The Value of Grass

A guide to the nutritional composition of grazed and ensiled grass
The ability to grow grass so successfully throughout most of the year gives Ireland’s ruminant production systems a very strong competitive advantage over both European and international competitors. For many years now the value of grazed grass has been highlighted. It is by far the cheapest feed available and the better you can manage it the cheaper you can grow it. It is also adding value to Irish agriculture by helping portray the clean green image associated with Irish animal-based food production.

To achieve the full benefit of grass, livestock farmers must manage it across the full year, in order to optimise the balance between grass supply and demand, while also ensuring sufficient quantities are conserved as silage to provide adequate feed when animals are housed. Research from Teagasc has shown a strong relationship between grass utilisation and farm profitability, with each additional tonne of grass DM/ha utilised resulting in an increase in net margin by €160/ha.

In this guide we aim to help livestock farmers gain a better understanding of the nutritional composition of grass. We provide simple definitions and highlight the importance of different components for maximum livestock performance. We also provide pointers on how to attain the best performance from your sward. Whilst effective as a stand-alone crop, grass is also commonly grown with white clover as a companion species, so we include references to the nutritional contribution of white clover where applicable.
Dry matter

Why is dry matter in grass important?
The dry matter (DM) content of forage (measured as a percentage) is the proportion of total components (fibres, proteins, ash, water soluble carbohydrates, lipids, etc) remaining after water has been removed.

Knowing the dry matter percentage of forage is important. The lower the dry matter content, the higher the freshweight of forage required to achieve a target nutrient intake, whether this is grazed grass or conserved forage.

Dry matter is also used as a term to measure yield. Recorded as kg DM/ha, this is used as a measure of sward carrying capacity (stocking rate) and is an essential element of effective grazing management. It is also used to measure silage crop yields.

The range of dry matter in grass
In terms of dry matter content, field and weather conditions will cause significant variation, and there are also inherent differences between diploid and tetraploid varieties. All other factors being equal, diploids have higher dry matter content (typically 2% higher) than tetraploids, due to diploids having smaller cells and a lower cell wall to cell contents ratio.

This means ruminants fed entirely on a tetraploid sward will need to consume more fresh grass per day to achieve the same nutritional intake as from a purely diploid sward.

Looking at dry matter yield, modern ryegrasses have been bred for maximum production. The best rated perennial ryegrass varieties on the Recommended List are now capable of grazing or conservation yields in excess of 14 t DM/ha whilst weed grasses (e.g. creeping bent or annual meadow grass) can yield as little as 2 t DM/ha. Production from ryegrasses over a season follows the classic growth curve, peaking at around 120 kg DM/ha per day in May and typically dipping to around one-third of peak levels by early autumn.

Making the most of dry matter
In grazing terms, the aim should be to present a sward that offers the ideal balance of fresh nutritious growth with the appropriate fibre content for optimal rumen passage. This balance is best achieved by using a grazing rotation of 18-21 days in peak season. Poor sward management will increase the proportion of dead and dying plant material, resulting in a significant decline in forage quality and intake potential.

When making silage, the aim should be to cut at 16 - 20% dry matter and ensile at 30 – 35% dry matter (for clamp silage) and 35 – 40% (baled). This will ensure a good fermentation and optimum intakes, and minimum risk of aerobic instability.

Seasonality of grass production
Increasing grass production at the shoulders of the season (in the spring and again in the autumn) has the potential to improve farm profitability due to the reduced requirement to buy in more expensive feed such as concentrates and also reduce the reliance on silage. Grass growth is dependant on soil temperatures reaching above 6°C, while clover requires temperatures above 8°C. In Ireland, due to the climate, we typically have very low grass growth rates in the spring and again in the autumn, with maximum growth rates being achieved during the month of May. Although there is little we can do about the weather in the spring and autumn periods, there are a number of measures we can take to improve grass production at the shoulders of the season.

Annual and total DM yield values when selecting the best varieties from the Irish Recommended List

Remember animals on wet pasture will have to consume more fresh weight of forage per day

Delaying cutting for silage increases yield but decreases quality

Overall DM yield from a grass/clover sward with optimum white clover content is broadly compatible with a straight ryegrass sward, assuming average Irish nitrogen fertiliser applications.

