5 | JULY 2025

The potential of digestate in agriculture

- 10 years of research showing the way

In field experiments in northern Sweden and Finland biogas producers and researchers have collaborated to strengthen the role of digestates in agriculture. During ten years we have studied the effect of digestate fertilization on grain crops, maize, forage and energy crops in field experiments. The yields have often been comparable or higher to the yields with mineral fertilizers. In most cases we fertilized with only digestate and did not complement the digestate with mineral fertilizers. Most fertilizations have only been made once in the same place. The results show that many of the digestate products tested give the same or better fertilization effect than mineral fertilizers. When we have applied digestate more than once the result has been similar all times.

What is digestate?

Digestate is a nutrient rich residue from biogas production that can be used as a fertilizer. It can be liquid, dewatered, pelletized or composted. It can replace mineral fertilizers fully or partly. It improves soil structure, is sustainable and often locally produced.

About our trials

During ten years and within different projects we have fertilized crops with digestates. They have come from five biogas plants in northern Sweden and Finland. On page 3 you can find contact details if you, as a farmer, want to test digestate to your crops.

Types of digestate used

Alviksgården (SE): Pig manure & slaugher waste.
Norrmejerier (SE): Based on dairy waste.
Skellefteå Municipality (SE), Hemab (SE) and Stormossen (FI): Municipal biowaste from restaurants and households.

The nutrient content in the digestate varies depending on the substrate, digestion conditions and treatment after digestion (Table 1). The content can also vary with time from the same biogas plant. This is clearly seen in digestate from Norrmejerier, which we have used most often.

Since the content of the digestate has varied it has been difficult to plan how much to apply. The amount of nutrients that we actually applied thus varied. We always aimed to apply the recommended amount of ammonium nitrogen, which was applied in the fertilized control, consisting of:

- Liquid digestate: 15–45 t/ha
- Dewatered digestate: 14 t/ha
- Composted digestate: 15 t/ha
- Pelleted digestate: 1.5 t/ha

Table 1: Nutrient content of digestates used in trials 2016–2025

Digestate	Biogas plant	Dry weight %	Total nitrogen kg/tonne	Inorganic nitrogen kg/tonne	C/N-ration	Phosphorous kg/tonne	Potassium kg/tonne
Liquid digestate	Norrmejerier avrage	3,0	3,6	1,4	3,0	1,1	2,0
Liquid digestate	Norrmejerier max	4,8	4,8	2,9	4,1	1,5	2,5
Liquid digestate	Norrmejerier min	0,9	0,9	0,6	1,9	0,2	1,3
Liquid digestate	Hemab 2021	5,7	6,6	4,6	3,5	0,42	2,4
Liquid digestate	Hemab 2023	5,2	4,2	2,8	1,0	0,36	1,7
Liquid digestate	Skellefteå	0,7	1,7	1,4	7.9	0,09	0,7
Dewatered digestate	Skellefteå	24,3	12,3	3,2		2,2	1,3
Composted digestate	Stormossen	41,4	9,6	0,7		3,9	3,0
Pelletized digestate	Alviksgården	94,6	66,6	56,1		10	26

We have applied digestate to different grain crops, maize, grass/clover forage and energy grass. In what is reported here we used only digestate and did not complement the digestate with mineral fertilizers.

Our results

When grain crops were fertilized with digestate, the ammonium content in digestate from pig manure or food waste was a good measure for the nitrogen effect if the digestate was incorporated into the soil before sowing (Figure 1). That is, if we fertilized with 80 kg of ammonium per ha in the digestate the yield was approximately the same as if with 80 kg of N in s NPK or NS-fertilizer.

However, there is a risk of soil compaction that can be negative: The digestate from Hemab to barley was applied after rain and we saw poor growth in the tractor tracks and the harvest was lower than expected.

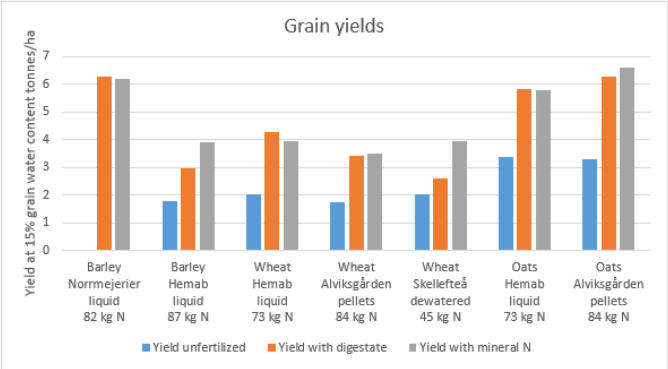

Figure 1. Harvests of grain crops fertilized with either digestate or mineral fertilizer N. The fertilized control was 100 kg mineral N/ha for all comparisons except the first (barley given Norrmejerier´s digestate), which was given 80 kg mineral N/ha. The delivering biogas plant and amount of ammonium nitrogen/ha applied with the digestate is given under each comparison.

Fertilizer effect of different digestates

The digestate from the dairy industry, Norrmejerier, on the other hand, had a nitrogen effect that could be large even though the amount of ammonium applied with the digestate was small (figure 2).

This digestate had a lower proportion of ammonium-N than other liquid digestates (table 1), but also a very low C/N ratio. This indicates that also some organic nitrogen will become plant available during the season. Another possible explanation is that the digestate stimulated mineralization of nitrogen from the residues from grass and clover that was the previous crop.

