Climate-friendly agricultural practice in Latvia

Direct incorporation of organic fertilisers into the soil

Aim for the implementation of the measure

To reduce losses of nitrogen by spreading liquid organic manure on the soil or by incorporating it into the soil on those farms, which have liquid manure and/or slurry storage facilities or biogas plants. The measure is suitable for crop and livestock farms with areas of cereals, maize and grassland.

Aggregate for incorporation of acidified liquid manure
Source: archive materials of the Farmers Parliament

Essence of the measure

Manure spread on the field should be incorporated into the soil as soon as possible, since 50-60% of ammonia evaporates during the first twelve hours. Ammonia losses can be reduced if liquid manure is spread during the crop growth; besides, the length of plants may not exceed 20 cm. The Cabinet Regulations No 834 (23.12.2014.) "Regulations on the Protection of Water and Soil from the Pollution with Nitrates Caused by Agricultural Activity" stipulate that litter manure is incorporated into the soil within 24 hours after spreading, liquid manure and slurry - within 12 hours. Liquid manure and slurry shall not be incorporated if they are applied as an additional fertiliser after sprouting of the respective crop. In the autumn, liquid manure, digestion residues and slurry are used for the fertilisation of fields only together with plant post-cutting residues and they are incorporated into the soil.

It is recommended that the fertiliser is spread with the equipment, which incorporates it immediately into the

soil; thereby, avoiding the risk of spreading harmful gases and odours. It is advisable to determine the content of nutrients in both livestock manure and the soil in the laboratory and to calculate the rates of fertilisers according to the soil composition and crop requirements using environmentally friendly technologies.

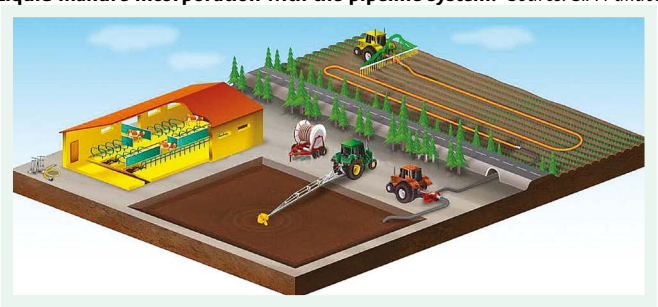
There are several ways for spreading liquid manure on the field:

1. **By air**, spreading with a deflector plate. Working width 12-24 m. Usually, it is used for incorporation as surface fertiliser for cereals, grass and maize. Such technology is used by 80-90% of Latvian farms. The essence of the method is to quickly spread the fertiliser from the liquid manure tank. A capillary cloud of liquid manure forms behind the fertiliser tank, so the main drawback of the method is the evaporation of ammonia, and thus, losses of nitrogen. When spreading liquid manure on the grass, cutting or grazing is not allowed earlier than six weeks after the manure spreading. In addition, there is a very uneven distribution of nutrients;

2. **Directly on the soil**, using a tube rod. The most important advantage is that liquid manure hardly ever gets on the leaves and they are protected from burning in hotter weather. Spreading aggregates can be mounted behind the liquid manure tank but the spreading is done by means of tongs directly between the plant lines and close to the soil. Spreading this way reduces nitrogen losses and also environmental impacts. This method is less popular in Latvia but it is very convenient and productive if the liquid manure storage site is not more than 4 km from the field areas. If the field areas are located further away or they are difficult to access, it is possible to use a pumping system with an additional pump or special intermediate storage facilities. Stationary pipelines are also used to pump manure up to 8 km but this is a significantly more expensive system. Pipeline transportation of manure has a number of essential advantages: less odours, roads are protected, no sealing of soil, saving of fuel (up to 40% compared with barrel transportation),

less noise, faster incorporation (time saving, especially in spring), lower nitrogen losses, high productivity – approximately 1200 m3 of liquid manure may be spread in approximately 30 ha area working 10 hours a day as well as it is possible to reduce the width of the protection zones. It is possible to pump the fertiliser if the dry matter content in the liquid manure is below 5%, then the pipelines will not block. It is recommended to separate the solid fraction at a higher dry matter content. Various obstacles (roads, neighbouring land, water reservoirs etc.) may hinder the pipeline placement;

Liquid manure incorporation with the pipeline system. *Source: SIA Pakaus*



3. **Band spreaders consisting of a tank**, pipelines, splitter-shredder and a set of spreading pipes attached to a rod. These spreaders spread the fertiliser in bands, spreading the same fertiliser rate on each pipe across the width of the rod. The construction of band spreaders varies depending on the construction of the spreading device, their working width ranges between 6 m and 36 m. The advantage is even spreading of fertiliser and lower nitrogen (NH_3) emissions compared with raft spreading by a deflector plate, the possibility to use on growing plants without smearing them with fertiliser, higher spreading productivity and more convenient manoeuvrability compared with direct incorporation spreaders; it can also be used on rocky fields or fields with particularly heavy soil. However, it is necessary

to incorporate the fertiliser separately.

