BETTERRETURNS

AHDB

Growing and feeding maize silage for Better Returns

Manual 10

BEEF & LAMB

Contents

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Photography: Bayer Crop Science Ltd, AHDB Dairy, DLF-Trifolium, Environment Agency, Germinal GB, Grainseed Ltd, Maize Growers Association and Kate Phillips.

Introduction

The starch, energy and intake characteristics of maize silage, together with its high dry matter yield potential, make it a good feed for beef cattle and sheep.

England has both suitable and marginal areas for growing maize. The best places experience high temperatures during summer, have medium textured soils and are at low altitude. However, maize can also be grown on less favourable sites, where techniques such as drilling under degradable film will increase the rate of crop maturity.

Wherever it is grown, maize requires attention to detail, from ground preparation right through to ensiling. A good seedbed and careful sowing will give maize the best start. Keeping on top of weeds during establishment helps maximise yield. Field tests can determine the right time to harvest, while consolidation and sealing at the clamp will produce a high-quality feed.

Maize plants are efficient harvesters of sunlight and make excellent use of nutrients applied in spring. However, the crop has gained a bad environmental profile due to soil wash issues and potential nutrient overload. Producers must take actions to mitigate these.

Maize silage is a good cereal replacement due to high starch levels, but its protein content is low. If fed with a high-protein component, it can provide a well-balanced, cost-effective feed for beef cattle and sheep at key stages in their production cycle.

This BRP manual covers growing and feeding maize, and will help producers make the most of this potentially valuable crop.

Katie Thorley
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AHDB Beef & Lamb

Where to grow maize

Maize produces good-quality conserved forage for ruminants but is not suitable for growing in all parts of England. Farm location, soil type, altitude and field aspect must be considered carefully before deciding if and where to grow it.

Field selection

Maize is a high-risk crop for soil erosion. This is because the soil is left exposed before the crop establishes and the crop is harvested in autumn with heavy machinery, which can damage soil structure. Selecting appropriate fields is crucial to manage this risk.

Location

A maize plant needs heat to reach maturity. Crop heat units (also known as Ontario Heat Units) are calculated with equations using maximum and minimum air temperatures. Online heat unit calculators are available to do this.

Maize should not be grown in areas that receive less than 2100 heat units. Fields that achieve between 2100 and 2200 would be considered marginal. Any above 2200 are deemed suitable for maize.

Most of England is suitable for growing maize for silage, with only areas in the far north and the wetter, more exposed west regarded as 'marginal'.

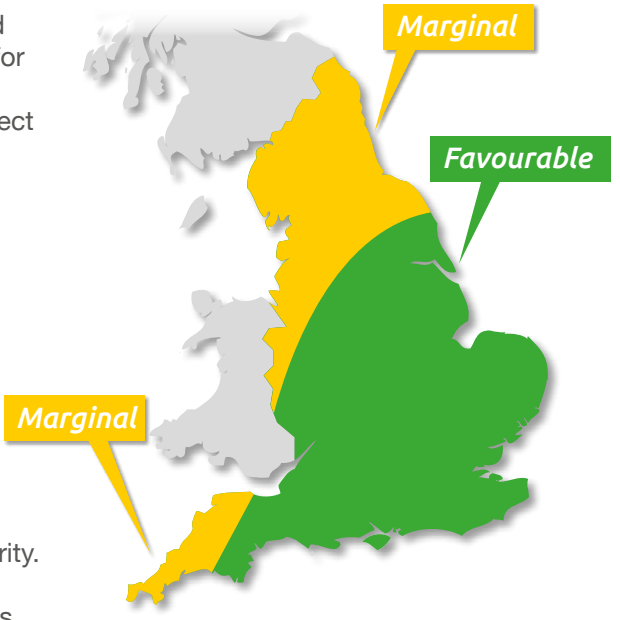


Figure 1. Suitability of ground for growing maize in the UK

Maize can be grown successfully in the grey shaded areas on Figure 1 however, special steps will be necessary such as drilling maize under degradable film to encourage germination.

Soil type

Maize does not do well in heavy, wet soils as they take a long time to warm up in spring, which shortens the growing season. Harvesting in autumn can also be a problem on heavier land. Growing maize in light soils increases erosion risk, therefore medium-textured soils are best.

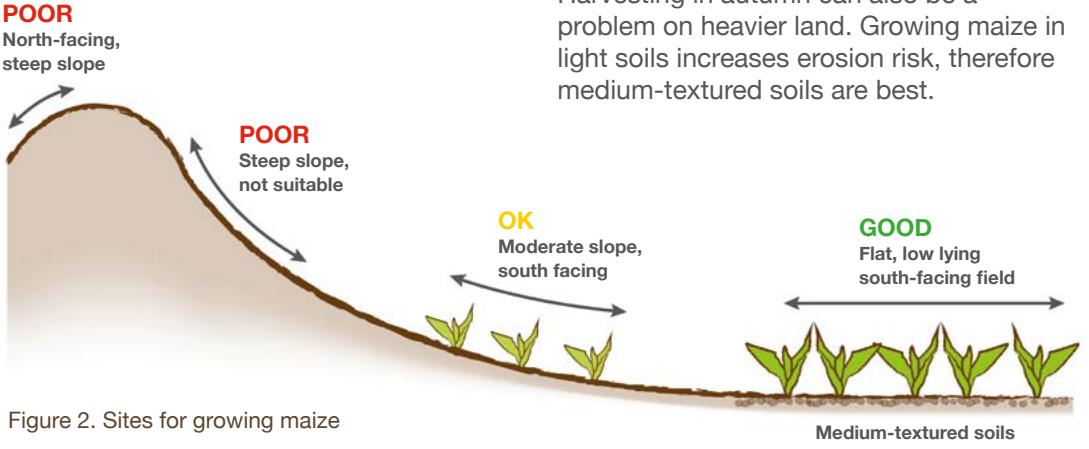


Figure 2. Sites for growing maize

Altitude

Air temperature drops by approximately 1°C per 100m (330ft) increase in height above sea level. Forage maize will have a shorter growing season at higher altitudes, lowering its yield potential. Harvest dates will be delayed and as a consequence, the risk of winter soil erosion increases.

