9 Managing your silage-making

Objective:

- To produce high intake silage with maximum efficiency by reducing field and clamp losses.

Challenge:

- Ensure your silages have high nutritional value and a stable lactate fermentation
- Reduce your actual cost of utilised silage DM by 10% this year.

Target

Make consistently good quality silage for less than £109/tonne utilised DM.

Good Silage Time After Time

Experience shows that consistently good silage results from attention to detail at all stages of silage making – in the field, ensiling and at feed out.

Time invested in producing well preserved silage has been shown to pay handsome dividends throughout the winter – reducing concentrate feed requirements by up to 2kg/hd/day.

There is no reason why well made big bale silage should not be of similar quality and nutritional value to clamp silage. Bales are not necessarily more expensive than clamp silage.

What's in this section?

- Understanding fermentation
- The importance of grass quality
- Making good quality clamp silage
- Estimating clamped silage quantities
- Making good quality baled silage.

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Action plan

To make consistently good quality silage for less than £109/tonne utilised DM.

1. Make Good Quality Clamp Silage

Cut and ensile your grass quickly and cleanly from leafy swards with the best all-round practice for the greatest value at least cost (**Page 9:7**).

2. Manage Your Silage Effluent

Store and spread or feed all your silage effluent effectively to make the most of it while preventing pollution (**Page 9:8**).

3. Assess Clamped Silage Stocks

Make good estimates of your actual clamp silage dry matter stocks throughout the season as the basis for their most efficient management (**Page 9:9**).

4. Make Good Quality Big Bale Silage

Cut, bale and wrap your grass quickly and cleanly from leafy swards with the best all-round practice for the greatest value at least cost (**Page 9:11**).

5. Assess Big Bale Silage Stocks

Make good estimates of your actual big bale silage dry matter stocks throughout the season as the basis for their most efficient management (**Page 9:12**).

The fermentation process

A good understanding of the fermentation process is essential if you are to produce high quality silage. The processes of converting fresh forage into preserved silage involves four main stages and is the same in bale or clamp (**Figure 9.1**).

Figure 9.1: The Fermentation Process Under Good Ensiling Techniques

Aerobic Stage ↓	• Lasts a few hours • Oxygen levels are reduced • Enzymes remain active while pH is 5.5-6.5
Fermentation Stage ↓	• Begins when all the oxygen in the silo has been used up (anaerobic) • Can last several weeks – but the quicker the better • Lactic acid dominates • pH drops 3.7-5.0
Storage Stage ↓	• Acidic conditions limit microbial activity providing the silo is airtight and a stable low pH has been achieved • Micro-organism populations gradually decline • Some microbes can remain active particularly if pH is not low enough • Clostridia and bacilli can survive as spores
Feeding Stage	• Aerobic spoilage starts on exposure to air • Yeasts degrade preserving acids • pH rises and heat is generated • Moulds begin to grow and can produce harmful mycotoxins • Aerobic spoilage will be minimised by good clamp management techniques

It is essential when ensiling to exclude as much air as possible to achieve a strong lactic acid fermentation – dropping the pH as quickly as possible and restricting the activity of undesirable bacteria.

Table 9.1: Maximum pH Required to Produce Well Fermented Silage at Different Ranges of DM

DM range %	<18	18-20	20-22	22-24	24-26	26-28	28-30	>30
pH required	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.8

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The importance of grass quality

Grass Qualities for Good Fermentation

The rapid multiplication of lactic acid bacteria which is needed to drop pH rapidly requires an energy source – grass sugars. Without a good level of grass sugars (often termed water soluble carbohydrates or WSC) fermentation is likely to be slow and poor.

A minimum WSC content of 3% in the fresh crop is required

WSC levels in grass are highly variable but a few basic rules can help to maximise levels.

- High sugars are associated with dry sunny weather – and are further boosted by cold night time temperatures
- Grass sugars peak in the afternoon
- Traditionally tetraploid varieties have had higher sugar levels than diploids. IGER have produced high sugar diploids with superior sugar levels to most tetraploids
- Legumes are inherently low in sugars.

Nitrate-nitrogen levels below 0.1%

Although high nitrate levels increase crude protein content they can also lead to the production of ammonia in the silage which is alkaline and so increases pH.

