Climate-friendly agricultural practice in Latvia

Fertilisation planning and practical implementation

Aim of fertilisation planning

The basic aim of fertilisation planning is to ensure optimum fertilisation of agricultural plants, since the lack of basic elements needed for plants may reduce their growth and productivity, while the surplus of nitrogen not consumed by plants will result in economic and environmental losses, generating N_2O emissions and nitrogen leakages into the groundwater and surface watercourses as well as to ensure the compliance of fertilisations plans with the legal and regulatory requirements of the Republic of Latvia.

Short description of the measure

The implementation of fertilisation planning consists of the following processes:

- agrochemical study of the soil;
- drawing up a fertilisation plan for agricultural plants; and
- calculations of amounts of nitrogen and other elements necessary for plants.

Professor Aldis Kārkliņš emphasises that fertilisation shall be done deliberately and that it has already been highlighted by the founders of agrochemical science, for example, as Justus Liebig wrote in 1840: "A rational farming system should be based on a thorough examination of the plant nutrition types as well as the impact of soil content and the effect of fertilisers on these plants". Nowadays, the meaning is even more topical, since the intensity of farming has grown significantly, farmers have much more fast effective chemical industry products and the consequences of misuse of fertilisers can be more serious. There-

fore, the notion "fertilisation planning" should be self-evident among farmers. First of all, it is necessary to develop a strategy and tactics for the application of fertilisers and only then to perform the relevant activities. In this way, it is possible to exclude a chaotic activity – the unconscious application of fertilisers, relying on superficial recommendations, merchant advertisements, financial opportunities or other non-agronomic arguments. Mishandling of fertilisation not only affects the efficiency of farming but also the environment, which has a negative impact on the whole society (Kārkliņš, 2014).

Precision fertilisation applied on the spring barley grassland

The fertilisation plan may be more or less detailed as well as it may be linked to a single system with other agronomic activity planning and accounting documents, such as field history, plant protection measures, resource consumption records, monitoring information of sowings etc. In most cases, they will be computerised systems, making maximum use of the opportunities provided by modern information technologies. It is important to take into account the different natural conditions in each country, the research methods on the basis of which standards are being developed, and crop technologies, and to develop appropriate software for fertilisation planning themselves. In addition, potential users of software should be educated not only for the performance of

these works but also for the agronomically smart use of obtained results. This is the only way to ensure the agronomic (increase in yields from each kilogram of fertilisers applied) and economic (return of funds from fertiliser spending) return and to reduce negative environmental aspects (Kārkliņš, 2014). However, it is also possible, as a result of simple calculations, to identify the amount of fertilisers required for crops with or without the participation of consultants.

Positive effects:

- Gaining higher yields per 1 ha, more efficient land use.
- Yield increases, cash flow increases.
- Phosphorus fertilizer is added to the seed material, which would increase costs if used separately.

Negative effects:

- Fertilization plans are developed on farms, but are not always implemented in practice.
- Mineral fertilizers of appropriate composition are not available, therefore in practice it is difficult to implement the fertilization norms specified in the fertilization plan.
- Fertilizer is not available in small quantities (e.g. 3 tonnes).
- The divided application of fertilizer is not provided; thus it is difficult to balance the application fertilizer (it is used more than necessary).

Aspects	Limitations	Solutions
Technological	Limited technical possibilities for the implementation of a fertilization plan on the farm.	Use of software for fertilizer planning according to the soil agrochemical research.
Economic	Additional costs for agronomist consultations.	The introduction of fertilization plans on the farm makes it possible to use fertilizers more efficiently and obtain higher yields.

Agrochemical study of the soil and soil tests

The identification and assessment of soil agrochemical properties is the first step in the fertilisation planning process. The agrochemical composition of the soil is important information that should be known before choosing crops and fertilisation rates. If farmers cultivate crops without knowing the agrochemical composition of the soil, it may turn out that the crops are not able to make full use of fertilisers. Experts recommend to provide the agrochemical study of soils every 6 years.

