

# The Maize Guide

A Guide to Growing, Conserving and Feeding Maize Silage









## Foreword

Maize silage has been grown in Ireland for the last 40 years. Currently there are 10-12,000 ha of maize being grown by Irish farmers for forage. Maize silage can be used across a range of farm enterprises including buffer feeding in spring herds, winter milk production systems and beef production systems.

The cost of producing maize silage is strongly related to its yield and its value in producing a litre of milk or kilo of meat is dependent on effective conservation and level of inclusion in diets. This guide therefore, brings together the combined expertise of Teagasc, DAFM and industry experts on best practice in growing, conserving and feeding maize silage. As dairy enterprises expand contract growing of maize silage by tillage farmers is an option to increase forage supply, a maize silage contract template is also included to allow the farm-to-farm trading of maize silage, which values both the yield and quality of the crop produced.

I hope this booklet will enable informed decisions to be made by farmers currently growing or feeding maize silage as well as those considering maize silage in the future.

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## Economics of Growing Maize Silage

### Key Facts

- Maize silage is a cost effective source of forage if grown correctly
- Covered maize silage significantly reduces the risk of year to year weather variations when compared to uncovered maize silage
- Crop husbandry skills and available feeding facilities must also be accounted for when deciding to grow maize silage

The decision to grow maize silage (or any forage crop) is based on the production benefits of that feed in terms of intake and livestock productivity but more importantly its relative cost in the feeding system. In addition, there are labour and feeding machinery costs attached to the handling and feeding out of these feeds on farm and some account needs to be taken of these costs when deciding which feed to choose.

### Growing Costs of Maize Silage

The Teagasc estimated growing costs of maize silage and some forage crop options are outlined in Table 1. The costs are estimated using the full inputs allocated to each crop to achieve an optimum yield based on accepted best husbandry practice. Full fertiliser costs are used to replace crop off-take of nutrients with no account of potential savings if a farmer had sufficient organic manures available. Also, full contractor charges are applied to each crop including harvesting, pitting etc. if applicable to that crop. No labour for feeding of crops grazed in-situ is charged nor is there labour for feeding out of pitted forages.

## Risk Reduction

Maize silage is a high input crop, which is only economic when it delivers a high yield with a significant proportion of total dry matter (DM) present in the cob, in the form of starch. The growing of uncovered maize can be successful on less favourable sites with carefully selected varieties. Research at Teagasc Grange attempted to quantify the effects of weather related yield fluctuations on the feed cost of maize silage. The results showed that maize silage was cheaper than whole-crop and grass silages on average, but was the most costly and least costly harvested feed crop in low and high yielding years respectively. These yearly fluctuations were significantly reduced by growing maize silage under cover.

### Deciding Factors

It is not sufficient to simply assume an increase in animal intake or performance when evaluating maize. A full-system approach must be taken to examine its effectiveness for milk or meat production. Factors that need to be considered by the livestock farmer include:

- **What is the production potential of the current feeding system?**
- **Does the farmer possess the requisite husbandry skills to grow high yielding maize crops or should they be grown on contract?**
- **Can the forage maize be stored and fed with existing facilities and machinery?**



**Table 1. Forage Crop Margins based on Teagasc 2016 Costs & Crop Returns**

FORAGE CROP MARGINS TEAGASC	Whole Crop Wheat	Grass Silage	Fodder Beet	Forage Maize
MATERIALS (€/ha)	784	462	970	1045
Seed	75	8	180	200
Fertilisers	425	444	530	455
Film cover	0	0	0	280
Sprays:				
Herbicides	56	10	190	110
Fungicides	190	0	30	0
Insecticides + PGR	38	0	40	0
HIRE MACHINERY (€/ha)	622	826	1034	668
Seedbed Prep + sow	170	50	250	330
Spray	95	10	76	0
Fertiliser Spreading	57	50	38	38
Harvesting & Covering	300	716	300	300
Washing & Chopping	0	0	370	0
<b>TOTAL VARIABLE COSTS (€/ha)</b>	<b>1625</b>	<b>1288</b>	<b>2004</b>	<b>1713</b>
Dry Matter (t/ha)	17	12	13	17
Cost per ton of Dry Matter	96	107	154	100
UFL Value per kg Dry Matter	0.80	0.75	0.90	0.80
<b>COST PER 1,000 UFL'S</b>	<b>120</b>	<b>141</b>	<b>139</b>	<b>126</b>

UFL = Energy Value (1 UFL is the energy value contained in 1kg of standard air-dried barley)

*Summary facts:*

- *Costs per tonne of growing maize silage varies depending on agronomy and site selection, among other factors*
- *The use of organic fertiliser will reduce the cost of growing maize silage*
- *Growing maize silage under cover significantly reduces yearly fluctuations in yield and quality*
- *Production potential, husbandry skills, facilities, equipment and labour all need to be considered when deciding whether or not to grow maize silage*
- *Contract growing of maize silage may be more economical in medium to high stocking rate situations*



## Variety Selection

### Key Facts

- Variety selection has a major impact on crop yield and quality
- Seasonal weather variation will cause variation in variety performance
- The Department of Agriculture Food and the Marine Recommended List (DAFM RL) identifies robust varieties that have been proven to perform in Ireland's challenging and varying climate

### Maize and our Climate

Maize crops sown in Ireland in the 1970s failed because they were not suited to Ireland's temperate climate. Because of better selection, maize varieties that are more suitable for growing in Ireland have been identified in recent years. However, choosing the correct variety remains an extremely important factor in successfully growing the crop in Ireland.

Selection of varieties specifically suited to the site is an extremely important decision in growing maize successfully. Other factors to be taken into account when selecting varieties include sowing date, geographic location, altitude, harvest date, harvest conditions and the requirements of the end user in terms of yield and/or starch and energy content.

### Dry Matter (DM) Content/Earliness of Maturity

There are no agreed universal industry standards for maize maturity and this leads to difficulties in interpreting and comparing the different maturity ratings that are used. In Ireland it is recommended that DM content is used as the indicator of maturity.

In Ireland the earliness of a variety is determined using the maturity score in the

DAFM RL, which is based on DM content of the different varieties.

Earlier maturing varieties have values greater than 100 and later maturing varieties have values less than 100. To further aid growers in variety selection these values have associated descriptors of maturity as can be seen in Table 2 below. Later maturing varieties achieve higher yields while maintaining quality because of their longer growing season. However, later maturing varieties cannot be used across all sites as they will produce inadequate grain on less favourable sites. Earliness of maturity is important in variety selection because it is a measure of the suitability of a variety to a particular site.

**Table 2. Ranges of relative DM on the DAFM RL for different maturity descriptors**

Relative DM	Maturity Descriptor
≥ 108	Early
103 – 107	Early – Medium
98 – 102	Medium
93 – 97	Medium – Late
≤ 92	Late

A grower in an extremely favourable site can choose any variety on the RL, however they will generally choose later maturing varieties because they can achieve higher yields while maintaining quality due to that site's ability to mature the crop before harvest. A grower with a less favourable site will choose earlier maturing varieties because they will mature before harvest and can be harvested before ground conditions deteriorate. Earlier maturing varieties may also be selected by a grower who is sowing late in the season or who wishes to sow a winter cereal crop immediately after harvest.



The key factors when considering what variety to sow are:














- 1. Site Location
- 2. Maturity Rating

Table 3. Site Location

Pick Your Site	Type of Site	Attributes of Site
	Excellent	- 0-50m above sea level
		- Free draining
		- South facing
		- Sheltered
	Good	- 50-75m above sea level
		- Good soil condition
		- Southerly aspect
		- Reasonable shelter
	Marginal	- 75-100m above sea level
		- Heavy ground
		- Late sowing/early harvest
		- Exposed site

Note: Your site should achieve 3 to 4 of the attributes for a site type

Figure 1: Selection of varieties appropriate to a site type based on variety maturity

Maturity Descriptor of Variety						
Site Suitability		Late	Medium-Late	Medium	Early -Medium	Early
	Excellent					
	Good					
	Marginal	X	X			

- = Very suitable
- = Suitable
- = Risk involved
- X = Do not sow

Summary facts:

- Look for a very suitable variety for your site
- Late maturing varieties shouldn't be sown late
- Late maturing varieties tend to produce higher yields
- Early maturing varieties tend to have lower yield but higher starch



## Sowing Dates and Rates

### Key Facts

- Higher seeding rates will slow down crop maturity
- Sow maize once soil temperatures reach 8°C

### Sowing Uncovered Maize

To optimise seed germination soil temperatures are recommended to be 8°C or more before sowing can take place. In the south of the country sowing commonly begins around the 20<sup>th</sup> April. Sowing then spreads northwards as soil temperatures increase (see Table 4). Sowing at 110,000 seeds per hectare (ha) is the industry standard, however reducing seeding rates for later planting will assist in bringing forward harvest dates.

