

Climate-friendly  
agricultural practice in Latvia

# Separation of liquid manure and digestate

## *Aim for the liquid manure separation*

The aim of liquid manure separation is to increase the efficiency of manure management, to obtain additional products from manure; to reduce the processing, transportation and storage time of the produced nutrient concentrate; make

it easier to store and embed into the soil; to reduce energy consumption and the environmental impact associated with the embedding of manure into the soil; reduce odours and pollutant emissions and reduce the spread of plant diseases.

## *Essence of the liquid manure separation*

Liquid manure, including digestate produced in biogas plants, is a valuable fertilizer because it contains the nutrients necessary for plant growth (nitrogen, phosphorus and potassium). However, the spreading and incorporation of liquid manure is often limited by regulations governing the amount of manure and nutrients to be spread, and it is difficult to transport liquid manure over long distances. For many crops, manure provides the amount of phosphorus that the plants need, but at the same time the nitrogen content in the manure is insufficient. This leads to insufficient nitrogen and excessive phosphorus use. Separation of liquid manure solves this problem because the nutrient content is

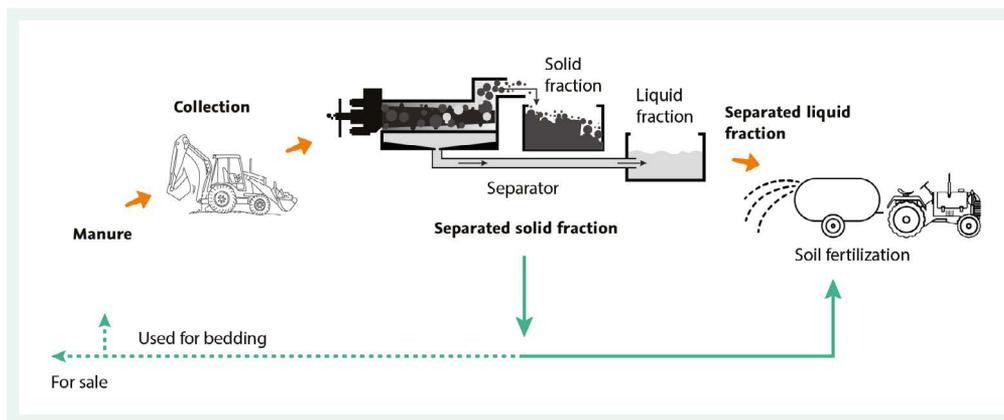
balanced and concentrated in the solid fraction of manure. This means that after separation, the solid fraction with a higher phosphorus-nitrogen ratio can be transported to more distant locations.

In turn, the liquid fraction can be applied locally by embedding it into the soil, after separation it is cleaner, without solid particles, which contributes to their faster absorption into the soil, can also be injected into wastewater.

Liquid manure separation is a special manure treatment technology, during which the solid fraction is separated from the liquid one by using gravity or mechanical systems.

*Schematic description of liquid manure separation and related processes. Source:*

*Aguirre-Villegas et al., 2017*



### Šķidro kūstmēsļu separēšanas un saistīto procesu shematiskais attēlojums

*Avots: Aguirre-Villegas et al., 2017*

## THREE ACKNOWLEDGED TYPES OF TECHNOLOGIES FOR SEPARATION OF LIQUID MANURE

- Gravity, by using settling basins or sloping screens that trap the solid fraction and prevent it from entering the liquid, but this technology is not popular in terms of reducing GHG emissions.
- Chemical, where chemical coagulants are used in the separation. The technology is expensive and after adding

- chemicals, manure spreading in the field is no longer so safe.
- Mechanical separation is the most popular technology, where a big variety of equipment can be used to obtain bedding material, compost raw material, concentrated fertilizer for crop production etc. The processing results in a mass of manure or digestate (solid fraction)

with a dry matter content of approximately 26% to 32% and a

liquid fraction with a dry matter content of approximately 2% to 4%.

Technological solutions vary and are different on farms. For example, if chopped straw is used as bedding on the farm

and mixing is used in the reactor, the straw fraction may be longer.