The agrochemical study of the soil is a set of measures including:

- preparation of the soil sampling plan projects and sampling of soil according to the approved methodology;
- analysis of soil samples in an accredited laboratory;
- computerised processing of the soil agrochemical analyses and preparation of assessment;
- preparation of a digital soil agrochemical survey map and agrochemical study case.

l sampling. *Source: State Plant Protection Service*

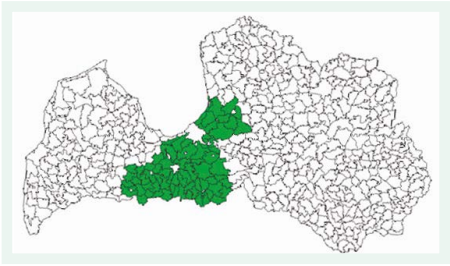
Soil sampling. *Source: AgTech*

According to the information compiled by the State Plant Protection Service, between 2011 and 2016, the soil agrochemical study has been done in only around 9% of the total area of UAA in Latvia. This means that a large proportion of Latvian farmers cultivate crops without knowing the agrochemical properties of the soil. In Estonia, the soil agrochemical study is one of the prerequisites for farmers to qualify for the EU aid, so the soil studies have been done for 80% of the UAA.

The soil agrochemical study is compulsory for farms applying plant protection products of Registration Class 2. It may be done gradually: until 31 December 2016 – the soil shall be studied in not less than 15% of the area managed; by 31 December 2017 – in not less than 30%; by 31 December 2018 – in not less than 45%; by 31 December 2019 – in not less than 60%, by 31 December 2020 – in not less than 75%; by 31 December 2021 – in not less than 90% and by 31 December 2022 – in 100% of the total area managed.

The soil agrochemical study is also compulsory for the areas of UAA located in particularly sensitive areas.

Soil agrochemical map



Particularly sensitive areas in Latvia.

On farms, often a simple soil analysis is performed for a specific field, without taking into account the soil map, but simply by dividing it into rural sectors and taking a sample from each sector. Due the fact that the soil composition in a given field is most often variable, the accurate analysis of the situation requires that the soil samples are taken according to the soil composition.

For example, company AgTech creates sampling areas based on long-term biomass survey maps. The areas are characterized by their heterogeneity - soil granulometric composition, problem areas, biological differences, biomass size and other characteristics. In cereals, sample areas of 3 hectares are most often used. When drawing up the plan, special sampling trajectories are created for the areas, which correspond to the geometry of the sample area.

Similarly, company Agricon takes into account soil granulometric composition and other parameters for soil agrochemical research and calculation of fertilization plans.

Crop fertilisation plan

The next step in the implementation of the measure "Fertilisation Planning" is the development of a crop fertilisation plan. According to the methodology for the deve-

lopment of a crop fertilisation plan (Skudra, 2008), the plan aims at ensuring the obtaining of economically more profitable and appropriate quality yield, maintaining soil fertility, preventing nutrient losses and environmental pollution. The plan development is necessary to promote the protection of water and soil from pollution with nitrates, i.e. direct or indirect leakage of nitrogen compounds (any chemical substance or chemical product containing nitrogen except for gaseous nitrogen) into the aquatic environment or soil, if such leakage threatens or may threaten human health, harms or may harm natural resources, the aquatic ecosystem and biodiversity.

Several important factors shall be observed when preparing the crop fertilisation plan:

- crop and its potential yield planned on a particular field;
- crop grown on the field during the previous season;
- agrochemical properties of the soil for a specific field (the soil agrochemical study data not older than 5 years shall be used in an environmentally sensitive area, for other territories – the data shall not be older than 7 years).

In order to ensure efficient farming practices, crop fertilisation plans should be developed for all farms applying any fertiliser in crop cultivation. The legal and regulatory enactments being in force in 2018 prescribe that the development of crop fertilisation plans in Latvia is mandatory for the following farms:

- located in particularly sensitive areas and applying fertilisers in the areas of 20 ha and more, while for farms growing fruit and vegetables - in the areas of 3 ha and more;
- applying plant protection products of Registration Class 2.

The fertilisation plan shall be developed for each crop based on the results of the soil agrochemical studies or soil tests of each field.

