Issue 4

terravesta

Energy, naturally.

The Essential Growers' Guide

Contents

Foreword

When it comes to the Miscanthus supply chain, quality is in everyone's interest. Growers who can consistently deliver premium quality crop will benefit from the best market price and create confidence in future supply. Buyers who can rely on consistently high standards will continue to fuel demand long into the future.

As a Miscanthus grower myself, I have experienced the day-to day issues of planting, establishing, baling and selling the crop first-hand. Today, Miscanthus really is a viable crop to grow commercially, and there is no doubt that, with very little input, it can deliver a lifetime of returns.

Developed from a pool of collective experience from long-standing growers, Terravesta is able to recommend some simple steps to ensure that for today's grower, it only takes a small amount of effort to safeguard a premium quality crop.

Lending its expertise in everything from propagation, planting, growing, harvesting, and plant breeding, at the heart of Terravesta's mission is continued investment into crop research and development, to meet a rising UK and international demand for miscanthus and grow ever-increasing markets for it.

With a global directive to reduce carbon emissions and the UK government aiming for 20% renewable energy capacity by 2020, there is increased interest in renewable energy sources both in the UK and internationally. The demand for biomass sector growth plays a critical part in reaching government targets.

The Essential Growers' Guide has been created to share the vital knowledge developed from years of experience to both new and existing growers, to help secure the highest quality of Miscanthus supply for the UK. For the new grower, by embarking on your first season, you are joining a network of hundreds of other farmers (myself included) who are already reaping the benefits of this miracle energy crop. Sharing information and making the most of others' experience means the whole Miscanthus market will grow stronger, better and together.

William Cracroft-Eley,
Chairman, Terravesta

What is Miscanthus?

Planted once, and with a lifespan of 20 + years, miscanthus has an annual growth cycle, and is harvested each spring. The crop thrives on poorer grade, marginal land and requires little or no inputs, including fertiliser.

Miscanthus x Giganteus is a sterile hybrid crop crossing. This means that the Miscanthus productivity is enhanced and plant heights can reach 8-12ft tall, producing harvestable yields ranging from 12-17 tonnes per hectare.

Crop characteristics:

- Low maintenance
- Low input costs after establishment
- High resistance to fluctuating environmental conditions
- Low moisture content during harvest >16% when baled
- Lack of identified natural pests and invasive competitors

Crop requirements

Environment:

- High sunlight exposure
- High precipitation
- Low wind-exposure

Soil:

- Will grow on all land types
- Soil pH must be between 6-7
- Will establish best if planted in a fine 6î tilth in April/May
- Strongest yields achieved on wet sandy soils
- Takes longer to establish in heavier clay soils but yields are more consistent
- Year one growth rates can be more dynamic in lighter soils

Starting Out - Site Preparation

Pre-planting

1

Autumn prior to planting

Take soil samples to test pH, P, K, Mg, EC

Spray off any evidence of weeds with glyphosate based product

Consult your agronomist and Terravesta on the outcome of your soil analysis. Take the appropriate action to balance element cocentrations

2

Spring prior to planting

Spray off any weeds that have germinated over the winter months with post emergent herbicide

Prior to planting, spray pre emergent herbicide to prevent any unwanted seeds from germinating

Post-planting

3

Post planting

It is imperitive that any weeds that arise after planting are combatted immediately

The first sighting on any invasive species should be tackled with a targetting post emergent herbicide