The higher the dry matter of grass (DM%), the lower the required intake to provide a given level of energy.
Grass quality

What is digestibility?
The quality of grazed grass is described by its digestibility value. Digestibility is the proportion of the forage that can be potentially digested by a ruminant. The digestible part of the forage comprises of a combination of crude protein, carbohydrate (including digestible fibres and sugars) and lipids (oils).

The digestibility of grazed grass
Digestibility of grass is highest when a sward comprises of fresh leafy growth and declines as the plants become more mature (stemmy). During May to June when a grass is starting to turn reproductive (seed heads emerge) the digestibility can reduce to as low as 67%. The top ranking varieties on the Recommended List will be higher at 72-75%. Swards managed within an 18-25 day rotational grazing period will have a higher D-value, typically in the region of 74-77%, with the top ranking varieties corresponding to 77-80%. Weed grasses will be substantially lower in D-value than modern ryegrasses.

What is Metabolisable Energy (ME)?
Metabolisable Energy (ME) is the amount of energy that an animal can derive from the feed. It is measured in megajoules of energy per kilogram of forage dry matter (MJ/kg DM). ME is directly correlated with digestibility because any feed has to be digestible in order for the energy to be available.

One percentage point of D-value equates to 0.16 MJ/kg DM of ME.

Making the most of digestibility and metabolisable energy
The higher the D-value that can be achieved, the better the ruminant performance will be in terms of milk production or growth rates. In Ireland, Teagasc estimates that a one-unit increase in digestibility value equates to 0.33 litres of milk per dairy cow per day.

<table>
<thead>
<tr>
<th>Grass species</th>
<th>Average D-value</th>
<th>Average ME (MJ/kg DM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perennial Ryegrass</td>
<td>73</td>
<td>11.7</td>
</tr>
<tr>
<td>Timothy</td>
<td>68</td>
<td>10.9</td>
</tr>
<tr>
<td>Smooth Meadow Grass</td>
<td>61</td>
<td>9.8</td>
</tr>
<tr>
<td>Red Fescue</td>
<td>61</td>
<td>9.8</td>
</tr>
<tr>
<td>Creeping Bent</td>
<td>58</td>
<td>9.3</td>
</tr>
</tbody>
</table>

Data from J. Frame, 1991

Typical nutrient content of farm feeds

<table>
<thead>
<tr>
<th></th>
<th>DM (%)</th>
<th>ME (MJ/kg DM)</th>
<th>Protein (% in DM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grazed leafy ryegrass</td>
<td>15-20</td>
<td>11.5</td>
<td>16-25</td>
</tr>
<tr>
<td>White clover</td>
<td>10-18</td>
<td>12.0</td>
<td>25-30</td>
</tr>
<tr>
<td>3 cut grass silage</td>
<td>16-28</td>
<td>10.5-11.5</td>
<td>12.18</td>
</tr>
<tr>
<td>Big bale silage</td>
<td>35</td>
<td>10.5-11.5</td>
<td>12.5-17.5</td>
</tr>
<tr>
<td>18% protein compound</td>
<td>86</td>
<td>10.3-12.0</td>
<td>20.9</td>
</tr>
<tr>
<td>Soya bean meal</td>
<td>88</td>
<td>12.9</td>
<td>47.6</td>
</tr>
<tr>
<td>Barley</td>
<td>86</td>
<td>13.2</td>
<td>12.3</td>
</tr>
</tbody>
</table>

Source: DAFM, 2015 Grass and Clover Recommended List

Grass species

<table>
<thead>
<tr>
<th>Total Annual DM Yield %</th>
<th>Digestibility (DMD%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>108</td>
<td>107</td>
</tr>
<tr>
<td>107</td>
<td>106</td>
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<td>106</td>
<td>105</td>
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<td>99</td>
<td>98.5</td>
</tr>
<tr>
<td>98.5</td>
<td>98</td>
</tr>
<tr>
<td>98</td>
<td>97</td>
</tr>
</tbody>
</table>

Source: DAFM, 2015 Grass and Clover Recommended List

Germinal varieties appear in yellow and green on the chart

Points on D-value and ME
Select the highest ranking varieties on the Irish Recommended List
Use a rotational (18 – 25 day) paddock grazing system with entry determined by the ‘Three Leaf System’ (see page 19)
Consider soil nutrient availability and when applying fertiliser always apply in accordance with best practice
Cut for silage prior to stem thickening, or approximately one week before heading
When necessary, top grazing swards to prevent heading

The Clover Effect
White and red clovers typically have D-values comparable to the highest ranking ryegrass varieties, with a greater proportion of the digestible material being in the form of crude protein (i.e. less carbohydrate).
The optimum white clover content in a grazing sward is an average of 30% over a grazing season.
If including red clover in a silage ley, it is important to use compatible ryegrass varieties to achieve the best overall D-value at cutting. As with ryegrass, D-value of red clover declines rapidly with increased crop maturity with the target being to cut when no more than half the plants are in bud.
Water soluble carbohydrate

Why is water soluble carbohydrate (WSC) in grass important?

