Our aim is to provide Anaerobic Digester growers and associates with relevant information enabling maximum crop and gas yields.

This guide is a companion to our varieties and will continue to be updated following the establishment of an extensive trials network across the UK.

Together with our European Breeders, SAATEN UNION, Strube, Caussade Semences and Florimond Desprez we have carefully selected material which is suitable for the UK market.

These varieties and new materials continue to be tested through our trials network and via our close working relationships with UK biogas producers.

We welcome any feedback and hope to see you at one of our Energy Trials days which generally take place early Summer or late Autumn.
Feedstocks

Numerous plants and plant materials have been tested for their methane formation potential.

To achieve a consistent high methane yield the anaerobic digester must be supplied with a stable blend of materials.

These blends can consist of slurry and manure, food and amenity waste and crops and residues. Using a single feedstock alone can pose problems for reliability of gas output. Incorporation of Energy Crops into the base feed can enable level production.

It is important for a farmer to choose an Energy Crop and subsequent variety which suits their rotation and land type. High yielding crops together with a mix which allows effective digestion are key for maximum methane output.

The retention time of different feedstocks within the digester can vary, see graph 1. These variations are due to the differences in composition; if a stock has higher levels of sugar and starch it will ferment quickly, if it contains more lignin and cellulose it is slower.

The design of the fermenters can differ, it is common practice for Energy Crops to be fed in conjunction with manure or other liquid substrates (co-digestion) so that favourable fermentation conditions can be maintained.

For example beet will generally take 5-10 days to ferment, whereas maize and Hybrid Rye are far slower at between 50 and 90 days. This illustrates the need for a blend to facilitate constant production.

Table 1: Feedstock comparison

<table>
<thead>
<tr>
<th>Crop</th>
<th>Fresh yield tonnes/ha</th>
<th>Dry matter %</th>
<th>Dry matter yields tonnes/ha</th>
<th>Biogas yields m³/tonne</th>
<th>Methane conversion %</th>
<th>Methane yield m³/tonne</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAIZE</td>
<td>Low 40 High 55</td>
<td>Low 28 High 33</td>
<td>Low 10 High 20</td>
<td>Low 200 High 220</td>
<td>Low 53 High 106</td>
<td>Low 117 High 117</td>
</tr>
<tr>
<td>ENERGY BEET ENSILED</td>
<td>65 97 Low 22 High 24</td>
<td>14 19 Low 180 High 200</td>
<td>55 99 110</td>
<td>84 95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FODDER BEET ENSILED</td>
<td>60 90 Low 19 High 24</td>
<td>10 16 Low 180 High 200</td>
<td>51 84 95</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYBRID RYE</td>
<td>35 50 Low 31 High 40</td>
<td>13 21 Low 190 High 200</td>
<td>54 100 108</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRITICALE</td>
<td>30 45 Low 28 High 33</td>
<td>8 17 Low 170 High 190</td>
<td>53 90 101</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POPULATION RYE</td>
<td>28 35 Low 28 High 33</td>
<td>10 15 Low 170 High 190</td>
<td>52 80 100</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1 illustrates the difference in methane yield. Each feedstock is not dissimilar in the amount of gas production, therefore variety choice is vital in achieving best performance. Different crops give different biomass yields per hectare - the same crop under altered conditions can give variable results.
All feedstocks have implications both in terms of growing and when blended for the anaerobic digester. The table below explains in further detail;

