BALED SILAGE GUIDE

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Introduction

This updated McHale baled silage guide will enable you to make more cost-effective use of this flexible silage conservation system. We hope the information assembled here will enable you to minimise costs, make better quality silage or haylage and significantly reduce storage losses.

In addition, we trust that the research findings and practical tips supplied will help you to improve safety and on-farm performance in what are challenging times for farming families everywhere.

McHale is synonymous with baled silage with machines like the Fusion integrated baler/wrapper being market leader in many countries around the world. Their current grassland machinery range also includes front, rear and combination mowers, tedders, rakes, fixed and variable chamber balers, round and square balewrappers, round bale handlers.

For feeding out McHale manufacture a bale splitter plus a silage feeder and straw blower. Finally, on behalf of the sponsors-McHale may we take this opportunity to wish you every success for the future with your machinery operations, forage conservation and farming business.

The editor Liam De Paor (left), was actively involved with the introduction of the Silawrap system of forage conservation to Ireland. He has edited the annual forage guides which have been published annually in the Irish Farmers Monthly since 1999.

One Euro = $1.21 or £0.88
(depending on the currency exchange rate)

History of Baled Silage in Ireland

Big bale silage was first introduced to Ireland in 1981 when Dick Lawes, founder of Pritchitt Foods and Volac Ltd funded a two year pilot project using the new bagged silage system pioneered by Lloyd Forster on his Northumberland hill farm in England. Lloyd had found it difficult to make good hay for his cattle and sheep due to unpredictable local weather conditions.

Unfortunately, the silage bags were easily damaged and as the polythene was loose, even the smallest hole allowed huge levels of silage spoilage so the system had limited appeal until the first blue Silawrappers were imported from Australia in 1986. There Integrated Packaging had succeeded in mechanising the new forage conservation system using a polythene stretch film to replace silage bags.

Lloyd Forster travelled all over the world promoting the baled silage system and received an award for his pioneering work. The new baled silage wrapping system received a very positive response from livestock farmers in Britain and Ireland before becoming a worldwide forage conservation system.

The first Irish demos were held in conjunction with ACOT and DANI at Ballyhaise and Greenmount Agricultural colleges during 1981. Thereafter, the current baled silage system developed rapidly with robust Irish manufactured wrappers, handlers, feeding equipment, and eventually balers, becoming available at competitive prices.

While all aspects of mechanisation developed, the replacement of twine by net and more recently, the replacement of net with Net Replacement Film along with the combination of wrapping and baling with one machine improved the speed and efficiency of the operation. Chopper balers became the standard for making most of the baled silage. However, equines prefer unchopped silage fed as high DM haylage. Crops now routinely baled include alfalfa, cereal ley crops, corn stalks, grass, hay, haylage, kale, hemp, lucerne, miscanthus, rice straw and whole crop cereals.

In the past one criticism of baled silage has been its higher perceived cost relative to clamp silage. The cost can be reduced significantly by greater attention to wilting, bale density and wrapping higher DM bales.

The suspension on the McHale Pro Glide F3100 front mower allows the cutterbar to move independently of the tractors front linkage.

Considerations before Making Baled Silage

- What type of forage is required on the farm?
- Where to use baled silage?
- Growing the best crop of grass.
- Cutting stage, quality and ensiling tests.
- How to optimise wilting?
- Is an additive required?
- Baling and wrapping for best results.
- Bale handling, transport and storage.
- Feeding out baled silage.

McHale V8950 Variable Chamber Round Baler is fitted with a 15 knife chopper unit and the double drive system aids belt rotation and bale formation. Every year McHale balers produce over 75 million bales of forage for farmers and contractors.

Advantages of Baled Silage

- Flexible conservation system suited to smaller and fragmented farms.
- Requires less capital investment in storage facilities than clamp silage.
- Improves grassland management by allowing excess grass to be conserved as high-quality silage.
- Different quality silage can be conserved and stored separately and fed to appropriate stock type; e.g. high digestibility to milking cows etc.
- Small quantities can be used during drought or shoulder season feeding without opening a complete clamp and incurring aerobic deterioration.
- Surplus silage can be sold as a valuable cash crop.
- Costs are in line with grass yield, and does not penalise lower yield, high quality silage cuts, including 2nd cuts.
- Wilted system with little effluent risk.
- Lower ensiling and storage losses compared to conventional silage.