Water soluble carbohydrates are the soluble sugars that are quickly released from grass within the rumen. These sugars provide a readily available source of energy for the rumen microbes that are responsible for digesting forage. These sugars also provide the fuel for silage fermentation. The higher the sugar, the better the silage is preserved and the higher the feed value for the animal.

The range of WSC in grass

Higher WSC is a major differentiating factor in modern ryegrasses bred at IBEERS Aberystwyth University over the last 30 years. Varieties higher in WSC than conventional varieties are now available as Aber High Sugar Grass.

Relative differences in WSC are maintained between ryegrass varieties even though the content typically rises and falls over a season, with varying weather conditions and even over the period of a day. On a warm sunny summer day, WSC content can be as high as 35% of dry matter, whilst on a cool cloudy autumn day it can be as low as 10%, but at either end of the spectrum differences between varieties are maintained.

Making the most of WSC

A high WSC will generally mean forage composition is closer to the 2:1 WSC-to-crude protein ratio that animal models suggest is the target for optimum nitrogen use efficiency in the rumen. This means that more of the feed is converted into milk and meat, with less going to waste in urine (and methane). Under ideal growing conditions, modern Aber HSG ryegrasses will achieve the optimum ratio of 2:1 for WSC-to-protein.

Pointers on WSC

- Select and sow grass and silage mixtures that have high digestibility and high WSC values
- Avoid over-use of fertiliser by following best practice guidelines
- Cut for silage late in the afternoon to maximise the WSC content
- Avoid making overly wet silage (below 28% DM) as this may result in sugar losses in the effluent and increases the amount of effluent; wet silage also has increased need for sugars to create a good fermentation and stable silage
- WSC generally peaks 3 -5 weeks after grazing or cutting

The Clover Effect

White clover is generally lower in WSC and higher in protein than perennial ryegrass so it is important to maintain the target of 30% white clover sward content over a grazing season for optimum performance

Red clover is generally lower in WSC than perennial ryegrass so growing it in combination with high WSC grass varieties is beneficial for silage fermentation

Average WSC over five years

<table>
<thead>
<tr>
<th>Average WSC over five years</th>
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<tbody>
<tr>
<td>WSC g/kg DM</td>
</tr>
<tr>
<td>March</td>
</tr>
<tr>
<td>Normal varieties</td>
</tr>
<tr>
<td>300</td>
</tr>
</tbody>
</table>

Effect of DM at ensiling on WSC content of silage as a result of fermentation

<table>
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<tr>
<td>WSC g/kg DM</td>
</tr>
<tr>
<td>Homfermentative Inoculant</td>
</tr>
<tr>
<td>22.3</td>
</tr>
</tbody>
</table>

Wetter silage ultimately uses up more sugar to achieve a stable fermentation, leaving less for the animal.
**Protein**

**Why is protein in grass important?**

Protein is a large and expensive component of livestock rations, and reliance on imported sources (e.g. soya) leaves businesses vulnerable to price volatility and supply. Greater use of homegrown protein is therefore desirable.

Protein in grass is generally reported as total crude protein (CP), which is 6.25 times the nitrogen content. Typically around 80% of the crude protein in fresh grass is true protein. The remaining fraction is often referred to as non-protein nitrogen. Both types of nitrogen can be used by the animal but the true protein is used more efficiently for meat and milk production. A larger part of the non-protein nitrogen is used inefficiently and is excreted by the animal.

Crude protein can be split into effective rumen degradable protein (ERDP) and digestible undegradable protein (DUP). ERDP, which is by far the biggest part of fresh forage protein, can be broken down by rumen microbes and converted into microbial protein that is digested later. DUP passes through the rumen intact and can be broken down and digested in the small intestine.

**Protein range in grass**

Crude protein content can vary within single varieties and between varieties and is influenced by management factors such as nitrogen fertiliser applications and crop maturity. The proportion of the crude protein that is available as true protein is lowest in the period after nitrogen fertiliser is applied, but rises as the grass grows and converts non-protein nitrogen into true protein.

