

SuMaNu policy recommendations – The Current Status in Partnership Countries

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1. Foreword

This working paper was produced in the Interreg Baltic Sea Region platform project SuMaNu (Sustainable Manure and Nutrient Management for reduction of nutrient loss in the Baltic Sea Region; www.balticsumanu.eu).

The project aims to formulate and promote recommendations for more sustainable manure and nutrient management practices in agriculture and thus decrease agricultural nutrient loads to the Baltic Sea. The recommendations are targeted to a wide range of target groups from farmers to policy makers but mainly are intended as a roadmap for policy makers of where to focus efforts to help achieve more sustainable manure use in the Baltic Sea Region (BSR).

This is a working paper of used during the formulation and revision of the policy briefs. Experts in manure handling and management in each country have compiled the information, but the contents have not been fact checked or referenced and should be regarded as personal statements. This paper was not intended to be published as a report, but we decided to make this working paper available on the SuMaNu website as background information to the policy briefs.

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2. Development of coherent P fertilisation policies in the Baltic Sea Region

SuMaNu recommends the following:

- “Minimum regulative measure for P fertilisation from manure should be 25 kg ha⁻¹ yr⁻¹ as set by HELCOM”
- “Optimally, P fertilisation limits should be based on crop requirements to avoid overfertilisation and be applied for all P fertilisers”
- “A joint P-index for mitigating P losses, including best management practices in areas vulnerable for P losses should be developed”

Currently these measures are partially implemented in the Baltic Sea Region (BSR) and the countries participating in SuMaNu as follows:

Finland

At the time of writing no regulatory limits for P fertilisation with manure exist, and the application rate of manure is dictated by its N content. However, if manure is processed into a fertiliser product, the regulatory limit for application is 325 kg water- or ammonium citrate soluble P/ha/5 years (Ministry of Agriculture and Forestry 2016).

Nitrogen fertilisation is regulated by Government Decree on limiting certain emissions from agriculture and horticulture (1250/2014, often referred to as Nitrates Decree) which implements the Nitrates Directive (91/676/EEC). The entire area of Finland is defined as a nitrate vulnerable zone. Thus, the maximum allowed total N applied in animal manure and in organic fertiliser products may not exceed 170 kg/ha/year. The Nitrates Decree also regulates the annual maximum amount of applied soluble N for different plants in mineral and organic soils. The Nitrates Decree also regulates that manure nutrient content needs to be analyzed at maximum every five years though fertilisation with manure may be based on either the analysis result or the table values given in the Decree.

On most Finnish farms, fertilisation is regulated via the voluntary agri-environmental program. At the time of writing, 87% of all farms take part in it, and this covers about 90% of the total field area. The program gives stricter limits for both N and P fertilisation than the regulation. The limits concern nutrients from all sources: inorganic and organic fertiliser products as well as manure. The agri-environmental scheme specifies maximum allowed application rates of P at field plot level, considering the cultivated crop, soil analysis results (soil type, organic matter content and soil P status) and yield level expected. Manure-based P is considered to be 100% plant available, i.e. equal to mineral P fertiliser. Exception is for animal manure in which 60% is considered available for plants. If fertilised solely with fur animal manure, slightly higher application rates of P are allowed. Phosphorus fertilisation can be given as storage fertilisation so that an average five-year dose can be given at once. For those farmers participating agri-environmental program, high field P

status restricts the P rates that can be given in manures. Thus, N limits are rarely reached, and additional N needs to be applied in some other form, commonly as mineral N fertiliser.

At the time of writing, Finnish regulation on fertilising products is being modified to agree with the EU Fertiliser Product Regulation (EU 2019/1009). In addition, the agri-environmental scheme is under modification due to changing program period in EU Common Agricultural Policy. According to the current plans, the voluntary fertilisation measure in the agri-environmental program is not going to be included in the new CAP period starting from 2023. Instead, there are plans to include P fertilisation limits into legislation at some level.

Estonia

It is permitted to apply up to 25 kg of manure P per hectare of cultivated land per year, including P that remains on the land with animal excrement when animals are grazed. The amount of manure P applied to arable land may be increased or reduced, if necessary; provided that the amount applied as an average over the current five years does not exceed 25 kg per hectare.

Regulation shall not apply if plant-available P need of soil is high or very high, and the farmer has carried out at least once in the last five years sampling and analysis of the soil for every five hectares by an accredited laboratory method. In Estonia, the soil P classes are expressed as P demand classes: for example, if the soil P content is high, the P demand class is "low".

In Estonia, there are regulative crop specific fertilisation limits for N and guidelines for P. The amount added as mineral fertiliser cannot be more than necessary to maintain nutrient balance according to soil type, planned yield, previous crop, crop rotation etc.

Applicants for support for organic production and support for environmentally friendly management must take a soil sample every 5 years for every 5 ha of arable land.

In Estonia there has been studies where P-index is recommended to use as one measure to reduce diffuse pollution in Estonia. However, till now the P-index is not mentioned in Estonian regulations.

Latvia

There are no P fertilisation limits in legislation in Latvia. However, there is a legal requirement for fertilisation plans for NVZ farmers and for the farms included in the integrated farming register.

Animal density in Latvia is under 0.3 livestock units per ha utilized agricultural area. As a result, yearly amount of manure applied is 3-4 t/ha in average, which do not create major risks for P leaching from soil. It is also proved by the yearly monitoring of leaching from agricultural areas, implemented by Latvia University of Life Sciences and Technologies. Exception for P concentration are few large poultry and pig farms which provide manure

for grain farms according to contracts. According to the monitoring data of the State Plant Protection Service Republic of Latvia, P content in soils is rather low.

According to the above mentioned, it would not be reasonable to set limits for P fertilisation in Latvia. P fertiliser is expensive, and this is another reason, why overfertilisation is not possible.

There have not been discussions in Latvia about P index.

Poland

At the moment, there are no limits for P fertilisation in Poland. In Poland 41% of the soil has a high and very high P content, while 33% has a low and very low P content. In most cases, P fertilisation is based on soil analysis. The action of co-financing the liming of fields helps to improve the P uptake of plants. It is planned to develop a P fertilisation program in 2022.

Germany

Phosphorus fertilisation and its planning is regulated in the German Fertilisation Ordinance - DüV (BMEL 2020). The phosphate fertiliser requirement must be determined taking into account the phosphate requirement of the crop and the expected yields as well as the P content in the soil.

It is necessary to determine the fertiliser requirement for phosphate for each field larger than 1 ha. The plant available P in the soil must be analyzed as a part of a crop rotation, at least every six years. The aim is to have a soil P content that is beneficial for plant growth and harmless to the environment. If the following soil P content (weighted average) is exceeded, the phosphate fertiliser application rates have to be adjusted on the possible uptake by the crop to avoid an oversupply of phosphate in the soil.

