Energy sugar beet to help boost biogas production

Specialist varieties of sugar beet and maize are being bred to increase anaerobic digester output, as **James Andrews** discovers

An energy-specific sugar beet variety could improve the efficiency of anaerobic digesters producing electricity in the UK and open a new market for sugar beet growers.

The beet is the first variety to be launched from KWS's energy-specific beet breeding programme, which hopes to produce varieties with high dry matter yields for optimum gas production, says Simon Witheford, UK sugar beet product manager.

"Conventional sugar beet is already the most efficient crop for biogas production, but we are working to enhance these attributes."

Maize is currently the crop of choice for most anaerobic digesters producing electricity in the UK, but adding sugar beet can speed up the process and increase gas production.

It is hoped the variety, which is yet to be named, will be European listed by the end of the year meaning it can be sold in the UK, he says. "We will have a small amount of trial seed available next year and it could be sold commercially in 2012."

A small amount of energy beet trial seed will be available next year, says Simon Witheford.

Mr Witheford says seed will be marketed directly through KWS, or through a distributor.

Dry matter yield is higher than conventional sugar beet varieties to maximise methane production, he says. "In trials, yields topped 100t/ha and dry matter was, on average, 1.2t/ha higher than conventional sugar beet."

Reinhard Lehrke, KWS European bioenergy manager, says conventional sugar beet produces the most methane per kg of dry matter of any biomass crop at just over 400 litres compared with maize at just over 300 litres.

"The energy metabolism of sugar beet is highly efficient and it's the fastest raw material for biogas production."

It takes just 11 days to break down in the digester, whereas maize takes 80-90 days, he says. "We would like to see a mono sugar beet plant as it is the most efficient feedstock, but we don't know if this is possible."

MIX OF PRODUCTS

"At the moment, the best idea is to have a mix of products to balance the bacteria in the digester."

Mixing 70% maize and 30% sugar beet gives a 40-day retention time and increases biogas output, he adds.

Conventional sugar beet varieties have lower dry matter yields, but they can be used in anaerobic digesters, giving growers a new market for surplus beet, he adds.

High soil tares can be a problem, so some growers may have to wash beet before feeding it into the digester.

To ensure year-round supply, some beet will have to be ensiled, says Mr Lehrke.

One option is to ensile whole beet in a clamp with plastic at the top and bottom, but some growers have stored whole beet in plastic tubes and experimented with crushed beet in lagoons, he says.

When clamping beet it is essential to collect the juice and feed it back into the digester. It is a valuable, nutrient-rich feed stock for the digester and can cause pollution if not collected, he adds.

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CASE STUDY

Dirk Ernst

ALGERMISSEN, GERMANY

* Adding sugar beet to his on-farm anaerobic digester has boosted electricity production by almost 15%, says Dirk Ernst who farms at Algermissen, south east of Hannover.

He started adding beet when he was getting a poor price for excess beet tonnage and has experimented with different quantities of beet in the feed stock.

He has found that adding 10% beet to the feedstock is enough to boost plant output by almost 15%.

At the moment, he is adding mixed maize and rye silage, rejected barley and sugar beet to the digester.

The plant was designed to have a 500KW output using maize silage, but from the first day of operation it produced 600KW, he says.

Since adding sugar beet this has risen to 680KW and he reckons he could boost output to 800KW plus if he devoted over half of the feedstock to beet.

He started washing beet before putting it in the digester, but stopped when he found his silty soils didn't upset fermentation. The soil sits in solution and comes out with the digestate, he says.

Beet boosts output by 15%, says Dirk Ernst.

Sugar beet is the most efficient fuel for biogas production, giving high yields and fast fermentation.

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Anaerobic digesters break down organic material to produce methane, which is then burnt in an engine running a turbine to create electricity.

See our quick guide to on-farm anaerobic digesters at **www.fwi.co.uk/biogas**

FORAGE MAIZE VS ENERGY MAIZE

Standard forage maize	Energy maize (biogas output)
Minimum methane production in the rumen	Maximum methane production per ha
Dwell time: 5-10 hours	Dwell time: 50-100 days
Maximum feed value (starch and digestibility)	Maximum biomass (Yield and dry matter)
Sufficient dry matter for feed intake (30-35%)	Sufficient dry matter for fermentation (27-31%)

Source: KWS

Hybrid rye offers benefits

Hybrid forage rye produces consistently high yields, is quick to ripen and can perform well as a pre-maize energy crop in the UK, says KWS's Raoul Buschmann.

The crop can reach 4-6t of dry matter/ha before being harvested in May, which leaves time to establish a following maize crop. Because the window for fresh-feeding the crop into the digester is short, it is necessary to ensile it.

Hybrid forage rye can be harvested up to mid June, but after this time lignin value increases rapidly, decreasing gas yield, he says.

Sorghum is very efficient in low moisture situations, but does not offer significant benefits over maize for most UK growers, he notes. "But it could offer benefits for some growers in eastern counties."

Forage maize vs energy maize

* KWS has developed a number of energy-specific maize varieties that boost dry matter yields and increase methane production.

Conventional forage maize varieties have a high dry matter yield. This makes them suitable for feeding into anaerobic digesters, but their high starch content means yields are capped.

KWS's energy maize varieties have a higher fresh yield, which in turn gives higher dry matter returns.

Because starch is not important for anaerobic digesters, as it is for ruminants, the firm's energy varieties tend to have diluted starch content and higher dry matter yields.

Athletico was the firm's first energy-specific maize variety, launched in 2006, which achieved yields of up to 70t/ha, says John Burgess, maize development co-ordinator at KWS. "The problem was that it matured too late for the UK and it couldn't be grown."

Since then, new varieties have become progressively earlier allowing them to be grown in the UK but, as a consequence, yields have dropped back slightly.

Francisco is the highest-yielding variety currently available, returning 65t/ha, but with a FAO of 260 it is still a late variety, he says.

FAO is a standard measure of earliness that takes account of both cob ripeness and greenness. The lower the number the earlier the maturity of the variety.

Ronaldino is slightly earlier with yields of 60t/ha and an FAO of 240. The latest variety, Fabregas, is earlier still with an FAO of 220 and yields of 55t/ha.

Maximising bulk is the main aim when growing maize for biogas, but growers have to be realistic with variety choice, says Mr Burgess.

"If you've got a large area of maize you need to give yourself a window of time at drilling and harvest."

This means planting a mixture of early-maturing, lower yielding varieties to spread the workload with high yielding, late varieties to get the yield, he adds.

"Drilling just one variety is very high risk, so it is better to go for three of four with a mix of early drilling and early harvest and late drilling and late harvest."

Establishing the right variety for farm soil type is an important consideration as some of the tallest can suffer from lodging on sandy soils.

Philip Jung, KWS maize agronomist, says UK growers should pay careful attention to FAO numbers. "Massive, late varieties will not be as good as those adapted for the UK.

"FAO maturity ratings are important and the focus of our energy maize programme is to get the highest yields we can with an FAO of 200–220."

The firm is also trying to breed frost-tolerant varieties, which would allow growers to plant earlier and increase yields, he says. "It would be good if we could get a variety you could plant in March."

To get optimum yield and biomass the crop needs to fully mature and produce a cob, he adds. Leaving harvest too late could allow lignin to be produced, which reduces methane yield.