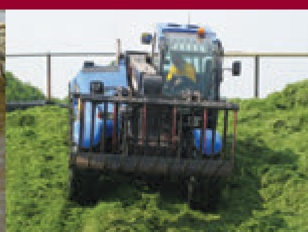
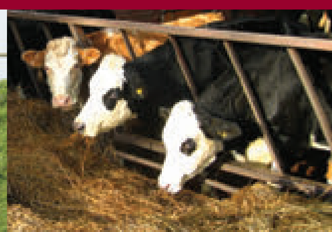
Better Returns Programme

BEEF AND SHEEP BRP MANUAL 5

Making grass silage for Better Returns





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This publication is available from our website at beefandlamb.ahdb.org.uk.

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Better Returns Programme

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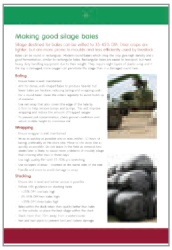
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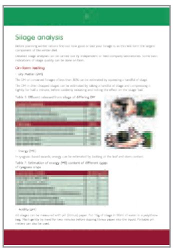

Silage analysis


Making up a forage shortfall

Grass grown for silage has different needs to grass grown solely for grazing. Done well, it can provide high quality forage for winter feeding.

As with all crops, good silage depends on using the right varieties of grass, while optimising soil conditions for growth. Then many management decisions are needed, including when to cut, how to store and how to feed.

Producing silage is not cheap. So the challenge is to produce enough of appropriate quality for the stock that is going to eat it, be it pregnant ewes, dry cows or finishing cattle.

This manual covers many of the key issues when making silage. It all starts with the soil, then selecting the right grasses and cutting them at the appropriate stage. It then discusses the pros and cons of bales and clamp silage and provides guidance on how to calculate winter feed requirements. Finally it indicates how much it costs to make good silage.

Dr Liz Genever

AHDB Beef & Lamb
Livestock Scientist

Growing good grass

The starting point for growing good grass for silage is the soil. Having adequate fertility and good structure are crucial.

Less than 30% of beef and sheep farmers regularly soil test and few dig holes to check what is happening under the surface. Without attention to the soil, grass and silage yields will be compromised.

Beef & Sheep BRP Manual 3 – Improving soils for Better Returns has more information on soil analysis. Download at **beefandlamb.ahdb.org.uk**, email **brp@ahdb.org.uk** or call **024 7647 8834** to request a free copy.

Selecting the right types of grass

Silage can be cut from a variety of field types, from specialist short-term leys to permanent pastures that are mainly grazed.

Ryegrasses have been bred for many decades for yield, quality and the ability to utilise nutrients. They are important for silage making.

Both white and red clover can also make excellent conserved forage, but selecting the right type is essential.

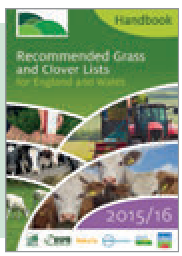
Table 1: Summary of how and when to use grass and clover types

	Specialist silage leys (1-3 years)	Medium term cutting and grazing leys (2-4 years)	Long term cutting and grazing leys (5+ years)
Perennial ryegrass (diploid)	✘	✔	✔
Perennial ryegrass (tetraploid[a])	✔	✔	✘
Italian ryegrass	✔	✘	✘
Hybrid[b] ryegrass	✔	✔	✘
White clover (small leaf)	✘	✔	✔
White clover (medium leaf)	✔	✔	✔
White clover (large leaf)	✔	✔	✘
Red clover	✔	✔	✘

[a] Tetraploids have a more upright growth habit and work better in a cutting system.
[b] Hybrid ryegrass is a cross between perennial and Italian varieties, combining the strengths of the two parent species.

The Recommended Grass and Clover Lists are updated annually providing information on the best performing grasses and clover available from merchants.

The scheme is funded by plant breeders through the British Society of Plant Breeders and the ruminant levy boards – AHDB Beef & Lamb, AHDB Dairy and Hybu Cig Cymru (HCC Meat Promotion Wales). The varieties that make it onto the list have been independently tested.



Growth stages

All grass wants to do is reproduce and throw up a seed head. Good grassland management prevents this happening. With silage, the aim is to optimise the amount of heading so that the nutrient content available, in particular the digestibility and energy, is correct for the type of livestock the silage will be fed to.

Grass varieties have different heading dates which are triggered by different temperatures, eg early heading grasses can start to grow at low temperatures in March and April.

The stage of growth at which the crop is cut will have more influence on the eventual feeding value of the silage than any other factor under the farmer's control.

