


# The little
# Green guide

**- The guide to good utilization of slurry and muck**

AgroTech



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*Getting the best out of your slurry and muck requires a good strategy and the right machinery*

# High usage, low impact

**THE USE OF SLURRY AND MUCK (ORGANIC FERTILIZER) IS A MUCH DEBATED ISSUE.** This is because organic fertilizer is an important source of nutrients but can also adversely impact the environment if not handled correctly.

**TO ENSURE** the efficient use of the nutrients in organic fertilizer and thus a low impact on the environment, SAMSON AGRO has a constant focus on improving application techniques. The Danish Agricultural Advisory Service (DLBR), AgroTech and the universities carry out numerous field trials to identify the best application strategies.

**THIS EFFORT HAS COMPLETELY CHANGED.** THE practice of slurry and muck application in the last 20 years. At the same time the EU and its member states have introduced regulations for the application of organic fertilizer to minimise the environmental impact, with associated repercussions for application practices.

**THIS IS AN INTRODUCTION** to the most common terms and practises used concerning organic fertilizer. The guide gives inspiration for how slurry and muck can be used to give the highest nutrient use efficiency and lowest environmental impact.

**THE GLOSSARY** explains the terminology used, for quick and efficient reference.

# Slurry and muck
# - an important source of fertilizer

The majority of livestock feed consists of plants. The plants contain a variety of nutrients. Some of these nutrients are converted by the animals into milk, meat or eggs, but the rest pass through the animals and end up as slurry or muck. When this is spread to crops, the circle is completed and the crops supplied with virtually all the nutrients they need. However, to partly compensate for the removal of nutrients in the animal products, there is often a need to supplement with a certain amount of inorganic fertilizer.




*Organic fertilizer contains all the nutrients that the crop needs*

**Nutrient content**
Organic fertilizer of animal origin consists of 70-95 percent water and only 5-30 percent nutrients and organic compounds. Solid organic fertilizer and deep litter have a high straw content and a relatively high concentration of nutrients and solids. Liquid organic fertilizer, such as slurry, has a high water content and only little straw, so the concentration of solids and nutrients is relatively low.

The largest nutrient concentrations in organic fertilizer are of the so-called macronutrients (for example, nitrogen, phosphorus, potassium and magnesium). Other nutrients can be found in lower concentrations (for example, sodium, copper, zinc, boron and molybdenum). Most of the nutrients can be absorbed directly by the plants. Nitrogen in organic fertilizer occurs in two forms: 1) ammonium, which is directly available to plants, and 2) organic nitrogen, which must be transformed in the soil before it can be absorbed by plants. Nitrate, which is an important component in an inorganic fertilizer, is, however, not found in large concentrations in organic fertilizer of animal origin.

**TYPICAL CONCENTRATIONS OF THE MOST IMPORTANT NUTRIENTS IN ORGANIC FERTILIZER OF ANIMAL ORIGIN**

| | DRY MATTER % | Total Nitrogen*, kg/tonne | Ammonium nitrogen, kg/tonne | Phosphorus, kg/tonne | Kalium, kg pr. ton |
|---|---|---|---|---|---|
| Cattle slurry | 8 | 5 | 3 | 1 | 3 |
| Pig slurry | 5 | 5 | 4 | 1 | 2 |
| Solid org. fertilizer (muck) | 20 | 6 | 2 | 2 | 3 |
| Liquid org. fert. (slurry) | 3 | 5 | 4,5 | 0,2 | 8 |
| Deep litter | 30 | 10 | 2 | 1,5 | 10 |

**Total nitrogen is the sum of ammonium and organic nitrogen*

**Get the organic fertilizer analysed**
The concentrations shown in the table are those typically found in practice. There will, however, be large variations between farms because of the differences in feeding practice, water waste, housing design, use of straw, etc., that will all influence the composition of the slurry and muck. The values in the table may therefore not be representative for the particular slurry and muck on the farm. For this reason it would be a good idea to have it analyzed for its nutrient content. This will help in the preparation of a good and factual fertilisation plan for the crops.

**Many laboratories offer analysis of organic fertilizer**. In Denmark an analysis typically cost 34-67 EUR. Packaging for shipment can usually be ordered from the laboratory.

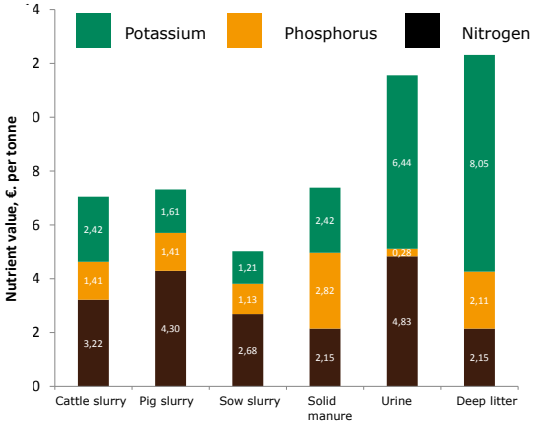
**What is the organic fertilizer worth?**
Organic fertilizer is able to partially or completely replace inorganic fertilizer in the field. There is therefore money to be saved on inorganic fertilizer if the slurry and muck is utilised optimally. There is no price list for organic fertilizer of animal origin, but its value can be estimated from the value of the inorganic fertilizer it substitutes. The figure shows the estimated fertilizer value for the five typical fertilizer types.

