out now, it is not possible to structure employees by profession. This work will be continued after data of AC 2020 is compiled.

To identify change of agricultural enterprise owners, information on enterprise owners and officials in RoE was analysed. To link RoE and SFS information, the registration number of enterprises and identity code of owner were used.

Every quarter we receive information from the Register of Enterprises on the change of owners and officials in enterprises, including in peasant farms. This information will be used to update SFR information.

3.3 Findings

Information for updating of SFR for holdings on which is no information available in administrative data sources and which have not been included in statistical surveys since AC 2010 was obtained.

[2] FSS 2016 weight coefficients used

Methodology used for evaluation and confirmation of data on holdings not covered by administrative registers for use in annual crop and livestock statistics, as well as IFS was developed.

Legislation, including Cabinet Regulations No. 827, foresee various exceptional cases when the enterprise or person employed does not have to indicate working time or distinguish working time in various professions at one employer, which, in turn, does not allow using SRS data for provision of statistical information, according to methodology.

It is not possible to ensure requirements of Regulation (EU) 2018/1091 of the European Parliament and of the Council of 18 July 2018 on integrated farm statistics and repealing Regulations (EC) No 1166/2008 and (EU) No 1337/2011 employment of family members in farms, as Cabinet Regulations No.827 foresee that family members employed do not have to indicate their working time.

Inconsistency between SRS and CSB definitions makes it difficult to use SRS information for provision of statistical information. Additional analysis is needed and, possibly attraction of other indicators, for example, profession of employee, identification of enterprise owner, working time indicator, as well as detailed analysis of exclusions included in legislation.

4 Activity 2: Calculation of Gross Nutrient Balances (GNB) in accordance with ESS Agreement on Nutrient Budgets, adapted for situation in Latvia

4.1 Introduction

The goal of this project is to ensure fulfilment of ESS Agreement on Nutrient Budgets by providing basis of nutrient budgets calculations made by Latvia itself.

Specific objectives of the activity are:

- update of coefficients used for nitrogen and phosphorus balance calculation,
- creating model GNB calculations in Latvia for 2018 and 2019,
- recalculation of GNB time series starting from 2000 based on updated and new coefficients.

Moreover, at national level, basing on results of the research, it is very important to assess more precise impact of GNB indicators to farming sustainability and to identify potential environmental risks caused by agricultural production.

In the following chapters, the implementation of activities with regard to the objectives, methodology used for GNB calculation adapted to the situation in Latvia will be developed and described.

Final report includes methodological approaches of calculation of balance data, mechanism for data acquisition, specifics of calculation in Latvia. As methodological basis for carrying out this task, Methodology and Handbook Eurostat/OECD Nutrient Budgets EU-27, Norway, Switzerland (2013) was used.[3]

Sections of the project include scientifically based descriptions of GNB calculation, prepared by Aldis Kārkliņš, *Dr. habil.agr.*, Professor (subcontractor of the project), that can be used in creation of objective assessment criteria in agricultural pressure in environment, for example, for calculation of balance of particularly sensitive territories, for carrying out calculations in some farms, etc.

4.2 Project status

The project was implemented in line with the activities planned and described in timetable.

4.2.1 Study of methodology and identification of data sources

Up to now, nutrient budgets in Latvia were estimated by Eurostat. During the project implementation EU methodology was studied – Eurostat/ OECD Nutrient Budgets Handbook, ESS Agreement on Nutrient Budgets, as well as all available documents regarding budget calculation. They served as a basic methodology in carrying out calculations applicable to Latvia's situation.

Two different designations for determination of nitrogen and phosphorus flows and interpretation of results obtained are used in EU methodology. The nitrogen and phosphorous budget is the accounted amount of nutrients which entered the closed system (e.g. agricultural sector of Latvia, farm, etc.) within the defined time-frame and left it. Balance is the difference between inputs, outputs as well as change of stock. Therefore, if inputs exceed outputs, the existing stocks of nitrogen or phosphorous increases, and balance will be positive. On the opposite – if outputs dominate in comparison to inputs, stocks will decrease producing negative balance for the specific period of time.

Several methods could be used for accounting of nitrogen and phosphorous budgets and balances. The difference between methods is the amount and specification of information used for accounting as well as assumptions used where exact data are unavailable.

Data flow for accounting of nitrogen and phosphorous Gross budgets is shown in Table 4.1.

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[3] https://ec.europa.eu/eurostat/documents/2393397/2518760/Nutrient_Budgets_Handbook_%28CPSA_AE_109%29_corrected3.pdf/4a3647de-da73-4d23-b94b-e2b23844dc31

Table 4.1: Schematic representation of Gross NP budget accounting

Nitrogen budget (balance)		Phosphorous budget (balance)	
INPUT			
1.	Mineral fertilizers	1.	Mineral fertilizers
2.	Manure stored on the holding	2.	Manure stored on the holding
3.	Manure withdrawals, net import/export	3.	Manure withdrawals, net import/export
4.	Other organic fertilisers	4.	Other organic fertilisers
5.	Biological N fixation	5.	Seeds
6.	Atmospheric deposition		
7.	Seeds		
8.	Total input (1+2+3+4+5+6+7)	6.	Total input (1+2+3+4+5)
OUTPUT			
9.	Nitrogen in the total harvested crops	7.	Phosphorous in the total harvested crops
10.	Nitrogen in the total fodder	8.	Phosphorous in the total fodder
11.	Nitrogen in the crop residues (removed from field or burned on the field), by-products	9.	Phosphorous in the crop residues (removed from field or burned on the field), by-products
12.	Total output (p. 9 + p. 10 + p. 11)	10.	Total output (p. 7 + p. 8 + p. 9)
13.	Nitrogen emission in the atmosphere		
BALANCE			
14.	GNS = p. 8 – p. 12	11.	PS = p. 6 – p. 10
15.	hGNS = p. 14 – p. 13		

GNS total nitrogen surplus (positive or negative).

hGNS total nitrogen surplus, entering the hydrosphere (assuming, if not removed by the harvest and not emitted into the atmosphere, it will potentially get into surface or groundwater).

PS total phosphorus surplus (positive or negative).

For accounting of nitrogen and phosphorous budgets for Latvia, agricultural sector **activity data** are necessary. It includes information about the economic activities leading to increase or decrease of nitrogen and phosphorous amounts within the period of concern (calendar year). The data provider is mainly the Central Statistical Bureau of Latvia. Quantification of nitrogen and phosphorous inputs and outputs are realised with the help of **reference values (coefficients)**, which characterize amount of N and P in the mass unit of material. Within the current survey renewed reference values were used.

Balance accounting area is the utilized agricultural area *(UAA)* – area that can potentially be fertilized, i.e., where fertilisers can be used. In situation of Latvia they include:

- arable land,
- permanent crops,
- meadows and pastures.

As several data are used, it is relevant to indicate each data source and data holder, etc. Data collection needed for calculations is included in Annex 4.1: Data sources and coefficients used for the GNB calculations.