Heading date

Grasses are classified according to heading date. This is the date on which 50% of the ears in fertile tillers have emerged. Choose a silage mixture with grasses with similar heading dates.

There is a tricky balance to achieve between producing low yields of highly digestible young grass and high yields of mature stemmy herbage which has low digestibility (see Figure 1).

The target will depend on the type of stock being fed, eg dry cows or growing youngstock.

Figure 1: D-value will vary depending on leaf/stem growth.

72 D-value, leafy growth. Typical first cut yield of a long term ley – 4.6t DM/ha	68 D-value, lengthening of stems. Typical first cut yield of a long term ley – 6.1t DM/ha	65 D-value, flower heads emerging. Typical first cut yield of a long term ley – 7.5t DM/ha

Weed control

High levels of perennial broad-leaved weeds such as docks and thistles reduce silage yield and quality. Weeds also use nutrients that have been applied to boost grass growth, wasting money.

Effective herbicides take up to three weeks to get into the roots. Plan spray dates and balance ideal growth stage of the weed for treatment, with the anticipated cutting date.

Use a targeted product whenever possible. Ensure the weed is actively growing and follow manufacturers' recommendations.

When considering whether to spray clover swards, assess the density of clover, then compare the value of the nitrogen being supplied by the clover with the cost of the yield reduction caused by the weeds. A 20% weed infestation will reduce grass yield by at least 20%.

Go to **www.voluntaryinitiative.org.uk/grassland** for more information on current weed control advice and crop protection regulations.

Nutrients for silage

The nutrient status of grassland can be boosted by inorganic fertilisers. However, the value of nutrients contained in organic manures, which have been deposited by animals or spread mechanically, should be taken into account before any inorganic fertiliser is applied.

Acidity (pH)

Yield reductions will result if pH falls below the ideal of 6-6.5.

pH	<4.5	4.5-5.0	5.0-5.5	5.5-6.0	6.0-6.5
Yield	87%	88%	91%	96%	100%

Phosphate and Potash

Fields which are regularly cut for silage have a higher requirement for phosphate and potash.

A 30% dry matter (DM) silage contains 2.1kg of phosphate and 7.2kg of potash per tonne of fresh material, so the addition of potash is particularly important to maintain grass yields.

Even at potash index 2+, the maintenance requirement in a multi-cut silage system, is between 40-60kg/ha at each cut. At index 2, on a grazing-only pasture, the maintenance requirement is nil.

Sulphur

Sulphur deficiency is increasingly common in grassland, especially in second or later cuts where high rates of nitrogen have been applied, especially on shallow or sandy soils. Deficiencies can cause large reductions in yield.

When sulphur deficiency is indicated by poor growth and a yellow tinge to the youngest leaves, apply 40kg of SO_3/ha, as a sulphate-containing fertiliser, at the start of growth before each cut.

Nitrogen (N)

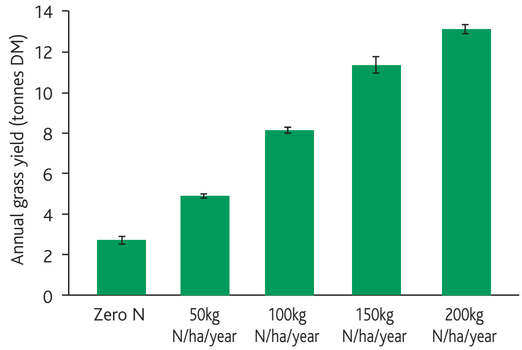
Grassland can utilise 2.5kg N/ha/day (around two units of N/acre/day) under ideal weather conditions. This can come from soil N, manures and inorganic fertiliser.

The average N fertiliser applied on UK beef and sheep farms is between 40-60kg/ha per year. Clover and manure deposition increases the amount.

Too much N produces grass with low sugar levels and any resulting silage can have high ammonia and butyric acid levels, making it less palatable. Too little N compromises yield and protein levels can be low.

Over the past few years silage crude protein levels have been falling. Carefully consider whether N fertiliser applications are either too low or too much in advance of harvest. The return on investment for fertiliser N compared to bought-in N in the form of high protein supplementary feeds in the winter is at least 3:1.

Figure 2: Effect of nitrogen on grass yield



Clover's ability to 'fix' N and make it available in the soil for plants, reduces the need for additional fertilisers or manure on grass/clover swards.

BRP has produced a manual that explains how red and white clovers can be incorporated into grassland systems. Email **brp@ahdb.org.uk** or call **024 7647 8834** to request a free copy.

Big bales or clamp?