4

Miscanthus shoot emergence

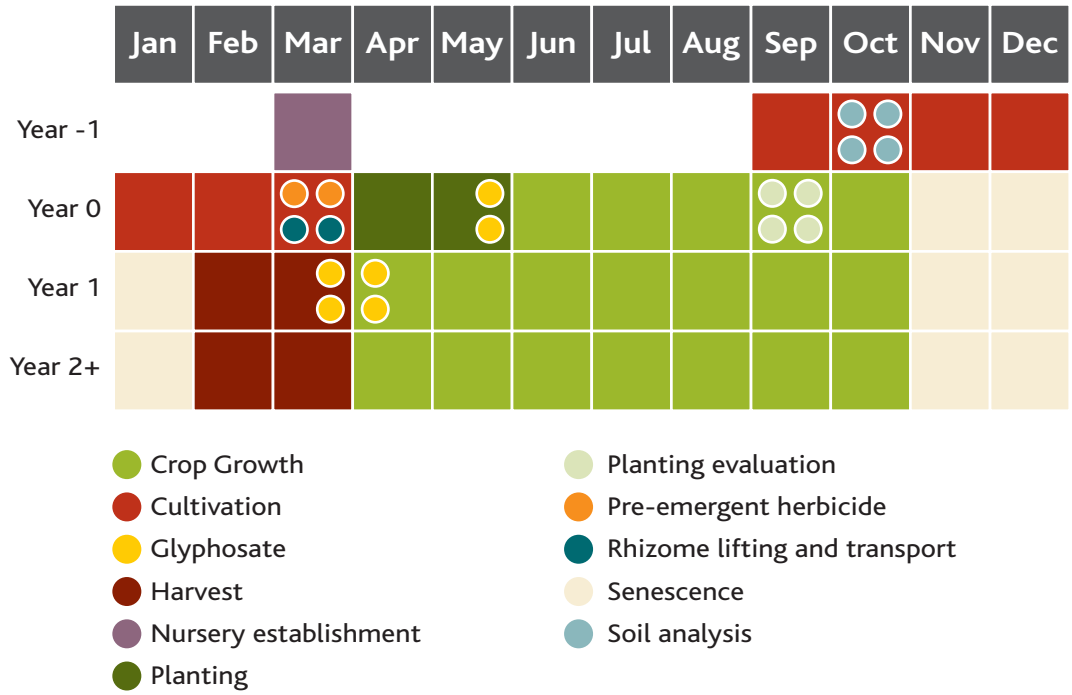
As soon as the Miscanthus shoots have emerged, absolutely no generalised post emergent herbicide should be sprayed as you run the risk of damaging the Miscanthus

Starting Out - Planting Miscanthus

Before planting takes place, the first step is to agree a planting window with a contractor and plan your cultivation programme backwards from this date.

It's important to ensure that the rhizomes have good soil contact when planted, so getting a deep fine tilth is important (as outlined earlier in the Preparing the site section). The planter should be set up to plant at around 15,000 rhizomes per hectare and the field should be rolled after planting.

Miscanthus key dates:



Planting Miscanthus

- Rhizomes will be delivered direct from our cold store and need to be kept cool, stored in cool, dark conditions
- It's crucial that rhizomes are watered daily to prevent dehydration
- Do not heavily stack the rhizomes when they are in storage, keep stacking to a minimum
- When handling try to prevent unnecessary damage as this can impair the buds and potentially reduce yields later on in the growth cycle
- When loading rhizomes onto the planter, do so at the field boundary's to reduce unwanted compaction
- Once the rhizomes are on the planter, keep them watered especially in hot and dry weather conditions
- The planter will plant in rows of four at 75-80cm spacing's between each row and rhizome drop
- Flat roll the field straight after planting to encourage contact between the rhizome and soil, which helps to reduce establishment time

Cultivation specification:

- A fine tilth of no less than 6" is required
- Clods should be less than 10mm in size
- The soil should be worked down as close to planting as possible
- The seed bed should be as clean as possible
- Muck can be spread prior to ploughing but no later

Rhizome storage

When they arrive on the farm, the rhizomes should be stored in the shade and close to a water source. In fact, if possible, placing a hose directly into the storage bags is ideal. It is crucial not to let rhizomes dry out, so avoid leaving them in direct sunlight.

Cutting

Harvest has three distinct processes, which take place between January and April every year.

Cutting, using a self propelled forage harvester.

Drying, to ensure that any sap drains from inside the cane, as much as external moisture sources due to rain, snow, wet ground, which may involve turning the swaths in a very wet season.

Baling, into Hesston type bales with a moisture content of less than 16%.

When it comes to achieving a dry and commercially viable crop, timing is of the essence. The following pointers will help ensure you get the timing spot on:

- The cutting process: Always cut to a cane length of 40cm or less using a self-propelled forage harvester. The machine needs to be set up to achieve the right cane length and the drum needs to be set so as not to split the canes longitudinally. Splitting the cane exposes the absorbent inner pith, which will then soak up rain and external moisture. Unsplit cane will shed external moisture sources, and can therefore sit for long periods in the swath without any detriment to quality.