In silage, the proportion of crude protein that is available as true protein is affected by the fermentation. A better fermentation results in more of the crude protein remaining as true protein.

Grazed grass provides the best source of true protein. Good ensiling practice will preserve more of the true protein in silage.

**Making the most of protein in grass**

Animal research has shown that typically only about 20% of protein consumed by ruminants is used (to maintain the animal and produce meat or milk); the rest is lost in waste products and excreted from the body. A better balance of protein and energy supply to the rumen will improve the proportion of protein that is used. Feeding forage (as grazed grass or silage) with a higher sugar (WSC) content has been shown to improve protein utilisation in ruminants.

Given the optimum balance of protein and energy sources, dietary crude protein concentrations can routinely be as low as 12 - 14% of dry matter without any detriment to livestock productivity (14% for milk production).

Apply fertiliser in line with best practice guidelines as soon as possible after grazing or cutting

Avoid making overly wet silage (below 28% DM) as this may result in soluble protein losses in the effluent

Optimum protein concentrations occur 3 – 5 days after cutting or grazing

**The Clover Effect**

White clover is generally higher in protein than ryegrass; it is important to maintain an optimum balance in grazing swards of an average 30% of dry matter over the season

Red clover is a high protein forage (typically 22% crude protein). It contains an enzyme (PPO) that in silage helps to maintain the proportion of true protein

**Typical nutrient content of farm feeds**

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Fibre

Why is fibre important in grass?

Fibre is essential in the diet of ruminants to provide the 'scratch factor' essential to stimulate rumen function. There is an important balance to be achieved in all diets for optimum performance.

Fibre is measured as NDF (neutral detergent fibre), this being the insoluble fibre fraction (cellulose, hemicellulose, pectin and lignin) that remains after boiling in a neutral detergent solution.

Carbohydrates within NDF are not as readily accessible as those in the WSC component of ryegrasses. However, NDF content is important for predicting ruminant voluntary intake.

The proportion of NDF that can be digested by ruminants is referred to as dNDF. This is a secondary source of slowly released carbohydrates that provides a useful source of fermentable energy for ruminants within the rumen and hind gut.

The range of fibre in grass

Grass fibre concentration can vary greatly during the growing season. It is at its highest (and the grass least digestible) when the sward is producing reproductive seed heads rather than vegetative leaves. Conversely, during the early spring when fresh growth is at its peak, fibre content is typically at its lowest (grass is most digestible).

Making the most of fibre in grass

The principle target with fibre is to maximise animal voluntary intake whilst ensuring sufficient rumen digestion time.

For grazing, the optimum NDF content of grass should be in the range of 30 – 40% of total dry matter, with dNDF around 20-30% of total dry matter, or roughly 60-75% of the total fibre content in a digestible form.

When grass fibre content falls below these optimum levels (e.g. early spring flush) supplementary feeding of fibre may be necessary to prevent grass passing through the rumen too rapidly.

When making silage, it is important to cut before grass becomes too mature (pre-heading) to avoid a significant reduction in digestibility.

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Why are lipids important in grass?
Lipids in forage grasses contain a high proportion of polyunsaturated fatty acids (PUFA). These are the ‘good’ fatty acids, better known as Omega 3 and Omega 9, which have positive human health effects.

From an animal production perspective, increased PUFA supply has been shown to improve animal fertility and result in positive effects on meat quality (longer shelf life and a more desirable colour). There is also evidence of reduced methane emissions from ruminants consuming high PUFA diets, an effect that is positive for the environment.

The range of lipids in grass
Early data suggests total fatty acid content of grass varies from about 2.5 to 5% of forage dry matter, with the PUFA component making up 65 – 78% of the total lipid content.

Making the most of lipids in grass
Lipids have approximately twice the energy content of carbohydrates (WSC and fibre) and are an important source of energy for livestock. Ruminant diets are frequently supplemented with high lipid feeds as a means of increasing the energy content of the diet.

Grass fed livestock will naturally consume more polyunsaturated fatty acids (Omega 3 and Omega 9) which is believed to improve the colour of aged meat and potentially extend shelf life.

Current and future grass breeding programmes at IBERS Aberystwyth University have identified lipid concentration and fatty acid profile as important objectives.