The choice of storing silage as big bales or in a clamp will depend on the farm management system; both have a place and often a mix of both is beneficial. Bales are often seen as expensive but the value of their flexibility can not be under-estimated. Whether using clamp or bales, management is the most important factor for making the system cost effective.

One advantage of clamp over big bales is that it tends to be a quicker way of harvesting a large area of grass. However, there is need for the infrastructure, labour and expertise to consolidate and sheet properly and the ability to collect the effluent. These factors can have a big effect on losses and therefore cost of silage per kg/DM fed.

Big bales can be useful to harvest smaller areas effectively, producing good quality silage whilst also maintaining grazing quality. There is greater flexibility when using bales but the plastic must be disposed of appropriately.

It has been found that DM losses can be higher for clamp systems compared to bales (25% versus 8%). This can be due to poor consolidation and sheeting which leads to wastage in clamp systems.

With bales, quality can be targeted easily to livestock needs. It is often easier and quicker to feed out from clamp systems, but there is a risk of wastage at the feed face if it is not managed well.

TOP TIPS:

Record the yield (number of bales or number of loads) harvested off each field to calculate total production. This will highlight underperforming fields.

To avoid soil contamination:

- Roll fields when ground conditions allow
- Carry out mole control in November
- Do not cut too low

Acid based additives can help reduce the impact of soil contamination.

Crops that contain red clover need to be treated slightly differently.

- Cut when the clover is in the late bud stage for high protein content, or when the clover is in early bloom for lower protein content
- Leave a stubble of 7-8cm
- Do not use a conditioner, leave in wide swaths and do not ted to reduce leaf shatter
- Chop the crop
- Wilt for a maximum of 48 hours
- Use a homofermentative inoculant
- Red clover is naturally more aerobically stable than grass, so good silage management will produce a good end-product

The ensiling process

Silage making preserves grass in lactic acid produced by bacteria naturally present on the fresh crop.

These beneficial bacteria allow fermentation to take place which maintains nutrient content even after months of storage. This process also prevents undesirable bacteria and moulds developing.

Wilting

As soon as the crop is cut, the grass starts to lose nutrients, due to plant respiration and the growth of unwanted micro-organisms which break down the sugars and protein.

Rapid wilting and ensiling minimises these losses by quickly creating acid levels that stop further respiration. These reactions require anaerobic (air-free) conditions, which is why good consolidation in the clamp and quick sealing is crucial.

Sugar

For best results the crop needs an adequate sugar content; 2-3% sugar in the fresh grass – equivalent to 10-15% sugar in the DM.

Young, leafy grass that has received full nitrogen recommendations, grass/clover mixtures and autumn cuts, tend to have low sugar levels and lactic acid production may be insufficient to stop all spoilage. Applying additives can help prevent this.

pH

The required pH drop will depend on the DM of the crop – low DM = low pH, high DM = high pH.

Clamp silage of a given DM will generally have a lower pH than baled silage of the same DM. Baled silage is less well chopped, which means the fermentation is more restricted so a lower pH is not required to achieve a stable silage.

Wet crops

Wet crops have to reach a lower pH to inactivate all undesirable bacteria. Under these conditions acid additives can help achieve a better preservation, as they need less sugar to drive the fermentation.

Fermentation

Aerobic stage (air present)

Lasts a few hours

Oxygen levels reduced

Fermentation stage

Begins when no air left

Can last several weeks

Lactic acid should dominate

Stable stage

Can be reached in two to three days if additive used

Aim for pH 3.8-5 depending on the DM

Storage stage

Acidic conditions limit microbial activity as long as clamp/bale is air tight

Micro-organism populations gradually decline

Potentially dangerous organisms such as clostridia and bacilli can survive as spores

Well fermented silage has a fruity smell and should look bright.

What happens when it goes wrong?

Poorly made silage has a noticeable, usually unpleasant smell. Animals will not be keen to eat it and there will be a high degree of wastage. Some silages can be dangerous to feed.

Table 2: Troubleshooting silage problems

Problem	Cause
Rancid, fishy odour. Slimy, sticky texture, dark brown/black	High butyric acid level due to: • Soil contamination, late manure application or low DM (<25%) • Poor consolidation • Inadequate sealing
Mouldy silage with a musty odour	Presence of oxygen due to: • Poor filling and sealing, high DM (>35%) or poor feeding-out management
Smells of vinegar	• Acetic acid fermentation due to high levels of unwanted bacteria
Sweet smelling silage	• High levels of ethanol produced by yeasts plus some acetic acid
Ammonia odour	• Excessive protein breakdown to ammonia or clostridial fermentation, or high pH
Smells like tobacco or burnt. Looks orange brown	• Poor consolidation • Not sheeting overnight when filling takes longer than one day • Excessive heating in the first few days after sealing or too high DM

Listeriosis

Listeria bacteria thrive in soil and can be picked up at harvesting if the crop is cut too low or there are a lot of mole hills in the field.