### Sowing Covered Maize

Sowing covered maize allows growers to sow up to 3 weeks earlier than is possible in uncovered crops, because of the heat benefits brought about by the covering. A reduced seeding rate of 105,000 seeds per ha is recommended for cultivation under cover, due to increased seedling germination. Aim to have all seeding completed before the middle of May, both in covered and uncovered crops.



Lower sowing rates are often used with maize under cover

Table 4. Mean temperature °C at 10 cm depth

	March	April	May
Cork Airport	5.9	7.9	11.3
Oak Park	5.4	8.1	12.0
Dublin Airport	5.5	7.9	11.5

### Summary facts:

- Higher seeding rates will slow down the ability of the crop to mature
- Lower seeding rates will reduce the time to harvest
- Ensure all sowing is completed by mid-May to optimise growing season



## Covered Maize

### Key Facts

- Covering maize increases seedling development
- Covering maize lengthens the growing season by facilitating earlier sowing
- Covering maize brings forward harvest date

When the maize seed is covered a mini greenhouse effect occurs which locks in moisture and increases soil temperatures. This gives the grower the opportunity to sow earlier thereby creating a longer growing season which will improve yield and quality and/or bring forward harvest date. The cover provides extra protection during germination and during the first few weeks of growth when the plant is often challenged by poor weather conditions. The higher temperatures under the cover will encourage rapid root development as well as increasing the availability of nutrients in the soil, particularly phosphorus.

A series of pin holes which are located above the seedling along the cover act as a temperature regulator to protect the plant from overheating.

The pin holes also assist the plants to easily breakthrough the cover and reduce damage to the leaves. A second series of pin holes (water holes) are located along the centre of the cover. These help reduce water running along the cover and into field depressions.

Not all varieties are suitable for covering and growers should consult the DAFM RL when deciding what varieties to sow.

Covering also means that herbicides have to be applied at sowing to ensure that adequate weed control is achieved.



Sowing maize under cover in Ireland

### Summary facts:

- *Covered maize rapidly increases seedling development*
- *Covered maize lengthens the growing season by facilitating earlier sowing*
- *Covered maize brings forward harvest date*



## Soil Nutrition

### Key Facts

- Always have an up to date soil analysis prior to sowing maize
- Maize is a high output crop and requires significant soil nutrients to support yield
- Be careful not to damage soil structure when applying slurry and Farm Yard Manure (FYM) prior to sowing maize crops

### Lime

Maize needs a soil pH level of 6.0 – 7.0. The optimum soil pH is 6.5. Soil analysis should be carried out and lime applied where required.

### Fertiliser

Fertiliser recommendations are as shown in Table 5:

- NPK can be applied as organic manure (slurry or FYM ploughed down) or chemical fertiliser.

- Chemical nitrogen fertiliser is best applied prior to the last cultivation so that it is incorporated into the soil.
- Top dressing Nitrogen (N) after emergence should be avoided as it can cause crop scorch.
- It is recommended when sowing uncovered maize to combine drill a phosphorus fertiliser, and possibly some nitrogen and trace elements.
- No fertiliser Potassium (K) is required when soil K is above 250 mg/l.
- N and Phosphorus (P) recommended rates are as per the Nitrates Directive (Table 5).
- Adjust N, P and K rates based on organic manure applications.

### Trace Elements

Magnesium, Zinc and Manganese are the most important trace element deficiencies in maize. Carry out soil analysis to identify likely deficiencies. Trace elements can be applied at drilling in a starter fertiliser, this is recommended where severe deficiencies exist. Otherwise apply foliar trace elements from the 4 leaf stage.

**Table 5: Fertiliser Requirements for Maize**

Soil Index for NPK	Index 1	Index 2	Index 3	Index 4
Nitrogen N	180 kg/ha	140 kg/ha	110 kg/ha	75 kg/ha
Phosphorus P	70 kg/ha	50 kg/ha	40 kg/ha	20 kg/ha
Potassium K	250 kg/ha	225 kg/ha	190 kg/ha	120 kg/ha

### Summary facts:

- *An up to date soil analysis is essential to ensure proper crop nutrition*
- *Apply the recommended rates of nutrients to support crop yield*
- *Examine growing crops regularly to identify possible deficiencies and to rectify them*



## Soil Management

### Key Facts

- With maize silage production heavy machinery can cause compaction
- Maize silage as a crop is very susceptible to compaction with yield depressions of 15% to 50%
- Dramatic increases in machinery weights and trailer loads have not been matched by tyre capacity changes
- Soil cultivation with maize silage often results in a soil structure prone to compaction

### Heavy Loads and Soil Compaction

A key challenge in maize silage production is avoiding soil structure damage due to the late season harvesting of the crop and the heavy wheel loads imposed by harvesting equipment. Very large silage trailers are commonly used to improve transport efficiency, often over frequently long haulage distances. These heavy trailers can exert axle loads of between 6 and 10 t per individual axle (of tandem) with very high ground pressures exerted on the ground. Similarly slurry and FYM are frequently applied with heavy machinery to areas designated for maize silage, often in winter and early spring when soils are vulnerable to damage.



**Increased machinery has led to more compaction on maize ground**

To avoid soil structure damage at harvesting, the following points should be considered:

- Select dry fields for maize silage production which are free draining and have suitable traffic pathways to avoid traffic problems at harvest
- Manage crops for early harvest to improve chances of drier field conditions
- Consult with contractor about harvest date, but also trailer and load sizes, tyre sizes and driving patterns in the field
- Avoid the heaviest trailers and value the use of larger tyres to reduce ground pressure
- Tyres large enough to work at low inflation pressures (1.5 – 2.2 bar) should be used (Table 6) and axle loads in excess of 7 t should be avoided if possible
- Avoid spreading slurry/FYM when soil conditions are poor. Target the period immediately prior to sowing the crop when conditions are drier and immediate incorporation will maximise N efficiency
- Consider low pressure tyres or umbilical slurry application systems to reduce the soil loading

**Table 6. Silage trailer loads, tyre options and required inflation pressure**

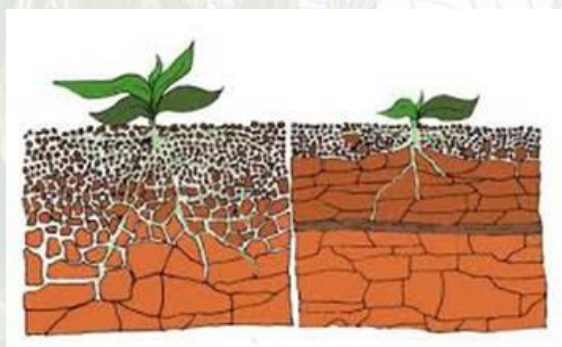
Trailer length (m)	5.5	6.7
Capacity (m <sup>3</sup> )	20	29
Silage load (t)	12	17
Wheel load (t)	3.5	4.9
Tyre option. 1	385/65R22.5	
Pressure (bar)	6.0	8.5
Tyre option. 2	560/45R22.5	
Pressure (bar)	2.6	4.0
Tyre option. 3	650/50R22.5	
Pressure (bar)	1.5	2.7



### Soil Management Approaches

In addition to compaction, post maize harvest soil may be prone to erosion. This encourages a lot of run-off with soil and nutrient loss and potential water-course nutrient enrichment. To prevent/deal with compaction and erosion, a number of approaches may be adopted:

**Figure 2. Effect of soil compaction**



- Soils should be examined for structure damage by digging spade-fulls to 30cm and examining aggregates, roots and porosity. Consider this in conjunction with visual cues of compaction such as poor crop growth in areas of high traffic
- Where compaction is found the emphasis must be on avoidance of future compaction before actions such as sub-soiling are considered, as immediate re-compaction is a real risk. While the compact layer beneath plough depth impacts negatively on root growth yield and drainage, it can protect the soil at lower depth from excessive compacting forces
- Where sub-soiling is necessary, the soil must be dry at sub-soiling depth and subsequent management must protect the vulnerable loosened soil. An alternative crop should be sown to avoid the harvest traffic load of maize.
- Growing maize as part of a rotation rather than as a monoculture allows the soil structure to recover. Establish

a winter cereal immediately after maize harvest to minimise soil erosion

- The establishment of cover crops to avoid erosion would be beneficial, but the practicality of establishing such a crop, either in the standing maize, or post-harvest has serious limitation