  Although contract costs for a forage harvester may seem higher than using a mower conditioner, the former allows for higher density bales (up to 100kg per bale). This in turn will deliver a substantial saving (as baling is charged per bale), while still ensuring the required cut quality. Long canes are no longer acceptable in any market, and will lead to bales being rejected.

- Crop senescence: When it comes to cutting, ideally the cane will only be green up to 1ft from the ground, but in a mild winter the crop may not have achieved this level of senescence (and still be green higher up). The standing crop is unlikely to senesce any more beyond the end of January. It is essential that the cut crop is left in the swath for long enough to enable the sap to dry out. The greener the crop at cutting, the longer this will take. Cutting early will induce the senescence process by exposing the stems, which are then left in the field to dry. In swath, senescence could take between ten days and four weeks.

- The best time to cut: The key is to cut as early as you can. The determining factor is likely to be ground conditions and whether the machinery can travel without creating damaging ruts. With this in mind, it's best to wait until the end of January. Providing the forage harvester is correctly set to leave the cane rods unsplit, the cut crop will withstand rain or snow and will quickly dry in the prevailing winds. Cutting late limits your opportunity to control senescence and hence moisture in the crop. Cut early and do not rush to bale.

We cannot emphasise enough - growers investing time and effort at this important stage to ensure crop has minimal moisture content, will quickly reap the rewards. It means a price difference of up to £15 per tonne, faster processing and collection, earlier payment, no redirection/return charges, cheaper haulage and less waste.

Drying and Turning

In a reasonably dry spring, the cane will dry without needing to be moved. The most important thing to ensure is that the sap has dried from inside the cane, which is indicated by a change in colour from green to golden brown.

External moisture will generally dry with a few dry days and breeze through the swath.

Turning (never raking) can ruin the quality potential of your crop, and therefore should only be done when necessary, and with extreme caution.

The aim of turning is just to invert and raise the swath to enable air to get to the damp underside.

You should never attempt to rake the ground litter into the swath;

- Ground litter is wet and can contain stones and grit, all of which lead to rejection at the pelleting plant.
- Ground litter acts as a mulch, suppressing weeds and preserving soil moisture in times of drought.
- Ground litter decomposes and returns nutrients to the soil.
- Ground litter is important for biodiversity as it is a rich habitat for invertebrates.

Turning is best done after advice from your baling contractor.

Turning is useful in the following circumstances;

1. In wet ground conditions following a wet spring, where the bottom of the swath is lying damp.
2. Where the swath has been cut green and has been lying for a long time so that the swath has flattened. Turning will fluff up the swath to allow air through, and enable final drying.

When to turn:

Turn with a fine forecast within a day or two of baling. As an operation it adds cost, so you do not want to be doing it more than once.

Baling

One of the greatest uncertainties growers have faced over the years has been when to bale.

Our advice is to leave the widest possible window after cutting to ensure that the crop is fully senesced and completely dry, as once it is packed into bales there will not be enough ventilation to dry it out further. You only have one chance to get this right, and it's always best to wait longer and be sure, than lose confidence and risk baling green or wet crop. Only bale crop that will meet moisture specifications or you will ultimately lose out when it comes to sale.

Before calling the baling contractor, you should visually inspect the swath for any green stems, and oven test some samples to satisfy yourself that it is dry.

In general, Miscanthus is a very hands-off crop. However, one of the only times you'll need to commit to being present on-site on a specific day and time is once you've made the decision to bale. Agree a time with your baling contractor beforehand and always stick to it to ensure you are fully involved in the process from start to finish. If you would like information on local contractors operating near you, please get in touch with the Terravesta team.

If you don't already have one, invest in a moisture probe. You can order one at: www.terravesta.com. Test the first four or five bales in several places when the contractor starts. Work to the wettest reading, not the average. Most contractors should have moisture probes in their cabs, so if you don't have one, ask if one is available. Aim for moisture content of 16% or less - if your bales do not meet this spec, the crop is not ready for baling. In this case, you should insist that the contractor stops and comes back when the crop is dryer.