<table>
<thead>
<tr>
<th>Crop/feedstock</th>
<th>Varieties</th>
<th>Rotation</th>
<th>Climate</th>
<th>Drilling</th>
<th>Harvesting</th>
<th>Storage</th>
<th>Other advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAIZE</td>
<td>ASTERI CS BORGSI CS TEKNI CS EURYTCI CS SULANO</td>
<td>Can be continuous</td>
<td>Needs sufficient heat units. Not suitable for the North, unless under plastic</td>
<td>Mid Apr to Mid-May. Soil temp 8/10°C</td>
<td>Oct</td>
<td>Easy to ensile</td>
<td>High biogas yields /ha. Cheap to grow. High net energy returns. Starch content not important in variety selection</td>
<td>Late harvest limits options for following crops</td>
</tr>
<tr>
<td>ENERGY BEET</td>
<td>BARENTS ARTUS</td>
<td>3 year min gap</td>
<td>Most of UK. Needs sufficient heat</td>
<td>Mid-Mar to Mid-Apr. Soil temp 5°C</td>
<td>Sept to Mar</td>
<td>Ensile on own or with maize or store anaerobically as thick liquid</td>
<td>Will keep growing in late autumn</td>
<td>Dirt and stones need cleaning out but energy varieties are bred for conical shape and low dirt tare</td>
</tr>
<tr>
<td>FODDER BEET</td>
<td>CAGNOTTE SPLENDIDE JAMON STARMON MERVEILLE</td>
<td>3 year min gap</td>
<td>As for Sugar Beet</td>
<td>As for Sugar Beet</td>
<td>As for Sugar Beet</td>
<td>Cheap to grow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYBRID RYE</td>
<td>SU DRIVE SU PERFORMER SU COSSANI SU SANTINI</td>
<td>Best in a rotation</td>
<td>Any cereal growing area. Ideal for light soils</td>
<td>Sept to end Oct</td>
<td>Late June/ Early July</td>
<td>Easy to ensile</td>
<td>Good synergy with maize in digester. High value digestate for use as manure. Early harvest for timely sowing of following crop. Helps blackgrass control (no viable seeds shed)</td>
<td>Lower energy yield than maize or beet</td>
</tr>
<tr>
<td>TRITICALE</td>
<td>TRIBECA (W) KEREO (W) TRIMOUR (S)</td>
<td>Best in a rotation</td>
<td>Any cereal growing area. Ideal for light soils</td>
<td>Sept to Dec, Mar to Apr</td>
<td>July</td>
<td>Easy to ensile</td>
<td>Cheap crop to grow</td>
<td>Lower yield than Hybrid Rye</td>
</tr>
<tr>
<td>POPULATION RYE</td>
<td>GENERATOR</td>
<td>Best in a rotation</td>
<td>As for Hybrid Rye</td>
<td>Sept to Nov</td>
<td>May to June</td>
<td>As for Hybrid Rye</td>
<td>As for Hybrid Rye. Opportunity to double-crop</td>
<td>As for Hybrid Rye</td>
</tr>
</tbody>
</table>

Digester engineers often advise on the appropriate feedstock for each plant, knowing the operator and the available local feedstock. This will ensure the retention time and safeguarding is sufficient. Energy Beet is a rapid catalyst for gas production; it is a very clean producer of methane meaning that the conversion process from gas to electricity is far more efficient than other feedstocks. The beet raises the pH within the digester which actively promotes the bacteria to be all-inclusive of the feedstock for methane manufacture. Anecdotally the blend of maize with wholecrop cereals will deliver a higher yield per tonne than maize as a sole feedstock.
Rotation

Any crop which is selected for use in an AD plant as part of a combination must provide stable yields.

The anaerobic digester needs a steady even intake, therefore the crops selected by a grower must perform season to season. The feedstock shouldn’t be restricted depending on pre harvest events.

To ensure a secure yield the grower must consider low risk crops like Hybrid Rye which is well suited to UK climatic conditions.

Harvest

Crops are frequently used for digestion directly after harvest. The harvest time can influence the biodegradability and hence the methane yield.

Late harvest is usually associated with higher cellulose content in the biomass, causing slower biodegradation and less methane yield. For a year round availability of substrates, the crops are most frequently stored in silage clamps. Under favourable circumstances, crops can also be dried, (by using for example surplus heat from a CHP). Each crop has it’s own harvest window, see Table 2: Implications of different Energy Crops, on pages 6-7.

Optimal ensiling results in rapid lactic acid and acetic acid fermentation, causing a decrease of the pH to 4-4.5 within several days. Addition of acid, or of commercially available ensiling additives, can accelerate the lactic acid fermentation and prevent silage failures. Silage may contain alcohols and acids that allow higher levels of methane to be produced.

Under such conditions, silage may be stored for many months, without major damage or losses.

Soil type

Hybrid Rye is well suited to a broad range of land types.

It gives growers a sound alternative to maize, where land may be too heavy, and the risk of a late harvest is too great. Hybrid Rye yields excellently on heavier soils, the high moisture levels facilitate good grain fill, thus resulting in higher dry matter yields. This crop does not have the geographical restrictions of other Energy Crops, see diagram 1.

Hybrid Rye has a wide sowing window. Seed rates will depend on time of sowing and soil conditions but approximately 2.5 units of 1 million viable seeds per ha (equal to 250 viable seeds per sq m) for late September or Early October sowing. Seed rates can be reduced for early/ mid September sowing, and should be increased when sowing after mid October.

Maize originates from far warmer more stable climates.

The crop requires high temperatures, warm soils, and a long summer period to attain high yields and optimum maturity.

Energy varieties have extremely high DM content, for a grower to achieve these levels the crop will be later in maturing which can pose complications in a wet year, or on heavier land.