Silage Review:
Recent Advances & Future Technologies for Baled Silages

Journal of Dairy Science
Volume 101, Issue 5, May 2018,

Some interesting extracts and conclusions are as follows:

Coblentz et al. (2016c) reported little difference in silage fermentation or nutritive value when alfalfa-mixed grass silages were wrapped with 4, 5, or 6 PE film layers, but it was noted that the risk of puncture was noticeably greater along bale edges between the flat-end and rounded-circumferential surfaces of the bale. Similar risks of internal puncture have been noted by Borreani and Tabacco (2008). Given these results, it seems likely that 4 1-mil (0.025-mm) PE film layers will establish acceptable anaerobiosis for fermentation, but this wrapping standard might not be acceptable to silage producers because of risks of internal or external puncture by rigid stems, vermin, or during additional handling and stacking.

To some degree, these concepts have been illustrated further in Ireland (O'Brien et al., 2007a); well-managed grass silages were wrapped with 6 layers of PE film and stored under controlled conditions for 6 weeks, and then compared with on-farm-produced bales wrapped in 4 PE film layers and stored for 8 months before sampling. Visual assessments of fungal contamination were observed on the surface of 15 of 18 on-farm bales, but none were observed on the well-managed bales ensiled annual ryegrass in both baled and chopped forms at about 65% moisture; the final pH for chopped silage tended to be the most acidic (pH = 4.5 vs. 4.8), but final concentrations of individual fermentation acids did not differ statistically.

In addition, typical measures of nutritive value, including CP, NDF, ADF, and in vitro true digestibility of DM, did not differ statistically across silage types

Silage fermentations restricted by field-wilting have long been associated with greater residual concentrations of WSC (McDonald and Edwards, 1976), and this has been observed specifically for baled alfalfa silages (Coblentz et al., 2014, 2016c). After ensiling 36 large-round bales of alfalfa-grass at 40.2% moisture, a mean loss of only 0.4 percentage units of WSC was observed after fermentation was complete (Coblentz et al., 2016c).

To some degree, these concepts have been illustrated further in Ireland (O'Brien et al., 2007a); well-managed grass silages were wrapped with 6 layers of PE film and stored under controlled conditions for 6 weeks, and then compared with on-farm-produced bales wrapped in 4 PE film layers and stored for 8 months before sampling. Visual assessments of fungal contamination were observed on the surface of 15 of 18 on-farm bales, but none were observed on the well-managed bales.

Baled Silage Comparison with Clamped Silage

The tables below detail two examples of good quality silage samples. The pH, ME, DMD levels are excellent while the ammonia is low. This should result in predicted high dm intake levels and strong performance for the liveweight gain and milk yields.

Farmer: John Farmer
Sample receive date: 14/09/2020 Receive date: 16/09/2020 Lab reference: SE21118

Item	Units	Desirable values	Result	Status
Dry matter	%	20 - 30	34.4	–
pH	–	4 - 4.7	4.0	Good
Ammonia N (DM)	% of total N	< 10.1	2.9	Good
ASH	%	< 8.6	8.0	Good
NDF	%	< 45.0	42.70	Good
DMD	%	> 68.9	79.6	Good
ME	MJ/kg	> 9.8	11.6	Good
Crude protein	%	13.5 - 17	14.2	Good

Item	Units	Desirable values	Result	Status
PDIN	g/kg	65 - 102	84	A
PDIE	g/kg	58 - 83	78	
PDIA	g/kg	16 - 37	26	
UFL	per kg	.65 - .90	0.91	
UFV	per kg	.59 - .89	0.88	
SFU	per kg	1.04 - 2.81	1.28	
LFU	per kg	.95 - 1.89	1.07	
CFU	per kg	.96 - 1.92	1.08	
DM intake cattle	g/kg $W^{0.75}$	70 - 130	124	
DM intake sheep	g/kg $W^{0.75}$	60 - 140	116	

Predicted performance (silage ad lib no meals)	
With good management	
Lactating cows (litres/day)	16.5
Dry cows (kg/day)	0.9
Beef cattle/incalf heifers (kg day)	0.8
Weanling (kg/day)	0.7

Supplementation	
Item	
Dairy ration protein %	18
Kg/day for 27 litres	5.6
Beef ration protein %	13
Kg/day for 1kg/day gain	2.62
Weanling ration protein %	14
Kg/day for 0.6 kg/day gain	0.0

CUT ID: 1 bales Cut date: 10/05/20 Cut system: Additive:

Note: Status A = average
Silage analysis results kindly supplied by FBA Laboratories.