The value of the slurry and muck on a farm is substantial. The table shows the total fertilizer value for different farm types and sizes. The calculated value is based on the value of the equivalent amount of phosphorus, potassium and used nitrogen in inorganic fertilizer. To realise its full value, it is important, among other things, to apply the slurry and muck in the right crops at the right time and with the optimal equipment.

*Nutrient values of typical fertilizer types. In the figure, values have only been calculated for nitrogen, phosphorus and potassium. To these should be added the values for, e.g. magnesium and copper. The values are based on the price of inorganic fertilizer in spring 2015. The price of the nutrients/fertilizer is from www.kornbasen.dk. This service follows the price of the nutrients/fertilizer by the end users – the farmers.*

**A HOLSTEIN FRIESIAN DAIRY COW** without breeding and bulls produces around 29 tonnes of slurry in a year. The value of the slurry is around 204 EUR per cow-year. A finishing pig produces around 0.6 tonne of slurry from the time of weaning until it is slaughtered. The value of the slurry is around 4.4 EUR per pig.

**EUR per tonne**




**VALUE OF THE ORGANIC FERTILIZERS ON DIFFERENT FARM TYPES**

| Production size | Fertilizer type | Fertilizer produced | | Value per tonne, EUR | Total value, EUR |
|---|---|---|---|---|---|
| | | Tonne/ animal | Total output, tonne | | |
| 850 sow-years incl. growers until 30 kg | Sow slurry | 9 | 7.650 | 5,02 | 38.404 |
| 10.000 finishing pigs, 30-105 kg | Finishing pig slurry | 0,6 | 6.000 | 7,32 | 43.893 |
| 300 cow-years incl. breeding and bulls | Cattle slurry | 37 | 11.100 | 7,05 | 78.221 |
| 500 cow-years incl. breeding and bulls | Cattle slurry | 37 | 18.500 | 7,05 | 130.369 |

*The amount produced is the standard annual production, and the nutrient value has been calculated based on the price of inorganic fertilizer in spring 2015. In the calculation of the value of the manure/slurry per ton, per livestock and per farm, the Danish standards for average content of nutrients in the manure/slurry dependent on type of livestock, feeding, type of housing and so on, have been used. Find the standards on the website of Aarhus University: http://anis.au.dk/forskning/sektioner/husdyrernaering-og-miljoe/normtal/*




**Mixing is important before application**
In the slurry storage tank the nutrients segregate during the storage process. Especially dry matter, phosphorus, organic nitrogen and some micro nutrients will segregate and build up in high concentration in the bottom layer and the floating layer. In a Danish study the phosphorus concentration in the bottom layer was five times higher than in the middle layer in slurry thank with pig slurry that was not mixed. Am monium nitrogen and potassium does not segregate as those nutrients are water soluble.

By mixing the slurry thorough prior to application you will have two advantages:

- The slurry is homogeneous and easier to pump. The tank can be emptied completely.
- The concentration of nutrients (especially phosphorus) is consistent from the first to the last load of slurry.

Be aware that some slurry types (especially pig slurry) might have to be mixed continuously during application to prevent new segregation, as it might happens after only a few hours after mixing has ended.

**THE UTILIZATION RATE** in percent is a measure of how much of the nitrogen (total-N) is used by the crop in the year of application (first-year effect). Nitrogen in inorganic fertilizer is defined to have a use efficiency of 100%. The first-year effect is mainly the result of the ammonium nitrogen content of the organic fertilizer.

**RESIDUAL EFFECT** is a measure of the effect of the nitrogen in the years following the application of the slurry and muck. The residual effect is mainly the result of the organic nitrogen content. The residual effect over a period of 10 years is estimated to be 7-10% from pig slurry, 10-15% from cattle slurry and 16-24% from solid organic fertilizer.

**Nitrogen utilizatrion varies widely**
The table on page 5 shows that animal manure typically contains 5-10 kg nitrogen per tonne of organic fertilizer. The table on this page shows that the percentage of nitrogen actually taken up by the crop is somewhat lower, and very variable.

How much nitrogen the crop takes up varies because of the differences in how much of the slurry and muck is organically bound to indigestible plant residues and therefore not available to the plants. The highest bioavailability of nitrogen is in slurry and urine. That is why the utilization of nitrogen is higher in liquid liquid organic fertilizer than solid organic fertilizer.