Some areas of the UK successfully grow maize, although earlier ripening hybrids are needed if the market wishes to expand further into the North.

Maize pack size is typically 50,000 seeds and the suggested sowing rate is 110,000 - 115,000 per ha.

Growers could plant Energy Beet across the UK, providing the land type lends itself to fitting beet into the rotation.

This crop, like maize can prove problematic due to the time of harvest, and the time of planting.

Energy Beet is packed in 100,000 seed units and suggested sowing rate is 1 unit per ha.
Balance

The rotational balance for the grower is just as important as the balance within the AD plant itself.

A grower and AD owner must work together to get the best out of the land available. These choices may be a result of geographical location, rotation or AD demand, but ideally will be a mixture of all three and work in relative harmony.

Maize can be incorporated into most rotations, or continuous cropping could be an option. This is providing climatic and geographic conditions are stable. Care must be taken if the maize is to be grown in close proximity to cereals because of the escalating risk of fusarium.

When maize is mixed with a wholocrop cereal it should produce the maximum amount of methane yield per hectare. European growers and AD managers’ report that this combination provides a higher yield per tonne of input material than maize fed on its own.

If maize is not suitable for the cropping area due to climate, for example Northern Britain, a mixture of Energy Beet, Hybrid Rye and grass may be employed. This will provide a good methane yield despite the loss of maize in the mixture.

Hybrid Rye lends itself to a range of locations throughout the UK. In a rotational mix it fits easily behind maize or early beet. If replacing a cereal crop in a rotation it would ideally sit in the second wheat slot. In the ideal growing conditions and in warmer locations the grower does have the opportunity to double-crop, following hybrid or population rye with an early maize crop.

Energy Beet yields will peak when lifted from mid to late November, or in warmer areas it can stay in the ground until after winter. The grower must be aware of nematodes when growing beet in the rotation, it should not be grown any closer than one in three.

The use of Energy Beet in a rotation can have a beneficial impact on yield output from the land area available. By selecting all three products the grower is opting for a more sustainable approach with the opportunity to produce very high yields. When formulating a mix the user must safeguard that the combination allows the plant to function efficiently. The retention time and buffering time must be monitored. Please see both tables opposite.

### Table 3: Comparison of fresh root yield, dry matter yields and gas yields

<table>
<thead>
<tr>
<th>Variety</th>
<th>Fresh yield t/ha</th>
<th>Dry matter % of fresh yield</th>
<th>Dry matter t/ha</th>
<th>Biogas yield Nm³</th>
<th>CH₄ yield Nm³</th>
<th>CH₄ yield Relative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar Beet</td>
<td>80</td>
<td>20.7</td>
<td>16.6</td>
<td>10.400</td>
<td>5.760</td>
<td>121</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>14.5</td>
<td>12.4</td>
<td>9.100</td>
<td>5.040</td>
<td>106</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>12.5</td>
<td>7.800</td>
<td>4.320</td>
<td>4.770</td>
<td>91</td>
</tr>
<tr>
<td>Maize Silage</td>
<td>50</td>
<td>31.3</td>
<td>15.7</td>
<td>10.000</td>
<td>5.300</td>
<td>111</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>14.1</td>
<td>9.000</td>
<td>4.770</td>
<td>4.770</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>12.5</td>
<td>8.000</td>
<td>4.240</td>
<td>4.240</td>
<td>89</td>
</tr>
<tr>
<td>Fodder Beet</td>
<td>90</td>
<td>17.1</td>
<td>15.4</td>
<td>8.100</td>
<td>4.500</td>
<td>94</td>
</tr>
</tbody>
</table>

Table 3 shows Biogas from maize and beets; data sources: FNR; Leitfaden Biogas - Von der Gewinnung zur Nutzung (Biogas Guidelines - from production to usage), Gülzow 2010; Statistical Office of Niedersachsen, Schleswig-Holstein, Bayern, Rheinland-Pfalz: Actual yields of Silo Maize, Sugar Beet and Fodder Beet from harvest reports 2003-2012. Danmarks Statistik, www.statistikbanken.dk; HST6; Harvest by Crop and Unit; Fodder Beets; Average yield per hectare, 2003-2012; Limagrain UK Pocket Guide to Forage Crops Trial Results: Limagrain UK Fodder Beet Trials 1998-2011.

### Graph 2: Silage biogas generation rates

Source: Linke, Institut für Agrartechnik Bornim.
Hybrid Rye

Widely grown in Northern Europe, Hybrid Rye is proving to be an increasingly popular choice for improving the performance of AD plants.