Farmer: John Farmer
Sample receive date: 14/09/2020 **Receive date:** 16/09/2020 **Lab reference:** SE31760

Item	Units	Desirable values	Result	Status
Dry matter	%	20 - 30	27.8	–
pH	–	4 - 4.7	4.0	Good
Ammonia N	% of total N	< 10.1	6.1	Good
ASH	%	< 8.6	8.3	Good
NDF	%	< 45.0	42.20	Good
DMD	%	> 68.9	76.1	Good
ME	MJ/kg	> 9.8	11.0	Good
Crude protein	%	13.5 - 17	13.8	Good

Item	Units	Desirable values	Result	Status
PDIN	g/kg	65 - 102	81	A
PDIE	g/kg	58 - 83	76	
PDIA	g/kg	16 - 37	25	
UFL	per kg	.65 - .90	0.86	
UFV	per kg	.59 - .89	0.83	
SFU	per kg	1.04 - 2.81	1.36	
LFU	per kg	.95 - 1.89	1.12	
CFU	per kg	.96 - 1.92	1.14	
DM intake cattle	g/kg $W^{0.75}$	70 - 130	118	
DM intake sheep	g/kg $W^{0.75}$	60 - 140	110	

Predicted performance (silage ad lib no meals)

With good management	
Lactating cows (litres/day)	14.2
Dry cows (kg/day)	0.8
Beef cattle/incalf heifers (kg day)	0.7
Weanling (kg/day)	0.6

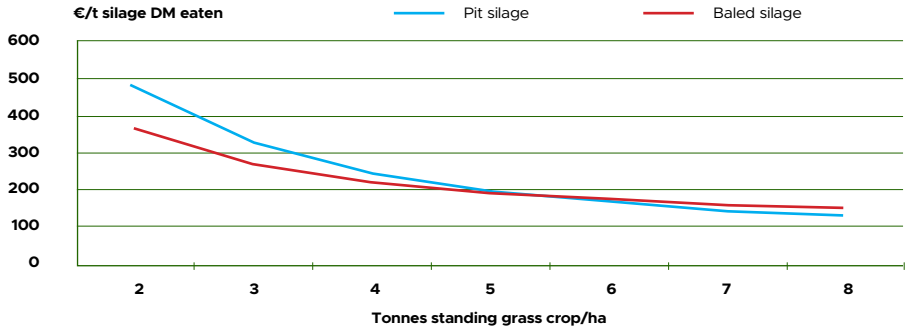
Supplementation

Item	
Dairy ration protein %	20
Kg/day for 27 litres	6.3
Beef ration protein %	14
Kg/day for 1kg/day gain	3.67
Weanling ration protein %	15
Kg/day for 0.6 kg/day gain	0.4

CUT ID: 1 silage **Cut date:** 14/05/20 **Cut system:** **Additive:**

Note: Status A = average

Baled silage compared with clamped precision chop and forage wagon system (data source: Teagasc Grange)



	Precision	Wagon	Baler
DM intake (g/kg Lwt.)	15	16	17
Carcass gain (kg/d)	0.68	0.68	0.71

Assumes:

- **Grass DMD = 720 g/kg**
- **Pit silage**
  3% field DM loss
  16% silo DM loss
  1% feeding DM loss
  2% unit DMD decline
- **Baled silage**
  5% field DM loss
  10% silo DM loss
  5% feeding DM loss
  2% unit DMD decline

Conclusions: The option of preserving forages as baled silage has increased rapidly in popularity over the last 2 decades, particularly for small and mid-sized dairy and beef producers. There are several reasons for this trend, and the most prominent is a reduced risk of weather damage to valuable forage crops compared with preservation as dry hay.

Although most management principles for baled silages remain similar to those for precision-chopped silages, there are some notable differences between silage types. Typical recommendations for forage moisture (45 to 55%) within baled silages are somewhat drier than those for precision-chopped silages.

Additional wilting, coupled with the long-stemmed nature of most baled silages, acts to restrict the rate and extent of fermentation for baled silages, thereby suggesting emphasis should be continued on maintaining anaerobiosis through:

(1) applying PE-film wraps promptly; (2) using an appropriate number of PE-film layers (6 to 8); (3) selecting a storage site free of sharp objects or other debris; and (4) monitoring wrapped bales closely for evidence of puncture, particularly by birds or vermin.