### Establishment of Maize

All crop establishment systems aim to establish a crop rapidly and provide conditions to support subsequent growth and yield formation. As maize is sown with a precision seeder and weeds are primarily controlled by soil acting herbicides, the approach to cultivation is to use a relatively intensive plough-based system in virtually all situations. With conventional systems, there are a number of priorities:

- Ploughing should be carried out in relatively dry conditions particularly where the soil was damaged previously. Plough depth should be sufficient to remove plough-layer compaction
- Secondary cultivation should only be to the depth that is necessary to enable the seeder to work satisfactorily
- The number of passes of cultivation tools should be minimised to reduce machine traffic and soil moisture loss

#### Summary facts:

- *Field selection, crop management and attention to machinery, can reduce the soil loading*
- *Avoid excessive axle loads and reduce the ground pressure of all machinery*
- *Use soil loosening techniques, such as subsoiling, cautiously*
- *Prepare seedbeds with the minimum level of cultivation to reduce traffic*



## Weed Control

### Key Facts

- Weed competition can cause large yield and quality losses in maize silage
- Good control of weeds early in the season is essential in maize silage

Control of broadleaved and grass weeds is one of the most critical factors in successful maize silage production. Maize is particularly susceptible to competition from weeds in the early stages of growth so good early season control is required. Even short periods of competition between weeds and maize in the early stages, when the maize is developing its root system, will have detrimental consequences. Therefore the aim of successful weed control in maize is to eliminate weeds before they begin competing significantly with the maize which is normally between the 2 and 5 leaf stage of maize growth.

### Effect of Poor Weed Control

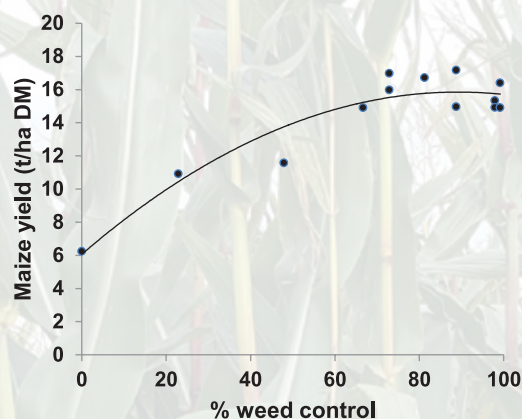
Weeds emerging at the same time as, or shortly after the maize plant, will be far more detrimental to yield than later



emerging weeds. Once a crop has developed a good sized canopy (usually 50 - 60 days after sowing) the crop will be able to outcompete any late emerging weeds and such late emerging weeds will have little or no effect on yield (Figure 3).

However, some weeds such as nightshade, if present at harvest, can cause problems at feed out if they develop sufficiently to contaminate the silage.

**Figure 3. Weed control effect on yield**



### Weed Control

Weed control in maize will normally be accomplished with either pre-sowing, pre-emergence or post-emergence herbicide applications or some combination of these. The choice of herbicide strategy will be governed by the weeds present and the sowing system (+/- cover) used.

### Perennial weeds

Perennial weeds such as docks, thistles and scutch grass can be difficult, and expensive, to control in a growing maize crop. These weeds should be controlled before the ground is prepared for sowing maize. Ideally, and where the crop rotation allows, these weeds should be controlled in the previous crop with an appropriate selective herbicide or in the fallow period after harvest of the previous crop using glyphosate. It is important that there is an adequate amount of weed foliage that is actively growing to ensure that there is good translocation of the herbicide to the roots in order to achieve good control of these weeds.

If any of these perennial weeds need to be controlled in the maize silage crop post



emergence products containing active ingredients such as clopyralid (thistles), fluroxypyr (docks and volunteer potatoes) or nicosulfuron/rimsulfuron (grassweeds such as scutch) will be required. Consult your crop agronomist for herbicide rates and usage.

### Covered Maize Silage

The majority of the maize crop in Ireland is grown under cover. This provides the ideal micro-climate for maize germination and early growth but also provides ideal conditions for weed growth. With cover, weed control must be achieved by herbicide application at the time of sowing. These herbicides are most effective when applied to fine, firm and level soil that is not subsequently disturbed such that a complete 'film' of herbicide over the soil surface can be achieved. Therefore cloddy seedbeds are likely to result in reduced levels of control. Weeds will be able to emerge from around clods without coming in contact with the herbicide. The activity of these residual herbicides can also be reduced considerably if prolonged periods of dry weather occur as the weed seedlings emerge through the soil surface.

Currently pendimethalin is the main component of pre emergence weed control programmes. To widen its weed spectrum it is mixed with a partner product, with a mixture of terbutylazine and mesotrione commonly used.

In some cases control of weeds by herbicides applied at sowing in the area between the covered rows is unsatisfactory and a follow up post emergence herbicide application is required. This is normally applied at the 4-6 leaf stage.

### Uncovered Maize Silage

Weed control in maize grown without a cover can be achieved through pre-emergence and/or post-emergence herbicide applications. Where a pre-emergence strategy is being used it is important that the herbicide is applied as soon as possible after sowing, ideally within two days of sowing. For post emergence applications the ideal timing is when the crop has between 4 and 6 leaves. At this stage the majority of weeds will have emerged but will not have started to compete with the crop.

### Herbicide Regulations

Growers should be aware that not all maize herbicides are approved for use on crops sown under cover and should always check product labels to ensure that the product can be applied under covered crops. Care also needs to be taken to ensure that the maximum number of times that a product can be applied in a season is not exceeded. All herbicides in the Republic of Ireland must have a PCS registration number.

#### Summary facts:

- *Use glyphosate to control perennial weeds before ploughing*
- *Early weed control is critical*
- *For covered crops apply a residual herbicide at sowing*
- *For uncovered crops a herbicide can be applied at sowing or post emergence*



## Pest Control

### Key Facts

- There are a number of pests which may attack the maize plant and have potential to significantly reduce crop yields
- The main risk period is at crop establishment
- There are limited options available for pest control in the growing crop
- Crop rotation, insecticide seed dressings, and regular crop inspections are effective tools for pest control

### Wireworm



The shiny golden brown larvae of the click beetle can be a problem – particularly when the crop follows grassland. They feed on the roots of developing and established plants. This can lead to plant death or poor growth performance. Some wireworm control can be achieved by using seed dressed with the insecticide Sonido®.

### Leatherjackets



Leatherjackets are the larvae of crane flies (Daddy long legs). The most serious

damage often occurs when maize follows grass or stubble fields that had a lot of grass the previous August/September. Leatherjackets feed on the roots and stems of the maize plant just below the soil surface. Ploughing up old grassland before early August will remove the egg laying sites of the flies, and should reduce damage to any spring sown crop. If chemical treatment is deemed necessary, then seed treated with the insecticide Sonido® can be used.

### Slugs



Slugs are another potential threat to the establishing crop in warm wet weather. Seed dressed with Mesurol® has some deterrent activity. However, where damage is taking place slug pellets should be applied to the field without delay.

### Frit fly



Frit fly (*Oscinella frit*) larvae will cause the leaves enfolding the growing point of the maize to twist and pucker. They burrow into the plant, which leads to a condition



known as 'deadheart'. A severe attack may kill the growing point, and lead to secondary tiller production. The extent of any damage is likely to vary depending on the time of peak egg laying in relation to the growth stage reached by the maize crop. If growing conditions are good then the plants will often grow away from the attack. Frit fly is a common pest, and so seed supplied in Ireland is normally treated with Mesurol® to protect against attack. Sonido® will also give useful control.

### Diabrotica (Western corn rootworm)



The adult beetles of the western corn rootworm (*Diabrotica virgifera virgifera*) lay eggs which hatch into larvae that feed on the roots of maize plants, reducing yield and causing lodging. Crop rotation is the most effective means of control, as this helps break the Diabrotica's life cycle. Diabrotica has not been identified in Ireland to date. It is a major pest in continental Europe.