Another method (less popular with those in charge of the kitchen!) to determine whether cane is ready for baling is the microwave test. This involves finely chopping a sample of cane and weighing it before microwaving for 30 seconds. Weigh again and repeat the process until the weight stabilises. Comparing the final weight with the original weight allows you to calculate the moisture content percentage.

Baling (continued)

As well as meeting moisture specification, bales should also be tightly packed, for stability and economical haulage. Bales must meet Terravesta's specifications:

Large Hesston

Bale height	(mm)	1220 - 1320
Bale width	(mm)	1150 - 1250
Bale length	(mm)	2250 - 2650
Bale weight	(kg)	525 - 650
Density	(kg/m)3	125 - 143

Chasing: Some contractors offer a chasing service, which has been praised by those who use it. It reduces the risk of compaction which is a long term yield inhibitor.

Finally, remember that all farmers have a health and safety responsibility to any contractors working on-site - preparing risk assessments, method statements and proper induction procedures are your legal responsibility.

Bale Format: Full-size Hesston bales only please (as per specifications on the left)

From experience with both processors and end users in 2012, there is a need for all supply to meet a single standard format going forward. Quadrants have never been acceptable as they do not enable plants to run at anywhere near full capacity. To a lesser extent, the same applies to Midi Hesstons (this has been addressed in the new Krone high-density Midi, although these machines are not yet widespread).

Having two bale sizes creates issues at the plant intake, particularly for those using automated cranes and intake barns, as the two formats cannot be mixed in the stacks. This means that Midi Hesstons have to be received as part of a dedicated run, which severely restricts the off-farm movement opportunity. This is a dimensional issue rather than a weight/ density issue, and for this reason there are intake storage yards full of unused Midi Hesston bales (for example, EPR Ely will no longer accept them). Despite the emergence of the excellent Krone Midi, at Terravesta we believe that it is important to stick to one format, which for the time being is the full-size Hesston.

Stacking and Storage

After ensuring crop is dry during harvesting and baling stages, it is important to ensure that its potential is not thrown away through poor storage.

The ideal solution is an indoor site with a dry floor. While the premium price of a dry crop, combined with other seasonal uses, justifies the erection of a building for the purpose, many will already have buildings available in the form of empty pole barns, cattle sheds or grain stores. The Miscanthus harvest is generally just coming in at a time when cattle are being turned out of sheds to grass, pole barns (once full of straw for winter bedding) are empty, and grain is leaving the farm. If you do have the opportunity to store bales indoors but need the building back at a certain time for another use, Terravesta can arrange the collection in line with your requirements. Just let us know via the harvest declaration form.

However, we do understand that indoor space is not always available. If you are stacking bales outside, consider the following:

- **Site:** Storage sites must be accessible all-year-round whatever the weather, so ensure there is sufficient access from the road for lorries and trailers to turn and stand as well as enough room around them to load up. Make sure stacks are kept on higher ground and not on areas prone to flooding otherwise you run the risk of rainwater compromising bottom bales. It is also worth considering the possibility of arson. Unfortunately it can happen, and if there's a recognised risk in the area, talk to Terravesta - we can manage speedy haulage to minimise any risk.

- **Covering:** To keep bottom bales clean and dry, roll damp-proof membrane across the bottom of the site before stacking (available from most builders' merchants). To protect bales at the top of the stack from rainfall ensure they are covered sufficiently. Use a stack sheet, held sturdily in place with ropes that are anchored low enough to enable tightening from the ground. If you decide to use sacrificial wet bales from last year, put these on top of either a stack sheet or damp-proof membrane to prevent water penetrating the bales underneath. If you do use stack sheets, they need to be easily and regularly tightened down.

Stacking and Storage (continued)

At the stacking stage, it is important to check moisture levels, so sample bales with a probe as they come off the wagon and are put onto the stack. If there are wet bales, stack them separately and inform Terravesta on the harvest declaration form.

Remember, long, thin stacks naturally ventilate better than square stacks, as more surface area is exposed to the air. While this also exposes more surface area to rain, this will dry out quickly in the prevailing wind. Bales should be stacked tightly together and as high as safely possible (the height will depend on the stacking machinery).

When it comes to stacking full Hesston bales, keep the strings to the side. This will help with the loading process, as lorries need to be loaded this way.