Aspect

South-facing slopes receive more heat and have a longer growing season than north-facing slopes. If planting on a north-facing slope, consider using early maturing varieties or sowing the seed under degradable film. Steep sloping fields should be avoided due to soil erosion risk.

Maize under degradable film

Crops that are sown early in warm soils mature quicker than crops drilled into cooler ground. Placing plastic film over drilled maize seed creates a row cover that helps heat the soil more quickly. Degradable film is typically used on marginal sites.

Research carried out in Ireland by Teagasc indicates this can give a three tonnes (t) dry matter (DM) per hectare (ha) (1.2t DM/acre) yield advantage and a 6–10 per cent starch advantage over sowing the crop conventionally. However, there are cost implications. See page 23 for estimated growing costs.

There are various pros and cons of growing maize under degradable film.

Pros:

- Allows maize to be grown in suboptimal conditions
- Accelerates plant maturity
- Increases in starch yield are possible
- May allow an early harvest so another crop can be drilled in the same year, reducing soil loss risk over the winter

Cons:

- The variety choice is limited as it must be able to break through the degradable film as it grows
- Increased cost £300/ha (£120/acre)
- Limits weed control options
- Requires deep, stone-free soil to ensure degradable film is well buried and remains in place

Improve soil and nutrient retention by:

- Choosing early maturing varieties and sowing and harvesting early, particularly on wet, unstable soils
- Choosing favourable fields
- Alleviating soil compaction before planting and post-harvest, to reduce soil-water run-off and flooding
- Minimising the area of light soils exposed over winter, using cover or winter crops
- Avoiding fields next to rivers, streams, roads or buildings
- Cultivating across the slope rather than down the slope

Seedbed preparation

Seedbed quality and careful sowing technique are important.

A good seedbed:

- Allows excellent seed-soil-moisture contact
- Encourages deep and expansive root development
- Has a moderately cloddy surface which reduces surface capping but enables good weed control

Cultivation

Most fields prepared for maize are ploughed. The secondary cultivation depends on the site and local conditions. These could include the use of power harrows (being careful not to over-cultivate the seedbed) and tined machines.

Other tillage options

While most maize is precision-drilled following the plough, an increasing area is being established with novel techniques such as:

- **Min-till** – Maize is sown into uncultivated or rough-cultivated ground. This has potential to cut establishment costs and reduce soil erosion and run-off but should only be considered if soil structure is good
- **Strip tillage** – Maize is drilled into cultivated strips within an uncultivated field, leaving the rest of the field undisturbed. This reduces the cost and increases the speed of establishment

Soil compaction

Like other crops harvested in autumn, maize fields are susceptible to soil compaction as a result of heavy harvest machinery travelling on weak, moist soils. Plants that struggle to penetrate the hard layers in the ground do not grow well and deliver low yields.

Heavily compacted soil in Photo A has restricted root and plant development. Photo B shows well-established maize roots, spreading deeper and wider because the soil is not compacted.

Compaction

Prevention

- Only travel when ground conditions are good
- Use machinery with suitably profiled and low ground-pressure tyres
- Minimise machinery passes over the field

