Agri-environmental Measures:
On the field

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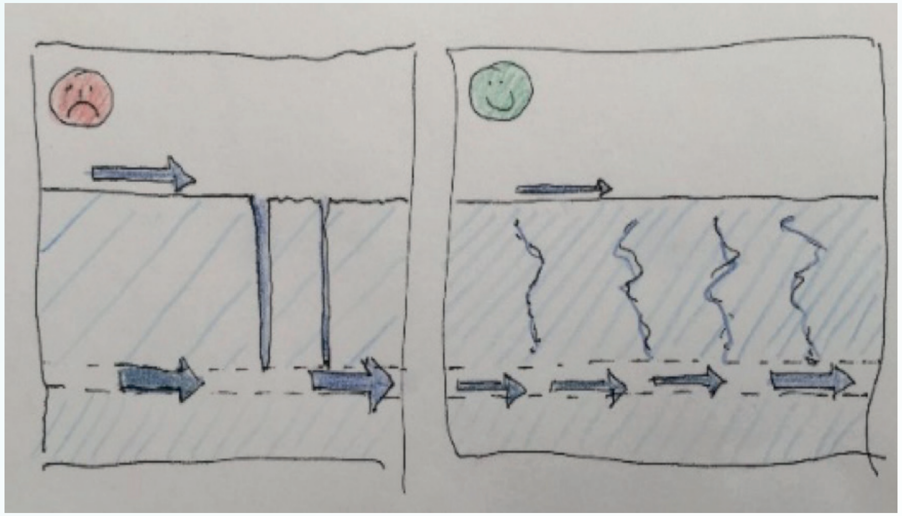
Agri-environmental Measures on the field:

1. Structural liming
2. Gypsum for improved soil structure
3. Subsurface application of manure
4. Monitoring of manure distribution


Structural liming

- Structural liming is a measure that improves soil structure in clay soils.
- Calcium ions in the lime interact with the clay minerals and builds porous aggregates. With better soil structure the water infiltration capacity increases and hence the risk for surface runoff and erosion.
- Also reduced is the risk for shrinking and establishment of crack structures where water can erode soil particles. Erosion of soil particles could be a major source to phosphorus losses from clay soils.
- Structural liming of clay soils gives benefits both for waters and for the farmer. A soil with good structure is easier to cultivate and may also increase productivity due to better water and nutrient retention capacity.



Structural liming enhances water infiltration capacity in the soil.

Localisation and implementation

Well-functioning field drainage and a clay content of at least 15% are prerequisite.

For best effect, the time for structural liming is directly after harvest when the soil moisture content is low and temperature is high.

Incorporation in the soil immediately after spreading is also important.

The type of lime and doses varies among regions depending on sources and prices.

Structural liming in southeast Sweden in August 2018.

Effects, duration and maintenance

Improved water infiltration capacity, reduction of phosphorus losses and potential for improved productivity are main outcomes of structural liming.

Biological activity in the soil may increase which means more biodiversity and higher soil organic content.

The effect is long-term if soil condition during implementation is optimal. After incorporation, no maintenance is needed.

	Good/positive
	Moderate
	Negative
	Unknown
	Not relevant

Effects								**Costs**	
Water retention	N retention	P retention	Ground-water infiltration	Productivity	Biodiversity	Carbon storage	GHG reduction	Duration	Maintenance
								Investment	None

Gypsum for improved soil structure

- Gypsum (CaSO4+2H2O) reduces erosion, particulate phosphorus (PP) and dissolved reactive phosphorus (DRP) leaching from clay fields. Also leaching of organic carbon may decrease.
- Gypsum occurs in nature as a mineral which can be mined, but e.g. in Finland, large amounts of gypsum is available as a by-product of the phosphoric acid industry.
- Gypsum has no impact on pH.

After gypsum application suspended solids settles down to the bottom. (No gypsum left, after gypsum application right, photos: Pasi Valkama).