With its excellent yield, flexible drilling dates, vigorous growth habit and very early maturity it provides growers with the opportunity for increased flexibility in terms of the position of Energy Crops in their rotation as well as reducing the risk of being able to achieve respectable harvest yields and crop quality.

With many AD plant managers now realising the limitations of maize and beet as sole or major sources of raw material for their AD plants, Hybrid Rye is becoming an increasingly attractive choice, both in terms of raw material security and also in terms of digester performance.

Hybrid Rye in the UK

Why grow Hybrid Rye?

Hybrid Rye is an excellent crop to balance other high production substrates such as beet or maize in the production of biogas in AD plants.

The addition of Hybrid Rye to beet or maize provides a different nutrient source for the bacteria in the digester. This has a two pronged synergistic effect - the Hybrid Rye increases methane yield due to a better balance of trace elements and a reduction in retention time in the digester. The latter is very significant as rye will take approximately 20 days to break down in the digester compared with 80-100 days for maize.

Hybrid Rye is also an excellent alternative to maize where the geography or soil types are not suitable for maize production. In such situations a Hybrid Rye and beet would make a good combination. Hybrid Rye gives higher DM yields than Triticale or wheat particularly on poor soils or in colder conditions.

The growing crop

Rotation

Hybrid Rye is an excellent crop for drought prone or lighter soils as the crop has a deep root system and is a good scavenger for nutrients and water. Modern hybrid varieties are shorter and stiffer than older conventional varieties and therefore - with an appropriate PGR programme - are suitable for a far wider range of soil types. Hybrid Rye suffers less from eyespot than wheat. It is also useful in the control of blackgrass because, with much greater height than wheat, far less blackgrass seeds are produced - and their viability is very low - and with an early July whole crop harvest the majority of blackgrass seeds will not have shed.

Sowing date

Hybrid Rye has a wide sowing window. Sowing can start from mid-September through to late autumn. It is a particularly good crop for later sowing as it tillers well with vigorous early spring growth. The yield loss experienced with late sowing of other cereal crops is therefore significantly reduced. Seed rates will depend on time of sowing and soil conditions but approximately 2.5 units of I million viable seeds per ha (equal to 250 viable seeds per sq m) for late September or Early October sowing. Seed rates can be reduced for early/mid-September sowing, and should be increased when sowing after mid-October.
Agronomy
Hybrid Rye is a crop with good foliar disease resistance and therefore is seen as a low input/high output crop. The vigorous crop growth gives excellent competition for weeds resulting in much reduced herbicide use. Nitrogen levels will be approximately 150 kg per ha in addition to P and K, a single PGR application on lighter soils and usually a maximum of a single fungicide. For heavier land a robust PGR programme is more appropriate, together with a 2nd or 3rd fungicide in situations of high disease pressure - especially Brown rust.

Harvesting and ensiling
The crop can be cut as early as ear emergence, like a green fodder rye, when the dry matter is about 20%. However the most economical timing is at the cheesy ripe stage when yields would have doubled and the DM increased to about 30-35%. Excepting barley, Hybrid Rye is much quicker in development than other cereal crops, including Triticale, and the cheesy ripe growth stage will usually be in mid to late June. This allows plenty of time for a catch crop or even double cropping. Chop length at harvest should be 7-10mm with the addition of a preservative such as lactic acid when ensiling.

SAATEN UNION varieties
The varieties selected by SAATEN UNION have improved crop morphology to allow more potential secondary grain sites to be pollinated and therefore grain yields to be increased. High importance has also been placed on introducing faster spring growth leading to earlier maturity. Disease resistance has also improved. SAATEN UNION have developed “TURBO-TECHNOLOGY” to overcome the issue of Ergot in rye.

SU DRIVE
Tried and tested
The most popular SAATEN UNION variety which is best suited to the conventional ensiling time at the cheesy ripe stage of growth or about 30-35% dry matter. SU DRIVE is stiff strawed and suitable for a wide range of soil types. It has good disease resistance, especially to Brown rust which is important in the South and East of the UK. Good ‘stay green’ characteristics have been bred into the variety widening the harvest window by a few days.

SU PERFORMER
A step forward in yield potential
Demonstrates the latest step forward in breeding from SAATEN UNION. Management is as with SU DRIVE although it is slightly later in maturing by 2-3 days. This is a very high yielding variety as has been shown in UK and European trials. It has a good resistance to lodging, excellent tiller ability and a sound disease profile.

SU COSSANI
Excellent disease profile
This is another variety from SAATEN UNION’s more advanced breeding programme. It can be managed in the same way as other varieties but trials have shown it to be 1-2 days later in maturing than SU DRIVE. This variety combines early ear emergence with high yield, and extremely robust disease resistance.