Remember, stacking outside (instead of in a building) should always be a last resort. On average, growers lose around 20% of their harvested Miscanthus because of poor storage, so keeping bales indoors is always the preferred option.

The harvest declaration

Communication is crucial for best returns. Notify Terravesta about all the details of your harvest as soon as possible using the harvest return declaration form. This way we can address any issues that could cause concern early. Harvest declarations are to be submitted online, details will be communicated each Spring.

The harvest declaration will allow you to alert us of ANY issue (e.g. crop moisture levels, the date a storage site needs to be vacated etc). Terravesta is here to help you get the best return for your crop - so it pays to keep us fully in the loop with your harvest.

Haulage

Transport makes up a significant proportion of grower costs, and absolute certainty of destination is key to avoid unforeseen charges.

Wasted journeys - for example, if bales have to be taken elsewhere because they are deemed too wet on arrival at the pelleting site - will increase your costs considerably. Payment for haulage is made after delivery, so every extra journey will add up.

Avoid mixing wet and dry bales in the same load, as this will only increase the likelihood of rejection, resulting in higher bills. It could also damage your long-term relationship with the haulier. Keep wet bales completely separate and make sure to declare them to avoid confusion - this will save time and costs in the long run. Making sure bales are easily accessible, and are within the necessary specifications is the best way to protect your return. For example, preparing for a quick turnaround with the collection lorry could bring your haulage price down by as much as half if it means the difference between one or two deliveries in a day.

For everyone's sake, the more growers can build a strong working relationship with transporters the better, as wasted time and journeys impact on the reputation of the UK grower network as a whole. This can push costs up even more than external factors like the price of diesel - and the best way to drive haulage costs down across the board is to build confidence through consistent quick turnarounds and guaranteed single destination journeys.

Key targets during haulage:

• **One-hour on-farm loading and turnaround:** This will not be achievable loading a single bale at a time, so those with their own reach trucks should consider investing in a three-bale grab.

• **Certainty of quality (dry or wet):** This ensures that the haulier will not refuse the load and that it will not be rejected at the planned destination.

• **Certainty of destination:** This is achieved by ensuring loads meet the required specifications before leaving the farm.

• **Certainty (where possible) of the haulier planning a second load:** Bear in mind that this could be from another, closer, farm, but it will impact on the price you are quoted for your load. Confidence in a quick turnaround, guaranteed quality and certainty of destination are all key for this.

Crop Maintenance and Community

As a hands-off crop, Miscanthus requires very little maintenance. However, as with any crop, good management maximises yield and return.

Weed control is essential in the first two years to avoid competition as the crop becomes established, and may be justified on a spot basis thereafter.

Miscanthus doesn't need fertiliser, so you should avoid using any manure or artificial fertiliser unless you can suitably demonstrate that there is a genuine need. Never spread sewage sludge onto the crop as it can contain traces of heavy metals which cause significant problems for end users. If you apply any manure or fertiliser, you must report full details of the application to Terravesta. Bear in mind that some fertilisers can have a detrimental impact on the sustainability of the crop, so you may be asked to explain their use by providing soil results.

There are currently no known diseases or pests affecting Miscanthus apart from hares and rabbits (although as mentioned in the Preparing the site section, avoid planting on areas affected by wireworm). When it comes to tackling hares and rabbits, use whatever measures are at your disposal. If rabbit-proof fencing is an option, for instance, be sure to budget for this at the planning stages. The crop takes around three years to reach full establishment, and after this neither pest will be an issue.

At the end of the first spring (one year after planting), it's unlikely that your crop will be economically harvestable. Generally speaking, best practice at this stage is to top the canes off with a tractor and mower, leaving the cuttings on the ground. There will be a further spraying opportunity before the emergence of the new shoots, so it's worth talking to your agronomist about this.

By the end of the second year, you should have your first harvestable crop. It's important to plan ahead for this by considering key elements, such as the storage site, to avoid any issues later on.

Addressing problem areas

Don't be deterred if you encounter problems during crop establishment. Remember that growing Miscanthus is a long- term commitment with long-term returns, so don't be afraid to put it on hold for a year if necessary. If in doubt, talk to Terravesta about any issues and the best way to address them.