After spreading gypsum is dissolved relatively quickly as calcium and sulfate ions and therefore the ionic strenght of soil pore water increases. When ionic strenght increases more phosphorus binds into clay particles and DRP leaching is reduced. When soil particles get closer each other and form larger aggregates erosion is reduced. Calcium also forms bridges between soil particles. Therefore, the fields amended with gypsum are less sensitive to erosion.

Localisation and implementation

Lime or manure spreader can be used to spread gypsum. (Photo: Pasi Valkama)

- Gypsum is spread in clay fields with lime or manure spreader.
- Suggested amount is 4 t/ha of gypsum to achieve effective phosphorus load reduction.
- Gypsum should be spread after the harvest and before tilling. It is suitable for ploughing, reduced tillage and no-till farming. No-till sowing should not be carried out directly after gypsum spreading.
- The sulfate losses form a potentially adverse side effect of gypsum. Thus it is not recommended to spread it in groundwater formation areas and lake catchments. The impact of sulfate on the internal load in the lakes should be more closely investigated.
- Gypsum has also been found to impair the absorption of selenium by plants during the first year after spreading.

Effects, duration and maintenance

- Gypsum reduces effectively erosion, phosphorus and organic carbon leaching from clay fields. The impact has been detected to last for five years.
- With gypsum amendment, the phosphorus load flowing into the Baltic Sea can be reduced immediately and cost effectively.
- Method is also easy to apply by farmers.
- Research data on long-term effects and impacts on other soils than clay are still needed.

	Good/positive
	Moderate
	Negative
	Unknown
	Not relevant

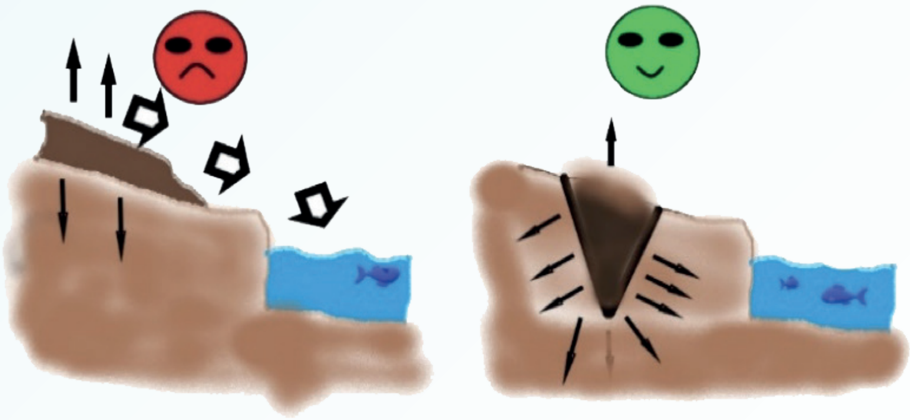
Effects								**Costs**	
Water retention	N retention	P retention	Ground-water infiltration	Productivity	Biodiversity	Carbon storage	GHG reduction	Duration	Maintenance
								Investment (5 years)	Repeated every 5 years

Subsurface application of manure

Subsurface application of liquid organic fertilizer based on manure under pressure into the grooves is a measure that makes it possible to increase soil fertility and improve soil structure, regardless of the type of soil.

In liquid organic fertilizer, nitrogen is in a more accessible form for plants than in solid fertilizer, and its introduction into the root zone allows the most efficient use of the potential of fertilizers.

The placement of fertilizers inside the soil, in less dense soil layers, under the surface soil crust accelerates the process of fertilizer infiltration, which excludes the formation of fertilizers on the soil surface, therefore, the risk of surface runoff of nutrients into water bodies is reduced.