## NITROGEN UTILIZATION OF ORGANIC FERTILIZER

### ... IN GROWING CROPS, SPRING AND SUMMER

| Fertilizer type | Crop and application method | Use efficiency, %, 1st yr |
|---|---|---|
| Pig slurry | Trail hose to winter crop (cereal, rape) | 65 |
| Cattle slurry | Trail hose to winter crop (cereal, rape) | 45 |
| Cattle slurry | Injected into grass | 50 |
| Cattle slurry | Trail hose to grass (acidified) | 50 |
| Liquid org. fert. | Trail hose to winter crop (cereal, rape) | 85 |
| Solid org. fert. | Broadcast to winter crop (cereal, rape) | 25 |
| Deep litter | Broadcast to winter crop (cereal, rape) | 85 |

### ... PRIOR TO SOWING

| Fertilizer type | Crop and application method | Use efficiency, %, 1st yr |
|---|---|---|
| Pig slurry | Injected into spring cereal or maize | 75 |
| Cattle slurry | Injected into spring cereal or maize | 70 |
| Pig slurry | Injected into winter rape | 65 |
| Liquid org. fert. | Injected into spring cereal or maize | 90 |
| Solid org. fert. | Ploughed in before spring cereals | 40 |
| Deep litter | Ploughed in before spring cereals | 30 |
| Deep litter | Ploughed in before maize or beets | 35 |

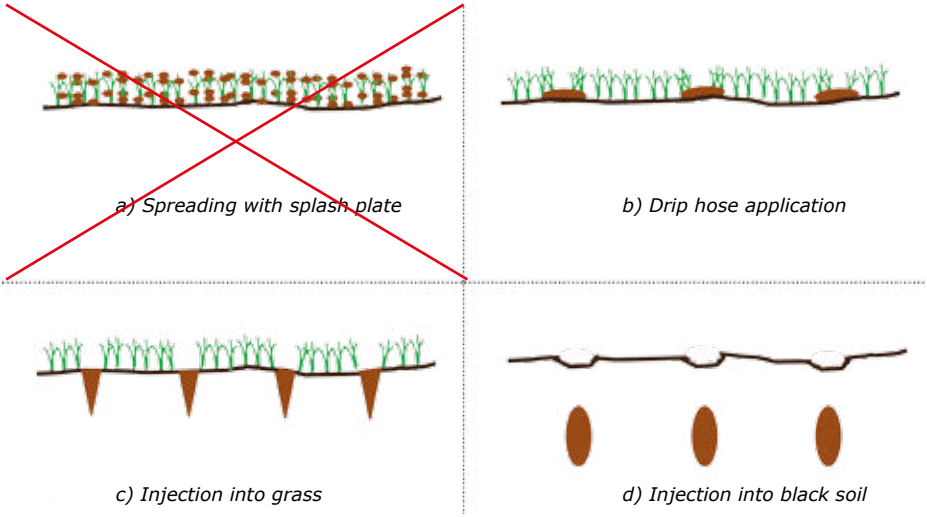
*Source: SEGES P/S*

Secondly, the degree of utilization varies because some of the nitrogen is lost to the environment before it is taken up by the plants. Read more on this from page 15. The best utilization of nitrogen is achieved when minimising these losses. This is achieved by, for example, choosing the most appropriate application equipment and only applying fertilizer in optimal amounts at the optimal time.

**Application method and ammonia losses**
Solid organic fertilizer for example deep litter can only be applied using a muckspreader. Ammonia losses from these types of organic fertilizers can therefore best be reduced by ploughing in the deep litter/muck as quickly as possible following application.

Liquid organic fertilizer, on the other hand, can be applied using a number of different techniques. The nutrient utilization can be optimized by choosing the most appropriate application method for the specific crop and time of application. The figure below shows appropriate methods for the application of liquid organic fertilizer.

**WE RECOMMEND**
applying most of the organic fertilizer in the spring months. Storage capacity for slurry and muck will therefore be needed for the autumn and winter months. The optimum is to have storage capacity for 8-9 months' production.




**Position of fertilizer in crop or soil following application**
*The black line illustrates the soil surface, and the brown blobs the manure. Note that the fertilizer contact with the atmosphere is very different with the four methods. This contact is quite significant using splash plate, which has the greatest evaporation of ammonia and thus the greatest loss of nitrogen. This method is therefore banned in Denmark.*

# THE ROAD TO SUCCESS
## with organic fertilizer

1. Make a plan. Which fields are to receive the organic fertilizer, when and how much?
2. Know the contents of your organic fertilizer. If necessary, have the nutrient content analyzed.
3. Apply the organic fertilizer early in spring for winter crops and new growth. Apply before sowing in spring cereals.
4. Be careful of structural damage. The soil must be dry and tyre pressure low. Try half loads on vulnerable areas.
5. Choose cool, calm days, if possible.
6. Slurry and liquid organic fertilizer:

   a) Choose injection into black soil on bare ground and drip hose in winter cereals.

   b) Choose the injection method for grassland. If the slurry is acidified, drip hoses can be used.
7. Solid organic fertilizer (muck and deep litter):

   Plough or harrow immediately following application.
8. Show consideration for neighbours. Do not, for example, apply organic fertilizer up to weekends and public holidays.
9. Follow the traffic rules and show respect for other road users. Pull in to allow overtaking.
10. Clean up after yourself. Clean soiled roads immediately after the job has been finished. SAMSON AGRO's slurry tankers have a dripstop system that protects roads against soiling with slurry.



