An exciting future for 'energy' maize?

Growing maize as a source of renewable energy could lead to an increase in plantings outside the UK's traditional livestock-dominated areas. One plant breeder is already developing varieties specifically for this sector.

By Martin Rickatson

Fermenting organic materials to produce methane gas which is then used to power an electricity generator is a practice still in its infancy in the UK. But on farms in some European countries — Germany in particular — biodigesters, which break-down organic matter anaerobically to produce gas for small-scale energy production plants, are now a fairly common sight.

With the Government's push for more of the country's power to be produced from renewable resources, the same thing could happen here, with farms having the potential to feed their own digesters to produce electricity — with a national grid connection enabling surplus power to be sold.

Experience has shown that relying on waste products for the process can lead to problems with the consistency of the 'fuel' and its supply. But growing crops specifically for inclusion in biodigesters overcomes this issue.

That's how one of the UK's first on-farm biogas plants will be working when it's completed next year — with a number of local farmers committed to growing just over 650ha of maize next season to fulfil its fuel requirements.

With the construction work having started in March this year, the facility on a farm in Norfolk is due to be operational by next summer, with the fermentor being fed chopped maize using a sheargrab-equipped telehandler.

'There are still several key political issues to be overcome.'

£4M investment

Philipp Lukas of Future Biogas is overseeing the development of the 1.4MW digester/energy plant in a £4M investment on the farm just outside Norwich.

"The Germans grew 1.76Mha of energy crops in 2008 and biogas provides over 1,600MW of power to the German electricity grid — representing a €2.5 billion market. He's currently trying to recruit other farmers to have biodigesters installed on their farms.

"The potential is certainly there to build a similar-sized renewable energy sector in the UK."

He acknowledges that there are several key political issues to be overcome before electricity generation from ▸

Philipp Lukas suggests biogas maize could give farmers another break crop option.

▸ biogas takes off in the UK. But with a number of farmers already signed up to produce maize for the Norwich bio-digester next season, this first operation is now well underway.

"I know of several biogas projects that have gone a long way down the line only to discover that the cost of connecting to the electricity grid made the whole operation unviable." Investment in a biogas plant is likely to be the single biggest purchase a farm will ever make, so "having an understanding bank manager is a must," he says.

Philipp Lukas believes renewable energy incentives are too low in the UK, compared with countries such as Germany. "There's currently no support structure in place to encourage the production or use of energy crops."

Government spending review

He also points out that many such industries which require a level of Government "encouragement" are currently awaiting the results of its spending review to see what it might mean for energy crops.

"And because the Environment Agency had lots of problems with large-scale compost plants a few years back — mainly from bad odours and flies — it's naturally cautious about bio-digesters. We're now working hard to overcome this, making clear that it's a sealed process — retaining and using the gas emitted by fermentation and not allowing it to escape or to smell."

With a maize-fed digester such as this, the feedstock store is no different to any other maize silage clamp, he says.

"Moreover, the technology is well-proven and the feedstocks are readily available whether they be waste or, in our case, specifically-produced crops. The only by-product is the bio-fertiliser which goes back onto next season's crops — making an excellent replacement for what the maize originally removed."

But biodigesters have a significant manpower requirement, stresses Philipp Lukas. "The need to be fed regularly and monitored closely, and they can't be neglected during busy times such as harvest. They're like concrete cows and need to be treated as such."

The German plant breeder KWS, whose UK division is based at Thriplow, Herts, has been developing plant types specifically for biogas production since 2002 — with maize and sugar beet having been identified as the most suitable for the process.

The company now has four specifically bred 'energy' maize varieties in its evaluation programme — selected for their high biomass and energy yields.

Recruiting local growers

Oliver Arnold owns the farm where Future Biogas' new energy plant is being built. He's been working with the company to recruit growers and to find suitable land for growing maize for energy (see panels opposite). Operating as a contractor as well as farming in his own right, he was already running a pair of maize drills and a self-propelled forage harvester.

"This has been a really difficult season for growing maize — both for forage types and the high biomass varieties we've been growing and trialling here for KWS. It was very dry when we sowed the crops in the spring, then we

Oliver Arnold has sown maize behind a variety of crops — including strawed carrots — without any problems, he says.

Beet biogas trials

KWS is also heavily involved in developing sugar beet varieties for biogas production.

Biogas beet is still lifted in the conventional way, although precise topping isn't so critical as the crown can be also used for biogas production (excluding the green leaf material) — adding around 9-14% to the yield. Crops are then clamped until they're required for processing.

"Sugar beet offers a very high biomass yield and excellent energy efficiency, which makes it well-suited as an energy crop," says KWS beet specialist, Simon Witheford.

