

## Sugar beets are full of gas

*Sugar beets could experience a renaissance, as experience shows that they are extremely well suited for biogas. There is also an increasing interest in beets as feed.*

By Frederik Thalbitzer

Sugar beets might once again adorn the Danish countryside after being on the decline for several years. The interest in sugar beets for biogas and feed is sprouting at a fast pace.

“Judging from the way people are talking about it, it is getting a lot of attention,” says Søren Ugilt Larsen, senior consultant at AgroTech, who points out that sugar beets in the form of energy beets are part of national tests, just as the traditional types of feed are being tested once again.

### Great yield

Søren believes that it is the great yield of sugar beets that is generating the renewed interest. “As for biogas, it is also important to produce as much as possible per hectare, and no other crop yields as much as beets,” he says.

For example, beets can yield approximately 25 tons of dry material per hectare, while corn yields two thirds of that.

### Quick decomposition

What makes sugar beets even more effective for biogas is the fact that they decompose very quickly. The beets’ sugar content turns into acids that transform into gas very quickly. This means that you can achieve much higher gas production in a reactor of the same size. In addition, you can utilise the beet top as well as the beet itself. Both parts are extremely well suited for the biogas facility. The national tests in 2008 and 2009 showed approximately 175 hectokilogram dry material in the beets and approximately an additional 50 hectokilogram in the beet top per hectare.

This corresponds to approximately 8,000 cubic metres of gas in one hectare of beets, while you get approximately 5,300 cubic metres of gas in one hectare of corn.

### Better rotation of crops

The production of crops for biogas in Denmark remains fairly small, but the development is leaning towards more biogas facilities to supplement manure. Things might therefore turn out the way they have just south of the border in Germany, where the production of corn for biogas facilities is so high that there is talk of corn deserts. Corn farmers are gradually being met with criticism because corn is taking over the landscape, one of the reasons being that the corn grows so tall that the landscape is not visible from the roads. You do not have that problem with sugar beets – and additional types of crops would also contribute to a variation in the landscape.

Søren points out that, from a crop rotation point of view, it would also be an advantage to have several different crops.

“The pressure of diseases increases and the pests multiply when you grow as much corn as they do in northern Germany,” he says.

### The soil is a challenge

However, there are also challenges associated with growing beets for biogas. If sand is stuck to the beets, this is deposited in the biogas facility’s reactor, particularly if the biogas facility was not built to receive large amounts of beets. This can mean that one fifth of the dry material weight is merely an inconvenience.

In one test series, the soil that stuck to the beets constituted 22 per cent of the beets' dry material. This means that one fifth was merely waste material.

The interest in beets for biogas has led to the development of three different types of beets for three different purposes: for sugar production, for animal fodder and for biogas. The biogas beets – or energy beets – are characterised by yielding the largest amount of dry material per hectare and the fact that the dry material percentage is larger than that of fodder beets.

“Now, you don't have to drive around with as much water,” says Søren.

However, they are not quite as smooth as fodder beets, which is why more soil sticks to them. This means that the beets must be washed before they enter the biogas facility.

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## **Energy beets improved the efficiency of the biogas facility**

*Dirch Ernst has improved the efficiency of his biogas facility by approximately one third by gasifying energy beets.*

It all began when he was able to buy some sugar beets for his biogas facility at a cheap price, but now, beets are a permanent part of the biogas facility's “feed plan” and the plan is for them to account for 25 per cent.

Dirch Ernst runs a biogas facility, Bioenergie Algermissen, close to Hannover, Germany, together with three fellow farmers. He is surprised at how well suited sugar beets are for biogas. “Ninety per cent of the energy has been extracted from the beets over the course of four days,” explains Dirch. In comparison, it takes two weeks to extract 90 per cent of the energy from corn ensilage in the biogas facility.

### **Controlling the speed**

First of all, this means that the facility he owns, which is a 650-kW facility, can deliver more power. The plan is to use a proportion of the beets that is so large that production reaches a megawatt.