There can be more of a problem with high DM later cut silage, which is more difficult to consolidate to exclude air.

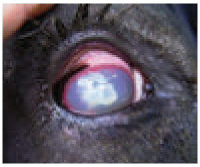
Listeria are micro-aerophilic, which means they only need a small amount of oxygen to survive and grow. Generally they are not found in the mouldy patches, but in areas of visibly good silage around the mouldy patches. Be sure to remove as much silage again from around the mouldy silage if feeding to sheep.

Sheep

Sheep are susceptible to small doses of listeria bacteria. Do not mix any potentially contaminated silage through a mixer or bale chopper with the aim of diluting it, as this increases the spread of the contaminated silage.

Affected ewes have drooping faces and drool, and walk in circles as a result of abscesses in the brain. Listeriosis also causes abortions in pregnant ewes and presents a risk to pregnant women. Most cases occur four to six weeks after eating affected silage.

Cattle



Silage eye (bovine iritis) in cattle can be caused by listeria infection from silage.

It can also cause abortions and circling. Healthy cattle are quite resistant, but poor feed quality, cold or wet weather and transport stress can increase the risk of infection.

Botulism

Clostridium botulinum, or the toxin produced by these bacteria, can be transmitted through silage. Whilst in some areas of the world soil contamination is the cause, generally UK soils do not contain this bacterium. The most likely cause is a dead animal ensiled in the forage which contained high levels of this organism. Even if the fermentation is good and controlled, the toxin will survive and kill livestock. Fields surface-spread with poultry litter containing animal carcases is another major risk factor.

Making good silage

Cutting date

Cutting date has a significant impact on silage yield and quality. As the crop starts to bulk up and yield increases, quality starts to decline as the grass begins to produce stems and heads. These are less digestible than leafy growth.

Optimum cutting date should be influenced by the class of stock the silage will be fed to.

Table 3: Targets for silage quality

	Good	Moderate	Poor
D-value	70	65	60
% of ear emergence	25%	50%	100%
Energy ME (MJ/kg DM)	11.5	10.5	9.5
Crude protein content %	16	12	10
Feed to:	Finishing stock, ewes carrying multiples	Growing cattle, autumn-calving suckler cows, ewes carrying singles	Dry stock, spring-calving suckler cows

Key: D-value = measure of feed digestibility.

As a rule, D-value falls by 0.5 units a day from when the grass starts to push up flowering stems. Fresh grass analysis can be useful to provide an estimate of D-value, nitrate N and crude protein. However, the sugar analysis will not resemble what is in the field at cutting, because it changes markedly from day to day and within each day, depending on the weather.

Moisture content

Reducing the moisture content of a crop by wilting saves carrying water and reduces effluent.

The target DM should be:

- 28-32% for clamp
- 35-45% for big bales

Rapid wilting ensures minimum losses in the field and better silage preservation. Long wilts increase the field DM losses and increase the likelihood of aerobic spoilage at feed-out.

In the field:

- Mow after the dew has dried off. Plant sugars are higher in the afternoon. A rapid wilt concentrates the sugars, allowing a quick and effective fermentation
- A conditioner on the mower splits the grass, so there is a greater surface area for water loss. This can increase wilting speed by up to 20%
- Leave a stubble of at least 5cm
- Spread the crop quickly and over a wide area. Water loss is highest for the first two hours after cutting
- Ensure rakes and tedders are set at the right height so they work efficiently and do not pick up soil or manure
- Wilt as rapidly as possible for a maximum of 24 hours; crops with high amounts of clover can be wilted for 48 hours
- Row up into even 'box-shaped' swaths immediately before pick-up or baling

See page 5 for details on making silage from red clover leys.

Chop length

Chopping grass when it is being picked-up or baled, results in a more efficient silage fermentation through greater release of sugars and the dispersal of trapped oxygen. The bales tend to be denser and 8-12% heavier than those made of un-chopped grass. In a clamp chopped material is easier to consolidate.

Chopped silage also breaks down more rapidly in the rumen, leading to higher animal intakes and performance. If feeding high levels of concentrate, a short silage chop length may exacerbate rumen health issues. However in sheep and beef cattle this is generally not a problem.

Additives

Additives cannot make a bad grass crop into good silage. When used well on good grass, they can improve fermentation and animal performance.