4.2.2 Updating coefficients used for nitrogen and phosphorus balance calculations

In accordance with ESS Agreement on nutrient budgets, the coefficients used to transform the physical livestock and crop data into nutrients must be provided every six years taking into account updates. Within the framework of the project, revision and adding of missing coefficients took place. Coefficients used in Latvia until now are compiled in Annex 4.1. Moreover, the annex also includes coefficients that were not used in calculations of balance in total in Latvia, as they correspond to indicators that have no statistical information at national level – they are non-significant. As the existing GNB calculation methodology is applicable in carrying out calculations also at farm level, coefficients are available for carrying out calculations (included in Annex 4.1) taking into account some crops that are cultivated in certain farms, but that are not significant in total in agricultural statistics.

4.2.2.1 Livestock excretion coefficients (Excel sheet 2.2)

Up to now, nitrogen (N) excretion coefficients were taken from Latvian national inventory report NIR for submission to UNFCCC and Estonian phosphorus (P) excretion coefficients were used.

After the implementation of the project, coefficients are available for those livestock that are kept in Latvia. Coefficients are included in Annex 4.1.

4.2.2.2 Manure withdrawals (Excel sheet 3.2)

This section includes manure used outside agricultural sector, non-agricultural use of manure, e.g. utilisation as waste, imports, exports, burning etc. Theoretically some amounts of treated manure might be exported and imported in Latvia, e.g. dried poultry manure. Practically amounts are negligible and cannot influence the NP budget accounting, therefore it was overlooked. If amounts become important in the future and should be taken into account for accounting, then reference values of 4.00 kg t^{-1} N and 0.75 kg t^{-1} P for natural dry product could be used.

4.2.2.3 Other organic fertilisers (Excel sheet 4.2)

For the situation of Latvia, other organic fertilisers (except manure) might include sewage sludge, composts from communal wastes, food processing waste and by-products (vegetable processing, milk, meat and fish processing, brewery and distillery wastes, digestate etc.) containing nutrients and used in agriculture as fertiliser or soil amendment. Amount of material is given as thousands of tons but NP content, as kg per ton of natural dry product.

Breakdown of information corresponds to the respective Eurostat data sheet and coefficients used for accounting are given in Table 4.2.

Table 4.2: Nitrogen and phosphorous content in other organic fertilisers, kg t^{-1} natural dry product

	N	P
Sewage sludge	6.75	2.25
Urban compost	2.50	1.20
Industrial waste products	1.00	0.75
Other products (digestate)	3.20	1.25

It was assumed that sewage sludge contains 15 % dry matter and NP content in dry matter is 45 kg t^{-1} and 15 kg t^{-1}, accordingly.[4]

Digestate (residues from biogas production) has become an important source of nitrogen and phosphorous recently. Different materials in different proportions for anaerobic fermentation could be used: crop residues, plant biomass, animal wastes, food processing wastes, sewage sludge etc., therefore chemical composition of digestate is changeable. The survey[5] where samples from 21 anaerobic fermentation units were analysed showed the following results (Table 4.3).

Table 4.3: Composition of digestate, natural dry product

Indicator	Range	Average
Dry matter, %	5.70 – 7.28	6.49
Total nitrogen, kg t^{-1} N	2.28 – 4.12	3.20

[4] Aggregate figures from: Gemste I., Vucāns A. (2010). *Notekūdeņu dūņas*. Jelgava: LLU. 276 p.

[5] Study "Development of Methodology for Calculation of GHG Emissions in the Agricultural Sector and Data Analysis with Modelling Tools Integrating Climate Change" Agreement No. 2014/94. Phase 5 review and final review. Latvia University of Agriculture: Jelgava, 2016. 141 p.

Total phosphorous, kg t^{-1} P	0.76 – 1.75	1.26

Coefficients used for NIR of Greenhouse gas emissions are based on the same data[6] originated from above mentioned survey. It was assumed that dry matter content in digestate is 7 % and nitrogen content in dry mater – 5.85 %. Therefore, natural moist digestate contains 4.41 kg t^{-1} N and 1.26 t^{-1} P and these values were used for GNB budget accounting.

Coefficients used in calculation of balance are indicated in Annex 4.1.

4.2.2.4 Crops and forage (Excel sheet 5.2)

In this Excel sheet, coefficients used in GNB calculations for 30 crop codes were updated or added. This especially relates to the dry pulses, root crops and vegetables. Up to now, coefficients used for the calculation of nutrient content in vegetables was estimated only for the total value of vegetables, but during the project new additional coefficients will provide more precise estimations and it will be possible to use them in carrying out calculations at farm level.

Coefficients used in calculation of balance, as well as available coefficients are compiled in Annex 4.1.

4.2.2.5 Seeds (Excel sheet 6.2)

Until now, N and P input were calculated by using default values of coefficients listed in the edition of Eurostat/OECD GNB Handbook. Contents of nitrogen and phosphorous entering into soil by these materials, kg ha^{-1} N and P. It is calculated based on commonly used seeding rate for the certain crop and chemical composition of seeds or planting material. Coefficients used are compiled in Annex 4.1.

Plausibility of data can be characterized as comparatively high, as sowing density of crops is relatively stable, their fluctuation margins are small.

4.2.2.6 Crop residues (Excel sheet 7.2)

Contents of nitrogen in crop post-harvest residues, by-products removed from the field or burned. Amount of residues, by-products are calculated based on amount of the main product (Table 4.4)[7]. For example, for triticale each ton of grain harvested additionally gives 0.6 t of straw, for buckwheat – 1 ton of the main product – 2.0 t straw, and so on.

It is assumed that on average only 30% (from the total harvested area) of cereal straw is removed from the field. All other – incorporated back in the soil for the following crop. Post-harvest residues from another type of crops, e.g. from rape, pulses, vegetables etc.

[6] http://tf.llu.lv/conference/proceedings2016/Papers/N069.pdf

[7] Kārkliņš A., Līpenīte I. Aprēķinu metodes un normatīvi augsnes iekultivēšanai un mēslošanas līdzekļu lietošanai: Rokasgrāmata. Jelgava: LLU, 2019. 200 p.

commonly are not taken away from the field. If this is the case, the reference values are available (Table 4.4). Burning of crop residues on the field is not practised in Latvia and it is even not allowed by national legislation.