The reduction of nitrogen losses can be achieved by acidifying the liquid manure.

Aggregate for incorporation of acidified liquid manure in 30–40 cm tall grassland.
Source: archive materials of the Farmers Parliament

Aggregate for incorporation of acidified liquid manure.
Source: archive materials of the Farmers Parliament

4. **Direct incorporation spreaders,** which incorporate the fertiliser directly into the furrows cut into the soil with or without closing the furrow. Spreaders may be fitted with disc-driven ploughshares or S-shaped prongs. They are used in tillage and stubble, minimal nitrogen losses, combined spreading and incorporation of fertiliser as well as loosening of the arable layer, even spreading, low nitrogen (NH_3) emissions, no odours, higher fertiliser dosage can be incorporated by deeper soil tillage. However, it should be considered that fuel consumption will be higher, it is an inappropriate technology on the fields with growing plants but it can be used for plants requiring the soil loosening, including the GPS navigation for steering. This is the most expensive technology with the most expensive operation due to many dwindling parts. The purchase and use of these spreaders will not be economically profitable for smaller farms; though the purchase of a liquid manure injection service could also be more appropriate for large and strong farms.

Direct technology may be used for the transportation, spreading and incorporation liquid manure and slurry into the soil, where the same machinery both transports and spreads the ferti-

liser, or re-loading technology, where different technical units are used for transportation and spreading.

The project "GreenAgri" implemented by the union "Zemnieku saeima" (Farmers Parliament) and the Estonian Chamber of Agriculture and Commerce has resulted in the development and testing of environmentally friendly organic fertiliser management methods and technologies, and the development of recommendations for reduction of nutrient runoffs from agricultural areas in the Baltic States simultaneously maintaining the competitiveness of farmers. This project is being implemented in consistence with the HELCOM Convention on the Reduction of Phosphorus and Nitrate Input in the Gulf of Riga and the Gulf of Finland. A detailed description of spreading liquid fertilisers with added costs can be found here: *http://zemniekusaeima.lv/wpcontent/uploads/2016/01/Greenagri_Organiska_meslojuma_izkliedesanas_tehnologijas.pdf*

Aggregate for incorporation of liquid manure in the topsoil.

Joskin SOLODISK XXL disc injector for incorporation of liquid manure.
Source: SIA AR AGRO

Positive effects

- The soil is not compacted.
- In Latvia, farms widely use it as a service.

Negative effects

- If barrels are used, soil is compacted and roads are worn off. There is a lack of clear, calculated evidence that the use of a baffle plate results in a significant increase in GHG and NH_3 emissions.
- There is a lack of information on how liquid manure is applied / spread on farms, currently in Latvia calculations are made on the basis of average data taken from the guidelines.

Aspects	Limitations	Solutions
Technological	• After spilling the fertilizer, it is not technically possible to embed it into the soil within 12 hours as specified in the regulatory documents. • Weather conditions often hinder spreading of the fertilizer and its embedding into the soil, especially in late autumn. • In pig farms, the amount of liquid manure is large, there is often a lack of areas for spreading it. • Injectors are not efficient and profitable, the work process is slow, the soil is compacted.	• Liquid manure and digestate spreading technologies differ, thus appropriate equipment is necessary. • Intermediate crops for green manure and stubble with sprouted slag can be used for spreading liquid manure and digestate in autumn. This will reduce nutrient leakage and nitrogen and ammonia emissions. • In the future, enhancing the use of pipeline systems for the transfer and spreading of liquid fertilizer. • The fastest evaporation of NH_3 occurs in the first hours after the application of slurry, and even faster at higher temperatures; therefore each farm must choose the most appropriate solution, taking into account resources and specific conditions.

Environmental	• Not suitable for all farms. • Very short time period for embedding of the liquid fertilizer into the soil; moreover, humidity conditions do not always allow it.	• The most efficient way and time of spreading liquid fertilizer is on growing plants, so-called non-root fertilization, which also causes the lowest GHG and ammonia emissions. • Measurements of GHG and ammonia emissions are necessary in grasslands, where deflector plates are mainly used. • Greater emphasis should be placed on increasing the C content in the soil and the requirement to control it.
Economic	• The effect is seen later (after 2-3 years). • Expensive measure, as the equipment is used on the farm only for a short time of the year. • Price is the decisive aspect in the developing of the service system.	• It is necessary to be able to rent equipment or farms must be able to cooperate in using of the equipment. • Encourage the interest of grain growers to use organic fertilizers on crop farms.
Social aspects (knowledge, experience, cooperation)	Lack of knowledge.	Arranging the demonstrations on farms to popularize the positive experience of applying liquid fertilizer to the soil.