“"We have found SAATEN UNION rye varieties to have good early vigour, even when sown late. The crops tiller well and have produced pleasing dry matter yields. Whole crop rye has worked well as a feedstock, as it complements maize. On heavy land, where maize is less favourable, it has given farmers the opportunity to tackle black-grass in their rotations”. Jon Myhill, Regional Feedstock Manager for Future Biogas
Energy Maize

With its potential to produce very high energy yields at a low cost, maize has formed the backbone of the Energy Crop sector for many years.

As in Germany, UK farmers now understand that realising the potential of maize requires a more sophisticated approach in terms of variety selection, as well as for using a combination of Energy Crops to balance the rotation, improve security of raw material supply and create a more efficient mix of raw material for use in the digester.

Experience has shown that later (by UK standards) maturing maize varieties (FAO 220-260) can produce significantly higher available dry matter yields than earlier maturing (FAO 150-210) forage types. Successfully growing a later maturing energy variety can make a massive difference to the total dry matter produced and hence energy yield, especially when a large area is being grown. Obviously, to choose the most appropriate variety, farmers need to assess their own circumstances in terms of drilling time, geographical location and typical harvest window.

The maize varieties chosen by Caussade Semences, SAATEN UNION and Elsoms for the UK market suit the climatic conditions faced by growers. They have been selected for their increased tolerance of heavier soils lending themselves to growers needs.

The crop will germinate at soil temperatures of 8°C or greater, and early development requires temperatures of 10°C or more. Late frosts can lead to plant death. If autumn temperatures drop below 7°C development can be significantly stunted.

Maize for biogas is chopped to a short length which will help speed up the process within the digester.

Maize has a long retention time of approximately 100 days.

Table 4: Variety attributes

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Maturity FAO*</th>
<th>DM %</th>
<th>Early Vigour</th>
<th>Resistance to Lodging</th>
<th>Stay Green Factor</th>
<th>Seed Rate (seeds per ha)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>SULANO</td>
<td>220</td>
<td>29.1</td>
<td>7.5</td>
<td>6</td>
<td>6.8</td>
<td>110,000</td>
</tr>
<tr>
<td>ASTERI CS</td>
<td>240</td>
<td>28.3</td>
<td>7.5</td>
<td>6</td>
<td>7</td>
<td>100,000</td>
</tr>
<tr>
<td>BORGI CS</td>
<td>250</td>
<td>27.9</td>
<td>7.5</td>
<td>6</td>
<td>7</td>
<td>100,000</td>
</tr>
</tbody>
</table>

Table 4: Variety attributes

**SULANO**

A very high yielding variety from SAATEN UNION and in BSPB / Pre Descriptive List trials in 2013-2014. Out yielded the mid / late season control Klifton by 15% at a 2.1% lower dry matter. Good early vigour and stay green factor, taller than SURIGA but good standing power.

**EURYTMIC CS**

Grown across the UK in small trial areas in 2015 this variety has received excellent results, high yields and low incidence of disease. The plant height is taller than Ronaldino but with lower ear attachment. Excellent early lodging resistance, high thousand grain weight, with good stay green factor and low sensitivity to rust and fusarium.

**ASTERI CS**

Tested in UK private trials 2011-2014 by Caussade Semences and commercially available since 2013. Averaged 13% higher yielding than Klifton when in the same trials with 3.3% lower dry matter. Very good early vigour, and stay green factor. Good standing power.

**BORGI CS**

Tested in UK private trials 2011-2013 by Caussade Semences and commercially available since 2013. Yields and dry matter results are very similar to ASTERI CS but it is more adaptable to high yielding soil types. In NIAB Biogas Trials for 2015 harvest.

**TEKNI CS**

A tried and tested variety in Europe offering growers a more economical alternative where land might be marginal for maize cropping. Good stem strength and resistance to lodging, sound stay green factor, reliable disease resistance.

**SULANO ASTERI CS BORGI CS**

**Maturity FAO***

<table>
<thead>
<tr>
<th>SULANO</th>
<th>ASTERI CS</th>
<th>BORGI CS</th>
</tr>
</thead>
<tbody>
<tr>
<td>220</td>
<td>240</td>
<td>250</td>
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</tbody>
</table>

**DM %**

<table>
<thead>
<tr>
<th>SULANO</th>
<th>ASTERI CS</th>
<th>BORGI CS</th>
</tr>
</thead>
<tbody>
<tr>
<td>29.1</td>
<td>28.3</td>
<td>27.9</td>
</tr>
</tbody>
</table>

