techtalk

Efficient maize for biogas

Maize remains a principal feedstock for anaerobic digestion and it is important to select varieties which maximise biogas yield. Limagrain UK has a long track record in the development of varieties employing a vigorous selection process to ensure only the very best varieties are available to growers.

Maize quality matters

High yields have characterised maize varieties grown for biogas. *CPM* finds out why quality is more important where efficiency is concerned.

By Lucy de la Pasture

> *"When looking at efficiency of biogas production, quality as well as quantity becomes part of the equation."*

A quarter of the 200,000ha of maize grown in the UK is grown as an energy crop. Its rise has been meteoric over the last decade but the growth in maize area has more or less levelled off, with any increase largely attributable to higher intake at newer anaerobic-digestion (AD) plants as they build to capacity.

Now the rapid growth phase of AD is over, the focus is very much on biogas productivity. Because the energy price is fixed, profitability comes from maximising the biogas generated and reducing input costs. That requires both efficient production and utilization of the maize crop — factors which bring maize variety selection under the microscope.

Agrii forage business manager, Brendan Paul, explains the factors growers need to consider when selecting varieties for biogas production.

What are the benefits of maize?

Maize, energy beet, rye and grass are the most commonly grown crops for AD in the UK. Of these feedstocks, maize has the highest yield potential for biogas production, at approximately 210m³/fresh tonne. Also coming in as the highest producer of dry matter (DM)/ha, maize makes a good case for its efficiency as a feedstock.

Introducing maize as a break crop in the arable rotation can bring a number of other benefits. Being a spring-planted crop, maize provides plenty of opportunity to control blackgrass pre-planting. Digestate, the nutrient-rich by-product of the AD process, can also be returned to land. Since no nutrients are lost during AD, farmers can close the nutrient cycle and reuse these vital minerals. Additionally, organic matter in digestate can build up the humus content in the soil.

What are the efficiency requirements?

Production of energy maize to date has primarily focused on producing a 'big heap', with maize production contracted on a fresh weight tonnage basis at 32-33% DM. However, when looking at efficiency of biogas production, quality as well as quantity becomes part of the equation and this is also affected by variety.

The objective when ensiling maize is to maximise forage quality in terms of Metabolisable Energy (MJ/kgDM). This is achieved through a combination of the two factors influencing energy — starch content and cell-wall digestibility (CWD). Generally, starch content is incremental with DM content and therefore will not exceed 30-35% as the two are linked.

CWD can vary between varieties by 5%, and often high starch varieties can have a low CWD %, so it's best to choose varieties with both high starch and CWD content.

CWD provides an indication of the feed quality of the leaf and stem material, which usually constitutes 45-55% of the ensiled material. The higher the

digestibility of this material, coupled with high starch from the cobs, the higher the energy content of the feedstock.

How does that affect variety choice?

When selecting varieties to maximise the production of biogas, the first indication of their potential is their total energy (ME) yield per ha. Growers should also check for a combination of both high ME content and overall ME yield.

It's also important to choose varieties suited to the farm's growing conditions which can achieve a dry matter content of 30-32%, with harvest date very much in mind. The range of varietal characteristics influencing these factors are available on the independent BSPB/NIAB descriptive list for AD.

The higher the digestibility of leaves and stems, coupled with high starch from the cobs, the higher the energy content of the feedstock.

What are the rotational /environmental implications?

The potential downside of maize in the rotation is a late harvest, which means it won't always be possible to follow with a winter cereal crop. To avoid maize becoming a 'two-year' crop, it's possible to manage harvest date by variety choice to some extent. But in practice, a range of varieties are often needed to spread harvest where a large acreage is in the ground.

Harvest needs to be at the optimal time to maximise efficiency. If a variety has 'gone over' and the DM is too high, then it won't ensile well and has a consequent impact on biogas productivity. What's more, overall digestibility will also have fallen as lignin levels increase in the plant as it matures.

Planting a green cover crop is becoming an established way of reducing soil erosion and run-off — both problems the Environment Agency is increasingly concerned about where land is left bare over winter. A useful rotation to help protect soil and water is maize followed by hybrid rye which is harvested in June, followed by a crop of forage rye ahead of a return to maize. Maize can also be undersown where planting a following crop isn't feasible.

What about carbon?

Increasingly sustainability will be an issue as growers strive to meet their carbon objectives, part of which is to limit greenhouse gas (GHG) emissions. From October 2015, electricity and heat generated by any UK anaerobic digester above 1MWe capacity that uses crops as a feedstock must achieve a minimum GHG saving of 60% relative to fossil fuel to receive Renewables Obligation Certificates (ROCs) or Renewable Heat Incentive (RHI) payments.

Variety choice also has a key role to play because a high-quality variety with a good yield and excellent biogas generation potential will help meet carbon objectives while a lower yielding, lower quality one won't.

Digestate, an organic fertiliser, offers an alternative compared with energy-intensive mineral fertilisers. They release very low (or even neutral) GHG emission values throughout their full production cycle.

A fixed energy price means profitability comes from maximising the biogas generated and reducing input costs.

What about maturity and FAO?

The FAO system describes the amount of heat units required for a maize crop to reach maturity and has historically been used to aid prediction of harvest date.

Maize needs around 45 heat units to form a new true leaf and approximately 300 heat units for the plant to fully emerge. Early varieties (FAO 150-160) require around 2100 heat units by the middle of Sept to reach maturity, ▸

AD plant calls for quality maize

Mark Voss, Operations Director with Ixora Energy has responsibility for a total of eight AD facilities, including three gas to grid units each with a 2MW equivalent output. The largest units use 14,000-16,000t of maize silage per year.