Additives are generally applied as the grass is being picked-up or baled, via a specific applicator. Different products vary in what they do, so it is vital the right one is selected.

Table 4: Summary of inoculants and how they work

Type	How they work	When to use it
Bacterial inoculants	**Homofermentative** inoculants containing bacteria such as *L. plantarum*, *Pediococcus* and *Lactococcus* which convert grass sugar to lactic acid. They improve speed of pH decline and reduce protein breakdown. To be effective on grass, one million bacteria/g of fresh forage must be applied	High quality grasses over 25% DM, late cut grass
	Heterofermentative inoculants contain species such as *L buchneri*, *L brevis* and *L kefira* which convert grass sugars to lactic and acetic acid. Designed to improve aerobic stability not fermentation quality. Require more sugar for the fermentation	High DM silage over 32%. Not on bales or low sugar crops such as legumes
Enzymes	Convert fibre in grass into sugars that bacteria can convert to lactic acid, or improve digestibility of low D-value silage at feeding	Crops low in sugar Generally results are marginal with enzymes
Acid, eg formic and propionic	Direct acidification of crop, so under wet or low sugar conditions can be useful. Propionic acid inhibits yeasts and moulds and can improve aerobic stability. Can be hazardous	Low DM silages, crops low in sugar
Sugar supplements, eg molasses	Increases amount of sugar for the lactic acid bacteria to convert. High rates and equal distribution needed	Crops low in sugar. Often needed in conjunction with a homofermentative inoculant, as the natural bacteria may be insufficient to convert the added sugar into lactic acid

Always evaluate the use of an additive before buying, based on its potential effect on the forage and livestock performance, as well as the cost.

Always follow the manufacturer's application instructions. Ask the retailer/sales representative for independent scientific trial results.

Making good silage bales

Silage destined for bales can be wilted to 35-45% DM. Drier crops are lighter, but are more prone to moulds and less efficiently used by livestock.

Bales can be round or rectangular. Modern round balers which chop the crop give high density and a good fermentation, similar to rectangular bales. Rectangular bales are easier to transport, but need heavy duty handling equipment due to their weight. They require eight layers of plastic wrap and if the top is damaged, more oxygen can penetrate the silage than in a damaged round bale.

Baling

- Ensure baler is well maintained
- Aim for dense, well-shaped bales to produce heavier but fewer bales per hectare, reducing baling and wrapping costs
- For a round baler, clean the rollers regularly to avoid build-up of material
- Use net wrap that also covers the edge of the bale by 2-5cm to help remove lumps and bumps. This will improve wrapping and reduce the amount of trapped oxygen
- To prevent soil contamination, check ground conditions and adjust stubble height to minimise risk

Wrapping

- Ensure wrapper is well maintained
- Wrap as quickly as possible and at least within 12 hours of baling, preferably at the store site. Move to the store site as quickly as possible. Do not leave in the field as removal two weeks later is likely to cause more problems of mouldy silage than moving after two or three days
- Use high quality film with 55-70% pre-stretching
- Use six layers of wrap – counted on the barrel sides of the bale
- Handle and store to avoid damage to wrap

Stacking

- Ensure site is level and winter access is possible
- Follow HSE guidance on stacking bales
  - <25% DM one bale high
  - 25-35% DM two bales high
  - >35% DM three bales high
- Bales within the stack retain their quality better than bales on the outside, so place the best silage within the stack
- Stack more than 10m away from a watercourse
- Net and bait stack to prevent bird and rodent damage

Making good clamp silage

Preparing the clamp

- Remove any old, mouldy or rotting silage and clean thoroughly
- Having airtight silo walls is very important – use a side sheet. It is almost impossible to obtain a good seal from oxygen without one
- Check there is adequate effluent drainage at floor level

Clamp filling

- Fill the clamp rapidly, spread silage evenly and consolidate well

The pressure exerted under the wheels of a heavy tractor will only be effective down to 20cm depth.

- If silaging continues the next day, sheet down overnight
- DO NOT ROLL the following morning as this creates a vacuum and pulls more air into the silage, when the aim is to get all the air out
- Prevent soil contamination by cleaning tractor tyres before rolling. Keep tipping area clear of mud
- Aim for 250kg DM/m^3 or 750kg fresh matter (FM)/m^3. This will improve quality, reduce DM losses and aerobic spoilage at feed-out
- Do not over fill a clamp. Compaction above the walls is at least 10% lower than if the silage is level with the walls. Poor compaction increases silo losses both during storage and at feed-out