### Birds

Pheasants, crows and other birds can cause damage to fields of maize, especially during the period of crop emergence. Mesurol® seed treatment will significantly reduce the feeding damage by these birds at crop establishment. Be aware that Sonido® seed treatment has no effect on birds. Solutions include regular patrols over a two or three week period, automatic bird scaring guns, kites and similar devices.

### Badgers

Badgers are very attracted to the starchy maize cobs and will push the plant over to eat them. Significant damage can be caused in localised areas of a crop. A low level electric fence can be put in place to keep badgers out. This is required from late August onwards as the cobs on the plants develop.

#### Summary facts:

- *Before sowing maize always consider the likely risk of insect pest attacks and damage by birds*
- *Mesurol® is the standard seed dressing for maize seed sown in Ireland over the past 20 years*
- *Sonido® seed treatment is an option to improve the control of wireworm and leatherjackets.*
- *Ensure seed has an effective seed dressing for the anticipated pests*
- *Ensure maize crops are inspected regularly to identify pest issues especially at crop establishment*



## Disease Control

### Key Facts

- Fungal diseases can reduce both quality and yield of maize
- The prevailing Irish climate can often be conducive to the development and spread of foliar, ear and stalk diseases
- Crop management, including rotation and variety choice are key to effective disease control

The mild damp climatic conditions that often prevail in Ireland from mid-summer onwards are conducive to the development and spread of fungal diseases of maize. The most prevalent and damaging of these include stalk and ear rot caused by *Fusarium* species, such as *F. graminearum*, eyespot caused by *Kabatiella zeae* and northern corn leaf blight caused by *Helminthosporium turcicum*. The prevalence and impact of these different diseases can be localised and is very dependent on the interaction of climate and local agronomic practices. As coastal regions are most prone to experiencing mild and damp climatic conditions maize silage crops in these areas are often more prone to disease problems and associated yield losses. However, in any given season where risky conditions prevail significant disease levels and yield losses can occur in all regions.

Control is based primarily on reducing initial inoculum and ensuring the resilience of the crop to infection. In high disease pressure environments, such as coastal regions or following a cool and wet July, fungicide applications can reduce infection levels and maintain yield.

## Fusarium Stalk and Ear Rot



This is caused by *Fusarium* species, primarily *F. graminearum* and *F. verticilliodes* and is easily identified by the pinkish mycelial growth that occurs either in the cob, often starting at the tip, or in the base of the stalk. In the case of ear rot, infection occurs during flowering/pollination with cool and wet weather during this period promoting infection. In the stalk the fungus can cause significant rotting towards the end of the season leading to increased risk of crop lodging and/or brackling. Level of infection and yield losses will increase if harvest is delayed. Infection in the stem is due to weakness in the plant, whether due to biotic (insect damage) or abiotic (e.g. wind damage) stresses. In areas of high production or continual production, varieties exhibiting high levels of resistance should be grown. Measures to reduce previous stubble through incorporation into the soil to promote decay should be undertaken to reduce available inoculum in the following season.



### Eyespot



Caused by the fungal pathogen *Kabatiella zae*, eyespot is a foliar disease that can cause significant reductions in yield where infections are left unchecked in conducive conditions. It is identified by small brown spots surrounded by a chlorotic ring which can occur on all leaf layers and which, when held up to the light gives the appearance of an eye. If infection occurs early in the season and is left unchecked significant reductions in yield can occur.

The pathogen thrives in cool damp conditions and produces air borne spores which are dispersed in the wind. Control is achieved through variety choice and ensuring any stubble remaining from the previous crop is removed. Rotation should be used as a control measure particularly after high infections in continuous maize silage sites. In high pressure seasons applications of a fungicide (Qol/azole mixture) early-mid season can reduce the impact of the disease.

### Northern Corn Leaf Blight

Caused by the fungal pathogen *Helminthosporium turcicum*, northern corn leaf blight is often observed in Irish maize silage crops but may not always cause significant reductions in yield. The disease is identified by brown oval shaped lesions that can occur on all leaf layers. Lesions merge to eventually completely infect the leaf. Similar to eyespot, reductions in yield



and starch may result from the reduction in leaf material available for photosynthesis. The disease is most prevalent in very humid conditions, with temperatures  $>18^{\circ}\text{C}$ . It can therefore be most destructive under Irish conditions in late summer and early autumn. Control where required is primarily through stubble removal or crop rotation and cultivation of tolerant varieties.

### Other Disease and General Control

In addition to the above Irish maize silage crops can suffer from a range of other diseases that affect maize worldwide. These include rust, smut and southern corn leaf blight. Control is in most instances achieved through varietal choice and crop management such as crop rotation and stubble removal

#### Summary facts:

- Irish maize crops can suffer from a range of fungal diseases
- The incidence and impact of these diseases depends greatly on local climatic conditions and agronomic practices
- Choosing resistant or tolerant varieties is essential, but ensuring good management such as crop rotation and stubble removal are equally important



## Harvesting and Ensiling

### Key Facts

- Target for harvesting maize silage is 30% DM and 30% starch
- Mature grains will increase starch content of the silage
- Premature harvest will result in yield/quality reduction
- Use additive on maize greater than 30% DM

Harvesting normally begins from middle of September and should be completed before 1<sup>st</sup> of November. There is little to be gained by leaving crops in the field after 25<sup>th</sup> of October due to lack of sunshine and risk of frost. Within this window harvest date depends mainly on the maturity of the grain as the majority of the total feed value is in the grain. The target for harvesting is 30% DM and 30% starch. Higher starch is desirable. However a higher DM than 30% is not desirable as it can lead to reduced feed intake and greater losses due to spoilage at the pit face.

Heavy frost will kill the plant reducing its ability to fill the grain due to reduced sugar levels. So if effected by frost the crop needs to be harvested before 70% of the plant is dead or at the latest within 10 days.

In practice determining the whole plant DM is difficult but it can be easily estimated by examining grains (kernels) from the cobs and determining how mature they are as described below.

### How to Determine Crop Maturity

**Take a cob from a plant at least 10 metres into the field**



**Break the cob in half and discard the half attached to the plant**



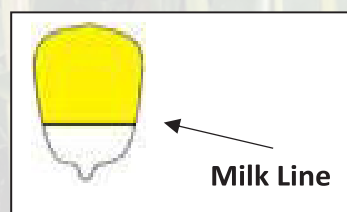
**Remove a kernel from the cob**







**Squeeze the kernel to assess the level of milk in it**



**Note the line where the solid starch and the milk begins**



**Table 7. Crop Maturity Estimation**

Grain Maturity		Cob % DM	Whole Plant % DMr
	Top 10% of kernel hard Insufficient starch	10-15	15
	Top 40% of kernel hard Still too watery	40-45	22
	Top 75% of kernel hard Harvest in one week	60-65	27
	100% of kernel hard Harvest immediately	80-85	33+



## Additive & Ensiling

Maize silage that is high in DM and starch is prone to secondary fermentation or heating when the pit is opened. Heating is undesirable as it means valuable feed energy is lost. Continuous rolling of the clamp while filling and before covering is essential to help reduce waste. Waste should be minimised at feeding out by having small pit faces or bagging/tubing of the crop. This will reduce secondary fermentation and facilitate the feeding of small/buffer quantities of the silage at a time.

**NOTE: Do not use a grass silage additive on your maize silage.**

Additives used to ensile maize silage are often different to those for grass silage. The optimum strains of fermentation bacteria for maize silage are different to grass silage.

The use of additives will help in reducing energy losses due to heating and improves the fermentation process which means more energy is available for milk or meat production. If the maize silage crop is greater than 30% DM an additive is recommended. Using an additive will also help increase feed intake, feed conversion rates and fibre digestibility.



**Ensiling maize silage**

Pests such as crows and other birds can often penetrate through the silage cover especially during prolonged periods of cold weather which leads to waste. It is common practice to place a woven plastic cover between the tyres and the silage pit cover to prevent this bird damage.

### Storage Requirement

**1 cubic metre** will store approximately **0.9 tonnes** fresh weight of forage maize



**Tight cover on maize silage**

### Summary facts:

- *Optimising harvest date is of paramount importance, if unsure contact your agronomist*
- *The cob is the main indicator of crop maturity*
- *Check grain fill weekly as harvest approaches*
- *As a last resort harvest the crop before the plant is dead*
- *The use of an additive will increase the feed quality of your clamp particularly if DM is >30%*
- *Use an additive if you intend to buffer feed during the summer*



## Maize Silage Contracts

### Introduction

With the demise of milk quotas and increasing dairy herd numbers, access to land and high quality forage availability have become issues on dairy/ livestock farms. Therefore purchasing forage from another farmer can be a very realistic option where land is a limiting factor.