### POSITIVE EFFECT

- The separated mass can be used on the farm as bedding.
- When used as a fertilizer, the separated mass is easier to spread on the field, lower transportation costs.
- By separation the digestate, in storage lagoons free space is obtained, the need to mix the mass in the lagoon is reduced.
- The separated mass can be used as an additive to ensure the operation of the bioreactor, thus

- reducing the need to use a maize silage additive.
- There is higher concentration of plant nutrients in the separate.
- Separation on pig farms is a good solution given the specifics of manure (sinking pig manure as opposed to floating cows' manure). The new separation equipment is cost-effective and efficient.
- By embedding the separate into the soil, its carbon content is increased.

### NEGATIVE EFFECT:

- The use of separated dirty water is disadvantageous for irrigation, because the volume is large, but the value of the fertilizer is

low, and its disposal in sewers or treatment plants is unprofitable (expensive).

Aspects	Limitations	Solution
<b>Technological</b>	<ul style="list-style-type: none"> <li>• A special separation device is necessary</li> <li>• When using a separate for bedding, appropriate humidity must be observed to avoid dust that is harmful to the animals' breathing.</li> <li>• Separation requires a large amount of manure, at the same time the issue of the use of the separate - its embedding into the soil - must be addressed.</li> </ul>	<ul style="list-style-type: none"> <li>• Separated digestate can be mixed with ash from cogeneration plants, thus obtaining a good fertilizer.</li> <li>• The measure can be used on all farms that produce liquid manure or digestate.</li> <li>• This approach is up-to-date and suitable for pig farms due to the specific properties of liquid manure.</li> <li>• The separate can be easily spread with a manure spreader.</li> <li>• Chemical analyses of the composition of the digestate must be performed at least once a year.</li> </ul>
<b>Environmental</b>	The direct impact on emissions is small	The need to transport large amounts of liquid and disperse it on the fields, thus creating risks of nutrient leakage and N emissions to the environment, is reduced.
<b>Economic</b>	Requires a separator and an oast for drying the separator	<ul style="list-style-type: none"> <li>• Cheaper and easier spreading of the separate for field fertilization compared to unseparated liquid.</li> <li>• Possibility to provide bedding for animals on the farm.</li> <li>• Provision of separation equipment rental services.</li> </ul>
<b>Social aspects (knowledge, experience, cooperation)</b>	<ul style="list-style-type: none"> <li>• Lack of knowledge.</li> <li>• Rarely used in farms of Latvia.</li> </ul>	<ul style="list-style-type: none"> <li>• Local governments' interest in business development and environmental protection.</li> <li>• Informing farmers about new, modern and efficient solutions for the use of liquid fertilizers and digestate.</li> </ul>

## *Experience in Latvia*

LManure separation is not very popular in Latvia, there are relatively more farms that use the separation of solid and liquid fractions as a complementary measure in bioreactors, where the anaerobic digestion process of manure

takes place and the separation is applied to digestate. "Pampāļi" Ltd. separates the digestate, the solid fraction is further dried at low temperature with the heat obtained in the bioreactor. In the monitored substrate (digestate) the

dry matter content is about 9-10%, but after separation the dry matter content in the solid fraction is 35-40%. The dry matter content of the liquid fraction separated during the separation process is 7-8%, the amount of liquid is reduced and it becomes more technologically and resource-efficient for embedding in the field. The farm works with an application system, where the digestate is delivered to the field via a piping system with the help of pumps. When the dry matter content exceeds 10%, the use of the system is difficult (the dry matter content threshold is 12%), because the flow capacity is low and the equipment is overloaded, as a result of which the use of the technology is not economically justified. The solid fraction of the separated digestate is too wet for use in the bedding of dairy cows, as well as it emits nitrogen in a volatile form, which creates a sharp and unpleasant odour in the housing for both humans and animals. When used as a substrate in greenhouses, leaf burns can be observed for tomatoes. "Pampāļi" Ltd. plans to use the separated digestate once a year to supplement the deep bed base in the