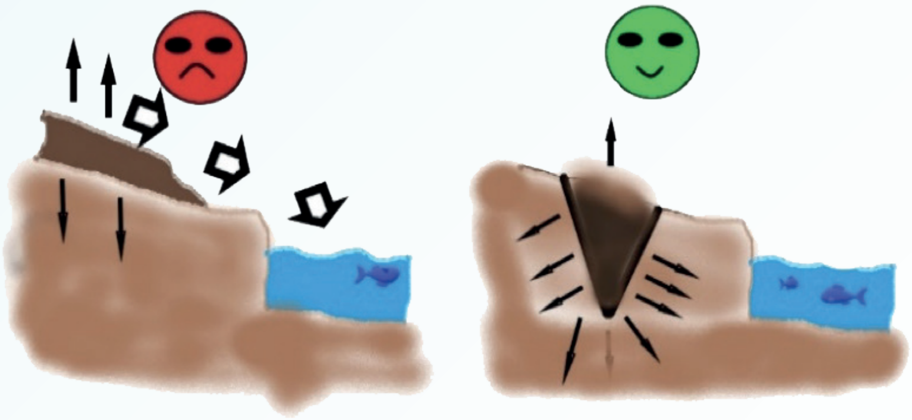


Subsurface application reduces emissions into the atmosphere and surface runoff of fertilizers

Subsurface application of manure

Subsurface application of liquid organic fertilizer based on manure under pressure into the grooves gives an advantage both:

- in terms of reducing emissions into the atmosphere and water bodies, and
- the farmer receives preferences by reducing the need to purchase mineral fertilizers, increasing soil fertility and obtaining large yields of crop products, including in meadows and pastures.



Subsurface application reduces emissions into the atmosphere and surface runoff of fertilizers

Also liquid organic fertilizer is an additional source of moisture during dry periods of the year.

Localisation and implementation

Machine for surface manure application
in the north-east of the Leningrad region 2020.

This method is intended for use on grassland or arable land with minimal tillage before planting and after harvest.

The method is used in almost all countries, but has some limitations: the method is less effective on very stony or on very thin or compacted soils, where it is impossible to ensure uniform penetration to the required working depth.

Systems for applying liquid organic fertilizer under pressure are more energy intensive than surface or belt application equipment.

The application rates vary depending on the characteristics of the fertilizers, the crops grown and the degree of soil fertility.

Effects, duration and maintenance

Accelerated assimilation of nutrients from fertilizers by plants, soil and exclusion of surface runoff, reduce nitrogen emissions and phosphorus input into water bodies.

The potential to increase productivity and reduce emissions and runoff are the main results of subsurface application.

The effect is long-term if soil condition during implementation is optimal. After incorporation, no maintenance is needed.

	Good/positive
	Moderate
	Negative
	Unknown
	Not relevant

Effects								**Costs**	
Water retention	N retention	P retention	Ground-water infiltration	Productivity	Biodiversity	Carbon storage	GHG reduction	Duration	Maintenance
								100 000 - 120 000 евро	None

Monitoring of manure distribution

The programme monitors the farm generation of nutrients (nitrogen and phosphorus) in the organic fertilizers and creates the logistical scheme of their application with due account for environmental and economic factors.

The functional objectives of the interactive programme are:

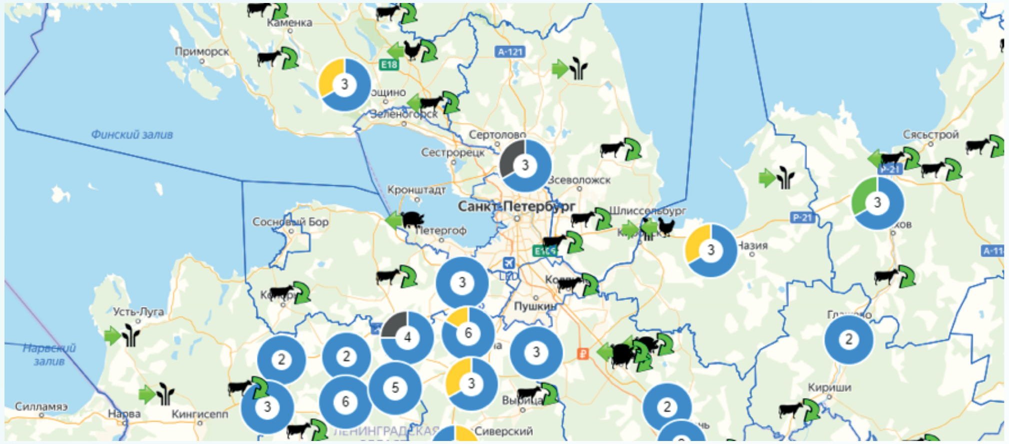
- To receive the relevant source information on the region, agricultural organisations, applied animal/poultry manure handling technologies, and manure storage types.
- To visualize all agricultural organisations on a digital map: location, name, specialisation, animal stock, available agricultural land.
- To calculate and display the current situation in agricultural enterprises: amount of organic fertilizer received, land sufficiency for all organic fertilizer application, and required volume of manure storages and composting pads.
- To calculate and display the forecast situation in agricultural organisations.
- To create the electronic passports of farms, districts and regions, including the logistics of organic fertilizers distribution from supplier farms to consumer farms, considering the nutrient load standards and the data on the nutrient load distribution within the boundaries of agricultural lands in the catchment area.

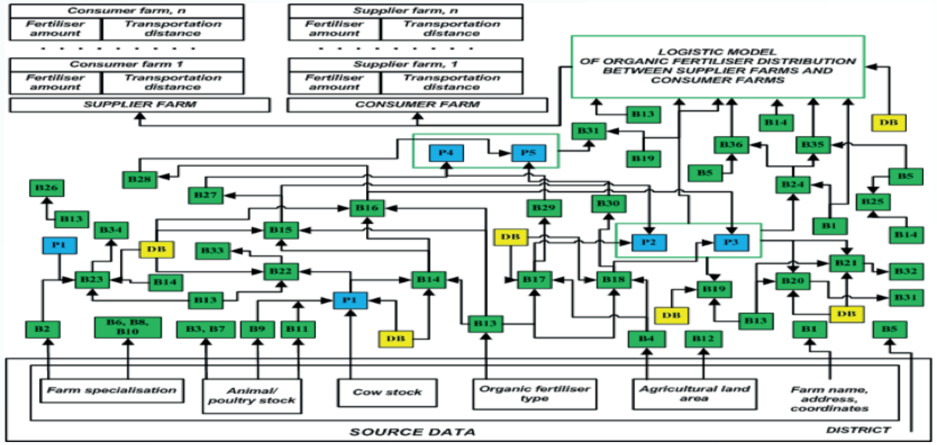
Localisation and implementation

The digital maps based on a selected geographic information system are used to position the farms and to determine the inter-farm relationships in terms of organic fertilizer distribution. This way the programming resources are combined with spatial visualisation, and the agro-monitoring and nutrient load management are made interactive.

The mathematical model for limiting the nutrients introduction per one hectare of agricultural land was adopted as the basis to create a forecasting system and a logistic scheme for organic fertilizers distribution.

The limiting factor in the fertilizer application dose is total nitrogen (170 kg/ha) and total phosphorus (25 kg/ha). When one of the indicators reaches the limit value, the programme will give a signal. The indicator (total nitrogen or total phosphorus) the limit value of which is reached first is considered the most significant in the calculation of the organic fertilizer application dose.





Effects, duration and maintenance

The programme makes it possible to manage the nutrients and to monitor the expected reduction of diffuse load from agricultural production on the Baltic Sea.

As a result, all produced organic fertilizers are distributed over the agricultural land that reduces the diffuse load in the Baltic Sea Region.

The programme is free for relevant executive authorities and agricultural enterprises. The effects are noticeable as long as the programme is used. After implementation, the programme requires regular data updates for optimal operation.

	Good/positive
	Moderate
	Negative
	Unknown
	Not relevant

Effects								Costs	
Water retention	N retention	P retention	Ground-water infiltration	Productivity	Biodiversity	Carbon storage	GHG reduction	Duration	Maintenance
								None	Data updates

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