Fresh grass provides a better PUFA profile than many dry feeds
Forage-based systems have the potential to produce better quality human food due to the favourable PUFA profile in grass
When silage making, rapid wilting will increase the level of lipids retained in the forage

White clover lipid content is generally reported to be slightly lower than that of ryegrass, with a range of 2 – 4.4% of forage dry matter.
Red clover is generally reported to be higher in polyunsaturated fats than ryegrass.
Minerals and Vitamins

Why are minerals and vitamins important in grass?

Minerals include various elements like calcium, selenium and iron. These basic elements, like the more complex vitamins, have important roles in the health and performance of livestock. Understanding the mineral and vitamin content of supplementation that may or not be required.

The range of minerals and vitamins in grass

The mineral content of a sward will depend largely upon the mineral availability in the soil and the pH (see table). Mineral and vitamin content will not usually change in silage, though in very wet crops some losses may occur in effluent. Whilst many vitamins are synthesised by rumen microbes, some lipid soluble vitamins must be obtained from feed (vitamins A, D and E) and all vitamins provided by feeds can be a useful addition to the ruminant’s diet.

Nutrient availability chart

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Soil pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>NA</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>HA</td>
</tr>
<tr>
<td>Potassium</td>
<td>MA</td>
</tr>
<tr>
<td>Sulphur</td>
<td>MA</td>
</tr>
<tr>
<td>Calcium</td>
<td>MA</td>
</tr>
<tr>
<td>Manganese</td>
<td>MA</td>
</tr>
<tr>
<td>Iron</td>
<td>MA</td>
</tr>
<tr>
<td>Magnesium</td>
<td>MA</td>
</tr>
<tr>
<td>Zinc</td>
<td>MA</td>
</tr>
<tr>
<td>Copper</td>
<td>MA</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>MA</td>
</tr>
</tbody>
</table>

Making the most of mineral and vitamins in grass

Accurately managing a sward for mineral and vitamin content will require soil analysis for each paddock. Where any mineral is found to be deficient, provision of supplemental licks or mineral boluses can overcome most deficiencies.

When turning stock into lush pastures of rapidly growing grass, particularly in the spring, it is advisable to monitor them to further reduce the risk of tetany. Supplement rations with minerals in line with silage analysis.

Pasture Profit Index

What is the Pasture Profit Index?
The Pasture Profit Index (PPI) is a selection tool for perennial ryegrass varieties, developed by Teagasc, which places economic values on the traits of importance for a grass-based ruminant production system. The purpose of the Pasture Profit Index is to help the grassland industry and farmers identify the most appropriate perennial ryegrass varieties for their farm. The PPI comprises of six sub-indices outlined opposite:

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The performance values included in the Pasture Profit Index are based on data collected from the DAFM grass variety evaluation trials.

Using the Pasture Profit Index

When using the PPI to select grass varieties, using the sub-indices presents the opportunity to select varieties for specific purposes. For example, if selecting a variety for intensive grazing, the emphasis would be placed on seasonal DM yield and quality with less importance on the silage performance.

If selecting a variety specifically for silage production then greater emphasis would be placed on the performance of that variety within the silage sub-index and persistency.

How are economic values determined?
The economic value of each trait is determined using the Moorepark Dairy Systems Model. The economic value of a unit change in each trait is outlined below:

The economic merit of a variety for each trait is calculated by determining the difference between the performance of each variety and a base value for each trait. This difference is then multiplied by the economic value of the trait. The sum of the individual trait is then calculated to determine the total economic merit of a cultivar (€ per ha per year).

The performance values included in the Pasture Profit Index are based on data collected from the DAFM grass variety evaluation trials.

From 2015 onwards, the Pasture Profit Index will be published annually by Teagasc and the Department of Agriculture, Food and the Marine (DAFM) in conjunction with the Irish Recommended List for Grass varieties.
Grazing management

In order to maximise the nutritional value of grass it is important to manage grazing effectively. This means ensuring the optimum balance between sward quality and quantity, thereby maximising intakes when the grass is in its best nutritional condition.

Regardless of whether livestock are set-stocked or rotationally grazed, the key is to assess pastures regularly (at least weekly) in order to establish when grass is at the right stage for grazing and when it is time to close an area to allow re-growth. Over and undergrazing a sward both have negative consequences for the subsequent rotation. Overgrazing will result in slower regrowth and may affect the persistence of the sward if it occurs repeatedly, as well as reduced animal performance and losses in animal condition and bodyweight. Undergrazing results in poor utilisation of the sward, increasing the wastage of the feed and resulting in poor quality stemmy material being present in the sward at the next grazing rotation.