New Developments with Baled Silage

The biggest change in recent years is the switch to combined baling and wrapping operated by one tractor which eliminates the need for another tractor and operator in the field. This has obviously made the system very attractive to silage contractors.

The McHale Fusion 3 (see photo) is unique in that it has been specifically designed as a high output Integrated Baler Wrapper. It is a very compact and manoeuvrable machine with an 18 roller fixed chamber baler, a patented bale transfer system and a total machine length of only 5.8 metres (19 ft.)

The operator has the option to upgrade to a selectable knife system from the standard 25 knife-chopping unit. The Fusion 3 range is fitted with a drop floor unblocking system, which means blockages can be fed through in three simple steps. An automatic progressive greasing system delivers grease around the system. Five rolls of film can be stored inside the panels on either side of the machine. Two additional rolls are transported on the dispensers. The film holders fold down to allow the operator to easily unload the film from the storage area.

The McHale Fusion 3 Plus uses Film on Film technology to apply film to the barrel of the bale in the bale chamber which replaces netwrap. The film that binds the bale together forms a wrap layer and gives better film coverage on the largest surface of the bale. When balewrap is applied to the barrel of the bale it can be stretched to approx. 20%. The stretch ratio is higher than what can be achieved with net wrap or twine which ultimately results in a more compact and better shaped bale.

A fully automatic machine, it is controlled

by the McHale iTouch Control Console and has two inbuilt cameras to monitor baling and wrapping operations. McHale engineers realised that changes in temperature and sun light could affect the wrapping film. For example, as the day got hotter or cooler the film was either overstretched or under stretched, and this would cause reliability problems and inefficient film use.

Their patented film application system ensures consistent film stretch, reliable application, optimum bale shape and density. Should an operator wish to use netwrap for hay or straw this can be done with a simple adjustment on the iTouch Control Unit.

The user friendly console has an inbuilt system to ensure that the film is applied by the wrapper to the bale even if there is a film break or one dispenser runs out of film. From the control console in the cab, the operator can adjust the number of film layers being applied by the wrapper as well as the number of layers of barrel wrap being applied in the chamber.

The operator can select as follows: the knives in the chopper unit on or off, the machine to tip or hold the wrapped bale, a 'bale only' programme for hay or straw, a lube alarm and various bale transfer options depending on ground conditions.

Advances in Baled Silage

Since the inception of baled silage due to improved baler technology the weight of bales made has increased significantly. As farmers usually pay their silage contractors by bale they are getting great value for money. Hay bales (high DM) are usually 250 -350 kgs in weight while silage bales typically vary from 650 kgs to one tonne. From a cost perspective, more dense bales will result in lower baling, wrapping, film and transport costs. The aim should be to optimise wilting and bale density to get as much dry matter as possible into each bale.

Combined balers and wrappers greatly reduce the labour required to bale and wrap and reduce the amount of handling of the bale pre-wrapping. They also facilitate the use of the most recent development of mantle film also known as the Film on Film system. At farmer level it is probably better known as barrel wrap (Net Replacement Film/NRF) and used as an alternative to netwrap. It adds film across the barrel surface of the bale which, with normal wrapping has less film cover than the ends. This makes a more compact and better shaped bale that better withstands handling and also reduces silage losses through an enhanced oxygen barrier that discourages mould growth.

Whereas netwrap will continue to elongate post baling, the stiffer configuration of the Film on Film maintains the pressure that has been applied within the baling chamber. This greater crop compaction enables more efficient forage storage.

Over the last 8 years the use of a wide polythene film to bind bales before wrapping, has grown significantly. Farmers and contractors in these varying geographic locations have realised the many benefits of the film binding system that includes a significantly better oxygen barrier, easy film removal, easier recycling, less waste and importantly, enhanced silage quality.

A Film on Film trial was conducted during 2016 on an English commercial farm under working farm conditions by Dr. Dave Davies from Silage Solutions Ltd, an

independent consultant to the Silage Advisory Centres. This trial demonstrated that Film on Film wrapped bales had:

- 7.5% less DM losses on Film on Film bales compared to netwrap bales due to an enhanced fermentation process.
- 80% less DM losses on Film on Film bales compared to netwrap bales due to mould formation on the bale.
- an overall 52% reduction on Film on Film bales compared to netwrap bales in DM losses.