Table 4.4: Output of nitrogen and phosphorus with by-products of crops (if that is harvested or burned), kg N and P of ha a year

Crops, by-products	Ratio, 1 : x[8]	Kg per ton of natural dry material	
		N	P
Head leaves and stems			
Potatoes (including seed potatoes)	0.7	3.40	0.26
Sugar beet (excluding seed)	0.8	3.20	0.44
Other root crops	0.5	3.20	0.44
Straw			
Cereals for the production of grain, including seed (in average)	1.0	5.30	0.93
Common wheat and spelt (in average)	1.0	5.30	0.76
Winter wheat	1.1	4.60	0.61
Spring wheat	1.0	6.00	0.92
Rye and winter cereal mixtures	1.2	5.20	0.87
Rye	1.2	5.20	0.87
Winter cereal mixtures	1.2	5.20	0.87
Barley (in average)	1.0	5.75	0.94
Winter barley	1.0	5.00	0.79
Spring barley	1.0	6.50	1.09
Oats and spring cereal mixtures	0.9	5.00	1.31
Oats	0.9	5.00	1.31
Spring cereal mixtures	0.9	5.00	1.31
Triticale	0.6	3.50	0.74
Buckwheat	2.0	7.00	2.40
Other crop residues			
Winter rape	2.0	5.00	1.09
Spring rape	2.5	5.50	1.01

Coefficients used, as well as link with residues estimation process can be found in Annex 4.1.

4.2.2.7 Biological nitrogen fixation (Excel sheet 8.2)

Only symbiotic nitrogen fixation is accounted, and it is related to cultivation of certain species of leguminous crops or grassland swards containing legumes. Crops grown in

[8] The ratio obtained by dividing the by-product yield by the basic product yield.

Latvia and their capacity to fix the atmospheric nitrogen is shown in Table 4.5. Values are in kg of N per ha of crop taking into account the yield level for the 2018 growing season.

Table 4.5: Biological fixation of nitrogen growing legumes, kg N per ha

Leguminous crops		
Dry pulses for the production of grain (including seeds and mixtures of cereals and pulses)		
	Field peas	65.81
	Field beans	67.81
	Sweet lupins	115.95
	Other pulses (vetch etc.)	65.00
Leguminous plants harvested green		
	Lucerne	65.28
	Clover	15.00
Legume grass mixtures[9]		10.00

The following assumptions were used for estimation of nitrogen biological fixation. For legumes like peas, faba bean, clover, alfalfa etc., 85 % of total nitrogen that was found in harvested parts of crops is biologically fixed. Therefore, the estimated amount of biologically fixed nitrogen is relevant to the obtained yield for the respective year. For dry pulses (peas, beans) only the yield of the main product (seeds) is taken into account.

For mixes of cereals with legumes (containing no less than 50 % of legumes), biological fixation was estimated as 50 % from the nitrogen removal. Here as well, coefficients are relevant to the obtained yield for the respective year. Values of nitrogen removal by yield of crops are taken from Annex 4.1: Data sources and coefficients used for the GNB calculations, Excel sheet 5 (Crops and forage). If legume content in different mixes grown in arable land is less than 50 %, as well as for grasslands (pastures, meadows), biological nitrogen fixation is presumed as 10 kg ha^{-1} N annually.

An example of calculation of biological nitrogen fixation coefficient, allocating it to situation of 2018, is shown in table 4.6.

Table 4.6: Example of calculation of nitrogen biological fixation coefficient

Crops	Yield, t ha^{-1}	N, kg t^{-1}	Output, kg ha^{-1} N	Fixation, kg ha^{-1} N
Legumes for seed production				
Field peas	1.97	39.30	77.42	65.81
Field beans	2.03	39.30	79.78	67.81
Sweet lupins	2.36	57.80	136.41	115.95
Legumes for forage				

[9] If the mixture contains at least 50% legumes

Lucerne	12.00	6.40	76.80	65.28
Clover and other legumes	8.50	6.10	51.85	44.07
Green vegetables				
Green peas	1.53	10.43	15.96	13.56
Green beans	2.00	10.43	20.86	17.73
Legumes – grass mixes (hay)	3.00	21.50	64.50	32.25

If it is not desired to derive these coefficients every year from current yield of crop production, they can be calculated taking into account the yield in some longer reference period, for example, over 10 years. Numeric values will be close to the previously mentioned calculation.

4.2.2.8 Atmospheric deposition (Excel sheet 9.2)

The following assumption was used for calculations: each hectare of land receives 5 kg ha^{-1} N annually in the form of gaseous, liquid or solid state as a sum of compounds with different states of oxidation.

More detailed data is currently not available because in other monitoring programmes (CLRTAP, UNFCCC) another approach is used. Deposition of nitrogen is derived from emissions from the agricultural land, e.g. it is assumed that the source of emission comes from agricultural activity and afterwards partly returns back to the soil. Practically the agricultural land receives depositions as a cumulative load from different origins – from farming activity, industry, transport etc. and its source could be national and transboundary pollution.

In the previous report[10] nitrogen deposition value was taken as 6 kg N ha^{-1}. The value selected was based on monitoring data carried out by Latvian Environment, Geology and Meteorology Centre (LEGMC), informative report of Latvia **On measures for reduction of total national air emissions**[11], as well as on modelling results of West Meteorological Synthesis Centre[12]. However, starting with 2008, LEGMC has terminated measures of nitrogen deposition and also the centre mentioned does not supplement these data and its website (Web Page of the EMEP http://webdab.emep.int/Unified_Model_Results/AN/) is closed. Taking into account improvements implemented in the sphere of air pollution

[10] *Pilot Studies on Improving the Quality of Agro - Environmental Indicators – Gross Nutrient Balances*: Grant Agreement No 40701.2008.001-2008.459, FINAL REPORT. Riga: Central Statistical Bureau of Latvia, 2009. 71 p.

[11] http://ec.europa.eu/environment/air/pdf/nat_prog/latvia_lv.pdf

[12] https://www.google.com/search?q=West+Meteorological+Synthesis+Centre&rlz=1C1GGRV_enLT751LV751&oq=West+Meteorological+Synthesis+Centre&aqs=chrome..69i57.1126j0j8&sourceid=chrome&ie=UTF-8

control, it can be assumed that currently total nitrogen deposition is around 5 kg ha^{-1} N annually.

4.2.2.9 Emissions (Excel sheet 10)

Data on nitrogenous compound emissions from agricultural sector can be found in the following reports:

- Latvia's National Inventory Report, Submission under UNFCCC and the Kyoto Protocol Common Reporting Formats (CRF), 1990 – 2017, 2019.
- Latvia's Informative Inventory Report 1990 – 2017, Submitted under the Convention on Long-Range Transboundary Air Pollution, 2019.

Member state may not carry out calculations for this section of N balance data file as methodology (Methodology and Handbook …, 2013) allows such option, and Eurostat will add indicators needed from UNFCCC and UNECE/CLTRAP reports (reports of member states). This option has some advantages as emission data for the current year are calculated with a certain time lag, methodology of calculations is very specific and the previously mentioned reports are internationally reviewed and revised, according to reviewers' comments. Therefore, parallel calculation or use of data without carrying out updates may cause discrepancies in the flow of information.

In this calculation, the volume of emissions was taken from EMEP database (the latest data available are for 2017)[13]. Emissions from livestock and other sources in agriculture are indicated separately in the database, moreover, separating reduced form of nitrogen (ammonia) and oxygenates that are expressed as NO_2. Indicators are compiled in Table 4.7.