Clamp sealing

- Seal as soon as consolidation is complete
- Cover with two sheets of plastic – preferably a thinner oxygen barrier sheet first and a thicker protective sheet above it. Or use a new sheet covered by last year's old sheet
- Place tyres or bales on top. Ensure all tyres touch each other
- Ensure the sheet is not punctured. Protect from birds with netting
- Ensure that unroofed clamps shed rainwater evenly and freely and that it does not seep into the clamp

Managing silage effluent

- Effluent must be collected as it is highly polluting
- Most effluent will be produced in the first ten days after ensiling. Short chop lengths increase early peak flow, as do acid-based additives
- Clamps should have an effluent storage capacity of at least two days at peak flow

Table 5: Effluent released from silage

DM % of crop	Amount of effluent released
25	Little
18	100 litres/tonne fresh weight per day at peak flow
15	200 litres/tonne fresh weight per day at peak flow

- Collected effluent can be spread on to land, but should be diluted 1:1 with water to reduce the risk of pollution and sward scorch. Aim for a rate of between 25-30m^3/ha (2,200-2,700 litres/acre). Do not spread near watercourses or bore holes
- In Nitrate Vulnerable Zones (NVZs), silage effluent has to be treated as an organic manure, so closed periods must be adhered to

Silage analysis

Before planning winter rations find out how good or bad your forage is, as this will form the largest component of the winter diet.

Detailed silage analyses can be carried out by independent or feed company laboratories. Some basic indications of silage quality can be done on farm.

On-farm testing

- Dry Matter (DM)

The DM of conserved forages of less than 30% can be estimated by squeezing a handful of silage.

The DM in drier chopped silages can be estimated by taking a handful of silage and compressing it tightly for half a minute, before suddenly releasing and noting the effect on the silage 'ball'.

Table 6: Effluent released from silage of differing DM

Amount of squeezing	DM %
Juice easily expressed by hand	<20
Juice expressed with some difficulty	20-25
Little or no juice expressed but hands moist	>25
'Ball' shape	**DM %**
Ball retains its shape and some free juice expressed	<25
Ball retains its shape but no free juice is expressed	28-32
Ball slowly falls apart	32-40
Ball rapidly falls apart	>40

- Energy (ME)

In ryegrass-based swards, energy can be estimated by looking at the leaf and stem content.

Table 7: Estimation of energy (ME) content of different stages of a ryegrass crop

Leaf and stem content	ME (MJ/kg DM)
Very leafy – no stem visible	12
Leafy – some stem present	11
Leafy with some flowering stems	10
Moderately leafy with large numbers of flowering stems	9
Stemmy – grasses at flowering stage	8
Stemmy – grasses at post flowering stage	7

- Acidity (pH)

All silages can be measured with pH (litmus) paper. Put 10g of silage in 90ml of water in a polythene bag. Mash gently by hand for two minutes before dipping litmus paper into the liquid. Portable pH meters can be used.

Understanding forage analysis

Dry Matter (DM) (%) – a measure of what is 'not' water

If silage is too wet (less than 25% DM), it can be difficult for animals to eat enough to meet their needs. If this is the case, more concentrate feed may be required to meet nutritional requirements.

Clamp silage: >25% GOOD – <22% POOR

Bale silage: >30% GOOD – <22% POOR

D-value (%) – a measure of feed digestibility

The higher the D-value the less concentrates will be needed to balance a ration.

70 GOOD – 58 POOR

Energy (ME MJ/kg DM) – a measure of the usable energy available to the animal when fed

When buying a supplement, make sure the ME is higher than that of the forage.

11 GOOD – <10 POOR

Crude Protein (CP) (%) – a measure of the protein content (but not of protein quality)

It is important to provide enough protein in supplementary feeds to make up any shortfall in the forage.

>14% GOOD – <10% POOR

pH – a measure of acidity

Target pH will vary depending on DM% of silage. Generally less than 3 or higher than 5 suggests poor fermentation.

4 GOOD – <3 or >5 POOR

Ash (%) – a measure of mineral and trace element content

For grass a maximum of 8% should be the target. A silage with 10% ash reduces the ME, indicates soil contamination, poor fermentation and should not be fed.

High ash figures for legume silages is normal due to their high mineral content.

Taking silage samples

It is important to take a sample that represents the whole clamp or all bales and to sample different cuts and fields separately.

If feed-out management is poor, the silage at the clamp face can be very different from the cored silage sample, with lower ME and protein. If this is the case consider taking more silage samples at feed-out from the face and adjust the ration accordingly. This may show management practices need to change.