“When the gas is released faster, you can get by with a smaller facility and save fixed asset investments that cost interest,” he says.

Dirch also sees other potential advantages: a biogas facility for a mix of corn, grain, manure and sugar beets. By controlling the proportions, you can also control the speed in the reactor and he envisages that, by planning a “feeding strategy”, he can ensure the most efficient production of gas, so that the power production is highest when the price for power is at its highest. For example, the price of power is higher during the day than at night.

### **Including soil**

Dirch and his business partners grow and buy crops from an area with clay soil. This means that he does not need to wash the beets before they enter the biogas facility. Clay soil does not deposit in the facility the way heavy sand grains from sandy soil do. The soil takes up room in the reactor but continues along and exits at the other end. If you have sandy soil, the beets need to be washed.

“But the industry has discovered beets and is offering beet washers, so the problems can be solved,” he says.

If Dirch was going to build another biogas facility, he envisions that he could design it so that it was better suited for gasifying beets and, if it was designed for that from the get-go, he might not need to wash the beets.

### Working on storage

One of the challenges of using beets in the biogas facility is storage. The beets require ensilage in order for them to keep. Moreover, it helps them transform quickly to gas in the reactor. Before entering the biogas facility, the beets need to be cut.

When the beets are ensilaged, there is a loss of juice corresponding to approximately 40 litres per ton of beets.

“The juice is not lost to the environment. It requires collection but can be put directly into the biogas facility and transformed into gas,” he says.

The juice consists of sugar that is quickly transformed into acid. Hence, it is very bad for the silo, which is visibly marked by corrosion.

Dirch ensiles the beets in a relatively simple way, namely by covering them with airtight plastic in a traditional driving silo for ensilage. It is extremely important to keep the ensilage airtight. The whole beets turn rubberlike and thus end up being very compact.

The stack has to be divided into sections that are separated by plastic so that oxygen does not reach the entire stack when one end is opened.

### Good business

In Germany, the cost for power from a biogas facility is close to DKK 1.50 per kWh, which is a good price that has prompted many farmers to invest in biogas. Hence, the number of biogas facilities has doubled since 2005 and Dirch owns one of approximately 6,000 biogas facilities in Germany today.

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## Skejby believes in beets for biogas

*The Agricultural Research Centre aims at developing a project to investigate how best to use sugar beets for biogas.*

“In a weak year, the yield from sugar beets is twice as big as that from corn and the beets have an incredible environmental profile for phosphorus as well as the nitrogen aspect.”

That is the argument put forward by Karsten Attermann Nielsen, national consultant, Agricultural Research Centre, who is seeking funding for a project that intends to show how sugar beets can be used in a biogas facility.

He will apply for monies from the GUDP funds, which requires the environmental profile to be first class.

### Only one downside

According to Karsten, beets seem ideal for the purpose.

“There’s only one downside to beets – they are dirty,” he says.

One of the hurdles that needs to be worked on in the project is therefore how to get rid of sand and soil on the beets.

“They are not that easy to wash; luckily, dry cleaning has come far,” he says.

However, he also believes that biogas facilities should simply be designed to allow the sand to be emptied out.

“It is unrealistic to believe that we can get completely rid of sand in beets; we need to figure out where it is cheapest to remove it,” he adds.

This means that designers of biogas facilities need to be involved in the project as well as those who process the beets.

DLF chooses smooth beets

DLF-Trifolium also believes in sugar beets for biogas. They have therefore resumed beet processing, which they have not done for many years. DLF takes their starting point in the genetics of the smoother fodder beets, with the very purpose of preventing the problem of too much soil/sand, which either makes the process more expensive or interrupts it.

“The combination of smooth beets and a high dry-material content, such as in the fodder beet type, Magnum, is therefore the right solution from now on,” says sales manager Jens-Olav Høst Hansen, DLF-Trifolium.

DLF is testing several new types of energy sugar beets that are likely to hit the market in a few years. Today, they sell the well-known fodder beet types, Magnum, Kyros and Nestor, for the production of beets for biogas facilities.