Table 4.7: Nitrogen emissions from agriculture, 2017

Source of emission	NH_3	NO_2	Total, expressed as N
Livestock, kg	6892894	164825	5717527
Other sources in agriculture, kg	7146310	4262432	7173607
Total, tonnes	14039	4427	**12891**

4.2.2.10 Calculation of the GNB in Latvia for 2018.

Year 2018 was selected as a case study for validation of input values and data flows. Therefore, importance of values obtained might be analysed paying attention to the sensitivity of coefficients used, e.g. how the changes of numerical values of coefficients are affecting the results of calculations.

Input

[13] https://webdab01.umweltbundesamt.at/cgi-bin/wedb2_controller.pl

The total inputs of nitrogen and phosphorous accounted to **135732 t N and 20451 t P**. Fertilisers comprised the major part (57 %) of nitrogen and (61 %) of phosphorous inputs. Mainly they are mineral fertilisers, contribution from other organic fertilisers (excluding manure), mainly from sewage sludge and digestate, was negligible – 2 % N and 4 % P from the total input. Imbalance of fertiliser consumption with strong preference for nitrogen is not a good tradition for Latvian farmers for already a couple of decades.

Total organic fertilisers (excluding livestock manure) are a category, where nutrient accounting is relatively difficult. It is due to the variety of materials (sewage sludge, composts, digestate, waste and by-products) as well as changeable chemical composition. The share of nitrogen inputs for this category is low (2 %), for phosphorous a bit higher (4 %).

Livestock manure provided 25 % of nitrogen and 36 % of phosphorous inputs. Bovine animals are the main source for both nitrogen and phosphorous (Table 4.8). UNFCCC calculations show that about 23 % of bovine animal manure are excreted on pastures or outside animal housing. This could be a source of nutrients for pastures. Poultry manure is an important source for plant nutrients, 8 % of nitrogen and 25 % of phosphorous from manure NP inputs.

Table 4.8: NP input, % of total manure input

Category of livestock	N	P
Cattle	73	55
Pigs	10	10
Sheep and goats	6	6
Poultry	8	25
Other (horses, rabbits, fur-bearing animals)	4	4
Livestock (of total input)	**25**	**73**

Other inputs (biological fixation, deposition, seeds) are important for nitrogen all together giving 18 % from the total. Biological fixation and deposition showed almost equal result – 7 – 8 % from the total. Calculation is based on several assumptions like capacity of crops to fix molecular nitrogen, share of leguminous species in the grass mixtures, dry and wet deposition of nitrogen compounds etc. Direct measurements are difficult and research data are variable. Variation of results represented in publications are mainly due to the different methods used by researchers as well as a number of biotic and abiotic factors affecting the capacity of bacteria to fix the atmospheric nitrogen. Grasslands compose large areas, therefore their impact on final results is substantial. Uncertainty of obtained results is relatively high.

Contribution of seed and planting material to the NP input is small – only around 3 % from the total.

Output

Total nitrogen output with crop production harvested and fodder harvested (used), residues after harvest (by-products) comprised **82710 t N** and **13259 t P**. Majority or 63 % N and 67 % P is allocated to crop production, but 33 % N and 29 % P to fodder harvested. The part of residues after harvest (straws) is very small, around 4 % N and P of the total output volume (Table 4.9).

Accuracy of these data is rather high as precise inventory data on yield harvested can be obtained, and chemical composition of yield (contents of NP) is relatively stable.

Table 4.9: N, P output, % of the total

Agricultural crops	N	P
Total harvested crops	**63**	**67**
Cereals for the production of grain (including seed)	47	49
Leguminous plants for seed (peas and field beans)	5	4
Root crops (potatoes)	1	1
Industrial crops (rape)	8	12
Fresh vegetables and strawberries	0.0	0.0
Permanent crops for human consumption	0.0	0.0
Ornamental crops (nurseries)	0.0	0.0
Total other harvested crops	0.0	0.0
Fodder – total	**33**	**29**
Plants harvested green from arable land	21	19
Meadows and pastures: net production	13	9
Crop by-products, removed	**4**	**4**

Balance

The Gross nitrogen balance for 2018 was 53034 t N surplus, but Gross phosphorous balance – 7414 t P surplus.

Recalculating that per hectare of utilised agricultural area that comprises 27 kg ha^{-1} N and 4 kg ha^{-1} P. If nitrogen emission is taken into account, balance of nitrogen is 40131 t or 21 kg ha^{-1} N.

If balance is expressed as its Use Efficiency ratio using formula:

$$I = \frac{Input}{Output} \times 100;$$

the total balance of nitrogen is 164%, but deducting emissions – 149%. This indicator means a relatively low use of nitrogen in agriculture. But for phosphorus the intensity of balance is 154 %.

The relatively low average yield obtained in Latvia is the main reason for positive nitrogen balance (nitrogen surplus) (Table 4.10). Perennial grasses on arable land, pastures and meadows occupy large areas of agricultural land, but their outputs are very modest. These areas usually are not obtaining fertiliser nitrogen but biological fixation and deposition still contributing some amount for the overall calculation. Probably these areas are not potential risk areas because nitrogen migration (leaching, run-off) is impossible. Higher risks might cause cereals and rape obtaining relatively high fertiliser (organic, mineral) amounts but producing moderate yields.

Table 4.10: Average yield of main agricultural crops in Latvia, 2018, t ha^{-1}

	Per sown area	**Per harvested area**
Cereals	2.98	3.03
Winter cereals	4.10	4.13
Spring cereals	2.37	2.42
Leguminous crops, seed	1.94	2.01
Potatoes	19.14	19.31
Fodder beet	25.96	25.96
Open field vegetables	15.47	16.00
Winter rape	1.99	2.05
Spring rape	1.66	1.70
Hay from perennial grass	×	2.71
Crops for green feed and silage	8.44	8.50
Maize for silage and green feed	31.09	31.28
Hay from grassland and pastures	×	2.33

Modelling of possible nitrogen and phosphorous balance with increase of average yield. Assuming that yield level in 2018 could be 5, 10 or 20% higher as it was in reality and plant nutrient inputs was maintained at the same level, the changes of nitrogen balance will be as follows (Table 4.11).

Possible increase of yield at the same rate (5, 10 or 20 %) increases plant nutrient removal. The main increase of output provides main products yields harvested from arable land. The impact of by-products is low. The forage products, both cultivated on arable land and in permanent grasslands also show significant impact on nitrogen outputs.