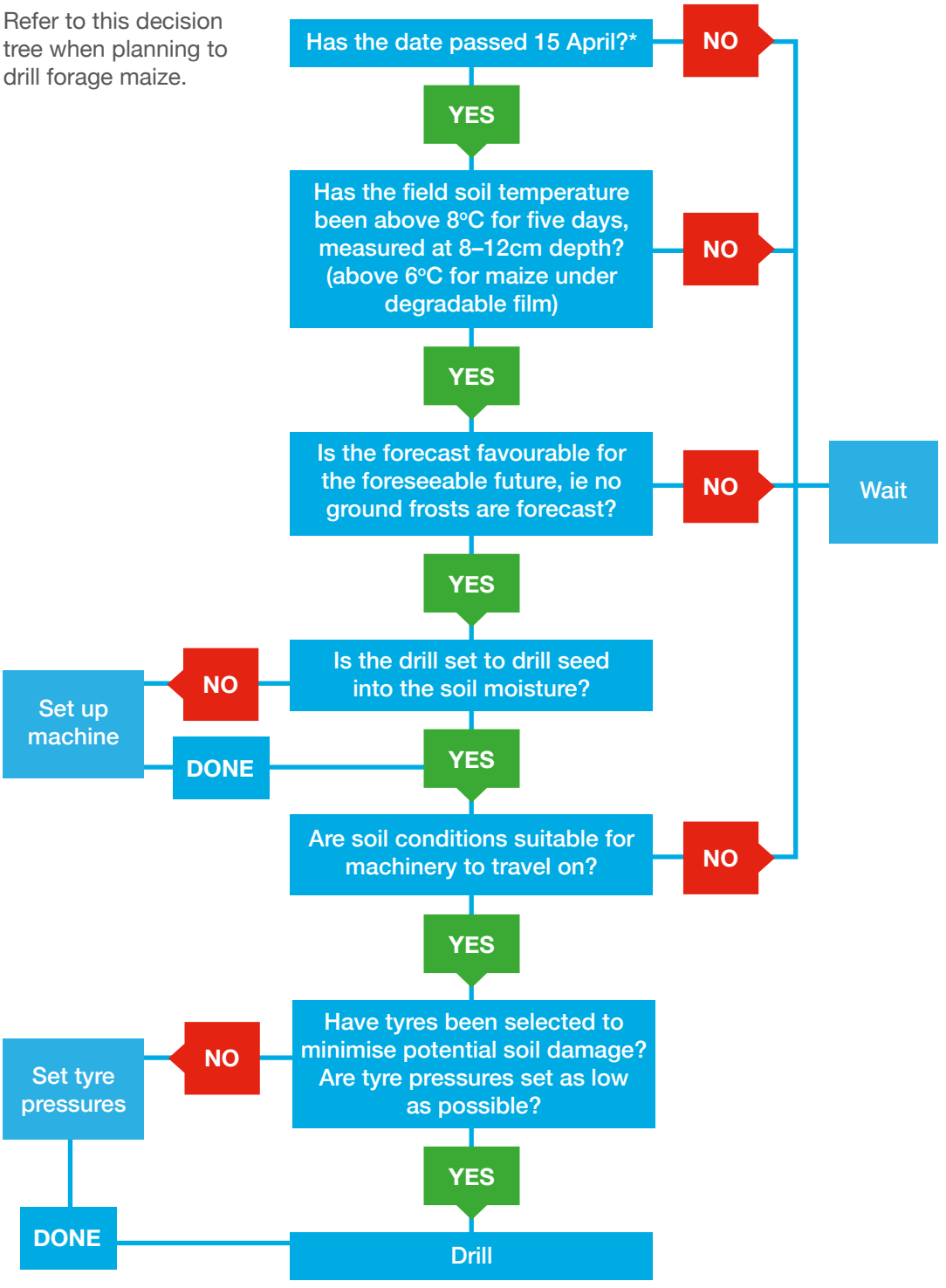
Treatment

- If compaction is suspected, dig soil pits, look for hard, compressed horizontal layers and determine their depth
- Compaction within the top 15–20cm (6–8 inches) will be removed by ploughing
- If compaction lies deeper than 20cm, use machinery to lift or subsoil 2.5cm (one inch) below the problem layer. Note, there are slurry spreading restrictions within 12 months of subsoiling over drains
- Deeper soil structure issues are best dealt with post-ploughing using specialist machinery

Sheep and Beef BRP Manual 3 **Improving soils for Better Returns** has more information.

When to drill forage maize

Refer to this decision tree when planning to drill forage maize.



*This date is rough guidance, some maize growers drill earlier when soil conditions and temperature are right.

Which variety?

Use local knowledge to identify varieties that work well and consult the British Society of Plant Breeders (BSPB) Forage Maize Descriptive List. Use varieties that have proven to work well in your area on 80 per cent of the cropping area, and try out new, promising varieties on the remaining 20 per cent.

Maturity

The primary factor to consider when selecting a variety is maturity. Each one has a specific heat requirement – early maturing varieties need less heat than those that mature later.

Maturity is determined by the whole plant DM content (%) at a set harvest date. The higher the DM at harvest, the earlier a variety will be mature. In the example table below, Variety 2 is the earliest to mature at 36.8 per cent DM content at harvest.

Early maturing varieties have a shorter growing season than later ones, so their total yield is lower, but the risk of poor harvest conditions is reduced.

Early maturing varieties that reach 34 per cent DM or above at harvest are recommended for growing in most areas of the UK. Farms situated below a line running from the Wash in the East to the Severn estuary in the West, can also grow later-maturing varieties successfully.

Table 1. Characteristics of some example maize varieties (taken from the BSPB Forage Maize Descriptive List)

Variety	DM content at harvest (%)	DM yield (t/ha)	Metabolisable energy (ME) of fresh plant at harvest (MJ/kg DM)	Starch content of whole plant at harvest (%)	Cell wall digestibility (%)	Early vigour*	Standing power at harvest*
Variety 1	36.3	17.0	11.54	34.7	58.5	7.1	8.3
Variety 2	36.8	16.7	11.82	37.7	59.5	7.5	7.9
Variety 3	34.9	17.4	11.37	33.8	57.1	7.8	7.7
Variety 4	34.9	17.2	11.70	35.1	59.4	7.5	8.2

*9 = good, 1 = poor

Yield potential

Maximising forage maize yields spreads the fixed costs of growing the crop. Yield variation between varieties within the same maturity class can range between 6–8 per cent.

For example, a grower looking at Table 1 who is aiming for 34.9 per cent DM at harvest, may be more inclined to choose Variety 3 rather than Variety 4 for its greater yield.

Feed quality

Other quality factors such as starch content, energy and digestibility vary less between varieties.

Varieties to use with degradable film

There is limited independent UK data on variety performance under degradable film.

Growers should seek local knowledge of what works in their area, as well as looking at the Recommended Lists for Northern Ireland and the Republic of Ireland, as they test varieties sown in this way.

Sowing

Seed spacing
Maize is usually precision drilled in rows, 76cm (30 inches) apart. The seeds should be evenly spaced within the row and placed at a consistent depth. This encourages the seedlings to emerge at the same time, minimising competition between plants.

Drilling depth
Seeds should be sown into moist soils so their seed coats can soften and germinate. Drilling depth can vary from 2.5–10cm (1–4 inches) deep, depending on soil moisture depth.

Timing
Maize drilling should start when soil temperatures reach 8°C for five consecutive days or 6°C for maize grown under degradable film. This is generally after 15 April, although some maize growers drill earlier.

Other factors to take into account include the weather forecast and ground conditions.

Working with contractors
Most maize seedbed preparation and drilling is undertaken by contractors. Experienced operators will help producers optimise their forage yields. The National Association of Agricultural Contractors (**www.naac.co.uk**) has guidelines on charges for this service.