Digestate to forage and maize

The liquid digestate from Norrmejerier and Skellefteå both increased the yields of whole crop barley under sown with grass and clover even though mineral fertilizer N had a small effect (figure 2). Both digestates also had low viscosity and thus were suitable for fertilization of grass/clover since it infiltrated the soil well.

All digestates are not suitable for application to grass swards. In a demonstration experiment the digestate from Hemab, that had more dry substance and was thicker, did not infiltrate the soil under grass. The fertilization effect was small on grass growth and people living nearby complained that there had been bad smell- probably since most of the ammonium had evaporated.

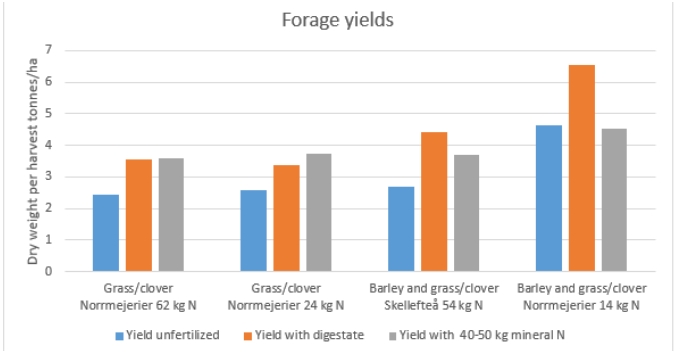

Figure 2. Harvest of forage in plots fertilized with liquid digestates compared to plots unfertilized or fertilized with 40 kg mineral N/ha (grass/clover) or 50 kg mineral N/ha (Barley with under sown grass/clover). The delivering biogas plants and amount of ammonium nitrogen/ha in the digestate is given under each comparison.

We also conducted a demonstration experiment with maize. We compared fertilization with cattle slurry to fertilization with compost made from digestate. There was no detectable difference in neither maize biomass nor forage quality but both fertilizers gave larger maize plants than without fertilization.

Long-term effect of repeated fertilization

We used digestate as fertilizer three years in a row to a ley (once at establishment and once a year at the harvest year. The fertilizing effect was similar both harvest years (Figure 2). The total nitrogen effect of liquid digestate was 113% compared to mineral nitrogen if the same amount of inorganic nitrogen applied.

We have also fertilized Reed Canary Grass with digestate from Norrmejerier after the first harvest in June or early July several years in a row. This gave good growth of the second harvests but was not quite enough for the first harvest the following year. This experiment had no mineral fertilizer control, so we do not show the data.

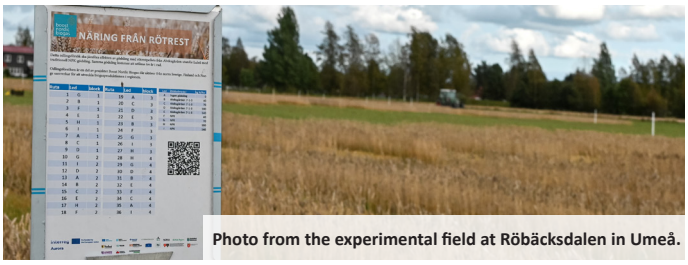

Photo from the experimental field at Röbäcksdalen in Umeå.

An ongoing (2023-2025) three-year trial with cereals gave a yield corresponding to the ammonium content of the digestate in the first year when we grew wheat.

In the second year when we grew oats there were no statistically significant differences between the different fertilization treatments between 40 and 140 kg N per ha with either digestate (liquid or pellets) or different types of mineral nitrogen. One reason may be an attack of the fungus crown rust on the leaves, which was more severe with more nitrogen fertilizer so that the kernels stopped growing too early.

Harvest time at the experimental field in Röbäcksdalen, Umeå.

Conclusions and recommendations

Liquid Digestate

Liquid digestate is an efficient fertilizer that often can replace mineral fertilizer completely, especially when it is applied before sowing and is incorporated into the soil. It has plant available ammonium nitrogen with a good fertilizer effect. However, is comprises more than 90 % water, that makes transport expensive for longer distances than 30 km.

Dewatered digestate

Dewatered digestate has lower water content, can be applied in smaller amounts and thus is cheaper to transport. One important difference is that dewatered digestate does not give the same nitrogen effect as liquid digestate. This is since a larger part of the nitrogen is organic and not directly plant available. It is a good source of phosphorous and potassium, though.

Pelleted digestate

Pelletized digestate, for example from Alviksgården has a very low water content and is suitable för longer transports. It is easy to handle and has a good fertilizing effect, which means that it often can fully replace mineral fertilizers.

Composted digestate

Composted digestate also has a lower content of plant available nitrogen, but it adds organic material that increases the structure and fertility of soil. It can replace animal manures, such as cattle slurry, and it is a good source of phosphorous and potassium. However, the nitrogen effect is limited.

Interested in testing digestate?

Biogas producers are often looking for farmers interested in trying digestate as fertilizer in crop production. Digestate can in many cases fully or partly replace mineral fertilizers.

Contact the biogas producers below if you want to know more or apply digestate on your fields:

Alviksgården (SE)
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Contact Information

We are happy to answer questions and share further information. More results from our research will be published on our home page.

If you have any questions please contact:
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Cecilia Palmborg, SLU, has analyzed data from all trials.

Interreg Aurora
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