Table 4.11: Balance of nitrogen at certain productivity rate

Indicators	**Yield level**			
	existing	**+ 5%**	**+ 10%**	**+ 20%**
Output, total, t	82710	86779	90912	99177
of which crops, t	51840	54366	56955	62132
of which fodder, t	27523	28899	30275	33028
of which by-products harvested, t	3347	3514	3682	4016
Total difference (Input minus output), t	53022	48952	44820	36555
Net difference (total difference minus emission), t	40131	36061	31929	23664

Total difference, kg ha^{-1}	27.4	25.3	23.1	18.9
Net difference, kg ha^{-1}	20.7	18.6	16.5	12.2
Output, kg ha^{-1}	42.7	44.8	46.9	51.2
Total balance intensity, %	164	156	149	137
Net balance intensity, %	149	142	135	124

It is under discussion what the reasonable (ecologically safe, economically effective) nitrogen balance for agricultural production is. A number of authors suggest a nitrogen gross balance intensity somewhere between 100 % to 130 % (Karklins, Lipenite, 2006). If net nitrogen balance indicator is used, which from the agronomic point of view is more reasonable, the above-mentioned ideal balance could be reached in a situation when the average yields will be at least 20% higher than in 2018.

Modelling of phosphorous balance is shown in Table 4.12. Emissions and other losses are not calculated for phosphorus, therefore Gross balance and Net balance are the same. There is some surplus also for phosphorous, but it is significantly less compared to nitrogen.

Table 4.12: Phosphorous balance at certain productivity rate

Indicators	**Yield level**			
	existing	**+ 5%**	**+ 10%**	**+ 20%**
Output, total, t	13259	13916	14579	15904
of which crops, t	8938	9378	9824	10717
of which fodder, t	3796	3986	4176	4555
of which by-products harvested, t	526	552	579	631
Difference (Input minus output), t	7192	6535	5872	4547
Difference, kg ha^{-1}	3.7	3.4	3.0	2.3
Output, kg ha^{-1}	6.8	7.2	7.5	8.2
Balance intensity, %	154	147	140	129

Phosphorous turnover in the soil differs from nitrogen turnover. Mobility of phosphorus in the soil is significantly lower and plant ability to absorb it – limited. Therefore, balance intensity for phosphorous is recommended somewhere between 160 to 200% (Karklins, Lipenite, 2006).

Advisable balance intensity is very much linked with the plant available phosphorous content in soil. If the phosphorous content is lower (very low or low category) then balance intensity is preferable to be higher (values should be higher). On the opposite – in soils with medium, high or very high plant available phosphorus content – balance intensity preferable to be lower. Balance intensity lower than 100 % (gross balance negative) is admissible only when plant available phosphorous content is very high.

Monitoring results done by State Plant Protection Service[14] show the phosphorous status in agricultural soil of Latvia. Permanent grasslands (meadows and pastures) are purely supplied with plant available phosphorous. Here low and very low phosphorous status are for 78.2 and 74.6 % of the total area.

Very high phosphorous content was found only for 8.6 % of arable land, 5.4 % of orchards, 0 % for pastures and 4.6 % of meadows. Only for these areas negative phosphorus balance (intensity < 100 %) could be reasonable.

Permanent grasslands (meadows and pastures) are a significant land use in Latvia and cover 634.8 thousand ha or 32.8 % of the agricultural land. Soil fertility status for these soils is lower compared with the average for the whole agricultural land.

If soil agrochemical cultivation index[15] (level of cultivation) is used as soil fertility rate, according to the 2017 survey results, it was low in 36.4 % of arable land, for areas of fruit trees and berry bushes – in 18.6 %, but at pastures – in 86.8 % and at meadows – in 78.2 % of area. Therefore, average yield harvested in Latvia is low (Table 4.10). However, if biological fixation is calculated as 10 kg ha^{-1} N, deposition as 5 kg ha^{-1} N, but output comprises $2.33 \times 6 = 13.98$ kg ha^{-1} N. Thus, meadows and pastures, even if they are not fertilized with fertilizers containing nitrogen, already comprise positive (1.02 kg ha^{-1} N) total nitrogen balance. Per total area it comprises 647.5 t of nitrogen.

4.2.2.11 Recalculation of the GNB data on the period starting from 2000 (using updated coefficients)

In accordance with the ESS Agreement on nutrient budgets, when the coefficients that are used to transform the physical livestock and crop data into nutrients are revised, the new coefficients must also be used for previous years (recalculate previous years with the new coefficients).

The GNB, recalculated are shown in Figure 4.1 as well as in Annex 4.2 and Annex 4.3.

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[14] file:///C:/Users/Lietotajs/Documents/LEJUPL%C4%80DE/augsnes_monitorings_2017.pdf

[15] An integrated dimensionless quantity that characterizes the relative correspondence of the four main agrochemical properties (organic matter content, pH, phosphorus and potassium content used for plants) to their relatively optimal values

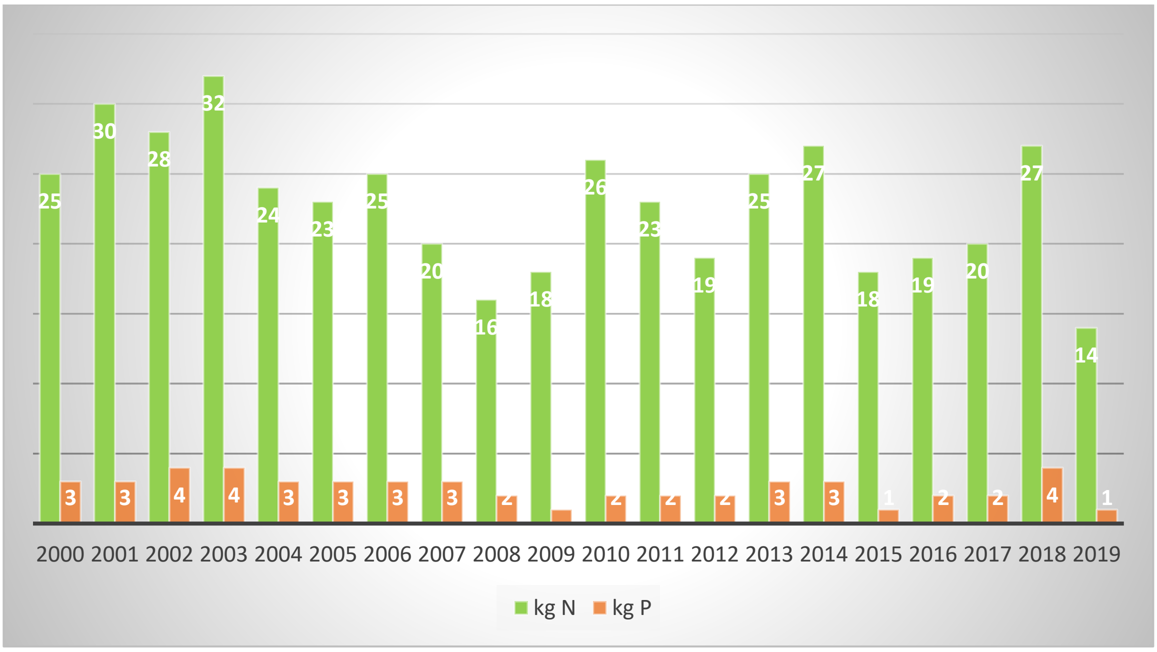

Figure 4.1: Nitrogen and Phosphorous balance, in Latvia, 2000 to 2019 (kg per ha of UAA) (Source: Project calculations)

4.2.3 Study visit

Within the project, it was planned to exchange experiences in the development of GNB estimation in a study visit to one of the EU Member States having appropriate background in GNB calculation. The organisation of the study visit was hindered by the fact that in some countries the majority of GNB estimates are made by environmental agencies or similar organisations lacking time for study visits.