Costs for the implementation of the measure

Alternative No 1

Transportation of liquid manure with a barrel and incorporation using injectors. Assuming that the basic method envisages spreading of liquid manure by air through the nozzles, a liquid manure spreading injector is the only individual object for investment. The set price, consisting of a coupling, discs and spreading tongs, is EUR 75 000 (SIA ARAGRO); the costs increase to EUR 100 000, if a transportation barrel is needed. Assuming the farm size of 500 ha and the depreciation period of the equipment 6 years, the costs for the introduction of the me-

asure are EUR 25 per hectare. Fertiliser savings, fertiliser losses are estimated to be up to 60%, assuming that losses account for 40%, the nitrogen intake is 100 kg per hectare and the price of nitrogen pure substance is EUR 40.80 per tonne, the savings attributable to the use of fertiliser amount to EUR 16.32 per hectare. The costs of the measure are EUR 8.68 per hectare.

Alternative No 2

Transportation of liquid manure using a hose system and incorporation using injectors. The hose system with incorporation injectors costs EUR 115 325 (SIA Pakavs offers Mastek 2000 system). Field tillage is possible at a distance of 2 km from the lagoon. Assuming an average field area of 11 ha and 2 lagoons at a distance of 2 km and the depreciation period 6 years, the specific annual application costs of the hose system amount to EUR 873.67 per hectare. More and more farms are choosing this system, as time and fuel savings are the most important benefits. According to the practitioners' assessment, savings of fuel compared with liquid manure spreading by barrel are 3.5 L ha^{-1}. The average savings from the reduction in fuel consumption are EUR 2.80 per hectare, assuming that the average price of diesel fuel excluding VAT was 0.80 EUR L^{-1} (SIA Lukoil Baltija R) in 2015. Time savings are estimated to be 6.5 h ha^{-1} per year, taking into account the working hours of a tractor's use, which include liquid manure spreading, fuelling and distance. If it is assumed that the tractor use is an outsourced service, which includes both technique and a tractor driver services and the minimum cost is EUR 21.22 per hectare per year, the time savings amount to EUR 137.93 per hectare. Fertiliser savings, fertiliser losses are estimated to be up to 60%, assuming that losses account for 40%, the nitrogen intake is 100 kg per hectare and the price of nitrogen pure substance is EUR 40.80 per tonne, the savings attributable to the use of fertiliser amount to EUR 16.32 per hectare. In general, it can be concluded that the costs of the measure are EUR 698.20 per hectare. Social costs associated with the use of public roads as well as the preservation

of soil fertility, which can be affected by soil compacting, which is unavoidable when transporting liquid manure barrels by the field are important advantages of using hoses. One of the methods for evaluating ecosystem services could be used in this case; though, these potential cost components are not taken into account in this calculation.

Incorporation of liquid manure in the cropland.
Source: archive materials of the Farmers Parliament

Incorporation of liquid manure in the grassland.
Source: archive materials of the Farmers Parliament

Impact of the measure on the reduction of GHG emissions

Research done in Denmark has shown that total nitrogen losses (NH_3 and NH_4) account for 2-3% when applying a disc injector, while they are 20-35% by spraying liquid manure. In Latvia, direct incorporation service providers estimate higher losses in the incorporation of liquid manure – 5-7%. Nevertheless, they simultaneously indicate that in practice the efficiency of liquid manure application is lower on average; thus, estimating losses of nitrogen up to 50%. The amount of evaporated ammonia is affected by the dry matter content in the fertiliser. If it is 6%, the evaporation from liquid ma-

nure is by approximately 20% higher than in the case of a dry matter content of 2%.

At the same time, it should be noted that despite the high efficiency of reducing nitrogen losses, liquid manure incorporation technologies are characterised by a relatively high range of nitrogen reduction. The research results of neighbouring countries show that the average reduction is 70-80% when using a disc injector, while the reduction is 35% when using tube rods. The incorporation efficiency may also be influenced by the incorporation speed, wind speed, water content in the soil, precipitation, time of incorporation (evaporation is lower in the morning compared with the afternoon) as well as the evaporation is significantly lower if tube rods are used on a field where the plants are 60 cm tall. In France, the calculations of emissions on the fields where fertiliser is incorporated include savings of 12.3 kg of nitrogen per hectare (range 0-18.4) that is suitable for spring plantings. The incorporation of fertiliser is combined with the following measures: fertilisation schemes, delayed initial incorporation of nitrogen and the use of inhibitors.

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