Methods to assess the condition of a sward for grazing include measuring sward height to establish herbage mass or grass cover (kg DM/ha). Using a rising plate meter or quadrant and shears are the most common methods of doing this. Guidelines on the optimum herbage mass are well established and widely published (see tables below).

Guideline pasture herbage mass (farm cover) for a spring-calving herd stocked at 2.5 cows/ha*

<table>
<thead>
<tr>
<th>Month</th>
<th>Stocking rate (on grazing platform) (cow/ha)</th>
<th>Growth (kg DM/day)</th>
<th>Target average farm cover (kg DM/ha)</th>
<th>Target cover per cow (kg DM/cow)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb 15</td>
<td>2.5</td>
<td>9.0</td>
<td>798</td>
<td>338</td>
<td>Cows grazing by day</td>
</tr>
<tr>
<td>Mar 15</td>
<td>2.5</td>
<td>37.6</td>
<td>568</td>
<td>243</td>
<td>Cows grazing full time</td>
</tr>
<tr>
<td>May 10</td>
<td>4.2</td>
<td>88.2</td>
<td>840</td>
<td>200</td>
<td>Supply exceeds demand</td>
</tr>
</tbody>
</table>

From May to August, use the grass wedge (maintain farm cover at 140 – 190 kg DM per cow)

<table>
<thead>
<tr>
<th>Month</th>
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<th>Growth (kg DM/day)</th>
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<th>Target cover per cow (kg DM/cow)</th>
<th>Notes</th>
</tr>
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<tbody>
<tr>
<td>Aug 15</td>
<td>2.5</td>
<td>65</td>
<td>848</td>
<td>342</td>
<td></td>
</tr>
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<td>Sept 15</td>
<td>2.5</td>
<td>37</td>
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<td>Oct 15</td>
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<td>1050</td>
<td>424</td>
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<tr>
<td>Nov 15</td>
<td>2.5</td>
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<td>650</td>
<td>262</td>
<td>Supplement introduced</td>
</tr>
<tr>
<td>Nov 22</td>
<td>2.5</td>
<td>3</td>
<td>560</td>
<td>224</td>
<td>Housed full-time</td>
</tr>
</tbody>
</table>

Monitoring the emergence of these leaves is commonly considered to be the best way to gauge the optimum pre- and post-grazing points in grazing swards, and planning the time that a given area will support grazing of the highest quality.

- The optimum pre-grazing stage is when the ryegrass tillers have at least two and a half and preferably three fresh leaves.
- Grazing when there are less than two fresh leaves reduces plant vigour and re-growth potential.
- Grazing when there are more than three leaves results in reduced sward productivity and reduced nutritional value as the proportion of dead and decaying material rises. In mixed swards, clover may be impaired due to excessive shading.

Using the Three-Leaf System

Whilst good and recommended practices, sward sticks and plate meters are primarily measurements of quantity whereas nutritional value is more related to quality. The established qualitative method of sward assessment is the Three-Leaf System.

This method is based on the understanding that a ryegrass tiller typically supports three green leaves.

As shown by the diagram, the typical ryegrass tiller structure includes the youngest green leaf (leaf 1) growing at the top; two further green leaves (leaf 2 and leaf 3) that are no longer growing; and a dead and decaying leaf (leaf 4).

Using the Three-Leaf System

Assessments should be made at least weekly prior to grazing, with more frequent counts in the spring when grass is growing most rapidly and less often in late-autumn.

Select a suitable ryegrass tiller

- Identify ryegrass from the red stem base
- Only use vegetative tillers (avoid anything with seed heads)
- Use the main parent tiller (as opposed to a daughter tiller)

Identify the remnant leaf

- The youngest growing leaf when the grass was last grazed (near the base of the tiller, likely to have a blunt end)
- Assess the length of the remnant leaf in relation to the fresh un-grazed leaf above it
- If the remnant is more than half the length of the first fresh leaf, count it as 0.5 – 1, but if not it should not be counted
- If there is no remnant leaf, do not include this tiller in the assessment
- If there is more than one remnant leaf (because the sward was under-grazed previously) counting should start with the youngest remnant