It may be that certain areas haven't established as well as expected, and in this case patching could be an option. However, for sites to be viable for patching, they must be the right size for the machinery used - so in some cases, replanting a bigger area might be a better solution.

If you do decide to replant, manual planting is usually not an effective method. Always bear in mind the machinery needed for the job, and ensure the ground is reworked first.

Miscanthus Establishment Process

Miscanthus Survey to Contract Timeline

1	Grower decides to plant Miscanthus on a 10-yr contract. This contract is RPI-X index linked.
2a	Contract application form signed and completed.
2b	Sustainability data return signed and completed.
2c	Self billing agreement signed and completed.
3	Grower writes a cultivation plan to achieve 6" fine tilth by April/May.
4	Grower reads Planter User manual & Essential Growers Guide and signs planter loan agreement.
5	Official contract signed.
6	Plant crop.

Biomass Markets

Current

Electricity production:
Miscanthus has a high calorific value of 4444Kwh/t making it highly energy efficient. Its diverse nature allows it to be burnt as either pellets or whole bale straw in the power stations.

BBQ briquettes and winter logs:
Miscanthus's low moisture nature allows it to be processed into briquettes and logs for BBQ usage in the summer and heating stoves in the winter. Its substantial burn time enables consumers to burn less fuel to reach the same heat requirement, saving time and money.

Cat litter and horse bedding:
The highly absorbent and clean nature of Miscanthus makes it a perfect candidate for its usage in horse bedding and cat litter. Unlike its fellow competitors this allows for the litter and bedding to be changed less often whilst remaining clean and highly functional.

Future

Building:
Miscanthus can be baled into smaller bale sizes for use in the construction industry. It's dry and sturdy nature make it a fantastic structure makes it's a very viable product for use as insulation or even structural support.

Bio-oil:
Miscanthus can be grown on reclaimed land and then once harvested and exposed to fast-pyrolysis, the heavy metals previously in the soil can be extracted and disposed of leaving a clean bio-oil.

Bio-ethanol:
Pre-treating Miscanthus, a lingo-cellulosic biomass, with Sodium hydroxide, and then exposing it to enzymatic pyrolysis can produce bio-ethanol. Bio-ethanol can produce an extremely diverse range of products from car fuel and lighter fluid all the way to alcoholic beverages.

Notes

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Teravesta is here to discuss any aspect of Miscanthus growing.
If you have any questions or queries, please get in touch today.
Tel: 01522 731873 Email: enquiries@terravesta.com

Terravesta Sustainability Policy

Terravesta aspires to be a leader in the responsible and economic evolution of sustainably grown and processed energy crops. We aim to be at the forefront of sustainable procurement through a set of principles that are applied across our energy crops business.

Sustainability Principles

Our policy is designed to ensure that we can verify that our biomass and energy products have been produced legally and are environmentally sustainable. We will comply, as a minimum, with the sustainability requirements being introduced by the UK Governments, reflected through the needs of our customers.

In addition, our procurement process is aimed at ensuring that the production and delivery of our products will:

- Significantly reduce greenhouse gas emissions compared to fossil fuel derived alternatives;
- Not result in a net release of carbon from the vegetation and soil of either forests or agricultural lands;
- Not endanger food supply or communities where the use of biomass is essential for subsistence (for example for heat, medicines or building materials);
- Not adversely affect protected or vulnerable biodiversity. Where possible we will give preference to biomass production that strengthens biodiversity;
- Deploy good practices to protect and/or improve soil, water (both ground and surface) and air quality;
- Contribute to the prosperity and social wellbeing of employees and the local population in the area of energy crop growing and processing.

Implementation

These principles are based on the developing regulatory and policy initiatives of the UK, European Union and other markets. Over time we will seek to amend or improve them by working with accredited bodies to develop the use of internationally recognised standards and principles which apply to all of our procurement and production activities. In so doing we hope to foster environmental leadership today and in the future.

Accordingly we will:

- Use our purchase contracts to ensure our suppliers address these principles and provide Terravesta with the required information to demonstrate that these sustainability principles are being met.
- Participate with applicable regulatory and policy initiatives to share experience, learn and help shape policy that will ensure sustainable biomass fuels throughout the UK and abroad.
- Systematically review these principles and their application to anticipate, meet and lead sustainability policy in the UK and all the countries in which we operate.

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