Spring rape

Precision and appropriate fertilisation – good yield of rape

Calculation of the nitrogen balance

The calculation of nitrogen balance is necessary to determine the nitrogen circulation on the farm. The balance allows judging on the efficiency of nitrogen application and reduces the risk of nitrogen losses on the farm. The nitrogen balance provides information to the farmer on the nitrogen application rate and helps identify the risk of nitrogen leakage and other losses from the field and the farm in general. The nitrogen balance provides important information necessary for improving fertilisation planning and financial position of the farm.

A positive balance (with the "+" mark) or a balance with a nitrogen surplus means that the nitrogen outtake with the yield is less than the nitrogen intake, i.e. the amount of nitrogen incorporated into the soil with fertiliser. Part of the incorporated nitrogen will contribute to the formation of soil organic

matter, while another part will increase the risk of nutrient leakage. Moreover, it should be noted that a significant surplus of nitrogen is economically disadvantageous and points to inefficient use of resources.

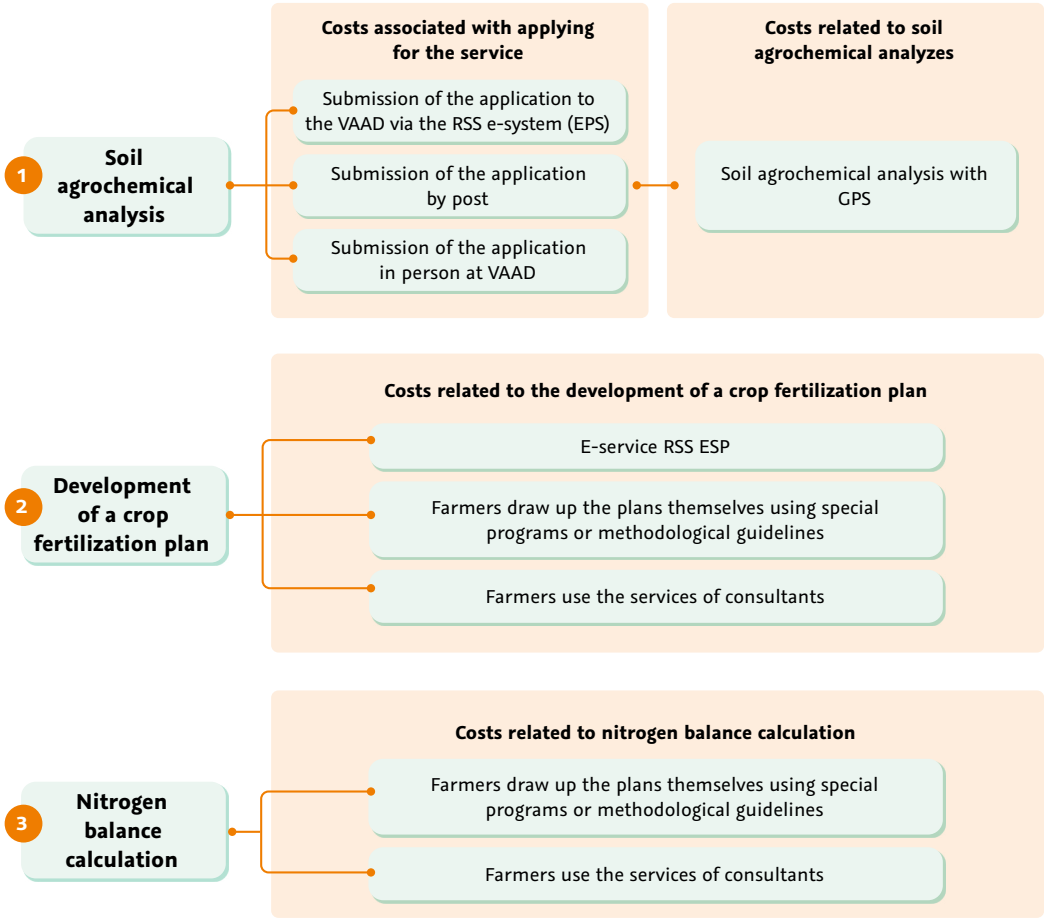
In contrast, if the nitrogen balance is negative (with the "–" mark), this indicates that crops use more nutrients than they are incorporated into the soil with fertilisers. If the balance is negative for a longer period, the soil fertility is low and crop productivity decreases. The ideal situation is when the amount of nutrients taken up by plants is equivalent to the amount of fertilisers incorporated into the soil, and the balance is close to zero.