High nitrates indicate that nitrogen taken up by the sward has not been fully metabolised into plant protein, usually due to high nitrogen inputs or due to weather conditions. During a dry period grass nitrogen uptake often slows, and when rain arrives it can produce a sudden peak of nitrogen in the sward.

Failing to account for the nitrogen content in slurry is a frequent cause of high nitrate levels in silage.

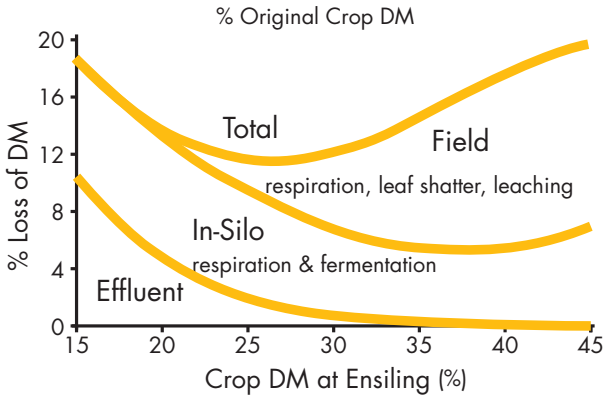
Dry matter content – 25-30% in clamp (10% higher in bales) silage dry matters of 2-3% below the above range can be fed but will compromise dry matter intakes.

The lower the dry matter content of the forage the more acid is required to preserve it, so the lower the pH needs to be.

The higher the dry matter of the forage the harder it is to consolidate, so the more difficult it is to create anaerobic conditions, both at ensiling and at feed out.

Dry matter losses are minimised between 25 and 30% (**see Figure 9.2**).

Figure 9.2: Typical DM Losses in Silage-making



Source: J Bax

Low DM silage needs very acidic conditions for a stable silage to be produced. Very wet, low pH silages are not a good base for a winter ration and intakes will be reduced.

Analysing grass prior to cutting can provide useful information about the quality of forage and how you manage it. It may prompt you to consider delaying harvesting or it could influence the way you handle one particular problem field.

Grass Qualities for High Nutritional Value

Leys with a high ryegrass content (70%+) are essential to an efficient silage system. Grass weeds and broad leaved weeds like docks will compromise both yield and quality.

Silage nutritional quality, intake potential and milk production value are governed primarily by the digestibility (D Value) of the grass being ensiled.

A drop of one unit of D represents a 5% decline in animal productivity.

Grass digestibility can decline by up to three units/ week with the onset of stem formation and heading.

Once 50% of the sward has started to head the D value is likely to be below 67D.

As digestibility decreases protein content will also decline, by around 3% a week. Grass protein levels are influenced by nitrogen applications as well as stage of maturity. Uptake of nitrogen and protein formation can also be restricted by soil deficiencies in potash (K) and sulphur.

It is important to match the heading dates of your grass varieties to suit your cutting dates to maximise quality. Be aware that heading dates will vary depending on altitude, aspect and on seasonal weather conditions.

Recent work at Moorepark has suggested that late perennials are most suited to providing high quality silage if the leys are to be included in the grazing rotation in early spring before being shut out for silage. (Humphreys and O'Keily 2006.)

Early spring grazing will delay heading dates and subsequent decline in digestibility by around 10 days.

For the highest digestibility silage, swards must be cut early while the grass is still leafy and before heading starts.

Early cuts of silage have been associated with lower DM yields/ha in single cut systems.

However, research from SAC Crichton Royal Farm shows that with two silage cuts, yields are similar but quantity better with earlier cutting (**Table 9.2**).

Table 9.2: Cutting Date, Silage Energy Content and Yield

	Early Cutting Date		Conventional Cutting Date	
	1st Cut	2nd Cut	1st Cut	2nd Cut
Metabolisable Energy (ME) (MJ/kg DM)	11.8	11.4	11.1	11.3
Yield (tonnes DM/ha)	4.2	4.1	5.5	2.5
Total yield (tonnes DM/ha)	8.3		8.0	

Source: Thomas, Bax and Osman (1998) More Milk from Grass.

Cutting 2nd cut silage later will also reduce its digestibility by up to four units, as well as delaying regrowth for subsequent grazing.