**Early Vigour**

<table>
<thead>
<tr>
<th>SULANO</th>
<th>ASTERI CS</th>
<th>BORGI CS</th>
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</thead>
<tbody>
<tr>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
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</tbody>
</table>

**Resistance to Lodging**

<table>
<thead>
<tr>
<th>SULANO</th>
<th>ASTERI CS</th>
<th>BORGI CS</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>6</td>
<td>6</td>
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</tbody>
</table>

**Stay Green Factor**

<table>
<thead>
<tr>
<th>SULANO</th>
<th>ASTERI CS</th>
<th>BORGI CS</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.8</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

**Seed Rate (seeds per ha)**

<table>
<thead>
<tr>
<th>SULANO</th>
<th>ASTERI CS</th>
<th>BORGI CS</th>
</tr>
</thead>
<tbody>
<tr>
<td>110,000</td>
<td>100,000</td>
<td>100,000</td>
</tr>
</tbody>
</table>

*SULANO results from NIAB Pre Descriptive List trials 2013 & 2014. ASTERI CS and BORGI CS results from Caussade Semences private UK trials 2011 - 2014. All of the above varieties will not be in all the trials. As the results have come from two separate trial series the results are not precisely comparable.*
Energy Beet offers a combination of very high (consistently achievable) dry matter yields, excellent digestion efficiency and strong agronomic advantages.

Whilst maize remains at the heart of most Energy Crop rotations, Energy Beet, along with Hybrid Rye, is now forming a vital part of farmers strategic plans for achieving the performance required.

Sugar Beet provides higher comparable yields and energy levels than Energy Maize with other valuable characteristics for biogas production.

It has excellent substrate and fermentation features which stabilise the microbial conversion and improve the technical processes in the fermenters. Beet dry matter primarily consists of directly fermentable carbohydrates (sucrose) which are quickly converted into energy. Sugar Beet is often completely decomposed in less than 15 days. In good agricultural regions, Sugar Beet achieves a methane yield per hectare which is 20% higher than the yield from ensiled maize.

Specifically selected for the UK ‘Energy Crop’ sector, BARENTS has the ideal characteristics for energy production.

Strube’s best selling beet for biogas in the advanced German market.

Table 5 illustrates BARENTS’ performance compared to other Energy Beet varieties on the current market. Table 6 compares BARENTS agronomically with other varieties. BARENTS offers well shaped low-tare roots for easier harvesting.

*RT: Rhizomania tolerant , NT: Nematode tolerant. ** Scale 1-9: where 1 = deep root groove/greater tendency to fanginess, 9 = no root groove/no root branching. *** It is Strube’s contention that the optimal crown height above ground is 60-70mm which can give reduced harvest losses. More than 80mm will often have an adverse effect that can lead to crop losses.

BARENTS’ performance

Table 6: Agronomics comparison

Table 7: Biomass variety trials, Germany 2012-14

ARTUS’ performance

The table below shows an extract referring to the three-year mean results from the German SVB trials 2012-2014 for the varieties known to be available to UK growers and used as standard controls (*).

ARTUS shows the ideal combination of high yield and good sugar content with very low relative dirt tare.

*Control varieties.
Advantages of Energy Beet
Compared to alternative choices of Energy Crop, Energy Beet provides farmers with a number of advantages:
- Higher energy levels than maize
- Stable yields across seasons
- Excellent rotational advantages
- High dry matter yields
- Highly efficient fermentation characteristics
- Rapid fermentation
- Facilitates rapid AD plant re-start.

Disadvantages of Energy Beet
- Needs careful storage.

Rotational advantages
- Spring sown - allows time to aggressively manage grass weeds and also to gain from the advantages of using a high performance Catch Crop such as CONTRA oil radish or INTENSIV viterra green manure mixture.
- Deep rooting - following crops can gain significantly from the improvement in soil structure, especially maize.
- Ground cover - excellent coverage from early summer onwards suppresses weeds, conserves soil moisture and reduces soil erosion.
- Harvest window - potentially very long, especially compared to maize, resulting in less pressure on already hectic autumn workloads.
- Drought tolerance - compared to many crops, Energy Beet’s deep root and good ground cover enable it to cope well with periods of drought.
- Long growing season - unlike maize, Energy Beet has a very long growing season during which poor weather periods are often compensated for by consistently high year on year yields.