An agreement was made with the Hungarian Central Statistical Office. The study visit took place on 10–11 September 2019 in Budapest. The agenda of the visit covered more information on GNB estimation for mineral fertilizers, manure input, manure withdrawal (of special interest), organic fertilizers (other than manure) – sewage sludge etc. (of special interest), crops (of special interest – fodder), seeds, nitrogen/ phosphorus balance – total results, availability and use of appropriate coefficients (including update of coefficients), level of detail used in the GNB estimates, any other subjects considered to be interesting or worthwhile for the GNB estimation.

As Latvia has never carried out balance calculations, Hungary's experience in carrying out these calculations was very useful because Hungary is already calculating GNB since 2000.

During the visit, each position of the balance was analysed (Excel sheet), as well as coefficients of N and P contents used in calculations.

Part of the data and coefficients used for calculation of GNB have to be corresponding or harmonized with those used in calculations for the annual National report for the UN

Convention on Climate Change (UNFCCC) prepared by the Ministry of Environmental Protection and Regional Development. Special attention was paid to this specific part of calculations during the visit. In Hungary these data for the calculation of balance are prepared by the meteorology centre. Representative of the centre shared her experience and indicated specific issues that need special attention.

The last block of issues corresponded to publication of GNB for national data users; we were also acquainted with this process. The Hungarian Central Statistical Office publishes national GNB, but without emission data.

The visit to the Hungarian Central Statistical Office definitely was very important for carrying out further GNB calculations.

4.2.4 Presentation of the results to data users

In line with activities planned within the grant project on 17 June, after the end of the emergency situation caused by Covid -19, the CSB held a meeting with data users on evaluation of the results of the project, as well as to clarify the interest of data users in carrying out future calculations and publishing data. The meeting was attended by the CSB representatives from Agricultural and Environment Statistics Department, Ministry of Agriculture, the Ministry of Environmental Protection and Regional Development, Latvian Rural Advisory and Training Centre, Institute of Agricultural Resources and Economics, State Plant Protection Service, Latvia University of Life Sciences and Technologies. During the meeting the results of GNB for 2018 were presented as an example, as well as total results of balances for 2000 to 2019. The subcontractor of the project presented the methodology used for estimations of the balances for each calculation Excel sheet, and interpreted results of the balances from scientific and agronomic points of view. Also, there was a discussion on the results of balances; how they reflect the pressure on the environment (use of mineral fertilisers, etc).

Conclusions drawn and suggestions made in the meeting:

- Data users are very interested in the results of GNB calculations.
- It is desired that also in the future balances are calculated at the smallest level of detail as they provide more objective calculations, and it is possible to use algorithms developed for calculations of GNB in some farms.
- It is desired that balances are published in the CSB database with a short explanation of indicators for data users.
- Data users would be interested in GNB calculations at regional level.
- Such expert meetings are very useful and should also be organized in the future.

4.3 Subcontracting

It was foreseen that calculations of GNB done by the CSB were performed in close cooperation with a subcontractor. The tasks to be subcontracted referred to the update of coefficients used for nitrogen and phosphorus balance calculation. Work also included model calculation of the GNB in Latvia for 2018 with interpretation of the results obtained. An external expert – Aldis Kārkliņš, *Dr. habil.agr.*, Professor, a person having specific knowledge and experience in soil-fertilizer interactions and cropping systems, research-oriented approach and publications concerning calculation of GNB and analyses of the impact to environment – was chosen via public procurement. The subcontractor also created descriptions of GNB calculations that are comprehensible to data users, which it will be possible to add to balance data if published. The sub-contractor actively participated in the meeting organized for data users to evaluate the calculation results and to identify actions for the future. The subcontractor made a presentation "Methodology and results of nitrogen and phosphorus balance in the agriculture of Latvia".

In addition, the subcontractor provided more detailed recommendations for methodological developments of gross nitrogen and phosphorous budgets in Latvia:

- **Contents of nitrogen and phosphorus in livestock excretion.**

Cabinet Regulation[16] No. 834 (Adopted 23 December 2014) **Requirements Regarding the Protection of Water, Soil and Air from Pollution Caused by Agricultural Activity** is the single official document where a definition of nitrogen content in animal wastes is included. It states that an animal unit is a specific animal which produces 100 kilograms of nitrogen with livestock manure, in a year. Therefore, the animal unit could be used to calculate how much nitrogen could be excreted from certain types of livestock. However, values included in the above mentioned Cabinet Regulations do not correspond to those used for UNFCCC Latvia's National Inventory Report. Coefficients used for GNB calculation were generally harmonised with UNFCCC ones (Table 4.13).

These indicators are used in different reports, both internationally, and within Latvia. In Latvia, also for solving practical issues, for example, planning fertilization, assessment of enforcement of provision of Good agricultural practice, etc.

Table 4.13: Coefficients that are used for calculation of nitrogen in livestock excretion

Livestock categories	Livestock units (LSU)	N kg annually, accordingly	
		Cabinet regulations	GHG, GNB
Dairy cows	0.7	119.0	113.9
Horses	0.48	81.6	44.00

16 https://likumi.lv/ta/id/271376-prasibas-udens-augsnes-un-gaisa-aizsardzibai-no-lauksaimnieciskas-darbibas-izraisita-piesarnojuma

Sheep and Lambs	0.13	22.1	15.30
Goats	0.13	22.1	15.80
Rabbits	0.024	4.1	8.10
Deer	0.15	25.5	9.00
Laying hens	0.006	1.02	0.55

Several projects were taking place in Latvia within the last decade where livestock execration rate and chemical composition of excreta were investigated. All agro-environmental assessments are based on an approach where livestock manure production and use are calculated using coefficients of animal execration rate and nitrogen and phosphorus content in excreta multiplying it with the average number of animals per period of concern. Therefore, the precision of these coefficients developed and used by the country has great importance.

One of the most recent and largest of this kind of projects was the INTERREG project **Manure standards**[17]**.** When compiling information acquired in these projects, and if needed, exploring some aspects additionally, it would be needed to harmonize normative variables used in Latvia. Especially, it might relate to the update of existing Cabinet Regulation No. 834.