- »20 mg phosphate (P_2O_5) per 100 g soil according to the CAL (Calcium-Acetat-Lactat) method,
- »25 mg of phosphate (P_2O_5) per 100 g of soil using the DL (Doppel-Lactat) method or
- »3.6 mg P per 100 g soil according to the EUF (Elektro-Ultrafiltration) method

Based on the soil P content and plant requirement, P application above calculated removal is prohibited. If limit values are exceeded in water bodies that are attributable to the application of phosphate fertilisers, the competent authority under state law shall order that only small amounts of phosphate may be applied, or they have to prohibit the application of phosphate fertilisers.

The agri-environmental programs within the second pillar of the CAP are designed and implemented by the federal states (agri-environmental climate commitments AUKM - Agrarumwelt- und Klimamaßnahmen and farm advisory programs). Some of the programs aim at reducing nutrient inputs into waterbodies (e.g. extensive grassland). These programs are voluntary but can be targeted especially to critical areas (BfN 2015).

Sweden

Application of P from manure has been regulated since 2004. The maximum application rate is $22 \text{ kg ha}^{-1} \text{ yr}^{-1}$ averaged for the farms entire spreading area over a five-year period. The amount of P in manure must be determined by one of two approved methods: 1) table values for various livestock types, age groups and production levels or 2) documented balance calculations for P excretion accounting for specific farm management conditions and practices.

The Swedish Board of Agriculture annually publishes guidelines and recommendations for economically optimum fertilisation and liming to reduce the risk for losses of plant nutrients. The recommendations are based on results from field trials, practical experiences and estimates of yield and mineral nutrient prices. There is no regulation of mineral P use. The cost of mineral P and the general trust in the annually updated recommendations for economically optimum P fertilisation reduce the likelihood of overuse of mineral P.

3. Fertilisation planning and nutrient balancing

SuMaNu recommends the following:

To optimise nutrient use efficiency and enhance nutrient recycling on farm level, all farms (esp. livestock farms) in the Baltic Sea Region (BSR) should implement:

- Annual field-level fertilisation planning for nitrogen (N) and phosphorus (P)
- Annual farm-gate nutrient balancing for nitrogen (N) and phosphorus (P)
- Regular soil nutrient content determination

To support farm-scale measures:

- National guidelines for fertilisation planning for both N and P should be developed in all BSR countries.

Currently these measures are partially implemented in the BSR and the countries participating in SuMaNu as follows:

Finland

Finnish farmers conduct fertilisation planning at the level of field parcels. As previously mentioned, 90% of the field area belongs to the current agri-environmental scheme, in which maximum N and P levels are crop specific. If yield levels of cereals and oilseeds are higher than baseline yield, N rates can be increased based on documented yield levels. Soil test for mineral N content in agricultural soils is not required in Finland, but N

fertilisation limits are lower in organic soils and highest in mineral soils low in organic matter content. P fertilisation is based on soil P test, where soluble P content is determined with acid ammoniumacetate (pH 4.65). Soil samples must be taken from all field parcels for laboratory tests every five year. Except in case of potatoes and sugar beet, P application is not allowed in the two highest categories, and with lowest P categories fertilisation rates causes P surplus in order to increase soil P levels towards satisfactory P category. In case of higher yield expectations, also P fertilisation rates can be increased. Farmers are required to have a bookkeeping for the used amount of fertilisers and crop data in case of check-ups. Farm-gate nutrient balancing is not required in Finland. If farmer do not belong to the current agri-environmental scheme, regulatory limits for N and P fertilisation apply (see section 2).

Many farmers use either advisory services or commercial fertiliser planning programs to combine data from soil analysis, crop nutrient demand and fertilisers in use on the farm. The use of computer programs helps farmers also to document their crop management for possible inspections.

Estonia

Estonian farmers have to register applied fertiliser type and amount, NPK amount, planned and harvested yields for every field in a field book.

Every farm having 50 ha or more of arable land and using N fertiliser shall draw up a fertilisation plan each year before sowing or, in the case of perennial crops, before the start of the growing season.

The spreading of liquid manure in a quantity corresponding to 400 or more livestock units is permitted only based on a liquid manure spreading plan approved by the Environmental Board.

The maximum amounts for N with manure fertilisation is 170 kg N/ha.

It is permitted to apply up to 25 kg of manure P per hectare per year, including P that remains on the land in animal excrements when animals are grazed. The amount of P applied to arable land with manure may be increased or reduced, if necessary, provided that the amount of P applied as an average over the current five years does not exceed 25 kilograms per hectare. This does not apply in soils, where plant-available P need of soil is high or very high, and the farmer has carried out, at least once in the last five years, soil sampling and analysis for every five hectares by an accredited laboratory method.

Regulated are crop specific fertilisation limits for N but not for P, as there are guidelines. The amount added in mineral fertiliser cannot be more than necessary to maintain nutrient balance according to soil type, planned yield, previous crop, crop rotation etc. Farm gate balancing is not required in Estonia, but the Agricultural Research Centre makes annually farm-gate balancing monitoring for 600 farms by bookkeeping data to evaluate the impact of different support schemes on soil fertility and environment.

Applicants for support for organic production and support for environmentally friendly management must take a soil sample every 5 years for every 5 ha of arable land.

In nitrate vulnerable zones, the law further gives the possibility to restrict the following:

1. N applied in mineral fertilisers during one year up to an average of 100 kg per hectare (+ max 170 kg N in manure);
2. keeping livestock up to 1.5 livestock unit per hectare of land under cultivation;
3. the use of sewage sludge.

Outside a nitrate vulnerable zone, it is permitted to spread all the amounts (which are assigned by the regulation) of N with manure N to maize, herbaceous grasses and grasslands with at maximum 25% of leguminous plants. The manure shall be spread before 15 August and in several parts. This exception shall not apply to peat soils. The agricultural producer shall keep records for every field regarding the application of N and P into the soil and removal from the soil.

Latvia

Part of Latvia is assigned for the Nitrate vulnerable zone status (NVZ), where special increased requirements are implemented for water and soil protection from agricultural nitrate pollution (regulation of Cabinet of Ministers No.834). For NVZ, special requirements are set for fertiliser spreading, allowed N amount from manure and artificial fertilisers, including maximum limits for specific crops. If agricultural land of the farm is larger than 20 ha (plant production and/or animal farms) or 3 ha for vegetables, fertilisation plan should be prepared yearly. For the development of the plan, agrochemical analysis of the soils should be done, which is a complicated process. In the calculations, soil analysis results, nutrient uptake by plants, utilization rate etc. must be considered. After each season farms are requested to submit a summary of the fertilisation plan to the State Plant Protection Service (VAAD). NVZ farmers are requested also to have 50% of soils covered in winter season.