The reduced losses that resulted through the use of the Film on Film wrapping system meant that the farmer on this farm gained more forage to feed to his herd. For a dairy farmer, preserving forage more successfully could provide a significant financial benefit as follows:

- This farmer gained an average of 7.35kg DM (Dry Matter) per bale using the Film on Film wrapping system.
- As 1kg of Dry Matter = 11.8 MJ ME (Metabolisable Energy), this means that the farmer gained 86.73 MJ ME per Film on Film bale (7.35 kg DM x 11.8 MJ ME).
- In order to produce 1 litre of milk you need: €5.8MJ/litre MJ ME.
- Therefore the 86.73MJ ME averagely gained for each of the Film on Film bales could give an additional 15 litres of milk production (86.73 / 5.8 = 15 litres).

It is important to note that the above trial was undertaken in real and robust commercial farm conditions and not on a research institution farm where bales are carefully handling and stored in perfect conditions by trained research staff.

This greater crop compaction enables more efficient forage storage. Trials undertaken by ILVO (Instituut voor Landbouw – en Visserijonderzoek / Institute for Research in Agriculture and Fisheries) in Belgium have found that Film on Film System bales were on average 2cm smaller in circumference than traditionally netwrapped bales in addition to being 10% denser.

This system also makes the feed-out process easier too. If using a bale handler and mixer wagon it is possible to feed out the contents of these bales with minimum human intervention. The feeding process is also quickened thanks to the easy removal of both films from the bale.

Once opened, the film peels cleanly from the bale as no fodder can become enmeshed in it as with netwrap. As both films are manufactured from the same material, there is no need to separate them for recycling. It is estimated that the Film on Film system now has a 20% market share and continues to increase.

Improving Silage Quality

Grass nitrates can affect preservation by increasing buffering capacity. However, there is good evidence that sugar levels are actually the more important consideration. A grass crop will on average use up 2 units of N per day for first cut, and more during good growing conditions. This is only a general rule and should not unduly delay cutting date. Farmers should test for nitrates in addition to sward sugars at their local advisory offices.

Wilting is very beneficial to silage preservation where sugars are marginal and/or nitrates remain elevated. The aim should be to increase crop DM to a minimum of 27-30%. It also reduces the number of bales per acre/hectare. The drying rate of grass depends on the grass (DM and leaf content), how thinly that grass is spread out, whether it is

conditioned or not and most importantly the drying conditions. Wilting should be carried out as quickly as possible as feeding value and physical losses will increase over time. The aim should be to leave the grass just one night on the ground.

- Heavy low DM grass crops are best spread to give 100% ground cover either with a spreader mower or separate tedder.
- Where standard mower conditioners are used, the swath should be left to occupy as much of the field area as possible e.g. 80% of area covered with grass.
- Additional tedding will speed up the drying rate but be careful of leaf loss and forming poor swaths.
- Conditioning on its own will only have a limited effect on drying if a very dense swath is used.
- Tedders will speed up drying by mixing dried and undried grass, but swath structure (% ground cover) will still impact most on the drying rate.
- Do not over wilt as a very restricted fermentation may leave less stable silage prone to aerobic deterioration and very dry forage may reduce the animal performance achieved from an acre /hectare of conserved grass.

This is best achieved by tedding out rows and wilting for 24 hours in good conditions. Data from Teagasc Grange shows that grass left in larger rows (3m+) will not dry sufficiently to be effective. Where surplus bales are made from shorter leafy grass, wilting to 30% plus will result in better preservation and bales that hold their shape over longer storage periods.

The feeding value of silage is determined by the nutritive value (energy and protein density) per unit of DM, and the voluntary animal intake. In establishing silage feeding value, DM intake is more important than any chemical factor.

The nutritive value of a clamp of silage is determined by:

- The energy density of silage DM is influenced by the digestibility of the herbage ensiled, and the efficiency of preservation. The typical values found in silage analysis are:

Dry Matter Digestibility (DMD) %	ME (MJ/kg DM)
68 – 76	**9.7 – 10.9**

- Satisfactory protein values are in the region of 14.0% to 17.0%. Excessively high crude proteins are composed largely of non-protein nitrogen. These are of little nutritive value and make good preservation more difficult to achieve.
- The major minerals of importance are calcium, phosphorus, magnesium, sodium and potassium. Where there is good soil fertility, there is not wide fluctuation in the major minerals present in silage. However, there can be inadequate amounts of copper, selenium and iodine to meet animal requirements.