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## **9–14 per cent higher yield in special energy beets**

*Companies are now processing special energy beets for biogas production*

Four years ago, the German seed company KWS divided the processing of beets into beets for sugar production and beets for biogas (energy beets). This has led to a great increase in profit and ensured that even more gas can be produced per hectare.

According to Elo West Larsen, agronomist at KWS, there are several things that you do not need to take into consideration when producing energy beets, but which are crucial if you wish to produce sugar from the beets. This means that the yield of energy beets is 9–14 per cent higher than in beets for sugar production.

“When you don’t need to consider the sugar content, you can achieve a higher dry-material content,” he says.

No consideration for the factory

In practice, you grow energy beets with the aim of achieving a high level of dry-material yield, a high dry-material percentage, a high methane and biogas yield and as little adherent soil as possible. In sugar beets, the sugar yield and the sugar percentage also play a role.

When you grow energy beets, you can also use fertiliser differently because you do not need to consider the sugar production. When you take into account all type and growing differences, you can typically obtain 69 tons of dry material per hectare with sugar beets for factories, while you can harvest 74 tons of dry material per hectare with energy beets.

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## **Lemvig Biogas needs 500 hectares of beets**

*The yield potential in beets is 20,000 feed units per hectare and pays DKK 1 per feed unit.*

Lemvig Biogas likes beets. According to managing director Lars Kristensen, they seek 10 million feed units a year, corresponding to beets from 500 hectares.

“We do not want corn ensilage instead of beets, because the beets yield 10–20 per cent more biogas per feed unit than corn ensilage,” he says.

In addition, the facility is not designed to receive corn ensilage.

The Lemvig Biogas facility buys the beets as pulp and pays DKK 1 per feed unit. The manufacturer delivers the beet pulp to the facility, where Lemvig Biogas extracts samples of the beets to determine how many feed units are in the beet pulp.

According to Lars, there are many advantages for growers of sugar beets as well. You can grow up to 20,000 feed units per hectare, and for biogas you can accept mould in the beets. For many growers, beets can also be a plus for the rotation of crops and their yield is stable and high; work is also spread over a large part of the year.

Currently, less than five Danish biogas facilities have tried out beets. In Germany, 300 biogas facilities out of a total of 5,000 have already discovered energy beets.

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## Gigantic washer prepares the beets

*Gigantic, mobile beet washer can sort out rocks and wash the beets for as little as DKK 20 per ton of beets.*

One of the challenges of beets for biogas is soil, which both fills and can deposit in the biogas facility’s reactor. Hence, Henning Christensen, who produces beets for Lemvig Biogas, was excited when a large beet washer that had taken the approximately 600 km journey from just south of Hannover, Germany, to Lemvig, Denmark, arrived in February.

“It went well,” says Henning.

The beet washer, which was developed by the German seed company KWS, certainly did a good job. This means that any rocks were cleaned off, the beets were washed and 500 tons were crushed before ending up in a silage stack where they were ensiled together with straw pellets.

“This is in order to increase the dry-material percentage, otherwise we can’t control it,” adds Henning.

### Problems with mud

In addition to the 500 tons that were ensilaged, 1,500 tons of beets were washed and cleaned. These needed to be crushed and delivered fresh to the biogas facility on an ongoing basis. The ensilaged beets were delivered last.

“We are anxious to learn what will yield the most – the fresh beets or the ensilaged beets,” he says.

AgroTech, who took samples for analysis, are examining this.

However, Henning also faced challenges. As it turned out, it was difficult to drive to the stack due to mud. The beet washer therefore had to be placed on solid ground and the beets driven there.

### 50–70 tons per hour

The beet washer can handle 50–70 tons an hour. According to Elo West Larsen, KWS, who brought the beet washer to Denmark for testing, the hourly cost is DKK 1,120 in addition to the cost for transporting the beet washer. There is also a water consumption of 30–50 litres per ton of beets.

If several people in one area need to wash beets, the transportation costs can be minimised.

“That would leave us with a price of just under DKK 20 per ton of beets,” Elo estimates.