"Its methane yield — both per hectare and per cubic metre — sits ahead of maize, and sugar beet is quicker to release its gases, with a retention time in the digester of 30 days, rather than 70-90 for maize." That makes it the fastest raw material for biogas production, he adds.

"We're also involved in research work looking also at how blends of different crops enhance each others' performance in the digester. Trials have shown that a blend of 25% chopped beet with 75% maize silage has proved effective."

The beet's amino-N content is irrelevant for biogas production, so higher nitrogen rates can be used than for standard beet, he continues. "But the roots need to be free from soil residues.

"Early research looks promising but the sugar regime makes things a bit complicated. But biogas could be a valuable outlet for C quota beet — and it could re-utilise some of the capacity and knowledge that was lost when the beet factories shut in Yorkshire and the West Midlands."

had some late frosts which affected them quite badly." Wind erosion also caused problems subsequently on some of the lighter land, he adds.

"But in spite of all that, the crops were 2.5m high by the first week in September — with some fairly decent-looking cobs." He believes maize is well-suited to his light soils and relatively low rainfall.

Oliver Arnold's drills are equipped with DAP fertiliser applicators — helping to get the crop off to a "flying start" and helping with weed suppression, he says. "But achieving good weed control early on is still crucial."

Rotational benefits

From a rotational point of view, there are a number of benefits from growing maize, he continues. "The main one is the fact that it provides more of an opportunity for grassweed control — being a spring crop and one that isn't a cereal."

Having maize in the rotation also helps to overcome the following crop restrictions with some sulfonylurea herbicides, he adds.

"We've even fitted it in to some rotations after carrots and, despite the amount of straw present on the soil surface from the carrot bedding, we had no germination issues at all."

Oliver Arnold's energy maize will be cut and clamped this autumn, ready for feeding into the digester as soon as it's complete. He's hoping to double that area next season, he says.

But because of the logistics of having to cart large quantities of harvested maize from field to digester, all crops will need to be a maximum of 15 miles from the farm, he adds.

Future Biogas has invested £4M in an biogas plant near Norwich. The fermentor is fed chopped maize to produce methane gas for electricity production.

To help spread his drilling and harvest workloads, Oliver Arnold planted 20% of his maize area with early-maturing varieties this year. "The bulk of the remaining area was then put down to a mid-early maturing variety, Ronaldinio, with the remainder drilled in late April/early May.

KWS has four 'energy' varieties ready for commercial sale — the early-maturers, Kadenz and Fabregas; and the later type, Francisco, in addition to Ronaldinio.

"We drilled the crops a little deeper than normal on our lighter land as they were going in fairly early — hence I wanted to protect them from frost." He typically uses a seed rate of 42,000 seeds/ha, with a goal of achieving 40,000 plants/ha.

"It's a slightly lower rate than for forage maize as the varieties are taller and need a bit more room for the light to penetrate." Seeds are sown 10cm apart on a standard row width setting, although he plans to trial closer rows next spring.

Harvesting will begin around 6-7 weeks ahead of the forage maize in mid-September to early October. "The bio-digester requires a very finely chopped product — 6-7mm versus the 16-17mm usual for forage — so that's a key consideration.

"Moreover, the lignin at the base of the stem won't ferment, so I aim to cut the crop at just above its first node. Depending on the customer's rotation, the stubbles are then ploughed-down before the following wheat crop is sown.

"With the high levels of trash left by maize, that's essential to prevent problems with mycotoxins in the following wheat crop."

KWS is conducting trials with first maize, continuous maize and after wheat, so it can give guidance to farmers who've never grown the crop before.

Unlike forage maize, high starch isn't a requirement for energy maize, so the breeder's efforts are instead targeted towards selecting high biomass varieties.

"For example, Fabregas has a 15% yield advantage over the very early forage types," says KWS's John Miles. "What we're selecting for in particular is yield security and cold tolerance so the crop may in future become an option for growers outside the current UK maize-producing area.

"Conventional forage maize, with its high starch content and dry matter, has a self-imposed yield limit but energy maize varieties support considerably higher yields which are optimised for biogas production." ■

What's it worth?

Future Biogas aims to be flexible with its contractual arrangements to fit in with different farming and landholding arrangements.

Land rental by way of 'crop licences' have proved to be the most popular option to date — with the company paying up to £400/ha where a farmer is prepared to plough and spray the land himself.

This figure includes a 'wheat escalator' payment of £1.25/ha for every £1 the average feed wheat price rises above £100/t. The payment also incorporates a 'yield bonus' which rewards growers when their maize yield exceeds 50t/ha.

Biogas and forage maize compared

Forage maize	Biogas maize
Minimum methane production in the rumen	Maximum methane production/ha
Maximum feed value (starch and digestibility)	Maximum biomass (yield and dry matter)
30-35% dry matter (for feed intake)	27-31% dry matter (for fermentation)