Lower grain prices over the last number of years and the loss of the beet industry have led tillage farmers to consider growing forage crops for the dairy/livestock sector as an alternative to grain production. Traditionally maize was grown on a per acre basis and grown on excellent sites. Both parties accepted small fluctuation within the growing season. When this is done on a continual basis the fluctuation in yield balance out over years. The aim of maize trading/contract growing is to provide certainty for both the grower and purchaser on an annual basis.

Contract growing of maize silage is a written and binding contract between a grower and purchaser to supply maize silage for an agreed price per ton as laid out in the contract. This is a **Tonnage & Quality** contract, where the base price per tonne is subject to an adjustment based on dry matter (DM) and starch content (See contract template over).

### Benefits to both grower and purchaser

The grower has a definite market and payment agreed on a contract basis. The purchaser has an agreed tonnage of high quality maize silage that will be supplied for his/her enterprise at agreed contract price per tonne.

In times of volatile commodity prices, the purchaser knows the cost of maize silage and the grower has the security of a forage crop on contract.

For the grower maize silage provides an excellent break crop (2-3 crop rule), which spreads the work load and breaks the cycle of weeds, pests, and disease. It allows the application of organic manure (dung, slurry or compost), thereby reducing the need for artificial fertiliser and increasing organic matter content and improving soil structure.

The purchaser gets high quality maize silage, which can be used either in spring or autumn as a buffer feed or as part of an indoor diet for cows or as a forage for fattening animals. Maize (high energy, low protein and high DM) is an ideal complement to grazed grass (high energy, high protein but low DM).

Very often in contract growing the option of the slurry/dung export from the livestock unit to the tillage farm is advantageous to both parties, as trying to spread this on grassland/silage ground in spring time can be problematic.

The heavy work load in spring time on dairy farms can leave little time to concentrate on planting maize silage, while the tillage farmer very often has the time, expertise, machinery and excellent sites to establish a quality crop of maize silage. This leaves more time for the dairy and livestock farmers to concentrate on calving and then on breeding.

As with any new proposal a certain amount of openness and trust is needed for agreements to succeed.



## Maize Silage Contract

Contract between a grower and purchaser on a Tonnage/Quality basis

Both grower and purchaser must agree and complete a contract

### Parties to this contract:

**Grower**      **Name** \_\_\_\_\_

**Address** \_\_\_\_\_

**Purchaser**      **Name** \_\_\_\_\_

**Address** \_\_\_\_\_

**3<sup>rd</sup> Party Adjudicator** \_\_\_\_\_

The grower and purchaser hereby agree to the following contract terms;

1. The grower will grow and supply to the purchaser between \_\_\_\_ tonnes and \_\_\_\_ tonnes (the range should allow for seasonal fluctuations) of maize silage grown covered/uncovered (delete as appropriate). (In the event of poor yield or crop failure it is up to the grower to supply the agreed tonnage of maize silage).
2. The grower will grow this maize silage crop in accordance with Teagasc best practice (Agronomy section of Maize Silage for Ireland).
3. Insert variety / varieties here ( \_\_\_\_\_ ).
4. The grower agrees to supply to the purchaser a (standing maize silage crop/or delivered to address above) (delete as appropriate), by \_\_\_\_\_ (insert date).
5. Under this contract it is agreed that the grower will retain the entitlements and Basic Payment Scheme (BPS) on land used to grow the forage maize crop.
6. For this contract tonnage agreement, the grower agrees to weigh the harvested maize silage at a certified weigh bridge that has been agreed by both grower and purchaser. \_\_\_\_\_ (insert location) If not all loads are weighed, then a minimum of 20% of total loads must be weighed to get the average weight in trailers which must be then multiplied by the total number of trailers (every trailer/20% of trailers) (delete as appropriate)
7. The grower and purchaser agree that the purchaser gets an independent 3<sup>rd</sup> party adjudicator to:
  - Assess when the crop is ready for harvest
  - To representatively sample the maize clamp
  - To send a sample to a certified laboratory to determine DM % and starch % under wet chemistry to use as the quality parameters.





The purchaser hereby agrees to pay the grower a **base price** (see Teagasc annual costs and returns for approx. forage values) of € \_\_\_\_\_/tonne **Plus/Minus** a bonus or penalty based on the following parameters.

- An average of 30% per t DM and starch equals the base price payable
- Bonus of €1.80 per unit % increase when the average of the DM % and starch % is >30%
- Penalty of €1.80 per unit % decrease when the average of the DM % and starch is <30%
- See example grid below

Value of Maize	Example 1	Example 2	Example 3
Base price at 30 % DM 30% Starch	€50.00 per t DM	€50.00 per t DM	€50.00 per t DM
<u>(Dry Matter % + Starch %)</u> 2	(29 % DM + 31 % Starch) ÷ 2 = 30	(34 % DM + 36 % Starch) ÷ 2 = 35	(27 % DM + 25% Starch) ÷ 2 = 26
Multiply the difference from 30 by €1.80	0 x €1.80 = €0	5 x €1.80 = €9.00	-4 x €1.80 = -€7.20
Above or below the desired 30% will determine the price per t DM:	€50.00 per t DM	€59.00 per t DM	€42.80 per t DM

Purchaser agrees to payment terms as follows based on quality grid above.

Deposit of € \_\_\_\_\_ by \_\_\_\_\_ (insert date)

Balance/Total of € \_\_\_\_\_ by \_\_\_\_\_ (insert date) (within the range at beginning)

Grower

Name: \_\_\_\_\_

Address: \_\_\_\_\_

Contact No: \_\_\_\_\_

Signature & Date: \_\_\_\_\_

Print Name: \_\_\_\_\_

Purchaser

Name: \_\_\_\_\_

Address: \_\_\_\_\_

Contact No: \_\_\_\_\_

Signature & Date: \_\_\_\_\_

Print Name: \_\_\_\_\_

Witnessed by 3<sup>rd</sup> Party Adjudicator & Date

\_\_\_\_\_





## Maize Silage Feeding Value

### Key Facts

- Maize silage offers a potentially home grown, high energy feed source
- Maize silage is a high quality buffer feed when offered with high protein grass silage or grazed grass
- Low protein feedstuff (~8-9%)
- Grown under cover maize silage offers a consistent quality feed stuff

## Maize Silage Feeding Value

Maize silage is a high starch (25-35%) feedstuff, therefore it needs gradual introduction to the diet of ruminant animals. Attention needs to be paid to storage and usage/day at feed out to avoid spoilage. Purchasing should be done on a yield and quality basis rather than on an area basis and ideally attention should be paid to the maturity of the crop at harvest. There are many factors that affect the feeding value of maize silage. These are covered in full in the Maize Silage Quality Section.

The target feed values for Irish grown maize silage are outlined in Table 8. If maize silage falls into the category of 'low quality'

there will be a negative impact on overall feed intake and subsequent animal performance as outlined in the following dairy and beef finishing sub sections.

**Table 8. Typical feeding value of maize silage grown in Ireland (per kg DM)**

	Target	Low quality
DM%	30-35	<20
Starch %	30-35	<20
ME (MJ/kg)	12.0	<10.5
NE (UFL/kg)	0.75	<0.70
NDF %	35-40	<30 or >40
DMD %	75-80	<75
Protein %	9-10	<9
PDI (g/kg DM)	50	53

## UFL and UFV

In Ireland the energy content of feeds is UFL per kg DM for milking cows and UFV per kg DM for finishing beef cattle. 1 UFL is the net energy content of 1kg of air dry standard barley for milk production. 1 UFV is the net energy content of air dry standard barley for meat production at or around production level of 1.5 times maintenance. This is average daily gain of approximately 1kg/day in finishing steers. Maize silage has a positive effect on milk solids and milk yield (Table 9).