1. Wait until six weeks after harvest
2. Take several cores across the clamp at least 1.5m deep, or from five bales of the same batch
3. Pack into a polythene bag and squeeze air out before sealing tightly
4. Send to laboratory early in the week
5. Give the laboratory as much information as possible, eg grass only, red clover, 1st or 2nd cut, bale or clamp, which additive was used

There are two types of analysis:

- Wet chemistry is the traditional method and uses laboratory techniques to analyse the sample
- NIRS (Near Infrared Reflectance Spectroscopy) uses the way light is absorbed and reflected, to analyse the components of a sample. NIRS has been calibrated back to wet chemistry, but care needs to be taken with non-grass forages, eg lucerne or chicory

If the clover percentage is greater than 30%, the results from NIRS may not be accurate. To obtain the protein content ask for wet chemistry analysis.

Calculating winter feed requirements

Work out how much forage is available. Then estimate how much is needed to feed the animals through the winter. Fresh weight (FW) does not reflect the amount of nutrients in a feed, so focus on DM requirements and availability.

Table 8: How big is the clamp?

	A	B	C	D	E	F	G	
Silage type	Clamp details (m)			Capacity (m^3) AxBxC	Density (see below)	Tonnes (FW) DxE/1000	DM%	Tonnes (DM) FxG/100
	Length	Width	Height					
Eg 1st cut grass	30m	10m	3.5m	1,050	588	617	30	185

Grass silage density

To calculate grass silage density, a silage corer, a tape measure and a set of scales are needed

1) Take a cored sample into the face

2) Weigh the silage removed from the corer (in kg)

Example = 0.147kg

3) Calculate the volume by measuring the hole (width and depth) in the silage clamp where the silage was removed from. The radius needs to be calculated by halving the full width.

Equation = 3.142 x radius squared x depth

Example = 0.025m wide hole and 0.5m depth

= 3.142 x $0.0125m^2$ x 0.5m

= $0.00025m^3$

4) Divide the weight by the volume

Example = 0.147/0.00025

= 588kg FW/m^3

By measuring the density at various points in the silage clamp, the silage quantity can be more accurately predicted (see Table 8 column E). Knowing the difference in density at various places should help improve consolidation across the clamp in future years.

Low density will often be found in areas where there is aerobic spoilage in the clamp.

Table 9: How many tonnes of silage in round bales?

	A	B	C	
Silage type	No. of bales	Bale weight (t)	DM%	Tonnes (DM) AxBxC/100
Eg 2nd cut grass	400	0.63	30	76

As a guide: 4ft wide round bales = 0.5t FW. 5ft wide round bales = 0.63t FW. Weigh a sample of bales to obtain an average, as a large variation in weight is common.

Table 10: How many tonnes of silage are in the field?

	A	B	C	
Silage type	Crop area (hectares)	Expected harvested fresh yield (tonnes/ha)	DM%	Tonnes (DM) AxBxC/100
Eg 1st cut grass	20	20	25	100

Now calculate stock requirements

The dry matter intake (DMI) of stock can be estimated as a proportion of their liveweight.

Table 11: Total amount of forage available in this example

	Tonnes (DM)
Clamp silage	185
Round bale silage	76
Crops in field	100
TOTAL	361

Table 12: Stock dry matter intakes (DMI)

Stock	Intake requirements (% of bodyweight)
• Dry ewes or cows • Mid pregnancy ewes or cows	1.5
• Late lactation cows • Late pregnancy ewes or cows	2
• Finishing cattle • Early to mid lactation cows • Mid to late lactation ewes • Replacements	2.5
• Growing cattle • Early lactation ewes* • Flushing ewes or cows	3
• Growing lambs	4

*DMI may exceed 3% in early lactation

Table 13: Silage requirements

	A	B	C	D	E	
Type of stock	Number	Average liveweight (kg)	DMI (see Table 10)	Daily requirements (kg) AxBxC	Feeding period (days)	Total tonnes required (DM) DxE/1000
Ewes	600	70	0.02	840	100	84
Suckler cows	80	600	0.02	960	150	144
Growing cattle	75	300	0.03	675	150	101
Total DM to be eaten (tonnes)						329
Safety margin – allow for losses, eg 5-10%						33
Total tonnes of DM required						362

Work out the difference

Finally deduct the DM required from the DM available to give the overall surplus or shortfall.

Remember that forage quality is key to animal performance. Reducing forage costs by growing bulky, low D-value crops is a false economy.