Farmers are positive towards the additional requirement for VAAD to monitor mineral N in the soils during spring season.

Requirements are in force from 2007 and ~1/4 of Latvia is implementing increased requirements for optimal N use.

There is no specific limitation for P fertilisation, but it is recommended to plan P application according to the plant needs and planned yields, with respect to soil type, previous year crop etc. Recommendations are developed by University of Life Sciences and Technologies. Animal density in Latvia is low and soils typically with low P content. Therefore, overfertilisation practically is impossible.

Field or farm level balancing for N and P is not a requirement, but for farms in NVZ it would not create problems.

For the rest of Latvia territory, special requirements are set for farms involved in integrated farming systems. Storage and labeling of the agricultural products are enforced by the Regulation of Cabinet of Ministers No.1056. This document requires also that those professional users of plant protection products (PPP), who use second registration class PPP, also must implement soil agrochemical analysis and prepare fertilisation plans. Additionally, plant rotation and field history register should be implemented.

Poland

Every farmer with more than 100 ha must prepare a N fertilisation plan every year. Farmers owning less than 100 ha and participating in agri-environmental programs must develop such plans too. Depending on the crop or the assumed yield, the maximum N doses are developed taking into account the applied manure. The standards for the content of individual components in manure have been included in the N fertilisation program in 2018.

Farmers or operators rearing poultry over 40 000 places or rearing pigs over 2000 places for pigs weighing over 30 kg or 750 places for sows may sell or hand over up to 30% of manure to another farmer. For the remaining part there must be sufficient field area for application on the farm, or the manure can be delivered to a biogas plant. It is also acceptable to dispose of the manure 100% to the biogas plant.

Smaller farms fertilise with manure on their own land, not exceeding the fertilisation dose of 170 kg N /ha. A surplus of manure they must sell or give to another farmer.

Farm gate nutrient balancing is not required. It is planned to establish a phosphate program similar to the nitrate in 2022.

Germany

Fertilisation and its planning is regulated in the German Fertilisation Ordinance - DüV (BMEL 2020). The DüV was revised in 2020, and stricter rules were implemented especially in so called red areas with increased N amounts at defined groundwater measuring points.

It is mandatory to document the determined fertilizer requirement and the actually applied amount of fertilizer for each field. The amount applied cannot exceed the calculated fertilizer requirement. Incorrect or incomplete recordings can be punished with up to 50.000 €.

The N fertiliser requirement for **arable land** is to be determined based on the DüV as a site-specific upper limit depending on the crop, the amount of available N in the soil and its subsequent mineralisation as well as the subsequent N mineralisation of former applied organic fertilisers, catch crops and other previous crops.

The N fertiliser requirement for **grassland** is to be determined based on the DüV as a site-specific upper limit depending on yield level including protein content, proportion of legumes, the amount of available N in the soil and its subsequent mineralisation as well as the subsequent N mineralisation of former applied organic fertilisers.

In revised DüV, a blocking period from December 1st to January 15th has been launched for the application of fertilisers containing phosphate on arable land and grassland. The blocking period for compost and solid manure has been extended by two weeks. Thus, it now applies from December 1st to January 15th.

The application of N and phosphate fertilisers (including solid manure and compost) on frozen soil is now prohibited. The previous exception that fertiliser can be applied on thawed soil during the day has been removed.

The distance regulation to waters was also revised. Depending on the slope, no fertiliser may be applied between the water and the field on a strip of 3-10 m:

- on slopes more than 5%: 3 m (previously 1 m)
- on slopes more than 10%: 5 m (previously 4 m)
- on slopes more than 15%: 10 m (previously 5 m)

In general, on slopes more than 5%, fertilisers on uncultivated arable land must be worked into the soil immediately (special rules apply to cultivated arable land).

The incorporation period was shortened. Liquid farmyard manure must be incorporated on uncultivated arable land within one hour, instead of the previous four hours (applies from February 1st, 2025).

There were also several changes in the regulation concerning the red areas with a high N pollution of groundwater (above 50 mg/l). These changes are valid from January 1st 2021. In the red areas, the maximum permitted amount of N is reduced by 20% from the calculated requirement. Exceptions apply to water-conserving farms (including organic farms) that apply less than 160 kg of total N per hectare and year (of which no more than 80 kg as mineral fertiliser).

A new field related upper limit for N was introduced. The upper limit for the application of organic and organic-mineral fertilisers with an amount of 170 kg of N per hectare and year now applies field-specific and no longer to an average of all fields. The amount of liquid organic fertilisers applied to grassland in autumn is limited to 80 kg of total N per hectare and year and 60 kg for catch crops without using as forage. The maximum surplus is 50 kg N per hectare and year. Based on the soil P content and plant requirement, P application above calculated removal is prohibited.

On the basis of "Stoffstrombilanzverordnung" -StoffBiIV (StoffBiIV 2017), there will be an obligatory farm-gate nutrient balance introduced stepwise in Germany. Since 2018, all farms with more than 50 LU or with more than 30 ha of usable agricultural area with a stocking density of more than 2.5 LU per hectare must prepare a farm-gate nutrient balance. From 2018 onwards, smaller livestock farms will also need to prepare a farm-gate nutrient balance if they receive manure from other farms.

For the farm-gate nutrient balance, all nutrient flows that go into and out of the farm are documented and evaluated. For the evaluation of the calculated balance only N is

evaluated. The ordinance provides two options: Either the company decides on a three-year operational farm-gate nutrient balance, or the company uses a company-specific three-year balance sheet value at which various loss potentials can be applied. The annual limiting balance value for the whole farm is 175 kg N per hectare or an individual limit value based on the "Stoffstrombilanzverordnung" (StoffBilV 2017), considering the maximum surplus of 50 kg N per hectare on field level and any other N losses e.g. from storage and application.

Before applying substantial amounts of nutrients, the amounts of nutrients available in the soil must be determined. The amount of nutrients defined as "substantial" depends on the crops nutrient demand. The soil N content must be determined on every field or every management unit (except on grassland and areas with multi-cutting forage cultivation) for the time of fertilisation, but at least annually, by one of the following methods: analysis of representative samples, following the recommendations by the competent authorities, by adopting the results of the analysis results at comparable sites, or by using calculation and estimation methods based on specialist knowledge. The soil P content must be determined by the analysis of representative soil samples, which are to be carried out for each field of more than one hectare, usually as part of a crop rotation, at least every six years.