Another important issue is livestock classification. Currently different surveys, project reports, publications have great diversity of it. Therefore, for some new development, e.g. GNB calculation, sometimes it is very difficult or even impossible to apply reliable values because in source information the livestock categorization is different. The subcontractor considers that, priority should be given to the Eurostat classification. It is very detailed and for Latvia's situation many categories are unnecessary, but the overall layout and schematic representation could be used for all further reporting and publication formats.

– **Sewage sludge and other organic fertilizers**

Sewage sludge is a significant source of N and P in agriculture and its role is increasing. As the data published show[18], chemical composition of sewage sludge may differ significantly. It depends on the location of sludge production, technologies used for water purification, as well as methods used for treatment of sludge.

According to the Cabinet Regulation No. 362 (Adopted 2 May 2006)[19] **Regulations Regarding Utilisation, Monitoring and Control of Sewage Sludge and the Compost thereof**, the producer of sludge or compost from the sludge should monitor the quality parameters for each batch including determination of dry and organic matter content, total nitrogen and phosphorous. Quality parameters are presented also for sludge (compost) users, but the producer is obliged to keep them for at least 10 years. Also, the producer

[17] https://www.luke.fi/manurestandards/en/frontpage/

[18] Gemste I., Vucāns A. (2010) Notekūdeņu dūņas. Jelgava, LLU, 276 p.

[19] https://likumi.lv/ta/id/134653-noteikumi-par-notekudenu-dunu-un-to-komposta-izmantosanu-monitoringu-un-kontroli

should register the user of the sludge (individual person or legal entity) or data about disposal of the waste. The regional authorities of Environmental protection are responsible for practical implementation of regulations as well as perform the information aggregation and submit it to the **Latvian Environment, Geology and Meteorology Centre.**

Therefore formally very detailed information on the production and chemical composition of sludge should be available in Latvia including data on quantities directly applied for agricultural land as well as quantities used for biogas production and afterwards used as fertilisers. How it works practically and its availability for GNB calculation – this is a question for inter-institutional discussions.

Other organic fertilisers. Food processing wastes and similar materials. Nitrogen and phosphorus content in it is very different and changeable. Approximate values might be developed but another factor is that statistics should identify its origin as precisely as possible. For example, wastes from starch production, alcohol distillery wastes, etc.

Digestate – Wastes from anaerobic fermentation of biomass - low quality grain, bran, also digestate already from biogas plant, liquids from production units, etc. Therefore, mass and chemical composition of digestate applied to soil could be very different and changeable.

We should consider that one of the most important components for biogas production is livestock excreta. Therefore, we should avoid double accounting. At first the livestock excreta are calculated using number of animals without information how it will be used (utilised). Part of it will be placed in the biogas production reactors and come out as digestate. Now it will be accounted already as this kind of fertiliser. To be correct, excreta used for biogas production should be registered in the spreadsheet ***Other withdrawals.*** But in this case more detailed information is necessary for data registration on farm level and on country level as well.

Survey results show[20] that also sewage sludge is partly used as a component for the biogas production. Here as well double accounting might be a case. Only the volume of sludge used for biogas production is not significant, therefore impact on the final results of GNB accounting are not substantial.

– Formally according to the Cabinet Regulation No. 834 (Adopted 23 December 2014)[21] **Requirements Regarding the Protection of Water, Soil and Air from Pollution Caused by Agricultural Activity**, monitoring of digestion production and quality control is set up. This information should be included in the fertiliser use plans. A summary of the plans is submitted to the State Plant Protection Service and aggregated into the State Crop Monitoring Information Database. But this requirement is valid only for the farms located

[20] Study "Development of Methodology for Calculation of GHG Emissions in the Agricultural Sector and Data Analysis with Modelling Tools Integrating Climate Change" Agreement No. 2014/94. Phase 5 review and final review. Latvia University of Agriculture: Jelgava, 2016. 141 p.

[21] http://tf.llu.lv/conference/proceedings2016/Papers/N069.pdf

in the Highly Vulnerable Zones of Latvia, but here the majority of biogas plants are operating.

– Reference values for manure calculation are relatively well developed. Additional updates might be necessary for some livestock categories but their proportion in total animal population is small. It is more important to harmonize categorization of animals as well as to unify the reference values published in Cabinet regulations because those are used for fertiliser planning.

– Development and updates of reference values under the chapter **Organic fertilisers (other than manure)** are current. Materials presented in this category are very diverse with changeable chemical composition: digestate, sewage sludge, composts, etc. Therefore, variations are significant. It seems that it is impossible to solve this problem by analysing great number of samples and based on that to develop some average values. A more realistic solution is to put the accent on pursuance of requirements already fixed in the regulations for more detailed monitoring of such kind of materials delivered for fertilisation purposes.

– **Biological fixation of leguminous crops** and **Atmospheric deposition**. Additional research is necessary. Other inventory programs (CLRTAP, UNFCCC) directly are not used in this kind of information, therefore data generalization, development of average values, are not carried out yet. Cultivation of legumes (protein rich plants) currently is pointed out as a priority in research programs. Therefore, there is some experimental basis for such kind of a research as well.

– **Seeds and planting materials**, nitrogen and phosphorous inputs. The subcontractor considers that data used for accounting has high plausibility and data set is relatively stable.

– Similar evaluation might be regarding coefficients used for calculation of nitrogen and phosphorous removal by harvested yield, both for main and for by-product. Stability and plausibility of developed coefficients (reference values) is high. Periodic updates are necessary for the period every 6 or more years due to the changes of crop varieties and agrotechnics which to some extent may influence the nitrogen and phosphorous content in the yield. It is more important for cereals and rape as they are main crops in Latvia.

– **Nitrogen and phosphorous content in the forage crops**. Periodic updates are necessary. Monitoring data on forage quality can be used. Forage quality control in Latvia is rather popular and data processing, publication of summaries are also realised. This helps to monitor the situation and to make the necessary corrections for the reference values.

– **Nitrogen emissions.** CLRTAP, UNFCCC reported values should be used. These monitoring programs have very well developed and strict data quality control at national and international level therefore data quality is high. There is no sense to do similar calculations in parallel unless there is attempt to implement additional emission factors which have not been used up to now.

– There are no specific remarks about the methods used for compilation of statistics data and its specification. Presented library of reference values (coefficients) ensure to make calculations for specific species of crops or some wider groups depending on the availability of statistical data.

– Issues of agro-environmental aspects are becoming more relevant. New requirements for fertiliser use planning are growing consistently. Even now annual fertiliser use planning is obligatory for farmers who are professional users of pesticides (the 2^{nd} class registration products) as well as farmers working in Highly Vulnerable Zones of Latvia. It could be reasonable to include the requirement for nitrogen and phosphorous budget (balance) calculation for preceding and actual year of fertiliser planning. This could be good motivation for assessment of farm sustainability and to eliminate environmental risks caused by farming activities. Accounting of budgets will produce objective indicators for assessment of farming impact and potential environmental risks caused by specific farms.