*On light soils the highest utilization of slurry nutrients is achieved with the black soil injection method.*

Four methods can be used but splash plate spreading is no longer permitted in Denmark. The best effect is achieved by minimising the exposure time of slurry to air. The longer the exposure to air, the greater the loss of nitrogen from ammonia evaporation/emmision. It is therefore better to use injectors, incorporators and drip hoses than splash plate spreading.

| Crop type | Crop examples | Recommended application method and time | |
|---|---|---|---|
| | | **Slurry and liquid organic fertilizers** | **Solid organic fertilizer (e.g. deep litter)** |
| Spring-sown crops | Spring crops (barley, wheat, rapeseed), oats, maize, beets, potatoes | Black soil incorporation to 10-12 cm depth immediately before sowing. Alternatively, drip hoses 3-5 weeks after germination. | Spreading and ploughing in or harrowing immediately following sowing. |
| Autumn-sown crops | Winter crops (wheat, barley, rye, rapeseed) | Application with drip hoses in spring around the time of crop germination. Application also to winter rape before or after sowing in the autumn. | Spreading and ploughing or harrowing immediately following sowing in the autumn, or applied in a thin layer to crop in early spring. |
| Grass | Grass in rotation for cutting or grazing, Permanent grass for hay or grazing | Injection with disc incorporators to 4-6 cm depth or drip hose application of acidified slurry in early spring and/or after each cut or grazing period. | Application of solid organic fertilizer to grass is generally not recommended. If there is no alternative, the organic fertilizer can be spread in a thin layer in early spring. |
| Nitrogen-fixing crops | Peas, beans, pure clover | Nitrogen-fixing plants do not need added nitrogen and application of organic fertilizer is not recommended. | Nitrogen-fixing plants do not need added nitrogen and application of organic fertilizer is not recommended. |

**Which application method to choose?**
A high nitrogen utilization can be achieved by choosing the optimal application method for the given crop and time. The table on page 11 shows a number of recommendations for the different application methods.

**Sophisticated equipment needed**
If organic fertilizer is used optimally, much of the nutrient demand of the crops can be met using slurry or muck alone and it will only be necessary to apply modest amounts of inorganic fertilizer. To ensure a uniform fertilization of the field, the fertilizer needs to be applied evenly across the entire field, otherwise plant growth will be irregular because some areas receive too little fertilizer while others receive too much. This results in lower yields and a variable crop quality.




*To avoid irregular plant growth it is important to apply the fertilizer uniformly across the field.*

## Characteristics of good application equipment

| | Recommended application method and time | |
|---|---|---|
| | Crop examples | Slurry and liquid organic fertilizers |
| Large and precise working width | In growing crops the working width should be as large as possible and preferably fit in with possible tramlines. The working width is very precise both with drip hose application and injection. | Spreaders with horizontal rollers and beaters have a larger working width than spreaders with vertical beaters.<br>The optimal working width of the spreader depends on the actual organic fertilizer used. |
| Good distribution across direction of driving | When using drip hose and injection methods, a distributor should ensure the precise distribution of slurry across the width of the implement. The coefficient of variation should be less than 10. | Beaters and any ejectors/discs should be designed to give a good distribution. In practice the distribution can be improved by using larger or smaller overlap on the last metres, where the dosing can be lower. The coefficient of variation should be less than 30. |
| Good distribution along direction of driving | The slurry tanker must have a flow meter to ensure that the pump produces a uniform flow from start to finish. | The speed of the floor chain should be adjustable so speed can be increased at the beginning and end of application when the dosing is lowest. |
| Avoiding lumps | Slurry should be stirred/homogenized before application. | The design and rotation of the rollers/beaters should be optimimized to ensure optimal shredding. |
| Field boundaries | With drip hoses or slurry injection the demarcation along field boundries. | A spreading limitator can be mounted to get a sharp demarcation of muck/deep litter along field boundaries. |
| Low field pressure | Multiple axles and a large tyre surface are an advantage and tyre pressure should be as low as possible. | Multiple axles and a large tyre surface are an advantage and tyre pressure should be as low as possible |
| Injection depth | The optimal injection depth is 4-6 cm in growing crops and 10-12 cm on bare soil. | Injection not possible. |

**See SAMSON AGRO's machines and implements on www.samson-agro.com**

## TYRE PRESSURE AND AXLE LOAD

- Heavy axle loads can lead to soil structural damage under the plough layer. Generally, a maximum axle load of 7 tonnes is recommended. Very few slurry tankers can comly with this recommendation, however. An option is to carry only half loads on the most vulnerable areas.
- High tyre pressures can lead to structural damage in the plough layer. The tyre pressure used in the field should therefore be as low as possible. A pressure of less than 1 bar is often optimal for slurry application in the field. Check the tyre pressure table for the relevant tyre.
- Systems for regulating tyre pressure are an advantage since you can lower the pressure when driving in the field and increase it when driving on the road. SAMSON AGRO can supply such a system.