Weed control

Maize seedlings struggle to compete with other plants, such as weeds or volunteers from previous crops. Weed control during the first six weeks after sowing is crucial.

Herbicides and inter-row hoeing are the main forms of weed control.

Competition with weeds for nutrient and moisture is most damaging during the first six weeks post-emergence. Weed control carried out at this stage will kill weeds before they impact on crop performance.

Pre-emergence

Residual herbicides are sprayed onto the drilled seedbed to remove any weeds that germinate alongside the maize. This approach gives the maize a head start.

Post-emergence

Most fields require a second, early post-emergence herbicide spray, when the crop has one to three leaves. This tackles the second flush of weeds. Delaying this post-emergence application will reduce the final crop yield.

Spray early

A Maize Growers Association (MGA) weed control trial showed that treating weeds early (within two weeks of crop emergence) resulted in low levels of competition and yields similar to all-season weed control (Figure 2). Leaving weed control to six weeks post-emergence resulted in significant crop yield reductions.

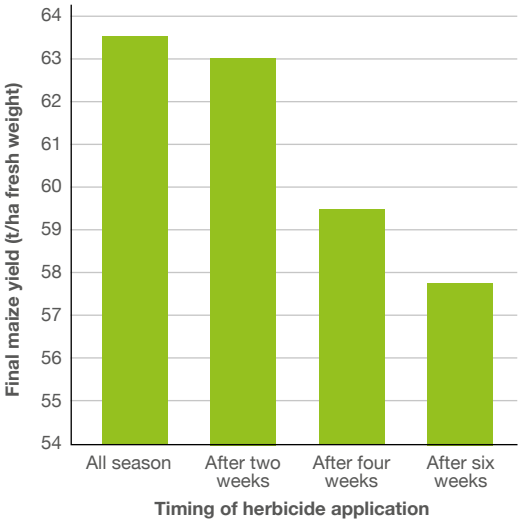


Figure 2. MGA trial of weed control timing

Product choice should be based on the weeds present and those expected to germinate over the coming weeks. Seek advice from a BASIS-qualified adviser and follow best-practice application to protect watercourses and the wider environment. The Voluntary Initiative offers further guidance **www.voluntaryinitiative.org.uk**

Pesticide regulations

From 2014, farmers have had to demonstrate their use of Integrated Pest Management (IPM) with regard to chemical applications.

From 26 November 2015, all sprayer operators were required to have the relevant certification to apply pesticides (including those previously exempt due to grandfather rights). From 26 November 2016, all working application equipment is required to have a National Sprayer Testing Scheme certificate.

Crop nutrition

Fields to be drilled with maize are suitable for organic manure applications – either farmyard manure or slurry.

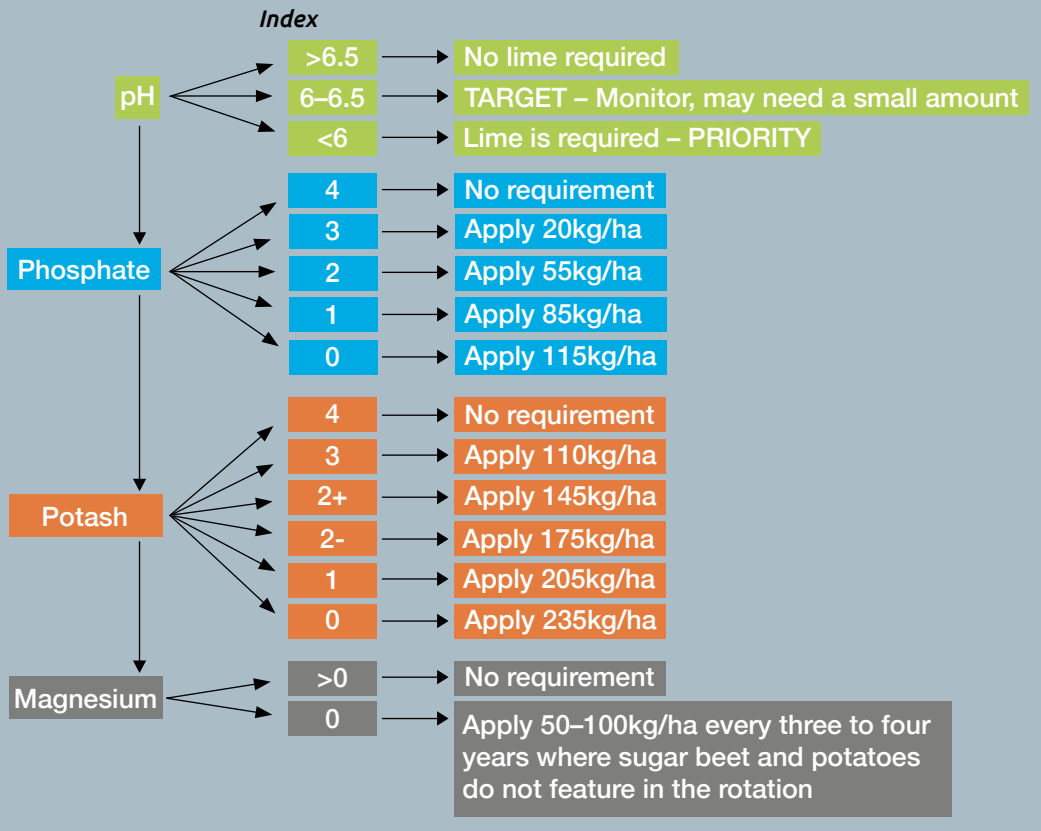
To manage nutrients effectively, first send relevant soil and manure samples to a laboratory for nutrient analysis. Use this information, along with crop requirement recommendations calculated from the **Nutrient Management Guide (RB209)**, to determine manure application rate and the amount of any additional fertiliser needed.