Delaying cutting date by a week can result in the death of over 2000 tiller/m².

Additive Use

Additives are an essential part of silage-making, helping to preserve nutritional quality and improve fermentation quality – but they do not compensate for poor management.

- **Inoculants –** Protect forage quality by ensuring rapid and effective fermentation. Applying an inoculant with lactic acid bacteria helps to quickly dominate the fermentation and keep more of the soluble proteins and sugars available to the animal. Select inoculants which provide at least 1 million bacteria/gram silage
- **Enzymes –** Can help to reduce heating and aerobic spoilage after opening the clamp. Particularly suited for high DM silages which can be at risk from moulding that produces toxins which depress intake
- **Acid based additives –** Formic acid reduces pH and can improve digestibility, intake and cattle performance – although is unpleasant to handle. Generally used in very poor conditions with wet silages where there is also a higher risk of soil contamination
- **Sugar sources** such as molasses supply additional sugars to naturally occurring bacteria in the silage but give a lower fermentation response than formic acid
- **Sugar beet pulp** can help retain effluent, but provides limited source of sugar to aid the fermentation process.

Making clamp silage

One key objective in silage-making must be to cut and ensile grass quickly and cleanly with minimal loss of dry matter and feeding value.

Once cut the grass leaf starts to die and continues to respire, losing water but also dry matter and nutritional value. The longer the wilting time, the more you lose.

Cutting

Silage quality can best be ensured by:

- Setting the mower to leave the widest possible swath to encourage wilting
- Mowing when the crop is dry to further aid wilting and enhance sugar concentration
- Leaving 7-8cm stubbles to avoid soil and manure contamination and encourage fast regrowth
- Keeping all operations as clean as possible; particularly when wet.

Spreading

Silage quality can best be ensured by:

- Spreading grass rapidly and evenly within one hour of cutting to encourage wilting
- Not rowing up swaths until immediately before pick up
- Not leaving rowed-up swaths overnight to heat up.

Wilting

Silage quality can best be ensured by:

- Achieving the target 25-30% DM content in 12-24hrs where possible
- Cutting, spreading and picking up in the same day in poor wilting weather.

Picking-up

Silage quality can best be ensured by:

- Setting the pick-up high enough to avoid soil contamination
- Chopping higher DM (25-40%DM) down to 10-15mm but longer chopping wetter crops to 25-35mm to optimise clamp consolidation
- If necessary adjust chop length as the day progresses, to ensure good consolidation in the clamp
- Keeping all operations as clean and quick as possible, particularly when wet.

Clamp filling

Silage quality can best be ensured by:

- Filling clamps as rapidly as possible
- Keeping the clamp apron clean by avoiding dirty wheelings where grass will be tipped
- Ensuring good consolidation by even filling and regular rolling of thin layers of no more than 20cm
- Cross rolling with a second tractor if possible
- Not over-consolidating low dry matter silages
- Filling large bunkers in a wedge shape from one end.

- Keeping the sides of the clamp slightly above the level of the centre so the tractor leans away from the walls
- Avoiding rolling before the next day's filling (as this will draw air in)
- Sealing the clamp after each day's work only if it effectively prevents the entry of air
- If silage is of high dry matter consider taking the last few acres as direct cut which will consolidate well and seal the top of the clamp.

Clamp sealing

Silage quality can best be ensured by:

- Making the final seal as soon as consolidation is complete
- Folding in exposed side sheets first, then covering the whole area with plastic sheeting
- Using two sheets; a new sheet covered with last year's sheet to reduce the risk of puncture
- Covering the whole sheeted surface with straw bales, tyres or special heavy silage clamp covers
- Ensuring the sheeting is not punctured, protecting it from birds with netting and repairing any damage
- Ensuring that unroofed clamps shed rainwater freely so it does not seep into the clamp.