*Drive with as low a tyre pressure as possible.*

# Organic fertilizer can harm the environment



*Nutrient that are not taken up by the crop can harm the environment.*

Nutrients in organic fertilizer are excellent at promoting a high crop yield. Unfortunately the self-same nutrients can constitute a problem if they end up in the natural environment instead of in the crops.

Some of the damage to the environment is not critical and is not evident until long after the fertilizer has been applied and may even happen a long distance from that. Denitrification and phosphorus losses are examples of that. Other damage can be acute and will very quickly be evident and severe. Leaching of slurry to streams during a thaw is one such example. But irrespective of whether the effect is in the short or the long term, the risk must be minimized. Once the damage is evident, it takes a very long time for flora and fauna to re-establish itself.

*PHOTO: COLOURBOX*

## Reduce the risk of environmental problems

| Type of loss | Why is it a problem? | When does it take place? | How is the risk reduced? |
|---|---|---|---|
| Ammonia evaporation | Increased concentrations of ammonia in the atmosphere can affect sensitive ecosystems where grasses, for example, gains ground at the expense of rare herbs. | When organic fertilizer is applied on the soil surface. | *Slurry and other liquid organic fertilizer:*<br>By acidifying or injectng.<br>*Solid organic fertilizer (e.g. deep litte)r:*<br>By quickly incorporating the fertilizer into the soil.<br>*All types:*<br>By applying slurry and muck in cool, calm weather. |
| Nitrate leaching | Nitrate is leached, for example to groundwater, causing pollution. Can also pollute streams and lakes via drains and cause oxygen depletion. | Both organic nitrogen and ammonium nitrogen can be converted to nitrate in the soil, and if organic fertilizer is applied at times where plants cannot absorb the nitrogen (autumn and winter), this nitrate can be leached. | By applying the slurry and muck in the spring and by using a winter cover crop. |
| Denitrification | Some of the nitrogen is converted to nitrous oxide, which is a powerful greenhouse gas. | If the soil becomes saturated with water immediately following the application of manure. | By avoiding slurry and muck application on saturated soil or just before heavy rainfall. |
| Phosphorus losses | Phosphorus ends up in streams and lakes where it can promote algae growth and oxygen depletion. | After heavy rain where soil and fertilizer particles are transported to water courses. | By injecting the organic fertilizer or using reduced soil tillage to reduce the risk of surface run-off. The establishment of extra wide buffer zones along streams where there is a particular risk of run-off can halt and catch nutrient and soil particles that are being carried towards the stream. |
| Surface runoff | Organic fertilizer can be transported along surfaces to streams, etc, causing pollution and killing fish and benthic animals. | During a thaw if the manure has been spread onto frozen or snow-covered ground (which is why it is prohibited). Can also happen with heavy rainfall. | By avoiding application onto frozen or snow-covered ground. Also avoiding application without injection or incorporation on steep areas sloping down to streamsetc, if rain is in the forecast. |
| Odours | Organic fertilizer smells and offensive to neighbours and other users of the countryside. | If organic fertilizer is left on the soil surface for a prolonged period. | By injecting or quickly incorporating the organic fertilizer.<br>By avoiding application close to small towns and up to weekends, public holidays etc. |

**Improved technology reduces environmental impact**
The choice of application technology is very important for the impact on the environment. This is one of the reasons why spreading slurry by splash plate has been prohibited in Denmark since 2003. Application technologies that reduce the environmental load are constantly being developed and improved. The table shows the relative effect on the environment of different application methods compared with a drip hose application.




**ENVIRONMENTAL EFFECT OF USING DIFFERENT APPLICATION TECHNIQUES**
Effect is shown relative to a drip hose application
0 = no effect. +++ = large positive effect. ÷ ÷ ÷ = large negative effect.

| | Ammonia evapora-tion | Nitrate leaching | Denitri-fication | P-loss | Surface run-off | Odour |
|---|---|---|---|---|---|---|
| Drip hose application | 0 | 0 | 0 | 0 | 0 | 0 |
| Spreading by splash plate | ÷÷ | 0 | 0 | 0 | 0 | ÷÷ |
| Acidification+drip hose | ++ | 0 | 0 | 0 | 0 | 0 (÷)* |
| Injection into grass | ++ | 0 | ÷** | ++ | ++ | ++ |
| Injection into black soil | +++ | 0 | ÷** | +++ | +++ | +++ |

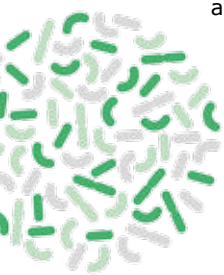
** Experience shows that odours may be exacerbated after application of particularly in-house-acidified manure.*
*** Denitrification occurs primarily when the soil is water-logged.*

# Avoid the spread of disease from organic fertilizer



One ml of slurry can contain more than one billion microorganisms. Some of these microorganisms are infectious and cause disease in animals and humans. This is why it is important to take precautions when handling slurry to minimise the spread of disease.