**Table 9. Intake and milk production performance for cows offered a high or low allowance of spring grass, and for cows on a low grass allowance offered supplementary maize silage**

	High grass 20 kg DM (HG)	Low grass 15 kg DM (LG)	LG + 4 kg DM maize silage
Herbage intake (kg DM/cow/d)	17.1	15.2	13.8
Supplement intake (kg DM/cow/d)	0	0	3.2
Total intake (kg DM/cow/d)	17.1	15.2	17.0
Milk yield (kg/cow/d)	23.2	20.7	23.7
Milks solids yield (kg/cow/d)	1.68	1.43	1.71
Milk fat %	3.89	3.78	3.94
Milk protein %	3.48	3.2	3.36

From Burke et al., 2008 Livestock Science 114:325-335



## Maize Silage as a Buffer Feed for Milk Production

### Key Facts

- Maize silage can be used to support a feed deficiency on highly stocked farms
- When fed with grazed grass maize silage will offer an excellent complementary forage
- Maize silage is a low protein feed so must be balance for protein within the diet

## Buffer Feeding Grazing Diets with Maize Silage

Grazed grass is the cheapest feed produced in Ireland, and should therefore make up as much of the cows diet as possible. However when grass silage is in deficit or when grass quality is suboptimal a supplementary feed may need to be fed. Maize silage can play a role in high stocking rate systems. At high stocking rates additional feed must be brought into the system. The choice of which feed to bring in will be decided by their nutritive value, cost and equipment/labour associated with feed-out.

Research carried out at Teagasc Moorepark showed that when a limited grazed grass supply was supplemented by feeding maize silage the following was achieved:

- Feed intake was increased
- Milk yield increased
- Milk fat % and protein % increased

Australian research also showed that when cows were underfed grass, supplementing them with maize silage increased milk yield and milk protein concentration. Work carried out in New Zealand found the production response to maize silage was

32-178 g MS/kg DM. High milk production responses can therefore be obtained from supplementing with maize silage when it is used appropriately (in a feed deficit).



**Maize silage stored in wrapped tubing for buffer feeding**

## Nutritional Value (mineral balance, protein balance, PDIN/PDIE)

Maize silage is a low protein, high energy feed. It contains approximately 9% crude protein. This is not sufficient to meet lactating dairy cow requirements. Therefore maize silage should always be fed alongside a high protein feed. Because the protein in maize is low, the PDI value is limited by nitrogen (PDIN). The PDIN of maize silage is approximately 52.

High quality maize silage generally contains about 30% starch and has a UFL of 0.80. In contrast poor quality maize silage can be as low as 15% starch and 0.75 UFL.

Maize silage is generally low in the macro-minerals Ca, Mg, Na and P. Therefore supplementation with these minerals is necessary to protect against deficiencies.

Good quality maize silage is characterised by a pH of 3.7-4.2, ammonia as % of total N of 5-7% and lactic acid of 4-7%.



## Indoor Feeding of Maize Silage

### Key Facts

- Maize silage in winter milking diets increases total dry matter intake (DMI)
- Milk yield and solids responses of 6-12% are typical, depending on forage quality
- Body condition score loss tends to be less with maize silage
- Ensure balance diets for protein and minerals
- Higher grazing stocking rate optimises use of maize silage in the feed budget

### Inclusion Level and Response

High intakes of conserved forage dry matter are the essential first step in building a cost effective diet for winter milk production. Inclusion of maize silage as a second forage has consistently been shown to increase total DMI compared to grass silage as the sole forage (Table 10).

The DMI response to maize silage inclusion is greater for lower dry matter digestibility (DMD) grass silage compared to higher DMD grass silage, reflecting the poor intake potential of low DMD grass silage relative to cows' feed intake capacity.

The inclusion rate of maize silage (as % of forage DM) affects overall feed intake responses. Lower maize inclusion rates (15-25% of forage DM) will give a 40-50% lower total intake benefit than the higher inclusion rates (55-65% of forage DM). In summary therefore, maize silage is most beneficial to total daily feed intake of milking cows when replacing poor quality grass silage at 55-60% of forage DM, and has its lowest intake response when fed at low inclusions with excellent quality grass silage.

It is worth noting also, that up to 85% of the maximum intake benefit of maize silage inclusion can be achieved at a rate of 30-35% of winter forage DM. At the systems level, this corresponds well with grazing stocking rates of 3.2 to 3.4 cows per ha; such systems typically run winter forage deficits of 30-35% so maize silage can have a dual benefit in this regard.

Assuming good starch and DM content (>25%), maize silage included in winter lactation diets increases milk yield and milk solids content compared to grass silage as the sole forage.

**Table 10. Intake response to second forage in early lactation diets**

Forage Mix <sup>1</sup>	67 DMD Grass silage		74 DMD Grass silage	
	Maize	W Crop	Maize	W Crop
<b>Total DMI<sup>2</sup></b>	+22%	+18%	+13%	+11%

<sup>1</sup>50% inclusion rate, <sup>2</sup>Includes 7kg concentrate

Typical response across numerous studies are approximately 8-12% for daily milk volume per cow, and 10-15% for daily milk solids yield, with higher milk protein percentage (0.05 to 0.10 percentage points) accounting for the additional level of milk solids improvement in most studies. These responses were achieved with inclusions of maize silage at approximately 40 to 55% of forage DM.

At these inclusion levels, maize silage also tends to reduce the degree of body condition score loss in early lactation, though the direct benefits to subsequent conception rates and fertility are difficult to quantify.



### **Diet Balance and Feed Efficiency**

Given its lower N content, the typical ratio of PDIE to PDIN protein is higher for good quality maize silage (1.3 to 1) compared to grass silage (0.97 to 1). This requires additional PDIN (crude protein) supplements. Nonetheless, winter milking diets containing maize silage can be balanced for optimal milk production and N efficiency at PDI values of 95-97g per kg DM and 15.5% crude protein in the total diet. The relative balance of lysine and methionine (as a % of PDIE) is similar for maize and grass silage.



### **Dairy cows feeding on maize silage**

Work carried out in Teagasc Moorepark has shown that the extra milk production from maize silage diets is derived largely from extra dry matter intake, and not from any increases in energy density or feed conversion rates per kg DM. It is important account for this when valuing traded maize per tonne DM.

Additional mineral supplementation (Ca and P) is generally required for milking diets incorporating maize silage.



## Maize Silage for Beef Production

### Key Facts

- Feeding maize silage with high DM % and starch % can reduce the amount of concentrates required
- The finishing period can be shortened with animals hitting target slaughter weights faster
- Maize silage can be fed to beef animals as the sole forage source or in combination with grass silage

### Introduction

As most finishing operations are based on grass silage diets, it is important to have properly preserved grass silage of high digestibility (>70% DMD). Even good quality grass silage does not have the feeding potential to finish animals and some degree of concentrate input will be required. In recent times the variability in grass silage quality and increased production costs have forced many winter finishers to remove grass silage from their finishing diets and many have moved to alternative feeding options which include maize silage. Compared to a grass silage based diet, some of these options offer benefits such as shorter finishing periods, lower labour and housing requirement, but more importantly a predictable level of performance can be more readily achieved.

### Nutritional value (starch content/protein balance)

The target starch content of forage maize is 30% as outlined in Table 8 previously. If maize silage is harvested and fed with a low starch content it will have a significant negative impact on DM intake and live weight gain (LWG) of beef animals as outlined in Table 11.

**Table 11. Effect of maize silage starch content on DM intake and LWG**

	Low starch	High starch	Difference
<b>Starch (%)</b>	9.8	31.5	21.7
<b>Silage DM intake (kg/day)</b>	7.45	9.17	1.72
<b>Liveweight gain (kg/day)</b>	0.89	1.02	0.13

Source: Teagasc, Grange

As CP is limiting in maize silage Table 12 gives the appropriate concentrate feeding level and crude protein content depending on the inclusion level of forage maize with grass silage. All diets are formulated to have an overall CP content of 13-15% and NE of 0.95 UFV/kg DM.

**Table 12. Concentrate for different levels of maize silage in the diet**

Inclusion levels (fresh weight) %		
Grass silage	Maize silage	Concentrate (CP %)
<b>100</b>	0	4.0 kg (13%)
<b>75</b>	25	3.5 kg (17%)
<b>50</b>	50	3.0 kg (19%)
<b>25</b>	75	2.5 kg (22%)
<b>0</b>	100	2.0 kg (26%)

Assumptions: Grass silage DM% = 20, DMD = 70%;  
Maize silage DM% = 25%, starch = 25%

Source: Teagasc, Grange



### Inclusion Level

The majority of maize silage is offered in combination with grass silage. Teagasc Grange have completed feeding trials with differing inclusion levels of grass silage and maize silage a summary of inclusion level (Table 12). The maize silage starch content was 31.5% and the grass silage DMD was 74%. All cattle additionally were offered 4 kg concentrate per head per day. The optimum inclusion level is 30-50% maize silage, with grass silage.