The nitrogen balance allows assessing the flow of nutrients to and from the farm. This makes it possible to see whether nitrogen fertilisers are applied in excessive quantities on the farm. If the farm has a good nitrogen balance, this means that the financial resources used for the purchase of fertilisers have been used rationally.

Costs attributable to the fertilisation planning

Three stages related with the implementation of fertilisation planning are distinguished on the farm: agrochemical study of the soil, development of the crop fertilisation plan and calculation of the nitrogen balance.

Scheme for the implementation of the measure "Fertilisation Planning"



Basic costs for the implementation of fertilisation planning:

1. The agrochemical study of the soil: costs depend on the field size and the choice of the farmer as to whether the GPS will be used in the study or not. Therefore, the costs of the soil agrochemical study or soil tests may range from EUR 27.67 to EUR 15.96 per hectare according to the price list of the State Plant Protection Service for paid services . The cost assumptions did not include costs of soil tests done by private companies, since the prices of such services are not publicly available and differ among companies.

2. Development of a crop fertilisation plan: there are a number of options for farmers to develop a fertilisation plan. Farmers themselves can do calculations and develop a plan using methodological guidelines and fertilisation standards (Kārkliņš, Ruža, 2013; Skudra, 2008) or use special software. In this case, the costs will be attributed as transaction costs. Farmers may also use services of plant cultivation consultants or agronomists; in this case, the fees for developing a fertilisation plan are around EUR 3 per hectare. Farmers may also use an online fertilisation planning system provided by the Rural Support Service as E-service (EPS – Electronic Application System), which helps customers identify how much it is necessary to fertilise/not fertilise of the farmed areas, taking into account many factors (foreplants/soil/planned yield etc.), making optimal use of the fertiliser available to the customer, considering the desired yield, the conservation of the nutrients in the soil at the existing level as well as the requirements prescribed by the relevant regulatory enactments.

3. There are a number of options for calculating the nitrogen balance for a particular field or farm in general: 1) to calculate themselves using methodological instructions (Kārkliņš, Ruža, 2013). In this case, the costs will be insignificant and will be attributed as transaction costs; 2) to use services of plant cultivation consultants or agronomists, the costs of calculating the nitrogen balance are about EUR 3 per hectare.

Possible benefits and costs of fertilisation planning

COST ITEM	COSTS (WITH "+")/BENEFIT (WITH "-"), EUR HA^{-1}	
	in Year 1	in the following years
Soil agrochemical study	+19	-
Consulting services	+6	+6
Transaction costs	insignificant	insignificant
Reduction in N consumption	-2,4	-2,4
Relative costs	**+22,6**	**+3,6**

Source: authors' calculations

The results obtained show that, when introducing this measure, the farmer has to consider additional costs in Year 1, which are around 23 EUR per hectare. In the following years, additional costs will be around 4 EUR per hectare, as the agrochemical study of the soil shall be done every 6 years. Moreover, the costs are offset by additional benefits in the following years, which the farmer derives from the introduction of this measure - a possible reduction in consumption of nitrogen.

[1] Price list of the State Plant Protection Service: the Cabinet Regulations No 493, Riga, 10 July 2012. Available at: *https://likumi.lv/doc.php?id=250279*

Impact of the measure on the reduction of GHG emissions

No studies have been carried out in Latvia so far to show the impact of fertilisation planning on the reduction of GHG emissions. However, studies carried out in France show that fertilisation planning results in a reduction of direct and indirect N2O emissions, as the consumption of nitrogen decreases by 27% on average (Pellerin et al., 2013; 2017). In Latvia, a similar situation could be in the case of medium-sized crop-livestock farms, where fertilisation planning and precision spreading of fertilisers on cultivated crops have not been done previously. The introduction of fertilisation plans allows both a significant reduction of nitrogen oxide emissions into the atmosphere and, in general, a protection of the environment from nutrient leakage.

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2020