However, during the transport and application of slurry and muck, there is a risk that disease can spread from one herd to another because the transport and application equipment can be contaminated with pathogens caused by surges, overflows and inadequate cleaning. It is therefore important to use equipment that does not overflow or spill during filling and that the equipment is correctly maintained and watertight so that surges during transport do not cause a problem. Frequent cleaning of the material will therefore also minimise the risk of spread of disease.



Generally, there is an insignificant risk of disease being transmitted to crops that are not harvested until maturity, such as cereals. This is because of the long interval between the application of slurry and crop harvest and that the infectios germs during that period are very effectively broken down by UV-radiation. The largest risk of disease transmission is with slurry applications to grass, and special guidelines should therefore be followed.




*Slurry contains 1 billion microorganisms in every ml. Some can spread disease, if not handled with care.*

# HELPFUL ADVICE
## for reducing spread and pollution with disease

- Avoid soiled application equipment – clean frequently.
- Wash only when parked on hardstanding and where there is drainage to slurry tank or similar.
- Ensure access roads are not immediately adjacent to animal housing.
- Do not drive slurry tankers on areas where slurry has already been applied.
- Avoid, if possible, application of slurry to crops that are eaten raw (for example grassland pasture).
- If slurry is used for pastureland, grazing should not commence until at least 30 days after application. If the slurry is fresh, wait at least 60 days before livestock are allowed on the grass.
- By shifting between cutting and grazing, you can reduce the risk of Barber's pole worm and lungworm.

**ZOONOSE** is the term for diseases and infections that can be passed between animals and humans; for example via the organic fertilizer.

### EXAMPLES OF DISEASES OR INFECTIONS THAT CAN BE PASSED VIA ORGANIC FERTILIZER

**PIGS** Regional enteritis, Swine dysentery, Ascaris suum, Salmonella, Parvovirus

**RUMINANTS** Paratuberculosis, Salmonella, E. Coli O 157

**POULTRY** Coccidiosis, Salmonella, Campylobacter

**MINK** Plasmacytosis

**Aerobic** means ”with oxygen”. Solid organic fertilizer (e.g. muck and deep litter) are stored aerobically, i.e. in the presence of oxygen. During aerobic storage, the solid organic fertilizer will undergo a composting process.

**Acidification of slurry** Reduction of slurry pH via the addition of an acid. Concentrated sulphuric acid is normally used. Acidification can take place in-house, in the slurry tank or in the field. With acidification, the ammonia losses are typically halved compared with a drip hose application.

**Ammonia evaporation** Also called ammonia emission. This is the loss of nitrogen that takes place when, for example, organic fertilizer is exposed to air.

**Ammonium** An ion, the chemical formula of which is NH4+. This is the plant-available part of the nitrogen in organic fertilizer.

**Anaerobic** Means ”without oxygen”. Liquid organic fertilizer is normally stored anaerobically, which means there is no oxygen present in the fertilizer.

**Animal unit** A fixed conversion unit for all types of livestock. One animal unit corresponds to 90-100 kg nitrogen in the organic fertilizer. See also “Fertilizer norms”.

**Axle load** Total weight imposed on soil by an axle and corresponding right and left-hand wheels. To protect the soil, a maximum axle load of 7 tonnes is recommended.

**Bare ground** an area where the coming crop has not yet been established. Is also somewhat misleadingly called black soil.

**Biogas plant** is a facility that produces biogas by heating organic fertilizer, organic waste and energy crops to 35-50°C in a reactor.

**Black soil** A somewhat misleading term for an unplanted area – in other words, an area where the subsequent crop has not yet been established, for example a field of stubble or a pasture under conversion. See “Bare soil”.

**Black soil injection** Injection into unplanted areas where there is not yet a crop that can be damaged by the injection. Injection can therefore take place in conjunction with heavy soil tillage. The slurry is typically placed at 10-15 soil depth immediately behind a strong cultivator tine.

**Coefficient of variation, CV** A statistical measure of how well the fertilizer has been applied across the driving direction. Inorganic fertilizer and slurry applied using drip hose and injection often have CV values of less than 10, while muck and deep litter often have a CV of more than 30.

**Deep litter** A mixture of animal manure and large amounts of bedding material (typically straw) that

**Digested slurry** A common term for the mixture of organic fertilizer, organic waste and energy crops that have been treated in a biogas reactor.

**Drip hose application** Application of slurry using drip hoses that are mounted on a boom at the rear of the slurry tanker. The slurry is applied in bands on the soil surface. The spacings between hoses are typically 30 cm.