Time nutrient applications to coincide with crop growth to maximise uptake. Splitting recommendations into lower rates enables soil to retain nutrients better.

Maize has poor tolerance of acidic soils (<pH 5.0), therefore achieving the right pH is the first priority.

To encourage rapid growth, all of the phosphate and up to 10–15kg/ha (8–12 units/acre) of the nitrogen (N) required, can be placed below the seed at drilling. The remainder of the N can be top-dressed when the crop emerges. Potash should be applied before seedbed preparation and thoroughly worked in.

Nutritional requirements of maize



Note: To convert 'kg per ha' to 'units per acre' multiply by 0.8. So 50kg per ha x 0.8 = 40 units per acre.

Nitrogen

Soil nitrogen supply (SNS) cannot be easily measured, so fields are put into categories depending on their cropping history to estimate their likely requirement for N. Use the tables in the **Nutrient Management Guide (RB209)** to determine the SNS index of any field.

Where maize is grown continuously, N can build up in the soil, particularly where organic manures are spread regularly. Rotating with another crop, such as grass or potatoes, or planting an autumn crop after the maize has been harvested, can make the most of any residual N.

Seek the advice of a FACTS-qualified adviser for detailed crop nutrition advice. Online tools such as 'Tried and Tested' are available to help develop a nutrient management plan.

Nitrate Vulnerable Zones (NVZs)

Managing nutrients effectively is important for all producers growing maize but there are statutory limits for those within a NVZ. On these farms, the maximum limit (Nmax) for maize is 150kg N/ha (120 units N/acre).

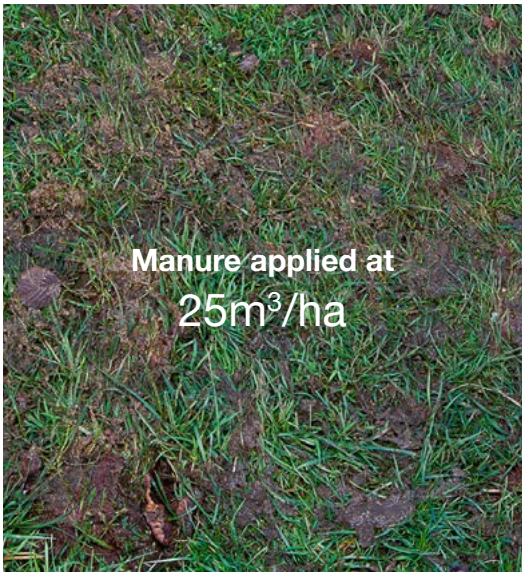
The Nmax must account for all organic manures applied and the amount of crop-available N present must be established.

From the end of the closed period (see Table 2) to the end of February, no more than 30m^3/ha (12m^3/acre) of slurry or 8t/ha (3t/acre) of poultry manure can be applied in a single application, with at least three weeks between individual applications.

Detailed guidance can be found at **www.gov.uk/nitrate-vulnerable-zones**

Table 2. Closed periods for nutrient application

Nutrient	Sandy or shallow soils	Other soils
Manufactured nitrogen	1 Sept–15 Jan	1 Sept–15 Jan
Organic manures, high in readily available nitrogen, eg slurry, poultry manure	1 Aug–31 Dec	1 Oct–31 Jan



Avoid nutrient overload

Nutrient application rates should be matched to crop requirements to avoid ‘nutrient overload’.

Surplus nutrients can be lost to the environment via direct run-off into surface water or leaching into ground water. Rapid incorporation of freshly spread manure will help make the most of the N content. Low emission spreading equipment, such as slurry injection, reduces ammonia losses.

Table 3. The value of slurry to maize

	Nitrogen (N)	Phosphate	Potash
Maize requirement (kg/ha)[a]	50	55	175
Total nutrients supplied by 30m^3/ha cattle slurry application (kg/ha)	78	36	96
Crop-available nutrients (kg/ha)[b]	29	18	86
Manufactured fertiliser required	21	37	89
Slurry value in year one[c]	£17	£22	£41
Total slurry value (per hectare)			**£80**

[a] Based on SNS Index 2, P Index 2 and K Index 2-
[b] Assuming 6% DM, not accounting for nutrient losses
[c] Assuming N = 90p/kg, P = 80p/kg, K = 60p/kg

MANNER-NPK is a free programme that can be used to determine the nutrient availability of manures and their value for the following crop. It can be downloaded from **www.planet4farmers.co.uk/manner**

Winter field management

Maize fields can be a significant source of soil erosion. All maize fields must be actively managed to reduce the risk of soil, nutrient and agrochemical loss to the environment during winter. Options for overwinter management include:

Undersowing maize with a cover crop – typically ryegrass or fescue
Broadcast or drill the cover crop into the growing maize around mid-June which reduces the likelihood of it competing with the maize in the early stages.

Typical grass seed rates are 5–15kg per hectare (2–6kg per acre). The cover crop will green up soon after harvest, using any surplus nutrients and reducing water and soil loss from the field. This is a useful way to establish grazing or cutting leys.

Establishing an autumn crop
Sowing winter crops, such as winter wheat, after maize may reduce the soil wash and erosion risk.

Cultivating the field immediately after harvest to encourage water infiltration
Research has shown that cultivated fields absorb more water than those left unmanaged, so less nutrients, sediment and agrochemicals are lost.

Pests and diseases

The threat posed by pests and diseases to maize can be split into those that affect the seed and those that attack the growing plant. The most potentially damaging pests are wireworm and maize eyespot.