Table 14: The surplus or shortfall in silage for winter feeding

	Tonnes (DM)
Total DM available	361
Total DM required	362
Surplus or shortfall	-1

Making up a forage shortfall

- ✔ If planning early enough, sow a brassica crop
- ✔ Reduce stock numbers or out-winter some stock
- ✔ Find alternative forage sources, eg standing maize or buy in moist feeds
- ✔ Consider straw and concentrates or liquid feeds, eg pot ale syrup
- ✔ Plant a grass catch crop to allow early spring turnout
- ✔ Reduce waste
- ✔ Check weigh scales on mixer/feeder wagons are accurate

Buying in additional feeds

Feed cost per tonne has a big effect on total feed costs. Remember to work out the cost/tonne of DM when comparing the value of one or more potential feeds.

Reduce the cost of bought-in feeds by taking full loads. Locate local sources of alternative feeds to keep transport costs down. Collect quotes from a number of suppliers.

Reducing avoidable losses

Dry matter and feed value can be lost at every stage of silage making.

Where losses occur	
In the field at harvest	2-12%
In the clamp (from respiration/ fermentation)	5-18%
In effluent	0-8%
Feeding out (from exposure to air)	1-15%

Exposure to air causes spoilage because yeasts destroy the preserving acids, so the pH rises and heat is generated. Moulds grow which can produce harmful mycotoxins.

Feeding out from a clamp

Minimise the amount of air that reaches exposed silage.

- ✔ Expose only the silage needed each day
- ✔ Use narrow clamps. Aim to get across the face in three days to avoid aerobic spoilage
- ✔ Use a shear grab and sharpen regularly
- ✔ If using big bales make sure each one is consumed ideally within five days of unwrapping

Managing feeding

Silage can be wasted in the feeding area due to competition and fighting by the animals. Ensure there are enough feeding spaces for them all to eat at once.

Feeders that make animals eat with their heads down can reduce waste, as can slanted bar barriers and feeders with solid bottoms.

Find a way to remove rejected silage effectively before putting out more.

Bales fitted tightly into ring feeders increase wastage. Leaving 30cm around the bale and the feeder will reduce wastage as silage pulled out is more likely to drop into the feeder rather than outside it.

Calculating the cost of silage

Knowing how much it costs to grow, make and feed silage allows farmers to make decisions about future feeding, ie whether cheaper alternatives can be bought in or whether different crops should be grown.

Step 1: Work out costs on an area basis

Rental value – everything grown on a farm carries a rental value. If a silage crop was not grown, the land could be let. £250/ha/year is a standard figure. First cut normally produces 40% of the total annual yield.

Establishment and grassland management – ie reseeding costs on average £250/ha*, so for a five year ley £50/year. Allocate 40% to first cut silage. Include weed control expenses on the same basis.

Inputs – limited on grassland but with crops like maize, include sprays and plastic etc.

Machinery – most contractor operations are easy to allocate on an area basis. The calculations can get more complicated when the farm makes its own silage. Use contractor prices as a guide.

Other costs – eg additives, sheeting, analysis. These are probably recorded on a per clamp basis. Simply divide the total by the area going into the clamp.

* Full reseed, including ploughing = £375/ha.
Overseeding = £175/ha.

Example (40ha, first cut, 68 D-value)

Costs/ha	
£250 x 40%	= £100
Reseeding costs	= £20
Fertiliser (400kg of 20:10:10) £270 x 40%	= £108
Slurry application	= £49.50
Rolling	= £26
Fertiliser spreading	= £5
Mowing	= £12
Tedding/rowing	= £19.50
Carting/clamping	= £128
Additive = £800/40ha	= £20
Sheet and analysis cost £120/40ha	= £3
Total/ha	**= £491**

NB: Some fixed costs should also be allocated, eg the cost of the clamp.

Step 2: Use the calculations on pages 14 and 15 to calculate the yield

Step 3: Work out costs – pence per kilogram of DM (p/kg DM)

Divide the total area costs by the estimated yield, eg 20t FW/ha:

£491/20t FW = £24.55/t FW = 2.5p/kg FW

To convert costs of FW into DM variable costs = cost/kg FW x (100/DM%)
So @ 25% DM = 2.5 x (100/25) = 10p/kg DM

To compare the cost of silage to other feeds available to buy, convert the costs of a kg DM into p/MJ of ME
So @ 11 MJ of ME/kg DM = 10/11 = 0.91p/MJ of ME

These calculations do not take into consideration losses. Weigh spoiled and deteriorated silage to give a cost of the wasted silage and encourage waste reduction in future. Remember these are just the visible losses. Invisible losses, as a result of poor fermentation and the production of carbon dioxide and water in the clamp, are much more difficult to determine, but can add up to another 5-10% of the total. Once this is done, re-calculate the real cost, as it will be different from the standard calculation.

Other BRP publications available

Joint Beef and Sheep BRP

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

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