Sweden

There is no requirement to prepare a fertilisation plan or farm-gate nutrient balancing. However, it is recommended to do so, and there is guidance in the legislation about how to calculate crop fertilisation needs.

Manure spreading should be distributed over the entire spreading area available on the farm and it is required to keep documentation on the amount of manure spread on each field. Documentation should also be kept on the estimated nutrient content of the manure which is to be determined by one of the approved methods specified in the legislation.

Within nitrate vulnerable zones, it is required to document N application from manure and show that application rates do not exceed quantity needed for the intended crops' expected yield on that particular field. The quantity needed must also account for N delivery effects of long-term manure application, previous crops in the rotation, soil fertility and use of other organic fertilisers.

4. National standards for handling and spreading manure

SuMaNu recommends the following:

- Establish national standards for determining manure quantity and nutrient content for all livestock and manure types.
- Allow spreading of manure primarily in the spring and summer for growing crops and limit autumn spreading only for establishing winter crops.
- Define minimum acceptable technologies and practices for manure handling and spreading while phasing out and banning those with poor environmental performance.

Currently these measures are partially implemented in the BSR and the countries participating in SuMaNu as follows:

Finland

Animal farms are required to have an analysis result of the manure composition available, and it has to be renewed at minimum every five years. Manure fertilisation is based on this analysis result or alternatively farmers can use the table values available in the Finnish Nitrates Decree. The table values are based on a large dataset of analysed manure samples. Finland also has a normative manure system (Luostarinen et al. 2017; excretion calculation being updated at the time of writing) which is used for setting average manure quantity and composition in Finland e.g. in emission inventories, nutrient balances and environmental permitting.

The Finnish Nitrates Decree (see chapter 2) sets the minimum storage capacity of manure considering different animal categories and manure types. The capacity should be sufficient for the yearly production of manure, i.e. 12 months, but the effect of pasturing and manure left on pasture can reduce the needed capacity to 8 months. Since 2014, new manure storage facilities need to be covered by at least natural crust. In addition, more defined or strict regulations may be set in the environment permit of the animal farm.

The shares of different covers for manure storages were last surveyed in 2013. Then all cattle slurry storages were covered with permitted cover options (73% natural crust and the rest with tents or solid covering), while 62% of pig slurry was in covered storages (mostly tents or floating covers). Of the different solid manures, 38-44% was in covered storages (Grönroos et al. 2017). A new survey on manure management is being planned at the time of writing.

Field application of manure and organic fertiliser products is forbidden from the beginning of November until the end of March. However, if exceptional weather conditions have

prevented manure application during the growing season, deviation from the prohibition is possible until the end of November. Surface-applied manure or organic fertiliser products must be incorporated into soil within 24 h. In fields with overwinter vegetation and from September 15th onwards, manure and organic fertiliser products must be injected or tilled into the soil unless winter crops are sown. Furthermore, the application of slurry, urine and liquid organic fertiliser products must be done with injection in areas with a slope of not less than 15%.

In the Finnish agri-environmental scheme, a farm can choose a voluntary measure which obliges the farmer to use injection of slurry, urine or liquid fertiliser product into the soil and offers a hectare-based compensation in return. The measure has been very popular and has increased injection application up to 55% of all slurry and urine (Grönroos et al. 2017). Solid manures are incorporated into soil within the 24 h as required, though approximately 50% of them are incorporated even faster, within 12 h (Grönroos et al. 2017).

Estonia

BATs are set for large cattle, pig and poultry farms.

The Estonian Water Act sets the minimum storage capacity of manure for 8 months.

Before spreading, the farmers with a manure storage facility must send manure samples to the accredited laboratory to determine the dry matter percentage of the manure and the content of total carbon, water soluble N, total K and P. The sample is taken from the manure, which has been standing for 4 – 6 months before spreading. The results of the analysis have to be available at the on-site inspection at the establishment.

In order to find the maximum permissible manure application rate, the limit value for the respective nutrient has to be divided by the amount of nutrient in the manure. The calculation should be made for both N and P, and then the smaller of the two application rates should be chosen, as then the limits are followed for both nutrients. If there are manure analysis data, then it is used in the calculations. Otherwise, it is possible to use the data of a relevant manure type from the Regulation No. 73 “Estimated values of nutrient content of different types of manure, methodology for calculating the volume of manure storage facilities and coefficients of the conversion of livestock into livestock units”.

All animal houses with over 5 animal units must have manure storage. The storage facility must hold at least 8 months amount of manure. When calculating the capacity of the manure storage, the amount of manure left by the animals on the pasture during the grazing period may be excluded. If there are five or less animal units in a livestock building and any manure or deep manure is produced, the manure may be temporarily stored in a watertight area near the building and protected from rainwater before spreading or transporting to the heap. A livestock building using deep-bed technology does not need to have a manure storage.

In Estonia there are some big pig and poultry farms which do not have agricultural land of their own. These farms can then make contracts with other farmers who use the manure

on their fields. Even if the manure storing and use are subcontracted to other enterprises, the animal house must have leak-proof storage facility for one-month quantity.

Liquid manure and urine storage must be covered to reduce ammonia volatilization. A storage facility is considered to be covered if the storage facility is covered by a hard, flexible or floating cover, including a natural crust.

In Estonia 99% of slurry storages are covered with natural crust and 1% with concrete or tent cover. Solid manure storages are covered with roof (32%) or only with natural crust (68%).

Restrictions on manure spreading according to the Estonian Water Act include:

1. It is prohibited to spread mineral or organic fertiliser when soil is frozen, covered with snow, periodically flooded or saturated with water;
2. It is prohibited to spread mineral fertilisers containing N from 15th October until 20th March;
3. It is prohibited to spread liquid manure from 1st November until 20th March;
4. The Environmental Board can vary the commencement of the break in manure spreading according to weather and growing conditions from 15th October;
5. It is prohibited to spread solid or deep litter manure or any other organic fertilisers from 1st December until 20th March;
6. Liquid manure broadcast spreading is forbidden from 20th of September until 20th of March;
7. Manure spread on bare soil must be incorporated into soil as soon as possible, but not later than in 24 h;
8. Fields with plant coverage can receive manure during November only, if the manure is incorporated into the soil within 24 h;
9. Areas with a 5-10% slope – no fertilisers from 1st October until 20th March;
10. Fertilisers should not be spread on areas, where the slope exceeds 10 degrees.

The spreading of liquid manure is distributed over the vegetation period so that over 50% is spread in spring, 10% in summer and over 30% in autumn.

In Estonia, from the whole amount of slurry 2.3% is applied to the fields by broadcast spreaders, 17% by trail hose spreaders, 40% by incorporation spreaders, 6.2% by stripe-incorporation spreaders, 23% open-slot injectors and 11% closed-slot injectors.