Count the fresh leaves

- Start with the remnant leaf (as above)
- Each of the next full leaves count as 1.0
- The youngest (top) leaf may only be partly grown and should be assessed by its size relative to the previous leaf (this top leaf may not be immediately obvious but is often close to the previous leaf and can be revealed by opening the evident leaf by rolling it between thumb and forefinger)

Count up to 10 tillers

- Select up to 10 tillers randomly across the field
- Calculate an average to create an accurate assessment
- An evenly grazed area will have most of the tillers assessed within a half leaf stage of each other

Guideline pasture herbage mass (farm cover) for a spring-calving herd stocked at 2.5 cows/ha*

<table>
<thead>
<tr>
<th>Month</th>
<th>Stocking rate (on grazing platform) (cow/ha)</th>
<th>Growth (kg DM/day)</th>
<th>Target average farm cover (kg DM/ha)</th>
<th>Target cover per cow (kg DM/cow)</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Feb 15</td>
<td>2.5</td>
<td>9.0</td>
<td>798</td>
<td>338</td>
<td>Cows grazing by day</td>
</tr>
<tr>
<td>Mar 15</td>
<td>2.5</td>
<td>37.6</td>
<td>568</td>
<td>243</td>
<td>Cows grazing full time</td>
</tr>
<tr>
<td>May 10</td>
<td>4.2</td>
<td>88.2</td>
<td>840</td>
<td>200</td>
<td>Supply exceeds demand</td>
</tr>
</tbody>
</table>

From May to August, use the grass wedge (maintain farm cover at 140 – 190 kg DM per cow)

<table>
<thead>
<tr>
<th>Month</th>
<th>Stocking rate (on grazing platform) (cow/ha)</th>
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*Targets are set for a stocking rate of 2.5 cows/ha and will have to be adjusted accordingly if actual stocking rate differs to this.

Source: Teagasc
Making quality silage

This quick reference guide to silage making assumes that soils are free from compaction and have optimum nutrient status. It is a prompt to seek further information if required.

**Mixture selection**

Important considerations when selecting a grass mixture for silage making should include:

• Planned duration of the ley
• Number and timing of cuts in a season
• Silage only or dual purpose
• Quantity and quality
• Clover (white clover may have a limited role in silage swards)

Addressing these points will help ensure that the type of mixture is fit for purpose. Mixtures for silage production will contain a number of ryegrass varieties and often may include perennial, hybrid or Italian ryegrasses.

To ensure you have the best mixture for your purpose:

• Ensure all varieties are high ranking on the latest Irish Recommended List and the Pasture Profit Index
• Consider the relative merits of diploid and tetraploid varieties
  * Diploids are more persistent and create a denser sward, better suited to wetter conditions and where long term grazing is also required
  * Tetraploids have a more upright growth habit and can be faster establishing
• Ensure the heading date range within the mixture is as tight as possible (1 week optimum) and coincides with target cutting dates in order to maximise quality

**Timing of harvest**

When making silage, it is usually the case that as quantity increases, quality decreases. This is because the more mature (and higher yielding) crop will have lower nutritional value, for reasons explained earlier in this guide.

Therefore, there is an inevitable compromise, with decisions on when to cut best determined by the class of livestock to be fed and stock performance targets as well as weather conditions around the time of harvest.

**Wilting**

Wilting to achieve an optimum silage dry matter of 30-35% (pit) and 35-40% (bale) should ideally be quick and short, so a maximum wilt of 24-36 hours. Avoid mowing and harvesting under very wet conditions.

• Successful wilting will greatly assist preservation and reduce effluent output. The best wilting occurs where the grass is mown after the dew has evaporated and is then placed in wide rows or is tedded.

**Making quality silage**

Quality grass silage can be made in both clamps and bales, and both systems have their place on livestock farms. The choice depends on individual farm circumstances and a range of variables. Silage additives will not salvage poor quality forage, but when the right product is selected for the right purpose they may help make good silage even better.

**Making good pit silage**

Fill the silo quickly, rolling the herbage throughout, and immediately seal it perfectly. This will help achieve the air-free conditions that are necessary for good preservation and to prevent mould growth.

• Ensure all machinery entering the silage pit have clean wheels with less oxygen trapped inside; chopping also releases sugars to assist a rapid fermentation
• Use good quality wrap and an effective wrapper to apply at least six layers
• Move bales for stacking as soon as possible after wrapping
• Protect bales from bird and rodent damage and examine frequently to ensure wrap has not being damaged

**Making good silage in bales**

The key to making quality baled silage is to ensure dense, air-tight bales, and ensure an air-tight seal.