"Our business model for AD production is actually very simple," he comments. "With prices fixed we have to maximise the gas output from feedstocks while reducing costs. With feedstock accounting for 30-50% of costs it's our number one priority and we pay close attention to the quality of inputs.

"Maize is a really important input — not only does it produce significant yields of methane per tonne of DM, it allows us to increase the proportion of poultry manure, slurry and FYM we can use as it balances the nitrogen in the waste. So we want high quality maize.

"For optimum efficiency we don't want a large quantity of low DM, low energy feed, yet this is exactly what happens when growers focus on varieties selected solely on yield."

A significant proportion of the maize used is grown on contract and Mark explains that variety choice is largely left to the contracted growers — it's important the variety suits the farm and the rotation. Early varieties are preferred because the crop is harvested in better conditions while allowing successor crops to be established.

"As we pay on a tonne of dry matter basis with a target of 31%DM, our growers have been focussing on varieties with high dry matter yields, but increasingly we're looking closely at the quality attributes, principally ME content and CWD.

"A key driver of efficiency is the rate of fermentation. The faster and more completely a feedstock is fermented, the quicker the gas is generated and the greater the total output.

"To help increase fermentation rate, we chop the maize much shorter than a typical forager to increase the surface area which means it will be more accessible to the microbes. We target 95% at less than 18mm.

"The other elements we need to drive up are ME content and digestibility. With 50% of the total energy being in the vegetative part of the plant, increasing CWD is becoming increasingly important. A low ME, less digestible plant takes longer to ferment. We may get the same gas yield, but it'll take longer to get it.

"Increasingly we'd like to be growing early maturing varieties with high DM yield, combined with excellent ME content and superior CWD. This will allow us to drive output and control costs which is essential with a fixed price, while ensuring we harvest the crop responsibly."

Mark Voss explains that the faster and more completely a feedstock is fermented, the quicker the gas is generated and the greater the total output.

Efficient maize for biogas: top tips

- **Check varieties for ME content as well as ME yield** – there's no point selecting a very high energy yielding but low ME content variety.
- **Choose varieties with both high starch and CWD content** – both affect energy content.
- **Early-maturing varieties present less risk** – harvesting tends to be in better conditions to maintain quality.

Brendan Paul highlights that variety choice affects harvest date, which can be important for timely harvest and helps avoid maize becoming a 'two-year' crop.

▸ while later varieties (FAO 180-210) need around 2400 heat units. Later maturing energy maize hybrids for biogas (FAO 240-260) may require a longer season with 2800-3000 heat units, depending on drilling date.

Limagrain has also produced a new selection tool that can help farmers find out how many heat units are available in their area and then select appropriate varieties. Also, a useful app, the Maize Manager, can help growers, contractors and consultants calculate their optimal harvest more easily date while the crop is in the ground.

Harvest needs to be at the optimal time to maximise efficiency. If a variety has 'gone over', its DM levels will be too high and its CWD will decrease.

What about diseases?

Diseases such as fusarium and eyespot can be a problem, especially when infection occurs late in the season, causing the crop to die back and lose yield, thereby reducing its energy content and biogas potential.

Premature senescence caused by disease results in plants with increased DM% levels and reduced feed quality. Mould spores may be introduced to the clamp as the plant begins to 'rot'. Consequent high DM% silage (>35%) is 'spongy' and more difficult to ensile, increasing the risk of aerobic spoilage on the face when the clamp is opened.

Eyespot can be controlled by fungicide application, whilst both diseases can be managed by rotation and careful variety selection.

How is a crop best established and managed?

For efficient maize production, maximising the total ME/ha, it's essential to get good establishment and a crop that grows away quickly. Seedbed preparation has an important role to play, with autumn ploughing proving best in many situations.

Maize is a shy rooter and is extremely sensitive to compaction, which can cause a loss in yield of 30-35%. The top 20-25cm of topsoil hold most of the nutrients and it's important to keep the soil structure as open as possible to allow the roots to explore the profile. The deep tap roots of maize will penetrate the subsoil to seek out water to a depth equal to the height of the crop if growth is unimpeded. Starter fertiliser, either placed or applied to the seedbed, will give plants an early boost.

Maize is generally grown on 75cm row widths, though there are advantages in narrowing row width. These include quicker canopy development and a herbicidal effect as the rows close quicker.

There's a critical period, 4-6 weeks after drilling (10-30 days post emergence of the crop), when the crop needs to be kept weed free to avoid yield losses from competition. With the right variety selection and attention to growing detail, growers can really exploit the full potential of the crop. ■

Digestate releases very low (or even neutral) GHG emission values throughout their full production cycle.

Premature senescence caused by disease results in plants with increased DM% levels and they don't ensile as well.

Sponsor message

While maize has always been a mainstay of AD plants in the UK, the understanding of its role and value has developed. While initially production was focussed on quantity with varieties selected primarily on freshweight yield and agronomic suitability, the emphasis has moved firmly towards quality and maximisation of gas yield.

The keys to high gas yield and consequently reduced feedstock costs are dry matter percent and energy content, which itself is a factor of starch content and also cell wall digestibility (CWD). With 50% of the total energy being in the vegetative part of the plant, increasing cell wall digestibility is becoming increasingly important.

New varieties such as Gatsby and LG31.211 are examples of the next generation of maize cultivars for AD, ensuring high yields of high energy feedstocks to drive efficiency and reduce costs. For more information visit www.lgseeds.co.uk/maize or email enquires@limagrain.co.uk

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