Latvia

There is a special formula for calculation of manure and technical water amount which could be applied. Manure management for the farms with more than 5 animal units in NVZ and 10 animal units in all other Latvia is regulated by the Regulation of the Cabinet of Ministers No.829.

The regulation of Cabinet of Ministers No.834 defines amount and content of the manure produced by different livestock groups. While developing a fertilisation plan, farm can use

these parameters – manure amount per year from animal unit, dry matter content, and NPK content.

Nitrogen content is calculated according to the N content defined in the regulation or according to analysis results of manure and digestate (accredited laboratory). Samples should be taken before spreading of manure. Thus, farmer can use either standard values or analysis results.

In the project "Manure Standards", detailed analysis of manure nutrient contents were conducted. Results indicate need for minor changes in the standard values included in the current official regulations. However, there is no concern about critical deviations by using current legally approved values.

BATs are set only for large pig and poultry farms but not limiting for other animal species.

Requirement for manure storages is set by Regulation of Cabinet of Ministers No. Nr.829. Requirement for capacity is 8 months storage period. There is allowance to deliver extra amount, the amount exceeding 8 months capacity, to other legal body.

In addition, requirements for solid manure storage and short-term manure storage on the field are described in the same regulation.

Covers of manure storages are also regulated by Regulation of Cabinet of Ministers No. Nr.829. Liquid and semiliquid manure storages are closed type or with permanent natural or artificial floating layer to reduce evaporation.

Currently there are no statistics of the share of manure spread using different spreading technics in Latvia. It is planned to gather data in the next agricultural counting (will be implemented in 2022). However, according to experts' view, there are higher numbers of broadcast spreading equipment, but according to the amount of manure spread, 1/3 is spread by injection technique. Large farms, which are spreading manure themselves, are using trailing hose to fertilise winter crops during growing season.

According to the experts of Latvia University of Life Sciences and Technologies, the ratio of slurry and solid manure of all the manure produced is 50:50. Of liquid manure, approximately 50% is spread during spring, and 50% during winter or the winter crops and next year crops. Solid manure is spread mainly in autumn. It is possible to apply only a small part, approximately 10% of solid manure during spring season, before sowing.

Poland

In 2018, the Nitrate Program aimed at reducing water pollution with nitrates from agricultural sources and preventing further pollution has entered into force. It concerns, among others, rules for manure storage, methods of their application, dates of use (depends on the type of fertiliser, soil and region).

By 2024, the capacity of the liquid fertiliser storage tanks should allow them to be stored for a period of 6 months. Tanks should be covered.

Unfortunately, broad spreading slurry is still permitted.

Currently in Poland, farmers can obtain funding for the construction of slurry storages and manure plates, as well as for the purchase of manure spreading machinery up to 50% of the costs, but the amount may not exceed 100 000 PLN (25000 € approx.) In the case of a young farmer, the subsidy is 60%.

Germany

The storage and spreading of manure as well as digestates are regulated in the German Fertilisation Ordinance - DüV (BMEL 2020). The capacity of storages of farmyard manure and digestates that are to be used as fertilisers must be adapted to the circumstances of the respective farm and water protection. The capacity must be greater than the capacity required during the period in which application is prohibited. Independently, farms must ensure that they can safely store at least the liquid manure or digestates produced for a period of six months. Farms with an animal density of more than 3 LU, and farms without their own land must ensure a storage capacity of 9 months for liquid manure and digestates. A storage capacity of 2 months must be ensured for solid manure and compost. Alternatively, based on written agreements, excess quantities of manure and digestates can be stored or recycled in other farms or companies.

Devices for applying fertilisers, soil or plant additives and growing media must comply with the generally recognized rules of technology. Devices that do not suffice the requirements are e.g. solid manure spreader without controlled manure supply to the distributor, slurry tanker with free discharge on the distributor, broadcast spreading and baffle plate.

In order to increase N efficiency and reduce nutrient losses in the form of emissions, there is an investing program ongoing, funded by the "Landwirtschaftliche Rentenbank", aiming to investments in the following technics (Rentenbank 2021).

- a. in low-emission application technology for manure and liquid fermentation residues (including special techniques for spreading of acidificated slurry)
- b. for storage (expansion / coverage of storage facilities),
- c. as well as for processing by separating liquid manure in small systems

Other typical techniques applied in Germany are e.g. the aeration of barns, covering of slurry tanks, lowering of the temperature of slurry and acidification.

Slurry acidification as a measure to lower emissions is included in the national program "Luftreinhaltung - TA-Luft" (BMU 2019).

Sweden

Standard values for manure quantity production for different livestock types, categories and management practices are available in Sweden and required to be used for calculating manure production and storage capacity. Standard table values for nutrient contents are also available for all livestock types, categories and production levels, as well as table values for loss of N from the manure during housing and storage. The amount of plant available N in manure can alternatively be determined by taking an ammonium nitrogen analysis of the manure. The amount of P in manure can alternatively be determined by a balance calculation for which there are guidelines for what needs to be included in the balance.

In general, there are no BAT lists for manure handling in Sweden, except of course for industrial sized pig and poultry farms that are regulated according to the Industrial Emissions Directive. There are some specific BATs listed in the regulations when storing and spreading manure within nitrogen vulnerable zones (NVZ), including required covers for storage and acceptable types of spreading equipment.

Minimum manure storage capacity for farms with at least 100 livestock units is 8 months for cattle, horses, sheep and goats, and 10 months for all other livestock. Farms with more than 10 livestock units must have storage capacity of 6 months for cattle, horses, sheep and goats, and 10 months for all other livestock. Within NVZ the minimum storage capacity for farms with more than 10 livestock units is 8 months for cattle, horses, sheep and goats and 10 months for all other livestock.

Animal slurry and urine tanks are generally covered with a natural or artificial crust, however 4% of slurry by volume is covered with a roof (*).

Spreading method used for animal slurry and urine for 2019 (*):			
Broadcast	Trailing hose	Injection	Acidification
20%	75%	5%	0%
The portion of animal slurry spread throughout the year is as follows (*):			
Spring	Summer	Early Autumn	Late Autumn
60%	17%	12%	12%

(*) Use of fertilisers and animal manure in agriculture in 2018/2019. Sveriges Officiella Statistik MI 30 SM 2002.