Table 4. Maize seed/seedling threats

Pest	Damage	Risk factors	How to minimise the risk	Control options
Birds	Crows in particular like to feed on maize seeds	Shallow sowing depth	Bury seeds well	Treat seed with bird repellent Employ traditional bird scaring techniques
Wireworm	Larvae feed on growing seedlings	Previously undisturbed grassland South-facing fields	Insecticide seed dressing Allow a substantial break between grassland and maize Ploughing	Seed dressing or cultural, eg crop rotation
Frit fly	Second generation maggots eat the young seedlings in May and June	Predominantly grassland areas	Leave a ten-week gap between grass and drilling maize	Seed dressing or cultural, eg crop rotation

Bird damage

Wireworm damage

Frit fly damage

Table 5. Maize plant threats

Disease	Damage	Risk factors	How to minimise the risk	Control options
Maize eyespot *Kabatiella zeae*	First seen as spotting on the leaf. When the spots are held up to the light, a yellow halo can be seen around each one	Wet, cool conditions Non-inversion cultivation techniques, eg min-till Proximity to fields with maize crop residues Two or more years of maize cultivation	Plough maize stubble Drill late into a warm seedbed Rotate the maize crop with other crops	Fungicide treatment as soon as disease is identified, plus second treatment if conditions remain wet/cold Disease stops at temperatures above 27°C
Fusarium mould	Mould populations can build in maize and pose a real threat to a following winter cereal	Repeated maize cropping Previous wheat cropping Exposure to crop residues and stubble	Grow maize in rotation with grass Do not rotate with wheat Remove or bury crop residues	No fungicides available

Eyespot lesions

Stem *fusarium*

Seek advice from a BASIS-qualified agronomist as to the most appropriate treatment for any crop pest or disease.

Harvesting

Maize should be harvested when the DM content of the whole crop is between 28–35 per cent.

This is best assessed by drying a representative sample (200–500g of cut-up material) in an oven or microwave:

- Weigh the sample before and after drying
- Divide the final weight by the initial weight
- Multiply by 100

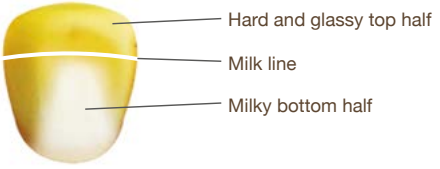
Using an oven

Leave the sample for 24 hours at 100°C (until weight loss stops) in the oven and then reweigh.

Using a microwave

Microwave the sample for several minutes and then reweigh to check weight loss.

Stop and reweigh every five to ten minutes. As the crop gets drier, 30-second intervals are more appropriate. Beware, the crop may smoulder or ignite if left too long, which is why stopping and reweighing regularly is required. Make sure a cup of water is put in the microwave alongside the sample to prevent combustion. When weight remains unchanged for two consecutive measurements, the crop can be considered dry. The 'milk line test' can be used as a guide out in the field. When the line separating the liquid and solid parts of the grain meet halfway down, the crop is ready to harvest.



Weather

Keep an eye on the weather forecast to avoid harvesting in wet conditions. Harvest as soon as possible after the crop has been frosted to minimise in-field deterioration.

Chopping

Use the forage harvester's corn cracker to break all the maize grains during harvest. Maize should be chopped to 12–18mm (0.5–0.6 inches) in length.

Table 6. How to work out when maize is ready to harvest

Source: Maize Growers Association

Grain description	Milky 	Milky doughy 	Doughy milky 	Doughy 	Hard dough, top is hard and glassy 	Hard and glassy 
Milk line	None	Beginning to show from top	¼ way down grain	⅓ way down grain	½ way down grain	At bottom
Husk	Green	Green	Green	Yellowing	Yellowing	Desiccated
Whole plant DM (%)	Less than 25	25–28	28–30	30–32	32–35	Over 35
Status	Not ready	Not ready	Not ready	Ready	Ready	Too late

Typically, the DM% of a maize crop increases by about two per week at harvest time. Having assessed the DM%, the harvest date can be predicted.

Clamping best practice

- Fill the clamp quickly
- Consolidate well, ideally, with a second tractor rolling continuously while a tractor at the front is pushing up the face
- Seal completely for rapid, anaerobic (without oxygen) fermentation. Thin, clear, degradable film 'cling film' under-sheets can provide an airtight seal. Weigh down the over-sheet with tyres, bales or weights
- Apply rock salt to the top (3kg/m^2) and shoulders (6kg/m^2) of the clamp to reduce surface spoilage
- Bund clamp areas, cover silage stores and use drains for clean and dirty water separation to reduce risk of effluent losses
- Speak to the Environment Agency two weeks before constructing new or substantially reconstructing clamps

Clamp face management

Clamps should be kept tidy, with as little surface area open as possible to prevent aerobic spoilage and access by birds.

Where possible, use a block cutter to remove the maize and maintain a flat feed face. Aim to move along the face at least once a week. Nets dropped down over the front can reduce bird damage.

Good hygiene around the clamp is important to prevent contamination with soil and muck.

Additives

Maize silage ferments well unaided and does not typically require an additive. However, additives can reduce aerobic spoilage, particularly if the clamp is wide and the maize is taken out slowly.

There are certain scenarios when additives may help to maintain feed quality (Table 7).

Table 7. Situations where silage additives may help maintain feed quality

Situation	Comment
>35% DM at harvest	Dry maize is difficult to consolidate
Long-chop length (>20 mm)	Long-chop maize is difficult to consolidate
Feeding out during hot weather	Warmer maize is more likely to deteriorate
Wide clamp face/slow feeding out rate	Maize left exposed to the air for a long time is more likely to deteriorate
Fast clamping/ insufficient consolidation possible	Poorly compacted maize will have significant oxygen levels which can result in aerobic spoilage
Aerobic spoilage experienced in the past	An additive may prevent this, but should not be a substitute for poor management pre-ensiling

Fermentation

The digestibility and starch content of maize silage improves with time in the clamp. Ideally, maize silage should be left for at least a month before feeding to allow pH and feed quality to stabilise. However, unlike grass silages, it can be fed immediately if needed urgently.