new dairy cow farm, by mixing it with slaked lime and straw instead of solid manure. After separation, the solid fraction is dried in a container at a low air temperature with air flow, as a result of which dried digestate with a dry matter content of 50-90% is obtained, Ltd. "Pampāļi" obtains a material with a dry matter content of 80-90%. Separation is necessary because it is not technologically possible to dry liquid products in a drying container, it would require a very high heat resource and time. The maximum capacity of the farm for the production of dried digestate per month is 80 m<sup>3</sup>, it is used in the deep beds of dairy cowsheds. Farm-dried digestate is not used for bedding in groups of pregnant cows and young cattle due to the presence of pathogens and dust, as this product is air-dry, resulting in lung problems and difficulties in breathing - coughing for young cattle and workers. Practical experience gives evidence that dried digestate needs to be mixed with slaked lime or some other binder to form a homogeneous mass and to avoid a slippery "sticky" surface when exposed to moisture. After scattering in the beds, rapid

heating of the digestate is observed due to the multiplication of microorganisms. The USA experts admit that dried digestate is one of the most valuable bedding materials from the point of view of cow comfort, but the drying process is not enough, it is also necessary to store it appropriately and further provide fermentation, eliminating the presence of any pathogens and further heating of the mass. In perspective, Ltd. "Pampāļi" is considering the possibility to increase the amount of digestate drying - to increase its use in bedding, as well as the possibility to press briquettes and sell them as fuel.



**Digestate separation plant at Ltd. "Pampāļi"**

*Source: archive of the Ltd. "Baltic Sales Agency"*



**Beddingi**

*Source: archive of the Ltd. "Baltic Sales Agency"*



**By using digestate bedding, the cows are clean**

*Source: archive of the Ltd. "Baltic Sales Agency"*

Also, on the farm "Vecsiljāņi", the thick fraction of manure in the process of passing through the biogas plant is also separated, the solid fraction is dried

and used on the farm as bedding. The processing of liquid manure by the farm “Mežacīruļi” in the bioreactor takes up to 100 days until the mass is completely fermented. Between the reactor and the lagoon there is a device for separating the digestate, where a by-product similar to dry, loose peat is produced - dry digestate and liquid, which contains a lot of minerals, especially nitrogen and potassium. The solid fraction is formed in a separation process, in which a valuable fertilizer is obtained - a medium-dry mass, which rich in humus, phosphorus and potassium, which does not contain pathogenic microorganisms (in the process of fermentation, at a temperature of 38-40 ° C they die). The solid fraction contains much less nitrogen than the liquid fraction because the nitrogen in it is volatile. On the farm, the solid fraction with good results is used as a substrate component in greenhouses in peat gutters, growing cucumbers, it has a positive effect on the biological activity in the soil, which is also enriching it with nutrients.



**Transportation of solid digestate fraction**

*Source: archive of the Ltd. “Baltic Sales Agency”*

Liquid manure is separated at Ltd. “Rāvas”. The manure is not processed into digestate on the farm, but a solution has been found to make it easier to incorporate liquid manure from around 700 cattle farms into the soil due to the high dry matter content of the manure and the difficulty of incorporating it into the soil with a pipe type equipment. In the separation process, a liquid fraction is obtained that can be easily then embedded into the soil, thus limiting the emission of nitrogen compounds into the atmosphere. The solid fraction with 35-40% dry matter is used for cow bedding. Therefore, it is possible to replace straw bedding on the farm. According to the farm manager, no negative effects were observed on either the animals or the workers using the solid fraction separated from the slurry.



**Separation of the digestite. Ltd.**  
*Source: archive of the Ltd. "Baltic Sales Agency"*

## *Advantages of separating liquid manure*

Liquid manure lagoon-type storage and liquid manure storage tanks are designed to store large amounts of liquid manure. Managing liquid manure in an environmentally safe manner is much easier and more convenient if the ma-

nure is separated by separating the solid fraction from the liquid one before it is transported to a lagoon-type storage or storage tank. Separation of liquid manure Climate - friendly agricultural practices in Latvia 8.