5. Regional nutrient reallocation

SuMaNu recommends the following:

- Take account of recyclable nutrient-rich biomasses, including manure, and their spatial distribution. Compare the nutrient availability to fertilisation needs on the same regions. Use the data as a basis for developing a national strategy and consequent measures to secure sustainable nutrient use.
- Create incentives to support production of manure-based fertiliser products especially in regions of intensive livestock production.
- Create incentives to support the use of manure-based recycled nutrients to substitute mineral fertilisers and demonstration of their use.
- Support development of manure processing technologies and the demonstration of their impacts on regional level.
- Support renewable energy production in conjunction with manure processing to improve the economic feasibility.
- Support for novel solutions and tools to raise awareness on and open practical possibilities for nutrient recycling.

Currently these measures are partially implemented in the BSR and the countries participating in SuMaNu as follows:

Finland

Finland has a national strategy for nutrient recycling for the years 2019-2030 (Ravinteiden kierrätyksen toimenpideohjelma 2019). The strategy was prepared in cooperation between four ministries responsible for agriculture and forestry, the environment, economic affairs and employment, and finance. One of the main funding instruments for companies, Business Finland, also took part in the group preparing the strategy.

The main aim of the strategy is that by 2030 a significant breakthrough in nutrient recycling has been achieved and the losses into the environment are small and nutrients are efficiently recycled. It also strives for returning nutrients from water environments, reduced need for imported nutrients and new businesses in the field of nutrient recycling.

Finland has the ambition to be a forerunner in nutrient recycling. The Government Programmes for especially 2015-2018, but also 2019-2022 have directed measures and funding towards improved nutrient recycling.

A separate demonstration funding is available for R&D activities for nutrient recycling.

Investment support for farm-scale processing technologies is available, though it does not very efficiently increase nutrient reallocation between regions but may improve nutrient recycling within the farm and between neighboring farms.

Investment support for large scale biogas plants is also available, and it is now a requirement to present also solutions for nutrient recycling through them. Additional and temporary incentives for nutrient recycling to e.g. improve current practices on existing processing plants will also be available for 2021-2022.

Still, only about 6% of all Finnish manure has been estimated to undergo processing (Luostarinen et al. 2019). Most of this processing is done in farm-scale and only a small amount of manure is being processed into transportable fertiliser products which are truly reallocated from one region to another. The most common manure processing technologies at the time of writing are slurry separation, composting and anaerobic digestion. The most important obstacle for manure processing is economic feasibility which is still low due to high investment costs and underdeveloped market for recycled fertiliser products. The incentives described above are expected to promote implementation of manure processing also in larger scale and with the goal of reallocating manure nutrients from regions of oversupply to regions in need.

To build the market for recycled fertiliser products, more incentives for their use are needed. In the Finnish agri-environmental scheme (2014-2020), farmers have been able to choose a measure in which the farmer is obliged to use organic fertiliser products, solid manures or separated solid fraction from another farm with a hectare-based compensation. The dry matter content of the material used must be at least 20% and the application rate 15 m³/ha/y at minimum. At the same time, the amount of nutrients applied must not exceed the limits set by the agri-environmental scheme. The measure has not been very effective and limited to a small field area (Luostarinen & Laakso 2019).

Estonia

Estonian farmers have possibility to apply support to invest manure processing facilities.

There is no national level plan in Estonia describing nutrients recycling regulation, including manure processing.

In Estonia, there are 17 biogas plants, from which 5 are using manure as raw material. Others are using sewage water or industrial residues.

A rising number of Estonian farmers are interested to use slurry separators to get bedding material from solid fraction.

Some farmers are using in-storage slurry acidification to enrich slurry with sulphur.

Some large pig and chicken producers who have no agricultural land are reallocating manure to other farms where it is applied to the fields.

Latvia

There is no national level plan in Latvia describing nutrient recycling, including manure processing.

Since there is large deficit of manure in Latvia, manure processing with the objective to transport nutrients from one region to another is extremely expensive and useless. The only exemption makes three poultry farms, where manure transportation to other farms is necessary, to avoid for example P overfertilisation. But it is considered to be responsibility of particular companies to deal with this challenge.

More important for Latvia would be efficient integration of the sewage sludge in the nutrient cycle through application to the agricultural lands. Especially this is a topic for small and medium wastewater treatment operators, where heavy metal concentrations are below the threshold values. Administrative system should be simplified.

Poland

Under the current CAP budget, there are no measures to finance the processing of slurry and solid manure. Farms that are not able to use the produced amount of fertiliser due to insufficient area (limit of 170 kg of N per ha) must have documented disposal of the surplus. The recipient may include a second farmer and a biogas plant.

Germany

There has been for several years manure import especially from the Netherlands. In 2018 it was 925 000 t (Agra Europe 2018). Manure transport between different German regions has reached a very high level with quantities of several million tons per year. Only from region Weser-Ems the manure export was 2.28 Mt (Fehlhaber 2016).

In Germany, the nutrient reallocation is regulated in the manure transport regulation WDüngV (WDüngV 2020). The aim of this regulation is the implementation of good agricultural practice in fertilisation, in particular with regard to the verification of nutrient flows, compliance with the application of the maximum permissible N quantities as farm manure and the transparency of the recycling of substances containing farm manure. It regulates recording, reporting and notification requirements for marketing (delivering), transport and the intake.

In order to fulfill the documentation obligations, the

1. transferring company (placing the product on the market),
2. the transporting company and
3. the receiving company,

must provide the following information:

1. Name and address of the transferring company, carrier and recipient,
2. Time of transfer, transport or receiving,

3. Type of manure or name of the substance that contains manure,
4. Amount in tonnes of fresh matter,
5. Content of N and phosphate in kg/t of fresh matter and the amount of N and P from the manure content of animal origin in kilograms.

The German Rentenbank will fund the processing of liquid manure by separating it in small systems. Otherwise, many research projects to develop and optimize different process chains for nutrient recycling from farm manure are funded (Rentenbank 2021).

Sweden

There currently is no national strategy for recycling nutrients from agriculture, nor is there any specific support mechanisms to produce or use recycled nutrients from manure. The P application limit is intended to reduce livestock density to decrease the issues of P surplus but it is not sufficient.

6. Minimal use of harmful substances and careful manure processing ensure safe recycling of manure nutrients

SuMaNu recommends the following:

- Animal rearing conditions need to be optimised (i.e., efficient herd health management practices) so that antibiotics and other pharmaceuticals are used only when necessary.
- Trace elements should only be used according to the nutritional needs of the animals to minimise their excretion to manure.
- The hygienic quality of manure needs to be secured, especially when processing manure from several farms and/or with additional feedstocks. Precautions should be taken during processing, storage, and logistics to prevent recontamination.
- Co-processing of sewage sludge and manure is not advisable as the risks related to trace elements, organic contaminants, and hygiene are typically higher in sewage sludge than in manure.