**Table 13. Effect of grass silage to maize silage in the diet**

	% grass silage in the diet. Balance is maize silage		
	100	50	0
<b>Silage DM intake (kg/day)</b>	5.1	6.8	6.8
<b>Carcass gain (g/day)</b>	653	698	737
<b>FCE (intake/carcass gain)</b>	12.0	13.6	13.0

### Finishing Diets

For finishing beef systems *ad lib* concentrate is the gold standard to reach target weights and significantly reduce the finishing period to get animals to slaughter. Table 13 outlines the feed value of maize silage compared to *ad lib* concentrate, with the maize silage option being competitive.

**Table 14. The relative feed value of maize silage to ad lib concentrate.**

	<i>Ad lib conc + 1 kg forage DM</i>	<i>3 kg conc + ad lib maize silage</i>
<b>Total DM intake</b>	100	96
<b>Carcass gain</b>	100	87

The feed cost of continental steers on different finishing diets is presented in Table 15. At current feed input prices, to finish steers over a standard feeding period (120 kg liveweight) can cost €218 to €240 per animal, depending on the diet offered. Standard grass silage supplemented with concentrate is the most expensive finishing option for steers, at 7% more expensive than maize or 8% more expensive than an *ad lib* concentrate diet. If grass silage quality deteriorates (65 DMD) and is a significant part of the finishing diet, then it becomes the most expensive finishing option available on the farm.



**Table 15. Feed costs for continental steers on different finishing diets**

Diet	Grass silage, Good (70 DMD)	Maize silage	Fermented whole crop wheat	Fodder beet	High concentrate
Concentrate (kg/day)	5 kg	4.35 kg	4.35 kg	2 kg	10 kg
Liveweight gain (kg/day)	1	1.2	1.1	1.2	1.3
Carcase gain (kg/day)	0.64	0.8	0.7	0.8	0.9
Days of finish	125	100	109	100	88
Feed cost per day (€/kg)	1.92	2.24	2.17	2.18	2.52
Feed cost (€/kg carcass gain)	2.99	2.81	2.97	2.73	2.76

Note: All cattle had initial weight of 550 kg

Grass silage = €117/t DM; Forage maize = €118/t DM; Fermented whole crop wheat = €127/ t DM; Fodder beet = €190/t DM; Concentrate = €190/t DM; Concentrate protein balancer = €220/t DM

#### Summary facts:

- *Maize silage is a high energy, high DM, low CP feed*
- *Maize silage can be used as buffer feed in high stocking rate milk production systems*
- *Maize silage can be used successfully as part of indoor diets for milking dairy cows*
- *Maize silage can be part of a diet for beef cattle that is competitive relative to ad lib concentrate feeding*



## Maize Silage Quality

### Key Facts

- Attention to detail is essential in growing the crop successfully
- High quality maize silage has a high dry matter yield and a high starch content
- Covered maize generally achieves higher yields and higher starch content than uncovered maize
- Correct variety selection is a crucial factor and one should use proven varieties from the DAFM Recommended List (RL)
- Analysis of nutritional composition is essential to accurately value the crop and/or to formulate diets according to the nutritional requirements of the animal

The definition of quality for maize silage or any other crop differs depending on the requirements of the end user. Because the overwhelming majority of the crop in Ireland is grown as forage for inclusion in ruminant diets, maize quality is determined by its yield and nutritional content. The quality criteria are therefore based on information that can be used by farmers and/or nutritionists in formulating balanced diets for various categories of livestock. Many references to the DAFM Recommended List (RL) are contained in this section. The DAFM RL contains varieties that have been independently evaluated across multiple sites and years and have been proven to be robust and able to perform in the challenging and varying Irish climate.

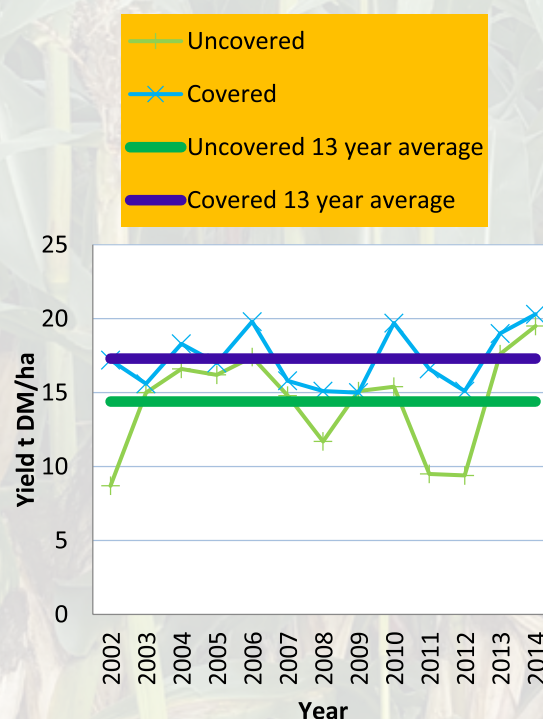
## Factors Affecting Maize Silage Quality

There are many factors affecting the quality of maize silage in Ireland. The most important factors are dealt with below:

### Covered Versus Uncovered Maize

An analysis of DAFM's RL trials from 2002 – 2014 show that covered maize yield was 2.9 t DM/ha greater than uncovered maize yield (Figure 4). In addition covered maize had 4.9% greater starch content than uncovered maize (Figure 5). The differences were particularly pronounced in poor maize growing years such as 2002, 2011 and 2012.

**Figure 4. Yield of covered and uncovered maize in DAFM trials 2002-2014**



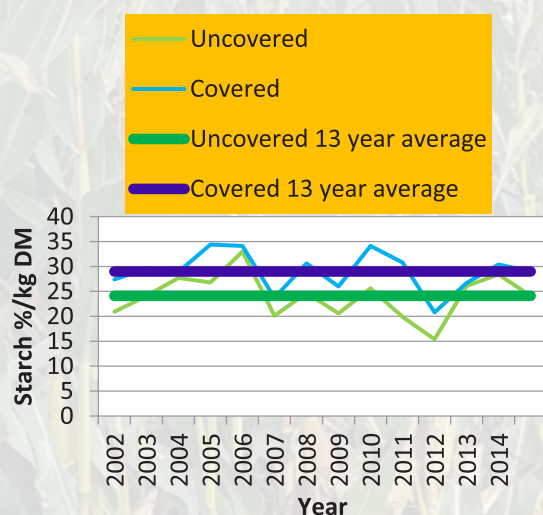
### Annual Variations

Temperature during the growing season has a significant effect on maize silage yield and starch content. As can be seen from Figures 4 and 5 there is large annual



variation in maize yield and quality. Between 2002 and 2014, uncovered maize yield ranged from 8.7 t DM/ha and 15.4% starch in poor maize silage growing years (e.g. 2012) to 19.5 t DM/ha and 28.4% starch in good maize silage growing years (e.g. 2006). In the same period covered maize silage yield ranged from 15.1 t DM/ha and 23.7% starch in poor maize silage growing years to 20.3 t DM/ha and 34.4% starch in good maize silage growing years.

**Figure 5. Starch concentration of covered and uncovered maize in DAFM trials 2002-2014**



### Variety Selection

Variety selection is an important consideration in ensuring that a quality crop is produced. In particular varieties should be selected based on their suitability to specific sites. This subject is dealt with in more detail in the agronomy section of this booklet.

### Crop Height

Crop height has historically been widely recorded in data produced in research for maize silage. However, it is not a reliable indicator of the DM yield or quality of maize

silage crops and therefore should not be used as an indicator of crop yield or quality.

### Varietal Lodging/Brackling Resistance and Emergence in Covered Crops

Lodging occurs where a plant falls/bends over from its normal vertical position at ground level. Brackling occurs where a plant breaks/bends at some point along the stem above ground level. Lodging and brackling resistance are important considerations because plants which lodge or brackle may not mature and harvesters may not be able to pick them up. Emergence through the cover was an issue when the covered system was first introduced. Varieties that exhibit lodging, brackling or do not emerge through the cover in covered crops are not placed on DAFM's RL. Therefore, selecting varieties from the RL will protect growers from these faults.