Managing Silage Effluent

- Silage effluent is highly polluting and should not reach field drains, watercourses or water supplies. As little as one litre of silage effluent can lower the oxygen content of over 10,000 litres of water to below a critical level for fish
- Silos should have an effluent storage capacity of at least two days at peak flow rate, which increases rapidly with declining DM levels
- Crops ensiled at 25% DM will produce little effluent
- Crops ensiled at 18% DM will produce up to 100 litres effluent/tonne/day at peak flow
- Crops ensiled at 15% DM will produce up to 200 litres effluent/tonne/day at peak flow
- Most effluent will be produced in the first ten days after ensiling. Short chop lengths will increase early peak flow levels, as will the use of acid based additives
- Collected effluent can be spread on to land but should be diluted 1:1 with water to reduce the risks of pollution and sward scorch. Aim for a rate of between 25-30m^3/ha (2200-2700gl/acre) and do not spread near water courses or boreholes
- Do not mix effluent with slurry in a confined area or in under-shed tanks as it will release toxic gases harmful to humans and livestock.

Managing feed out

Minimising aerobic spoilage and protecting silage quality once the clamp is open can best be achieved by:

- Pulling back the top sheet to expose only the silage that is needed on a daily basis
- Using narrow clamps to limit the area of the exposed face and to ensure that you move through and across the clamp quickly
- Taking the clamp face back at least 2m a week and aim to get across the face between three and seven days, the importance of this speed across the clamp will vary depending on consolidation, dry matter, fermentation, residual sugars and climatic conditions, the key point is to avoid secondary fermentation
- Keeping a tight clamp face – use a shear grab and sharpen regularly.

Assessing Clamped Silage Stocks

Be prepared to review both your assessment of silage stocks and its quality throughout the feeding period.

Dry matter losses, clamp wastage, animal rejection and animal performance all need to be continually monitored. Be aware that even in a clamp the silage is likely to be variable and rationing will need to be adjusted to take account of that variability.

The amount of silage clamped can be calculated easily for budgeting purposes from clamp dimensions and silage DM (**Example 9.1**).

Example 9.1: Calculating Silage Stocks

Clamp Length (m)	Clamp Width (m)	Clamp Height (m)	Clamp Capacity (m^3)	Silage Density* (kg/m^3)	Fresh Silage (tonnes)	Silage DM (%)	Silage DM (tonnes)
A	B	C	D=AxBxC	E	F=DxE ÷1000	G	H=FxG
20	12	3	720	650	468	26	121.68

** From Table 9.4*

Worksheet 12 provides a pro forma to calculate the quantity of silage in individual clamps.

Table 9.4: Silage Density

Silage DM (%)	Fresh Weight Density (kg/m³)
16	800
18	760
20	730
22	695
24	675
26	650
28	633
30	615

Alternatively, a quick assessment of silage stocks can be made from estimates of clamp size and silage DM (**Table 9.5**).

Table 9.5: Silage Stocks Ready Reckoner (tonnes)

Clamp Size (m³)	Grass Silage (% DM)		
	20	25	30
200	145	132	123
400	290	264	246
600	435	396	369
800	580	528	492
1000	725	660	615

A good estimate of stocks made throughout the season will allow forage supplies to be matched to livestock requirements as precisely as possible (**Section 8**).

Identifying a shortfall of conserved forage at first cut, for instance, enables greater provision to be made for silage-making later in the season.

Alternatively, grazing can be extended later into autumn to reduce conserved forage needs (**Section 7**) or early provision can be made for purchasing bulk feeds such as brewers' grains or pressed pulp, or sowing alternative forage crops (**Section 6**).

Big bale silage

Big bale silage is a flexible and economic way of conserving grass that can be used as a positive aid to maintaining grass quality.

Big bale silage costs about the same as clamp silage per tonne of utilised DM (**Section 2**).

Where smaller areas are to be harvested or three or four cuts are required, big bale silage may work out cheaper than clamp silage and it is also more saleable.

The quality of big bale silage can be similar to clamp silage and fermentation losses are generally half of those reported in clamps.

There can be benefits to integrating bale silage with clamp silage:

- Baling a small acreage a few days ahead of the main clamp silage will provide high quality forage and mean a quicker return of one or two paddocks to the grazing rotation ahead of the main aftermath area
- Having a stock of bales to buffer feed cows at grass will remove the need to open a clamp and expose a slow moving clamp face to aerobic spoilage
- Bales of different quality can be made to target small groups of cattle.

Making Good Quality Big Bale Silage

Good quality big bale silage-making demands essentially the same criteria as good quality silage in the field and swath.