Unique Strube seed quality
Strube is a leader in the development of high quality beet seed. All seed is produced with the aid of Strube’s unique 3D plus technology, which uses X-ray computer tomography to accurately measure and hence control seed quality and development at a minute level. When used in variety development, this technique ensures that only the most vigorous varieties are selected for further development whilst in seed processing it ensures that complete quality control is maintained during processing, priming and treatment operations with the result that only high quality, vigorous seed is delivered to farm.
Growing Triticale

Position on the farm and in the rotation
Triticale is a crop which is derived from a cross between wheat and rye and has been grown in the UK for well over 50 years. It is a relatively long strawed cereal and best suited to drought prone, light yielding sites. It is a very inexpensive crop to grow. Triticale is less affected than wheat by Take All and it is therefore a favoured crop instead of a third or fourth wheat. Within a rotation, or on lighter soils, Triticale is likely to be a financially better option than wheat when predicted wheat yields drop below 6 or 6.5 tonnes per ha. Triticale is less likely to be grazed by rabbits over winter and is therefore useful when fields are close to woodlands.

Sowing
Triticale can be sown from late September onwards. It is relatively unresponsive to time of sowing so most of the crop is sown in October, November and even December. There are also some varieties which do not have a vernalisation requirement and can therefore be spring sown. Seed rates will vary with drilling date and soil conditions. Triticale is a relatively poor tillering species when comparing to wheat but a normal mid October drilling rate is 325-350 seeds per square metre or 130-140 kg per ha which should counteract this. Seed is usually supplied without seed treatment unless high fusarium levels are detected in the seed stocks.

Agronomy
Triticale should be treated like a barley or lower yielding wheat crop. The deep roots of Triticale will give the crop the ability to scavenge for nitrogen (and water) and applied nitrogen levels will be around 125 kg per ha. Weed control is likely to be easier as it is a tall smothering crop and the spring sown option gives a good opportunity for autumn blackgrass control. PGR use is likely to be a single application, and with generally good disease resistance there will be a lighter touch on fungicide application.

Harvesting and marketing
Winter sown Triticale will come to harvest at approximately the same time as Hybrid Rye, July. Fresh weight yields range from 30-45 t per ha with a dry matter percentage between 28 and 38. There is a growing trend to harvest Triticale - especially from a spring sown crop-at the milky ripe stage and ensile the crop to produce a high volume, easily digestible whole crop silage. Triticale is extremely beneficial in an Anaerobic Digestor with production synergies when the ensiled crop is mixed at about 25% into a predominately maize feeding system.

Please turn to page 5 to see the comparison table.

Triticale

Triticale is a low maintenance cereal with an aggressive growth habit and robust agronomic characteristics that is increasing rapidly in popularity with farmers across the country.

New winter and spring sown varieties are now available that have seen a major improvement in the crops potential value to the grower.

Elsoms works in partnership with French plant breeder Florimond Desprez and through its modern varieties has maintained its position as a market leader in this sector.

Table 8: Tribeca Winter Triticale performance

<table>
<thead>
<tr>
<th>Crop</th>
<th>Fresh Yield tonne/ha</th>
<th>Dry Matter %</th>
<th>Dry matter Yields tonne/ha</th>
<th>Biogas Yields m3/tonne</th>
<th>Methane Conversion</th>
<th>Methane Yield m3/tonne</th>
<th>Methane Yield m3/hectare</th>
</tr>
</thead>
<tbody>
<tr>
<td>HYBRID RYE</td>
<td>30 55</td>
<td>28 38</td>
<td>8 21</td>
<td>180 200</td>
<td>54</td>
<td>97 108</td>
<td>2816 5940</td>
</tr>
<tr>
<td>TRITICALE</td>
<td>30 45</td>
<td>28 38</td>
<td>8 17</td>
<td>170 190</td>
<td>53</td>
<td>90 101</td>
<td>2703 4532</td>
</tr>
<tr>
<td>MAIZE</td>
<td>35 55</td>
<td>28 36</td>
<td>10 20</td>
<td>200 220</td>
<td>53</td>
<td>106 117</td>
<td>3710 6413</td>
</tr>
</tbody>
</table>


Table 9: Trimour Spring Triticale performance

<table>
<thead>
<tr>
<th>Crop</th>
<th>Date of Drilling</th>
<th>Total Fresh Yield (t)</th>
<th>Total Adjusted Yield (t)</th>
<th>Average Fresh Yield (t/ha)</th>
<th>Average Adjusted Yield (t/ha)</th>
<th>Average NIR DM %</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPETITOR SPRING RYE</td>
<td>11/03/2015</td>
<td>49.96</td>
<td>46.61</td>
<td>17.53</td>
<td>16.35</td>
<td>34.52</td>
</tr>
<tr>
<td>TRIMOUR TRITICALE</td>
<td>11/02/2015</td>
<td>51.1</td>
<td>46.5</td>
<td>25.17</td>
<td>22.91</td>
<td>33.87</td>
</tr>
</tbody>
</table>

Source: Future Biogas & Elsoms Norfolk Trial 2015.
Digestate

This is a by-product of the AD process, it is an excellent fertiliser and soil improver.