Currently these measures are partially implemented in the BSR and the countries participating in SuMaNu as follows:

Finland

The use of antibiotics in animal rearing is at a low level. According to EMA (2020), the sale of the various veterinary antimicrobial classes for food-producing animals (including horses) in 2018 was 20 mg of active ingredient/PCU (population correction unit).

Limits for the hygienic quality of fertilising products comes from the national legislation, and the limits are 1000 cfu/g for *E. Coli* and no Salmonella detected in a 25 g sample.

Co-processing of manure with sewage sludge is not practiced due to restrictions on the use of sewage sludge-based end-products in the fertilisation regulation and also some major cereal processors not buying cereals which have been received sludge-based fertiliser products.

Estonia

Limits for the hygienic quality of fertilising products comes from the national legislation. Limits are 1000 cfu/g for *E. Coli*, no eggs of *Helminth* in a 10 g sample.

In agriculture, landscaping and recultivation it is prohibited to use sewage sludge in which the content of at least one heavy metal exceeds the limit value specified in the regulation of the Minister of the Environment (Nr. 29. *Quality limit values and requirements for the use of sewage sludge used in landscaping, reclamation and agriculture.*)

Latvia

Use of antibiotics in Latvia for livestock farms is one of the lowest in EU. There are no official limits for antibiotic residuals or trace elements in manure. There has not been any previous monitoring or control of mentioned elements and residuals.

Wastewater sludge application is regulated by Regulation of Cabinet of Ministers No.362. Regulation includes complex administrative norms, and this is the main reason why sludge application in agriculture is at comparatively low level.

Poland

Antibiotics may only be used with prescription and under the supervision of a veterinarian. The breeder confirms with his own signature that he accepts the rules of antibiotic use and undertakes to observe the safety period from the last day of use. Independent use of antibiotics, their illegal purchase is punishable by law. As part of the Official Feed Control Plan, samples of water used for poultry, pigs and calves have to be taken to detect antibacterial substances (antibiotics, sulfonamides, quinolones). Inspections and sampling are unannounced.

Germany

In order to a fertiliser product including manure as a component material to be acknowledged to be marketed as fertiliser in Germany, it must meet certain requirements.

These requirements are formulated in the German Fertiliser Ordinance - DüMV (DüMV 2019).

- For the production of fertilisers, only approved component materials may be utilized.
- Every fertiliser must correspond to one of the following fertiliser types:
 - Nitrogen fertiliser
 - Potassium and phosphate fertilisers
 - Lime fertiliser
 - Mineral complex fertilisers and organic and organic-mineral fertilisers
- Every fertiliser must have a plant-physiological benefit and be materially harmless. This material harmless includes the requirements for pollutant levels and hygiene.
- Fertiliser producers are responsible for the quality of their products. Therefore, fertilisers should be regularly examined analytically.
- In order to meet the above mentioned criteria to be marketable, fertilisers must be properly labeled.

The German Fertilisation Ordinance (DüV) is the most important regulation for the use of fertilisers. Above all, the application rates, fertilisation times and the technology required for application are regulated there (BMEL 2020).

Sweden

There are currently no regulations on the amount of trace elements in manure. There is no need for securing hygienic quality of manure spread on your own land or on a neighbor's farm.

When co-digesting manure with other substrates, all animal derived substrates must be hygienised at a minimum of 70 °C for one hour. Furthermore, the total amount of metals spread in the digestate is limited to the same level as when spreading sewage sludge.

In general, sewage sludge is digested separately.

The addition of antibiotics to animal feed has been banned since 1986 and Sweden has the lowest use of antibiotics per weight of live production animals in the BSR (EMA 2020).

7. Knowledge transfer between farmers, authorities and policymakers

Policies and support mechanisms should foster knowledge transfer from research to practical action at regional, national and international level. Therefore, it is recommended to:

- Form national manure committees, which advice on manure legislation, knowledge transfer policies and research, both at national and international level.
- Build national manure knowledge transfer systems, which support successful implementation of recommended and required manure management techniques and practices.
- Support building of digital systems, which increase nutrient management data use efficiency and scope, both for farmers and society.

Currently these measures are partially implemented in the BSR and the countries participating in SuMaNu as follows:

Finland

In Finland, Natural Resources Institute Finland and Finnish Environment Institute are responsible for updating and maintaining data related to manure quantities and compositions. The work to update the data collection methods and improve knowledge transfer has been on-going for several years and will still be developed further especially in the latter.

Natural Resources Institute is also responsible statistical official for most of the agricultural information collected in Finland. The website <https://stat.luke.fi/en> contains information on nutrient balances, agri-environmental indicators, animal and crop production and many other issues related to agricultural production.

ProAgria is the largest agricultural advisory service in Finland (<https://www.proagria.fi/en>). They provide advisory for animal and crop farms in many kinds of issues related to profitable farming, including support for efficient nutrient use, farm-gate nutrient balances and manure management.

There are also other advisors in Finland providing support in different issues related e.g. to the environment, investments, improving profitability, animal welfare and energy efficiency.

The farms have received advisory services for free up to 15 000 € as they are paid by the Rural Development Programme (at the time of writing).

Estonia

Estonia has no manure committee or advisory board.

Estonia has no extra manure knowledge transfer system or plan.

Estonia has no big data system yet, but Ministry of Rural affairs is planning to build the agricultural big-data system, which can be used by agricultural software to share data between databases.

Agricultural software and registers in Estonia which are connected to nutrient or manure data are:

- Field books, fertiliser planning tools and herd books, produced by private companies
- Registers of agricultural animal
- Register of supported agricultural land, Land register (<https://www.maaamet.ee/en/objectives-activities/land-cadastre>)
- Soil map
- Land usability evaluation map
- Register of buildings
- Register of environmental permits
- Register of manure sample analyses
- Register of soil sample analyses
- Storage size calculator
- Mass balance calculator
- Soil humus balance calculator
- Register of mobile agricultural devices – this is used to apply investment support
- Fertiliser register

Latvia

Farmers Parliament in Latvia has provided invaluable input to knowledge transfer in translation of complex scientific and administrative information to the simple and practical language and to deliver clear messages and information to farmers. During the last 10 years, numbers of seminars and field days have been implemented with support of EU projects and commercial companies. The main idea has been to demonstrate and present BAT technologies, their advantages, characteristics, management principles and economical aspects. High number of participants, mainly agricultural producers, have participated in these events.

With support of the project financing, information materials such as leaflets, books and videos have been developed and delivered to the target groups. All materials are well recognized.

Due to the mentioned and high professional competence, policy developers and decision makers involve Farmers Parliament (Zemnieku Saeima) experts in decision making process.