Feed value

Maize silage feed characteristics

- High energy, high starch
- Cattle and sheep adapt to it easily in rations
- Palatable
- Consistent feed value
- Low protein content so should be fed with reasonably high-protein feeds

Cattle given rations containing maize silage tend to have a higher dry matter intake (DMI) than those fed rations based solely on grass silage. This extra DMI leads to higher energy intakes and, when offered as part of a balanced diet, should improve daily performance and feed efficiency.

The digestibility of maize remains fairly consistent throughout the growing season. As the crop matures, the quality of stem and leaf declines, but this is offset by the increase in grain in the cob, which is highly digestible and high in starch. This is why harvesting at the correct stage is essential to maximise nutritional value.

Generally, mineral content of maize silage is relatively low, so supplementation is required. Check with a mineral supplier/nutritionist for appropriate specifications to add to maize-based diets for cattle and sheep.

Silage analysis

Having an accurate nutritional analysis of conserved forages is essential when formulating rations so that they are used appropriately, accurately and cost-effectively.

Six weeks after harvesting, take several core samples from the clamp for testing. Continue to test samples from the clamp face throughout the season, as feed value continues to change in the months after harvest.

A list of companies offering forage analyses can be found on the AHDB Beef & Lamb website **beefandlamb.ahdb.org.uk**

Table 8. Feed values for different forages

Feed type	Dry matter %	Metabolisable energy MJ/kg DM	Crude protein % in DM	Starch % in DM
Maize silage	28–35	10.8–11.5	8–9	25–35
Grass silage – first cut	22–32	10.5–11.5	11–15	–
Fermented wholecrop cereals	30–45	9.5–10.5	9–17*	15–22

*Crude protein may be higher for cereals grown with bi-crops (eg peas, clover, vetches)

Table 9. Factors affecting the yield and feeding value of maize silage

	Dry matter yield	Dry matter %	Starch %	Dry matter intake	Clamp spoilage	Starch degradability
Harvest too early						
Harvest too late						
Cutting height >90cm						
Cutting height <90cm						
Aerobic spoilage						
Wet growing season						
Dry growing season						

Key: Positive Negative No effect Effect unknown

Maize grain

In southern England and the Midlands, maize grain is grown for crimping or whole cob maize, also known as ground ear maize (GEM).

This is ensiled to feed as a concentrate, either conventionally combined with a maize 'header', or the whole cob is foraged through a forage harvester.

The optimum DM content of the grain for crimping at harvest is 65–70 per cent and 60–65 per cent for GEM, which is higher than for maize silage. Therefore, harvest is typically three to five weeks later, which further restricts the areas where it can be grown. Choosing an early maturing variety is essential. Grain yield and standing power are also important characteristics to look for when buying seed.

The process of crimping or 'milling' through a forager for GEM, breaks the outer seed coat of the kernel and reduces the particle size. This increases its digestibility and reduces any loss of grain through poor digestion.

Maize grain contains more starch and energy than other cereal grains and also has a relatively high level of bypass starch. This travels through the rumen undegraded and is digested further down the digestive tract. This reduces the speed of fermentation and minimises possible dietary upset in a mixed cereal diet.

As with maize silage, additional protein, in particular effective rumen degradable protein (ERDP), is required to provide a well-balanced diet, along with a source of 'long' fibre to promote healthy rumen function.

Table 10. Nutritional composition of different types of maize feed

	Metabolisable energy (ME/kg DM)	Crude protein (% in DM)	Starch (% in DM)	DM (%)
Crimped maize grain	13.8–14.3	9–10.5	65–70	65–70
Ground ear maize	12.3–12.6	8.5–9	55–60	60–65
Maize silage	10.8–11.5	8–9	25–35	28–35

Feeding principles for beef cattle

Finishing cattle

- The high starch and energy of maize silage makes it ideal for finishing cattle
- For continental and/or dairy-cross finishing steers, maize silage can be the sole forage source
- For finishing heifers and native-bred steers, it can be mixed with forages which are lower in metabolisable energy, such as grass silage, wholecrop silage or straw to prevent unwanted fat deposition

Dry suckler cows

The metabolisable energy levels of maize silage are too high to be fed ad-lib or as the sole forage source for dry suckler cows.

- Maize can be included in a mixed-forage or straw-based ration for dry cows. It is important to know their maintenance requirements and monitor body condition to prevent them becoming overfat

Lactating cows

Maize can form a substantial part of a diet for autumn and late winter/early spring-calved cows with calves at foot, in early to mid-lactation. During this phase, nutritional demand is high, about double that of a dry cow and maize can provide a useful energy source.

Protein supplementation

Since maize silage has a relatively low protein content, it does need supplementation with a protein source when fed to cattle. This should be high in effective rumen degradable protein (ERDP) to improve starch and fibre utilisation. Sources of ERDP include rapeseed meal, pot ale syrup, beans, dried distillers' grains or feed grade urea (either included in a molassed liquid feed or as urea prills).

If using feed grade urea in any format, care must be taken to introduce it to cattle slowly. Measure amounts carefully and accurately and mix into the ration thoroughly. If in any doubt seek professional nutritional advice. Do not feed urea to cattle less than three months of age.

Table 11. Example maize rations for cattle

	Growing (300kg starting weight)	Finishing (500kg starting weight)
Liveweight growth target (kg/day)	0.8 to 1.0	1.3 to 1.5
Grass silage (kg fresh)	15	4
Maize silage (kg fresh)	7.5	12.0
Rolled barley (kg)	1.0	6.0
Rapeseed meal (kg)	0.9	1.2
Minerals (g)	90	100

Maize can reduce concentrate use without compromising performance

In a Harper Adams University trial, there was no significant difference in performance of beef bulls finished on a diet of 75 per cent maize silage and 25 per cent concentrate, compared to those fed a diet of 50 per cent maize silage and 50 per cent concentrate.