### **MANURE SEPARATION HAS SEVERAL ADVANTAGES:**

→ smaller lagoon-type storage or storage tank size, which reduces

construction costs;  
→ processing flexibility for manure

- storage and use increases, as the solid fraction of manure can be transported further at a lower cost than unseparated liquid manure;
- the amount of manure used decreases, but the concentration of nutrients increases;

- the separated liquid fraction is easier to transport and it can be done with lower capacity pumps;
- longer intervals between lagoon-type storage clean-ups reduce costs and make manure management as well as manure odour control more efficient.

## Disadvantages

Separation of liquid manure changes the usual way manure is managed on the farm and additional equipment is needed. Therefore, the main disadvantage is that the introduction of manure separation on the farm will require equipment for the storage of both the separated solid fraction and the liquid fraction, which may increase storage costs. The introduction of this measure will be more attractive for larger farms (starting with 200 cows), which manage larger volumes of liquid manure and thus can afford to invest in the purchase of separation equipment. With small amounts of manure, separation will be economically disadvantageous.



**Mobile separation equipment.**

*Source: archive of the Ltd. "Baltic Sales Agency"*

However, a simpler solution is possible - to use the services provided by companies. However, the main issue is the further use of separated pulp, including the market demand for such fertilizers. When planning the future development of farms, the slurry management system should operate in a way that is safe and efficient and thus facilitates the owner's daily life.

## Costs for the implementation of the measure

Manure separation is a process of mechanical dewatering of liquid manure by means of a sieve, vibratory sieve, drum sieve, centrifuge or auger. Currently, the

most widely used equipment for separating water from manure is FAN snail-type separators.

### TECHNICAL DATA OF FAN MANURE SEPARATORS

SEPARATOR MODEL	Power, KW	Maximum processing capacity, m <sup>3</sup> h <sup>-1</sup>	Use, number of animals in the shed
<b>FAN PSS 1.2 - 520</b>	4,0	40	Small - up to 100
<b>FAN PSS 1.2 - 780</b>	5,5 - 7,5	65	Medium - 500
<b>FAN PSS 3.2/5.2 - 520</b>	5,5	100	Medium large 500-1000
<b>FAN PSS 3.2/5.2 - 780</b>	5,5 - 7,5	100	Large - above 1000
<b>FAN PSS 3.2/5.2 - 1040</b>	7,5 - 11,0	100	Very large - over 2000

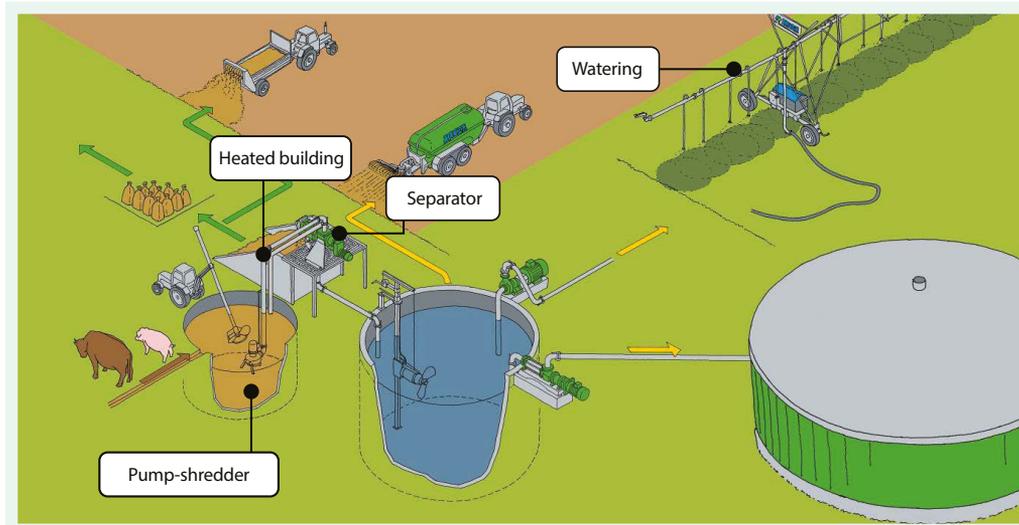
Source: [www.fan-separator.de](http://www.fan-separator.de)