Poland

The agricultural advisory system in Poland currently consists of 16 Provincial Agricultural Advisory Centers (ODR) and the Agricultural Advisory Center in Brwinów (CDR). All the centers are subordinate to the Minister of Agriculture. Advisory services in agriculture are also provided by private companies.

One of the primary tasks of the CDR is to improve the knowledge and skills of the advisory staff (ODR and private sector) as well as to raise and unify the standards of services provided by advisors to farmers. Under the Common Agricultural Policy for 2014-2020, the Rural Development Program includes an action „Knowledge transfer and information activities” where the beneficiaries are: public advisory entities (CDR, Provincial Advisory Centers, Chambers of Agriculture), research units and universities, agricultural or forestry schools and other entities conducting training activities. The aforementioned action enables the cooperation of various advisory entities. During implementation of various projects financed from the „Knowledge transfer and information activities” there was an opportunity to get participants acquainted with Manure Standard and Baltic Slurry projects and their results.

Germany

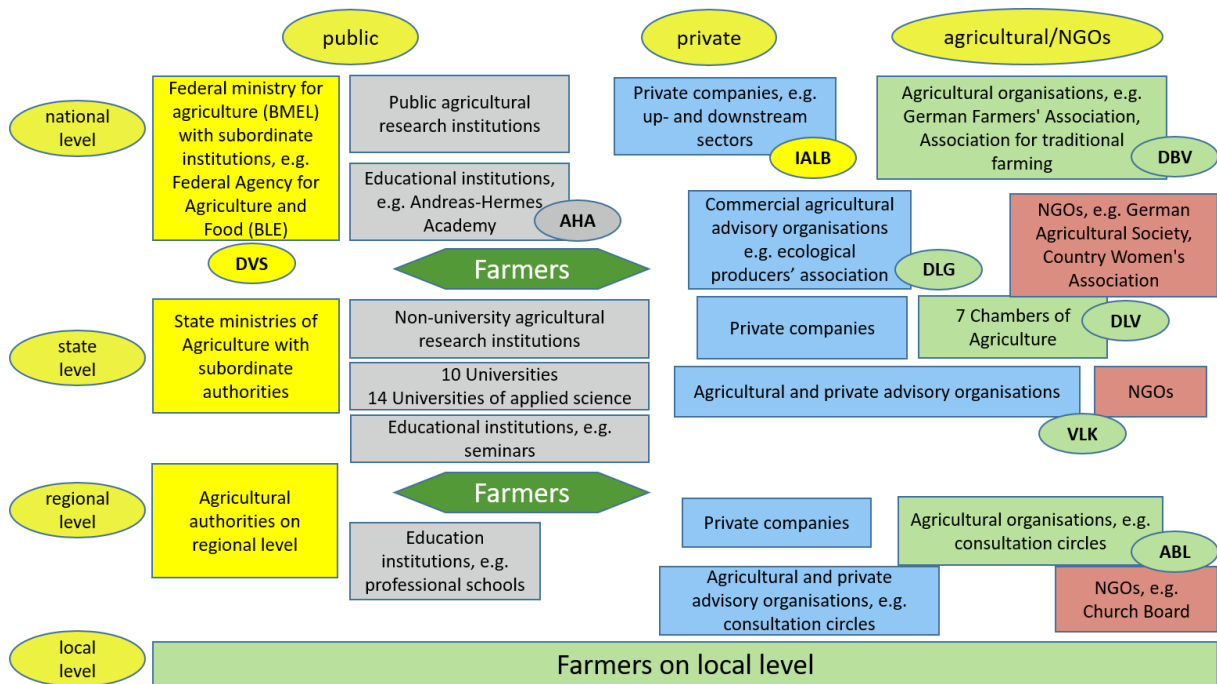


Fig. 1: The German agricultural knowledge system in 2013 (Mager, R. (2017): Wissens- und Informationssystem Landwirtschaft, Landinfo 1). Abbreviations: AHA: Andreas-Hermes Akademie (Andreas-Hermes Academy); BMEL: Bundesministerium für Ernährung und Landwirtschaft (Federal ministry for agriculture with subordinate institutions); BLE: Bundesanstalt für Landwirtschaft und Ernährung (Federal Agency for Agriculture and Food); DBV: Deutscher Bauernverband (German farmers' association); DLG: Deutsche Landwirtschaftsgesellschaft (German Agricultural Society); DLV: Deutscher Landwirtschaftsverlag (German agricultural publisher); DVS: Deutsche Vernetzungsstelle Ländliche Räume (German Networking Agency for Rural Areas); IALB: Internationale Akademie für ländliche Beratung (International Academy for Rural Advice); VLK: Verband der Landwirtschaftskammern (Association of Chambers of Agriculture)

The main tasks of the BMEL include ensuring the environmentally and animal-friendly production of high quality agricultural products, the development of rural areas and the further development of the common agricultural policy in the EU, which is communicated to the farmers through legislative processes, networks and numerous public events. The division of BMEL also includes subordinate institutions and four federal research institutes (FLI, TI, JKI, MRI).

The State ministries of Agriculture with subordinate authorities implement the legislation in their own state and publish recommendations. Commercial advisory organisations and private companies can develop new techniques and can give advice to implement and use

them on a national and state level. The consultation circles can advise the farmers on regional level to help with the implementation of requirements and recommendations.

The Andreas-Hermes Academy and the IALB are mainly focused on further education and knowledge transfer. New scientific findings are developed and published by public universities and non-university research institutions. The universities, educational institutions and professional schools are focused on education to enhance the knowledge and training of (prospective) farmers.

The communication between farmers and policy makers takes place on national level mainly by the organizations of DBV and DLG.

Sweden

The “Greppa näringen” program in Sweden, which translates to “Focus on nutrients”, was started in 2001 and is an example of how communication instruments can be successfully implemented to instigate change.

Greppa näringen is a voluntary on-farm initiative to educate farmers about the connection between nutrient management and farm economy. The program trains advisors and offers free individual on-farm visits to interested farmers to help reduce nutrient losses and improve sustainability.

Greppa näringen is characterized by voluntary participation which starts with an initial farm visit by an advisor to calculate a farm gate nutrient balance. Repeated visits during the following 5-6 years help develop farm-specific measures to improve sustainability and are then followed up with a visit to recalculate the farm gate nutrient balances. Farmers who sign up also have access to informational seminars and workshops organized to dealing with various aspects of sustainable farming that are regularly organized. Often these seminars are used to disseminate scientific findings and to encourage dialogue between farmers and scientists.

In 2015, the program had reached 8500 farms with over 1 million ha of arable land and had led to significant reductions in N and P surplus (Olofsson 2015). The reductions in nutrient surplus were found to be from reduced use of mineral fertilisers, increased harvest and reduced import of feed on animal farms.

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