The digestate can be spread or injected, and care must be taken to make sure the use is compliant with government guidelines.

Solid fractions are often separated from the digestate to undergo further composting. The separated liquid fraction of the digestate is in some cases partly re-circulated for substrate homogenization. If use cannot be guaranteed, digestate must be further processed or aerobically purified. The solid fractions can also be pelleted and used to feed biomass boilers, or for animal bedding.

Digestate can be applied at various times of the year; during spring before drilling, or following a Hybrid Rye crop before winter drilling, but all applications should fall within industry guidelines.

The specific value of the digestate obviously varies depending on the feedstock. Significant levels of N, P and K have been found in a range of digestates, in addition to other valuable nutrients that have a positive impact when returned to the soil. When used over a lengthy period of time soil structure and fertility have been improved dramatically.

Typical digestate values can be seen below.

Table 10: Typical digestate values

<table>
<thead>
<tr>
<th>Crop</th>
<th>Digestate values kg/tonne</th>
<th>N</th>
<th>P</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAIZE SILAGE</td>
<td>3.7</td>
<td>2.4</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>ENSILED BEET</td>
<td>2.2</td>
<td>1.0</td>
<td>2.2</td>
<td></td>
</tr>
<tr>
<td>HYBRID RYE</td>
<td>5.9</td>
<td>3.7</td>
<td>7.3</td>
<td></td>
</tr>
<tr>
<td>GRASS</td>
<td>5.3</td>
<td>2.9</td>
<td>9.4</td>
<td></td>
</tr>
</tbody>
</table>

Source: SAATEN UNION

Elsoms’ Partners

Saaten-Union GmbH was founded in 1965 and is an association of seven medium-sized plant-breeding enterprises, P.H. Petersen Saatzaht, Norddeutsche Pflanzenzucht Hans Georg Lemke, Strube Research, Nordsaat Saatzahtgesellschaft, Wv. Borries-Eckendorf, Ackermann Saatzaht und Dr Hans Rolf Späth Saatzaht.

The company has one of the biggest and most advanced biotechnology laboratories for plant breeding in Germany and has eight subsidiaries, one each in Great Britain, France, the Czech Republic, Poland, Romania, Hungary, Russia, and Ukraine.

In the Saaten-Union group there are 780 employees across Europe, 70 of whom work at the company headquarters in Isernhagen, Germany.

Strube is one of the world’s leading Sugar Beet breeders supplying seed of more than 170 varieties of Sugar Beet to more than 35 countries around the world.

In Germany, where there are now some 7500 biogas plants, Strube supplies more than 40% of the Sugar Beet seed required for the national crop and AD use.

With a long-standing reputation for innovation, backed by strong and continual investment in research and development, the aims of the research are not only to continue to increase crop yields, but also to develop improved tolerances to diseases, drought and environmental stresses.

When selecting for the biogas market Strube is concentrating on key areas; high dry matter content, ease of lifting, low dirt tare, lower soil adhesion and good storage characteristics.
CAUSSADE SEMENCES

Caussé Semences is a French independent company which creates and markets genetics for large-scale growing and forage productions.

Partner and actor of the agricultural world for several decades, Caussé Semences’ will is to meet the needs of the farmers, dealers, industrials and consumers with efficiency and relevance.

The creation of varieties must meet the numerous expectations of the agricultural and industrial sectors (food and non-food outlets) which Caussé Semences leads its research from.

The experience and competence of its teams enable the development of high-performance genetics of all the selected species, as to meet Caussé Semences multispecies requirements.

Florimond Desprez is an independent French family-owned company. The group breeds plant varieties and also produces seeds to meet the needs of the arable crop sector, harnessing genetic resources to create new high-yielding varieties.

The company’s breeding goals factor in various agronomic, technological and environmental criteria.

Florimond Desprez breeds plant varieties and also produces seeds, which spread its innovations across the different sectors of agriculture.

It’s aim is to continue investing in breeding small grain cereals in France and internationally. The main ambition is to be one of the market leaders in this sector, both in Europe and worldwide.

Florimond Desprez is making major investments to be competitive today and ensure its continued presence tomorrow on international markets.

The company devotes 17% of its income to research, which makes it the leading company according to this criterion, with 30% of its employees involved in research and development activities.

Florimond Desprez

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Open Days

We will be hosting a number of Open Days in 2016. All are free to attend, and we often have BASIS points available. Please email or call Heather or Jonathan to register your interest.
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