The higher DM of big bale silage, generally 35-40%, means a more restricted fermentation, making it especially important to guard against aerobic spoilage.

It is particularly vital to avoid soil contamination which can introduce potentially damaging listeria and botulinum micro-organisms into the bale.

Cutting

Silage quality can best be ensured by:

- Mowing when the crop is dry to aid wilting and enhance sugar concentration
- Leaving a 7-8cm stubble to avoid soil and manure contamination and to encourage fast re-growth
- Using a mower conditioner to promote rapid wilting
- Matching the swath to the baler width.

Wilting

Silage quality can best be ensured by:

- Wilting to 35-40%DM and an absolute minimum of 25% to avoid bale distortion which leads to air ingress
- Employing vigorous swath treatment to promote rapid moisture loss
- Using inoculants designed for high DM silages where required.

Baling

Silage quality can best be ensured by:

- Gathering several swaths into a windrow for improved baler performance
- Producing uniform box shaped windrows that match the baler's pick up capacity
- Making firm well shaped bales that are easier to enclose and store
- Bale chopping increases the density of the bales (fewer bales/ha so reducing costs)
- Chopping also reduces the air in each bale and releases sugars; both of which improve speed of fermentation.

Wrapping

Silage quality can best be ensured by:

- Wrapping promptly, within 2-4hrs of baling
- Wrapping close to the stack rather than transporting wrapped bales from the field to reduce chance of physical damage (this also prevents soil compaction in the field)
- Using six layers of wrap to improve sealing and also protect from physical damage. IGER research has identified big increases in lysteria associated with inadequate wrapping
- Using green or white wrap has been shown to reduce the temperatures of stored bales and to subsequently reduce the amount of moulding.

Storage

Silage quality can best be ensured by:

- Storing bales on a hard standing within 24hrs of baling and covering immediately
- Not moving bales once stacked or leaving them for at least three weeks before moving
- Avoiding spear type equipment to move bales since taping rarely produces a good seal
- Storing low dry matter bales (25-35%DM) only one high
- Stacking higher DM bales to a maximum of three high
- Controlling pests, especially rats and repairing any damage to bale wrap promptly
- Cover with netting to keep away birds and also farm cats
- Identifying bales of different quality to feed to different classes of stock.

Assessing Big Bale Silage Stocks

The weight of big bales can vary quite widely (400-800kg), so for an accurate assessment of quantities it is important to weigh more than just a few. Weights will be affected from field to field depending on dry matter and baler speed and settings.

Factor in that between weighing an unwrapped bale in the field to feedout it is likely that each bale will lose at least 5%DM in fermentation losses. Wet bales maybe even 10% with effluent losses.

Summary

- Failing to account for the nitrogen content in slurry is a frequent cause of high nitrate levels in silage
- The lower the dry matter content of the forage the more acid is required to preserve it, so the lower the pH needs to be
- The higher the dry matter of the forage the harder it is to consolidate, so the more difficult it is to create anaerobic conditions, both at ensiling and at feed out
- A drop of one unit of D represents a 5% decline in animal productivity
- Once 50% of the sward has started to head the D value is likely to be below 67D
- For the highest digestibility silage, swards must be cut early while the grass is still leafy and before heading starts
- Cutting 2nd cut silage later will also reduce its digestibility by up to four units, as well as delaying regrowth for subsequent grazing
- Delaying cutting date by a week can result in the death of over 2000 tiller/m^2
- Additives are an essential part of silage-making helping to preserve nutritional quality and improve fermentation quality – but they do not compensate for poor management
- One key objective in silage making must be to cut and ensile grass quickly and cleanly with minimal loss of dry matter and feeding value
- Big bale silage is a flexible and economic way of conserving grass that can be used as a positive aid to maintaining grass quality
- The quality of big bale silage can be similar to clamp silage and fermentation losses are generally half of those reported in clamps.

See also...

Section 2:	Calculating the Cost of Your Feeds
Section 6:	Supplementing Grazing
Section 7:	Shortening Your Winter Feeding
Section 8:	Planning Your Silage-making
Section 15:	Factsheet 12: Herbage Analysis
Section 16:	Worksheet 12: Clamped Silage Quantity

Refer to Factsheet 17 on interpreting silage analysis.