Separator prices range from 3,000 to 29,000 EUR. The price difference is formed by the equipment set, which depends on the technological process. In order to ensure this, it is necessary to install an additional pump-shredder in the liquid manure storage, which ensures the supply of liquid manure to the separator. The price of the FAN MAGNUM S pump is 8000 EUR. In Latvian climatic conditions, the working space of the separator must be heated, thus ensuring

continuity of operation in winter conditions. Depending on the technological solution, the costs of such construction in various projects range from 10,000 to 20,000 EUR. Operating costs, which depend on the capacity of the separator (KW) and the hours worked, must also be added to the costs. An additional benefit of reducing GHG emissions and other benefits from using manure dewatering technology is the reduction of capital investment costs in the construction of

manure storage facilities. When installing the separator FAN PSS 3.2 / 5.2 - 780, the volume of the open type lagoon for

a housing with 500 dairy cows decreases from 2500 m<sup>3</sup> to 150 m<sup>3</sup>.



**Technological process of manure separation by using a snail type separator**

Source: [www.fan-separator.de](http://www.fan-separator.de)

The separated liquid fraction can be used for watering plants and it is not necessary to build large volume tanks. The value of the solid fraction at the prices of mineral fertilizers is 50 to 70 EUR t<sup>-1</sup>, while the value of this mass in fresh form is about 3 to 5 EUR t<sup>-1</sup>. If the measure is introduced in a farm with 1000 animals and a depreciation period of 14 years, it will amount to 13.04 EUR, but in a farm with 100 animals 22.88 EUR per animal,

additional costs per year. The costs can be compensated by savings from the use of bedding if the separated solid fraction can be used for bedding. Higher savings are achieved for farms that keep animals in sheds all year round, if the animals are released into pasture 180 days a year, the savings are lower.

## *Impact of the measure on the reduction of GHG emissions*

Separation of liquid manure can reduce GHG and ammonia (NH<sub>3</sub>) emissions during the storage of manure and

after spreading it in the field compared to untreated manure.

### **MANURE SEPARATION REDUCES EMISSIONS IN SEVERAL WAYS:**

- methane (CH<sub>4</sub>) emissions from the storage of liquid manure are reduced because the volatile substances that cause the emissions are separated together with the solid fraction;
- if the solid fraction is stored, the ventilation provided during storage limits CH<sub>4</sub> emissions;
- in the separation process, fibre and large fractions of organic material are removed from the liquid manure, which prevents the formation of a natural crust on the surface of the stored liquid. The natural crust can create aerobic conditions that promote the production of nitrates on the surface of the liquid. Nitrates can then be

converted to nitrous oxide, which has 298 times larger environmental impact than that of carbon dioxide.

By using liquid manure separation, GHG emissions from manure management can be reduced by 20%. Although manure separation requires additional energy consumption and can lead to additional CO<sub>2</sub> emissions from electricity consumption, the increase in these emissions is insignificant compared to the reduction in manure emissions.

## COMPARISON OF GHG AND AMMONIA (NH<sub>3</sub>) EMISSIONS FROM MANAGEMENT OF DAIRY CATTLE MANURE WITH AND WITHOUT MANURE SEPARATION

POSITION	Manure treatment type	GHG, kg CO <sub>2</sub> eq t <sup>-1</sup> manure	NH <sub>3</sub> , kg t <sup>-1</sup> manure
<b>Storage</b>	Without separation	68	0,23
	With separation	50	0,95
<b>Spreading</b>	Without separation	30	2,05
	With separation	28	1,35
<b>Total</b>	Without separation	98	2,28
	With separation	78	2,3

Source: Aguirre-Villegas et al., 2017

In literature sources, it is also indicated that liquid manure separation reduces CH<sub>4</sub> emissions by 35-42% for cattle and 18-40% for pigs. Data on the impact on N<sub>2</sub>O emissions vary.



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