Other research has also demonstrated that maize silage can reduce concentrate input. However, the effect depends on the amount and quality of maize fed and the animals' DM intake.

Co-product feeds

Maize is versatile and can be used with a wide range of other feeds, including cereals, concentrates, co-products, liquid molasses-based feeds and root crops (such as stock-feed potatoes, fodder beet, parsnips).

Suitable co-products include:

- Waste bread, biscuit and confectionary meals
- Maize germ meals
- Wet distillery, brewing and starch extraction by-products
- Potato waste
- Processing by-products

It is important to compare co-products on a dry matter basis and to balance them with appropriate sources of protein and long fibre. Seek professional nutritional advice if unsure about the best way to formulate rations incorporating maize with co-products and other types of feed.

Carcase quality

Inclusion of maize silage in a finishing ration increases the white/creamy colour of the carcase fat, compared to cattle fed diets based on grazed or conserved grass. This is because maize contains fewer carotenoids than grass.

Feeding principles for sheep

Maize silage can work well as part of a ration for stock that require high-energy feed, ie ewes carrying multiples in late pregnancy, ewes in early lactation and finishing lambs. It is less suitable for ewes in early-to-mid pregnancy and those carrying singles, because they may become too fat.

When feeding maize silage:

- Balance with high-protein feeds. Make sure ewes close to lambing are offered enough digestible undegradable protein (DUP)
- Provide additional minerals, particularly calcium and trace elements, as maize has low mineral content. Use an appropriate product for sheep
- Check body condition score (BCS) regularly
- Ask the vet to blood test a sample of ewes three to four weeks before they start lambing to check energy and protein levels. Adjust ration if required

Table 12. Example maize rations for ewes

70kg Mule ewes	Weeks before lambing				
	8	6	4	2	1
Twins (kg fresh weight feed)					
Grass silage*	3	3	3	2.7	2.7
Maize silage	1	1	1	1	1
Home-mix or compound feed	-	-	0.2	0.4	0.5
Triplets (kg fresh weight feed)					
Grass silage*	3	3	2.8	2.6	2.5
Maize silage	1	1	1	1	1
Home-mix or compound feed	-	0.1	0.3	0.6	0.7

*Assumes grass silage of 10.5MJ/kg DM, 30% DM and 13% crude protein (CP). Compound feed 12.5MJ/kg DM and 18% protein.

The DMI of ewes will vary as lambing approaches, due to increasing lamb size. This also occurs if the dry matter of the forage or chop length were to change. Monitoring intakes and adjusting the ration according to ewe appetite is recommended for optimum results.

Maize rations for store lambs

Below is an example maize silage diet for store lambs weighing 30–40kg, with a target growth rate of 200g/day.

Ad-lib maize silage (estimated intake of 3–3.5kg fresh weight/day) + Protein supplement of up to 0.2kg of a 34%+ crude protein supplement, eg rapeseed meal, distillers' grains, protein concentrate or a protein-molassed liquid feed + Appropriate minerals

Costings

In 2017, maize cost in the region of £1300/ha (£550/acre) to grow, including a rental value of £370/ha (£150/acre)*

Below are example costings for maize silage and maize silage, sown under degradable film, compared to grazed grass and grass silage.

	Grazed grass (Ten-year ley)	Grass silage Three cuts (Seven-year ley)	Maize silage	Maize (Degradable film)
Yield of fresh matter (t/ha)	58	50	43	53
Typical dry matter content of crop %	18	25	30	30
Yield of dry matter (t/ha)	10.4	12.5	12.9	15.9
Establishment costs (£/ha)				
Ploughing	63	63	63	63
Cultivations	90	90	90	90
Sowing	30	30	45	45
Seed	135	130	175	175
Lime	120	120	30	30
Fertiliser[1]	52	52	180	180
Sprays	26	26	65	65
Fertiliser applications	12	12	24	24
Spraying	14	14	28	28
Additional cost of degradable film				320
Total	54[2]	77[2]	700	1,020
Additional annual costs (£/ha)				
Fertiliser[1]	150	307	0	0
Sprays	10	10	0	0
Fertiliser applications	72	72	0	0
Spray applications	14	14	0	0
Harvest and sheets etc	0	420	170	170
Rent (£/ha)	370	370	370	370
Total annual cost £ per ha (£/acre)	670 (271)	1,269 (514)	1,240 (502)	1,560 (631)
Cost per tonne of DM (£)	64	102	96	98

Notes: [1] Purchased fertiliser price assumptions: N=55p/kg, P=61p/kg, K=43p/kg. [2] Total establishment costs divided by ley duration.

* Figures produced by John Morgan, Creedy Associates. Fertiliser costs provided by Mole Valley Farmers.

Other BRP publications available

Joint Beef and Sheep BRP

Manual 1	Improving pasture for Better Returns
Manual 2	Improved costings for Better Returns
Manual 3	Improving soils for Better Returns
Manual 4	Managing clover for Better Returns
Manual 5	Making grass silage for Better Returns
Manual 6	Using brassicas for Better Returns
Manual 7	Managing nutrients for Better Returns
Manual 8	Planning grazing strategies for Better Returns
Manual 9	Minimising carcase losses for Better Returns
Manual 10	Growing and feeding maize silage for Better Returns
Manual 11	Using medicines correctly for Better Returns

See the AHDB Beef & Lamb website **beefandlamb.ahdb.org.uk** for the full list of Better Returns Programme publications for beef and sheep producers.

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