DAFM covered maize variety trial plots in Co. Kildare

### Agronomy, Maturity at Harvest, Ensiling and Feed out

Good agronomic practices will contribute to improved yield and quality in maize crops. It is also important that the crop is harvested at the appropriate stage. Optimum management of maize silage during ensiling and feed out are also important. All these factors are dealt with in more detail in the agronomy section.



## Maize Silage Quality Indicators

### Yield

Yield is the key determinant of the success of a maize crop. The amount of DM produced will determine the cost per kilogram, on a DM basis, of producing maize silage and hence its economic attractiveness compared to other feeds. DM yield, not freshweight (FW) yield, should be used as the sole measure of yield because the DM contains the nutritional content and feeding value of the crop. FW yields are often not correlated with DM yields and as such are unreliable indicators of the value of a maize crop.



**Freshly harvested maize from the field being put in a pit.**

### Example – FW v DM Yield

#### Crop A

100 tonnes freshweight maize at 30% DM = 30 t DM (feeding value)

#### Crop B

90 tonnes freshweight maize at 35% DM = 31.5 t DM (feeding value)

All other things being equal crop B has 1.5 tonnes more DM as feed for animals than crop A. Crop B has the added benefit of reducing ground traffic at harvest which can reduce soil structural damage and will also reduce fuel costs and effluent losses from the pit during ensiling.

## Starch Content

Starch content is an indicator of the energy content of maize silage. Starch content is generally expressed as a (%) or equivalent of the DM (e.g. 35% or 350 g/kg DM). The average starch content in DAFM maize trials between 2002 and 2014 was 24% and 29% for uncovered and covered maize respectively (Figure 5).

Starch is often expressed as t starch/ha, however this figure is not helpful to a farmer or nutritionist when calculating the amount of maize for inclusion in a balanced diet and therefore should not be used.

### Example - Varying Starch Levels

#### Crop A

A crop with a yield of 22 t DM/ha of maize at 25% starch = 5.5 t starch DM per hectare but the starch feeding value is 25%, i.e. every 1 kg of maize DM has 250 g of starch)

#### Crop B

A crop with a yield of 18 t DM/ha of maize at 30% starch = 5.4t starch DM/ha. But the starch feeding value of the crop is 30%, i.e. every 1Kg of maize silage DM has 300g of starch

From a starch perspective crop B is a superior crop to Crop A despite the fact that crop A has produced more starch per hectare. Every kilogram of Crop B has 5% or 50 g more starch than crop A and is therefore a superior feed for animals



There are 2 methods of determining starch content in a laboratory:

1. Wet chemistry
2. Near Infra Red Spectrometry (NIRS)



### Testing maize silage for starch using wet chemistry

Wet chemistry is the “gold standard” for calculating starch content, while NIRS uses predictions from wet chemistry analysis to calculate starch values. When discussing and comparing maize starch content it is important to know which method was used to carry out the analysis. When selecting a laboratory to carry out maize analysis, preference should be given to (i) laboratories that are accredited and (ii) laboratories who are accredited for the particular analytical test being requested.

### Energy Content

There are currently two systems of determining the energy level of a feed:

1. The net energy (NE) system
2. The metabolisable energy (ME) system

The ME system is used in UK, but in Ireland we have started to use the NE system as NE is the best measure of the energy available in feed which can be used by the animal. Both the ME and NE value of maize silage can be calculated from the chemical composition of the maize silage. There is no simple conversion from ME to NE, although generally as one increases so too does the other.

### Total Plant Digestibility

Total plant digestibility is expressed as DMD. Digestibility is important as it indicates how much of the plant can be broken down and utilised by the animal. Analysis from the DAFM maize evaluation trials shows that the digestibility ranged from 66 to 80%. This figure is useful for nutritionists and farmers as it is closely related to the NE.

In a mature crop the most digestible part of the maize plant is the cob while the green parts of the plant which is known as the stover (leaves, stem, etc) is less digestible. As the plant becomes more mature and more sugars are converted to starch the digestibility of the stem in particular decreases which coincides with the leaves turning from green to brown.

### Crop Maturity/DM Content

DM is an indication of the maturity (dry down) of the crop at harvest. Approaching maturity the sugars in a maize plant move from the leaves to the cob where they are converted to starch. Maize crops that are harvested in an immature state will have low starch in the cob because the sugars will not yet have moved from the leaf. In addition in crops that are harvested too early, there is a risk of losing nutrients through effluent loss from the pit. Maize crops that are harvested too late will have reduced digestibility and palatability which will reduce animal performance. It is therefore important to harvest the crop at the appropriate stage of maturity.



### Protein Content

Crude Protein (CP) is expressed in g/kg DM or as a % of DM. Maize silage is high in energy but low in protein, with a typical CP content of 9-10% (90-100 g/kg DM). Maize silage is therefore usually supplemented with a high protein feed.

The most important protein value of ruminant feed is Protein Digested in the Intestine (PDI). The PDI absorbed is the lowest of the two protein values PDIN and PDIE. PDIN is the number of grams of protein that is synthesised in the rumen from the breakdown of dietary nitrogen and is absorbed in the small intestine. PDIE is the number of grams of protein that is synthesised in the rumen from breakdown of dietary energy and absorbed in the small intestine.



### Fibre

Fibre is important in all ruminant diets in order to ensure the rumen functions effectively. Fibre is usually measured as Neutral Detergent Fibre (NDF), and is expressed in g/kg DM or as a % of DM. The typical NDF content of maize silage is 36-44%, which meets the requirement of the animal, but is not too high, which would limit intake.



## DAFM Recommended List

The table below shows how results are presented in the DAFM RL, and the text explains what these results mean. Growers should use the RL, in conjunction with the decision tree presented in chapter 1, as the

primary decision tools for variety selection. The RL only contains varieties that will perform in Irish conditions. These varieties have been evaluated across different years, sites and conditions and are therefore proven to be robust enough to perform in Ireland's varying conditions.

**DAFM Recommended List Tables Explained**

**Yield of Dry Matter**  
DM vs fresh weight because the DM contains the feeding value of the crop.  
100 t fresh @ 30% DM = 30 t DM  
90 t fresh @ 35% DM = 31.5 t DM

**Dry Matter Content**  
DM content indicates the maturity of the variety relative to the controls. For unfavourable sites particularly in north, higher figures (above 100) indicate more suitable varieties. Converse is true for favourable sites particularly in south

**Starch Content**  
Starch content determined by wet chemistry method. Actual figure may appear low as NIR method also used which results in higher starch figures

**Metabolisable Energy**  
ME is a system used to characterise the Nutritional value of animal feedingstuffs. It is an estimate of the energy available to an animal from digestion of a feed material, expressed in megajoules per Kg of feed (MJ/Kg DM)

R - Fully Recommended  
PR - Provisionally Recommended  
The number following the PR indicates the number of years the variety has been provisionally recommended.

Average actual yield, dry matter content and starch content of control varieties across 3 years of trial

Relative Yield, DM and Starch values. Average of control varieties is 100 for each trait

	Yield of Dry Matter (t/ha)	Dry Matter content (%)	Starch content (%)	ME (MJ/kg)	Earliness of emergence through plastic Score (1 – 9). (9 = earliest, 1 = latest).	Plant Height (metres)	Year first Recommended
Controls*	18.1t/ha	34.3	26.0	---	---	---	---
Award (R)	102	102	105	11.4	6.02	2.10	2011
Grosso (PR-1)	100	93	105	11.4	4.95	2.25	2015

With Plastic Cover

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Enniscorthy, Co. Wex  
Bia agus Mair

### Summary Facts:

- Maize quality is affected by sowing system, variety choice, sowing date, sowing rate, weather conditions during growing season, site favourability, crop agronomy, crop maturity at harvest and management during ensiling and feed out
- Analysis of crop prior to feeding/sale is vital to accurately value the crop and/or to accurately balance ruminant diets to meet animal requirements
- Important that only appropriate analyses are used in comparing/determining quality and/or value of maize crops
- Growers should use all tools at their disposal to ensure a quality crop is grown, that is comparable on an economic basis with other crops



NOTES









[www.barrettagri.ie](http://www.barrettagri.ie)



[www.jordanagri.ie](http://www.jordanagri.ie)



[www.southernfuels.ie](http://www.southernfuels.ie)



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