• Create a box-shaped swath
• Use a baler with a chopping function to produce denser bales
• Cover completely with a layer of car tyres, etc., placed edge-to-edge
• Seal the edges with a layer of sandbags for example
• As the silage sinks somewhat in the silo during the following week or two, adjust the plastic seal to ensure no ingress of air occurs
• Inspect the plastic cover frequently and immediately repair any visible damage
Understanding a silage analysis

Whether clamped or baled, conserved forage will often make up a large proportion of ruminant diets. It is important, therefore, to understand the nutritional value through a representative silage analysis.

Obtaining a representative sample

For clamps

- Cored sample in a diagonal line across the top of the clamp
- At least four samples per clamp
- Mix samples well, seal in an air-tight bag, and send for analysis without delay

For bales

- Three cored samples per bale, each taken from top to bottom
- Or, sample at feedout (when bales are mixed and chopped)
- Mix samples well, seal in an air-tight bag, and send for analysis without delay

Your silage analysis will include values for all of the main nutritional components. Review these values against target levels and adjust feed supplementation accordingly. As highlighted below, different parameters are related to crop quality in the field, success of fermentation, or both.

By understanding which parameter relates to which part of the process, steps can be taken to improve methods in future years.

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Abbreviation</th>
<th>Units</th>
<th>Range</th>
<th>Target value **</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter</td>
<td>DM</td>
<td>g/kg</td>
<td>150-500</td>
<td>280-350</td>
</tr>
<tr>
<td>Dry matter digestibility</td>
<td>DMD</td>
<td>%</td>
<td>55-75</td>
<td>&gt;70</td>
</tr>
<tr>
<td>Metabolisable energy</td>
<td>ME</td>
<td>Ml/kgDM</td>
<td>8.8-12.0</td>
<td>&gt;11</td>
</tr>
<tr>
<td>Neutral detergent fibre</td>
<td>NDF</td>
<td>g/kgDM</td>
<td>500-650</td>
<td>500-550</td>
</tr>
<tr>
<td>Acid detergent fibre</td>
<td>ADF</td>
<td>g/kgDM</td>
<td>230-350</td>
<td>300</td>
</tr>
<tr>
<td>Ash</td>
<td></td>
<td>g/kgDM</td>
<td>60-200</td>
<td>&lt;80</td>
</tr>
<tr>
<td>Crude protein</td>
<td>CP</td>
<td>g/kgDM</td>
<td>100-200</td>
<td>150-175</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td></td>
<td>3.5-5.5</td>
<td>Depends on DM</td>
</tr>
<tr>
<td>Ammonia N</td>
<td>NH3N</td>
<td>g/kgDM</td>
<td>20-300</td>
<td>&lt;80 (depends on DM)</td>
</tr>
<tr>
<td>Total fermentable acids</td>
<td>TFA</td>
<td>g/kgDM</td>
<td>20-200</td>
<td>&lt;100 (depends on DM)</td>
</tr>
<tr>
<td>Volatile fatty acids</td>
<td>VFA</td>
<td>g/kgDM</td>
<td>10-90</td>
<td>%TFA 25% (as low as possible)</td>
</tr>
<tr>
<td>Lactic acid*</td>
<td></td>
<td>g/kgDM</td>
<td>20-200</td>
<td>80-120</td>
</tr>
<tr>
<td>Acetic acid</td>
<td></td>
<td>g/kgDM</td>
<td>20-80</td>
<td>&lt;25</td>
</tr>
<tr>
<td>Butyric acid</td>
<td></td>
<td>g/kgDM</td>
<td>0-20</td>
<td>&lt;5</td>
</tr>
<tr>
<td>Residual sugars</td>
<td></td>
<td>g/kgDM</td>
<td>0-150</td>
<td>100 (as high as possible)</td>
</tr>
</tbody>
</table>

*For well fermented silage acid as the proportion as the total acids should be >75%.
**Different analytical companies use different units for expressing the values. This example shows g/kg DM to convert to %, divide the value by 10.

Indications of in-field crop quality – D-value, ME, Crude Protein, ADF, NDF
Indications of fermentation quality – Lactic Acid, Acetic Acid, Butyric Acid, Ammonia N, VFAs
Indications of both crop and fermentation quality – Dry Matter, pH, WSC

Acknowledgements

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