**Emission.** Another word for evaporation. See also ”Ammonia evaporation”.

**Essential nutrient** Common term for the 17 elements that are essential for plant growth (N, P, K, S, Mg, Ca, Mn, B, Cu, Zn, Mo, Fe, Ni, Cl, O, C and H).

**Eutrophication** Algae growth in lakes, fjords and coastal waters. Often caused by too large an input of nutrients (particularly nitrogen and phosphorus). Can lead to oxygen depletion.

**Fertilization plan**. A plan for the farmer’s utilization of organic and inorganic fertilizer. It will show the planned date, time and amount of fertilizer for each of the farmer’s fields

**Fertilization account** A combined statement of the organic and inorganic fertilizer which the farmer has used in the previous growing season.

**Fertilizer norms** This is a measure of how much organic fertilizer a farmer on average can apply to his crop. Cattle farmers can apply 1.7 or 2.3 animal units per hectare, while pig farmers, poultry farmers and fur farmers can apply 1.4 animal units per hectare. See also ”Animal unit”.

**Fertilizer value** The value of the nutrients in the organic fertilizer. The value is calculated as the value of inorganic fertilizer that the organic fertilizer can replace.

**Fibrous fraction** The solid fraction resulting from slurry separation. Typically has a dry matter content of about 30%. See “Slurry separation”.

**Field effect** The effect of nitrogen in organic fertilizer that is observable in the growing season when the fertilizer has been applied. See also “Utilization”.

**First-year effect** The effect of nitrogen in organic fertilizer that is evident in the first growing season where the fertilizer has been applied.

**Forage grass**

Grass for cutting or grazing. Also includes areas with permanent grass but not seed grass.

**Frozen ground**

Soil that is frozen at depth.

**Grass injection.** Injection of slurry into grass. Disc injectors are often used, either single-disc or double-disc, that form a 4-6 cm slit into the ground in which the slurry is placed.

**Greenhouse gases** — Common term for carbon dioxide (CO2), methane and nitrous oxide (laughing gas). The gases contribute to climate change by insulating against the radiation of heat from the soil surface to the atmosphere.

**Incorporation.** Common term for the turning of the soil by ploughing, harrowing or other soil tillage treatment, that can incorporate the applied slurry into the soil.

**Injection** — Method of slurry application where the application and incorporation is undertaken in one operation. Injection reduces ammonia evaporation and odour problems compared with drip hose application. See "Black soil injection" and "Grass injection".

**Inorganic fertilizer** — (Or synthetic fertilizer). This is a mineral fertilizer, which is produced on fertilizer factories. NPK-fertilizer, NS-fertilizer, liquid ammonia and urea are examples of inorganic fertilizers. Inorganic fertilizers may not be used on organic farms.

**Liquid fraction.** The liquid fraction resulting from slurry separation. Typically has a dry matter content of 2-4%. See "Slurry separation".

**Liquid organic fertilizer** — A common term for e.g. slurry, urine and digested slurry.

**Macronutrients.** A common denomination for the nutrients that are needed in large amounts (particularly, nitrogen, phosphorus, potassium, magnesium and sulphur). Typically measured in kilograms per hectare in contrast to micronutrients that are added in grams per hectare.

**Magnesium** — Chemical symbol: Mg. An essential macronutrient for the crops. Magnesium is not regarded as being problematic for the environment.

**Methane** — Chemical symbol: CH4. This is a powerful greenhouse gas that is formed, among other things, during anaerobic storage of slurry. Methane is also formed in biogas reactors and is the calorific part of biogas.

**Micronutrients** — A common denomination for the nutrients that are needed in small amounts (particularly mangane, borum, copper, zinc, iron and molybdenum). Typically measured in grams per hectare in contrast to macronutrients that are measured in kilograms per hectare. The soil often has a natural micronutrient content that makes their supplementation in fertilizer unnecessary.

**National trials.** Field trials carried out by DLBR (Danish Agricultural Advisory Service). On an annual basis 8-900 trials are carried out with different methodologies, fertilizers, pesticides, varieties, etc. The results are published every year.

**Nitrate leaching** Loss of nitrate from the root zone. Occurs when, for example, organic nitrogen in organic fertilizer or plant residues is converted to nitrate in the autumn and winter when plant growth is restricted. The nitrate formed can then be leached out with rainfall. The risk of nitrate leaching is larger on sandy soils than on clay-rich soils.

**Nitrates Directive** An EU directive that sets common European minimum standards for the storage and application of organic fertilizer.

**Nitrogen** Chemical symbol: N. An essential macronutrient for crops. Is easily lost through ammonia evaporation, nitrate leaching and denitrification. Lost nitrogen subsequently deposited on heathland can lead to vegetation changes. Grasses and trees take over at the expense of heather and other heathland vegetation. Nitrogen also contributes to eutrophication in lakes, fjords and coastal waters.

**Nitrous oxide** Chemical symbol: N2O (laughing gas). A powerful greenhouse gas produced during denitrification. The effect is 310 times as powerful as that of CO2, which is why a small emission has a large effect on the climate.