During the reference period, work carried out by the subcontractor was started on scientific and popular-science publications on topicality of GNB estimates, introduction of possible estimation methodology thereof used at farm level, as well as use of the results acquired in fertilisation planning that would facilitate management and elimination of environmental risks.

4.4 Findings

Update of coefficients is only possible with involvement of an expert with good experience and specific knowledge in this field.

Development and use of algorithms for GNB calculations are of a very high importance.

Development of GNB estimation system used for 2018 will ensure that balances of 2019 and upcoming years can be made easier and faster.

Methodology of NP budget accounting should be coordinated with and between other surveys and monitoring programs in Latvia and internationally.

Other practical activities e.g. fertiliser planning following the principles of Good Agricultural Practice should also use the same principles and reference values.

5 Activity 3: Participation in seminar on modernisation of agricultural statistics

5.1 Introduction

Within the framework of 3rd activity of agricultural statistics modernization project, representatives of CSB of Latvia participated in an experience exchange workshop. The main objective of the activity 3 was to participate in the workshop “Modernisation of agricultural statistics”.

The international workshop on agricultural statistics took place in Olsztyn (Poland) on 8–9 October 2019. It was organized by Statistics Poland and Statistical Office in Olsztyn as a part of the project "Modernisation of agricultural statistics". Statisticians from Eurostat and 16 European countries (Austria, Bulgaria, Finland, Germany, Greece, Hungary, Ireland, Latvia, Lithuania, Malta, Netherlands, Norway, Poland, Romania, Slovak Republic and Slovenia) participated in the meeting. The purpose of the workshop was to exchange good practices in the field of statistical farm surveys, with a special emphasis on modern methods of data collection, geospatial and satellite data, methodological issues, as well as modernisation of the statistical farm register.

5.2 Project status

In the workshop representatives of the CSB gave two presentations: “Modernisation of agricultural statistics in Latvia” and “Reduction of the burden of respondents and improvement of statistics quality by effective use of administrative data sources”, as well as presided at session “Modernisation of the statistical farm register (SFR)”.

Representatives of the member states shared experiences on activities for modernization of agricultural statistics. The most significant measure in the reduction of respondent burden and costs is the use of administrative data sources in the provision of statistical information. In this issue the experience of countries is different, as each country’s administrative data contain different information at different quality, and data availability for statistical needs also differs (publicly or privately). Countries emphasised differences in definitions between administrative sources and statistical indicators as a problem that significantly burdens the use of administrative data, and it is needed to additionally explain to respondents why in some cases it is not possible to use this information.

In this workshop innovative experience of countries (Poland, Finland, Germany) on the use of geospatial and satellite data (*Sentinel 1* and *Sentinel 2)* in agricultural statistics – yield forecasting, crop rotation in studies, etc. – was very useful.

an important issue in the workshop was on Farm register systems in member countries. In each country this system is built differently, according to national policy and administrative data systems. Also, there are different registers, farm register is not always under the responsibility of the statistical authorities. Main issue that was put forward for discussion in the workshop was: whether it is needed to create a common EU system and guidelines in the development and maintenance of a Statistical farm register. Member states were sure that it is not needed to change the already existing register system and create a new one that would be common to all member states. Eurostat emphasized that within the framework of the project, it is possible to develop and improve farm register maintenance methodology.

All member states emphasized the role of Eurostat in the area of modernization of agricultural statistics. Member states are offered various support instruments for modernization, development of the sector and provision of new requirements. Main instruments are methodological support, experience exchange, as well as financial support.

Materials of the workshop are available here: https://olsztyn.stat.gov.pl/en/seminars-and-conferences/workshop-modernisation-of-agricultural-statistics-olsztyn-poland-89102019/

5.3 Findings

It is not needed to change the already existing farm register system and create a new one that would be common to all member states; it is needed to develop and improve farm register maintenance methodology in each member state.

Using information from satellite images, it is possible to elaborate system for determination of crop areas, as well as for yield forecasts – in the result it is possible to ensure results faster, as well as to acquire vast data on land covering and its use.

Using geospatial and satellite data, it is possible to forecast agricultural crop yield, but there are problems with small crops and small field areas, which are hard to recognize in satellite images.

6 Conclusions

The project was implemented in line with the activities planned with no deviations from the plan.

Activity 1

1. The study results are relevant for implementing of IFS regulation in the next period, as well as for reduction of respondent burden.

2. Number of holdings on which is no information available in administrative data sources and which have not been included in statistical surveys since 2010 is high, but their impact on total agricultural production is negligible.

3. The methodology worked out during the project can be used for more precise estimation of annual crop and livestock survey results.

Activity 2

1. Data sources, coefficients, GNB estimation methods were documented

2. Availability of appropriate coefficients to transform physical data into nutrients is very crucial for GNB calculations
3. Calculations and recalculations of GNB since 2000 were done
4. Evaluation of the results took place
5. The results of the estimations were presented to the data users

Latvia has the basic set of information for annual accounting of the Gross Nitrogen and Gross Phosphorous budgets.

Activity 3

1. In the workshop representatives of Latvia gained valuable experience on the use of geospatial and satellite data in agricultural statistics
2. Still open question - whether it is needed to create common EU system and guidelines in development and maintenance of Statistical farm register.
3. The role of Eurostat in the area of modernization of agricultural statistics is crucial.

7 Action list for future

1. Work on SRS database analysis will be continued by carrying out detailed research on professions and working time of employees, basing on information acquired from AC 2020 on enterprises with agriculture as primary or secondary activity.
2. We will continue using the existing administrative data information for update of SFR and, possibly, also for provision of statistical information.
3. As data users are interested in calculations and publishing of balances, according to Latvia's situation, it was decided to carry on calculations and publish the results since 2010 in the CSB database.
4. Presentation of the results is very important for data users; such meetings should be continued.
5. Along with SAIO regulation becoming effective, Latvia will provide data also for GNB calculations at the EU level.
6. CSB of Latvia will continue work taken up in agricultural statistics modernization area, looking for new ways for acquiring data, developing and improving methodology principles to reduce respondent burden and CSB costs.

List of abbreviations

Acronym	Description
AC 2020	Agricultural Census 2020
ADC	Agricultural data centre
CAPI	computer-assisted personal interviewing
CATI	computer-assisted telephone interviewing
CSB	Central Statistical Bureau of Latvia
ERAF	European Regional Development Fund
ESS	European Statistics System
FSS	Farm Structure Survey
GNB	Gross Nutrient Balance
IACS	Integrated Administration and Control System
IFS	Integrated Farm Statistics
ISDAVS CASIS	Integrated Metadata Driven Statistical Data Management System
N	nitrogen
NACE	Statistical classification of economic activities
NH_3	Ammonia
NIR	National Inventory Report
NO_2	Nitrogen dioxide
OECD	Organization for Economic Cooperation and Development
P	phosphorous
RoE	Register of Enterprises
SFR	Statistical Farm Register
SRS	State Revenue Service
UNFCCC	United Nations Framework Convention on Climate Change

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