**Norms** Standard values set by the authorities for, among other things, the content of nitrogen, phosphorus and potassium in organic fertilizer. In practice, the contents can deviate significantly from the norms.

**Odours.** Noxious smells released from organic fertilizer. The odour is created by a wide range of malodorous compounds in the slurry or muck. More than 200 compounds contribute to the smell.

**Organic nitrogen** Nitrogen compounds in, for example, organic fertilizer that are bonded to carbon (for example in proteins). Need to be degraded to ammonium by microorganisms in the soil to be made available to plants. In a slurry analysis, the organic carbon content can be measured as the difference between total-N and ammonium-N.

**Oxygen depletion** A phenomenon of coastal waters – typically in late summer – when algae blooms and die back, the bacteria use all the oxygen in the water to decompose the dead algae. Prolonged periods with warm and calm weather increase the risk of Oxygen depletion/hypoxia. See also ”Eutrophication”.

**PH** an expression for level of acidity. The higher the pH of the slurry, the higher the risk of ammonia evaporation. The pH can be lowered by for example adding sulphuric acid (see "Acidification of slurry").

**Poultry manure** Solid organic fertilizer e.g. muck and deep litter from broilers and chickens. Poultry manure has a relatively high dry matter content of around 50-60% and a relatively high nutrient content. Should therefore be spread in a thin layer in the field.

**Potassium** Chemical symbol: K. An essential macronutrient for crops. Particularly thse crops that have to be harvested whole such as grass, beets, maize, wholecrop and potatoes, have a high potassium requirement. Potassium is not regarded as problematic for the environment.

**Residual effect**. The effect of nitrogen in organic fertilizer that is only evident in the years following the application. The total residual effect is typically 10-15% of the nitrogen, dependent on organic fertilizer type – highest for deep litter, lowest for pig slurry and digested slurry.

**Root zone** The depth of the soil layer that roots can reach. The depth is typically 1 meter on clay-rich soild and 75 cm on sandy soils.

**Slurry.** Mixture of urine, faeces, bedding and wash water.

**Slurry analyzis** A laboratory analyzis that determines the nutrient content of the slurry. A standard analyzis comprises: dry matter, total-N, ammonium-N, phosphorus and potassium.

**Splash plate spreading** The slurry is spread via splash plate to the field in a fan-shape. Has been banned in Denmark since 2003.

**Spreader plate** The plate behind the slurry tanker that spreads the slurry in the shape of a fan in the air. This method is not permitted in Denmark. See "Broadcasting".

**Spreading limitator** Fitted to spreaders so that muck does not spread across field boundaries. SAMSON AGRO's spreaders can be fitted with spreading limitators on each side of the spreader.

**Sulphur** Chemical symbol: S. This is an essential macronutrient for plants. Organic fertilizer contains sulphur, but this is not plant-available. Sulphur therefore needs to be supplied in inorganic fertilizer. Sulphur can also be added to the slurry in the form of sulphuric acid (see "Slurry acidification").

**Slurry separation** A separation of the slurry into a solid part (see ”Fibrous fraction”) and a liquid part (see ”Liquid fraction”). The separation is usually achieved with a screw press, chemical precipitation or with a decanter centrifuge.

**Solid organic fertilizer** Often just called muck. Collected manure and bedding from the animal house. Normally scraped out daily; should be stored in a heap on an impermeable base.

**Trailing shoe**. Expression for a light incorporation. The trailing shoe creates a shallow slit of ½-1 cm in the soil into which the slurry is injected. The slit is normally not deep enough to hold all the slurry. Trailing shoes are not an approved alternative to injection into grass. See “Grass injection”.

**Tyre table** A tables that lists the recommended tyre pressures for each type of tyre. Use only the values corresponding to the exact tyre you have.

**Utilization**. The percentage of slurry nitrogen that the plants can utilize in the first year following application (see “First-year effect”). The utilization percentage is given relative to that of inorganic fertilizer, since the utilization of inorganic fertilizer is defined as 100%.

**Working width**. The width over which for example the organic fertilizer can be spread. Corresponds to the width of the drip hose booms and injectors. Should be minimum as wide as the distance between the tramlines.

**Zoonosis.** Term for diseases and infections that can be passed from animals to humans.

# You can find more information here

**Organisationen, Unternehmen, Behörden**

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| • SEGES* | www.seges.dk |
| • AgroTech** | www.agrotech.dk |
| • Aarhus University | www.au.dk |
| • University of Copenhagen | www.ku.dk |
| • Agro Business Park | www.agropark.dk |
| • Danish Environmental Protection Agency | www.mst.dk |
| • The Danish AgriFish Agency | www.naturerhverv.fvm.dk |
| • SAMSON AGRO | www.samson-agro.com |

* SEGES is a part of DLBR (Danish Agricultural Advisory Service), which is a nationwide collaboration between the advisory Service and business. DLBR employs around 3,100 people.
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