It is essential that the farmer makes every effort to optimise the silage making procedure. Use good ryegrass pasture and ensure proper soil nutrient balance.

(i) Cut at correct stage of growth to achieve the best balance of yield, digestibility and protein content.

(ii) Mow once the morning dew has lifted. A dew can contain 1–2 tonne water and is more easily evaporated off if

the crop is still standing.

(iii) Use a tedder immediately after mowing and again in the afternoon or next morning once the dew has lifted.

(iv) If using a mower-conditioner, leave the swath boards as wide as possible to encourage less dense windrows which wilt quicker.

(v) Ensure good preservation by wilting or use an additive for low sugar or low DM silage. Bale within 24–48 hours.

Film Used for Wrapping Bales

Standard wrapping procedure in Britain and Ireland is typically 4 layers of 25 micron black film applied with 70% stretch level with some individuals choosing to move to 6 layers. A 750mm x 1500m film roll of silage wrap should typically cover from 28 to 32 bales per roll, based on four layers per bales. Six layers of film cover are recommended for higher DM silage, longer term storage, stemmy material or haylage made for equines and sheep.

Farmers have a choice of using black, green, pink or white film. Black film has a better tack in temperate climate as it attracts the heat. In Nordic countries and in hotter climates green or white film is preferred as it keeps the bales cooler.

Green or white film is often used in hotter climates and is also slightly more expensive. Pink film is used by charities for fundraising as they can charge a premium for this balewrap.

In Britain and Ireland farmers using the Film on Film system have found that while using only four layers of balewrap they have virtually no mould so the silage preservation is as good as using netwrap and six layers of film. Of course, netwrap is less expensive than using mantle film so this may be an issue for some farmers.

Haylage is part-way between hay and silage. The grass is baled slightly earlier than for hay, between heading and flowering. It is wilted and baled at 50% to 65% DM, instead of being left to dry to more than 80% DM as with hay.

Six layers of cover should be considered where: DM is high; considerable handling is anticipated; and/or sheep/equines are being fed. Between 22 and 24 turntable turns are required to achieve 6 layers of cover on a single dispenser machine.

Nowadays balewrap film is usually purchased by farmers rather than the silage contactor. A stretch film needs the appropriate mechanical properties to ensure it can be consistently stretched during the wrap process and maintains an airtight seal over time. While there is an international standard for bale wrapping film, many suppliers choose not to use it. It can be difficult to know if a stretch film is of adequate quality but the following should be considered:

- Does the manufacturer and supplier actively support the product in the market?
- Will this product work well during wrapping i.e. stretching consistently and not breaking or being damaged easily on the wrapper or when dropped?
- Is it strong enough to withstand handling from the field to the stack?
- Is it tacky enough to give a good seal between the layers?
- Does it maintain an airtight and weatherproof shield for the silage bale?
- Is the product a brand produced by different manufacturers with variable quality?

The price differential between the most expensive and cheapest film is often small equating to 6 to 10 pence or cents per bale.

How Many Film Layers?

Wrapping your forage with a minimum of 6 layers (conventional balewrap) will dramatically improve your feed quality ultimately reducing feed waste, saving money and improving milk yields and livestock weight gain.

With a minimum of 6 layers applied, not only do you achieve higher feed values, but also the extra layers can compensate for missed overlap in the wrap cycle, leaving at least enough film to give adequate protection to the bale.

Also according to Institute of Biological, Environmental and Rural Sciences (IBERS) 2007 research in Wales on using extra film layers on Silage bales had extra feed benefits for livestock. Increasing the layers of balewrap from 4 to 6 improved fermentation, reduced moulds, improved the oxygen barrier and reduced DM losses.

This was the first comprehensive experiment of its kind evaluating film layering at different DM contents that gave conclusive evidence that increasing film layers results in significant improvements.

Grass was ensiled at 30% DM, 40% DM and 50% DM (24 hour, 48 hour and 72 hour wilt respectively), and at each stage bales were wrapped in either 4, 6, or 8 layers of film. Film seal, mould coverage, silage chemical analysis and dry matter recovery were all assessed following the 180-day storage period.

Applying 6 layers of film significantly reduced the chance of mould coverage-on the bales compared with applying 4 layers but applying 8 layers resulted only in a small reduction when compared with applying 6 layers. Increasing the number of film layers applied also resulted in significantly more DM being recovered after the ensiling period.

The application of 6 and 8 layers of film resulted in respectively 5kg and 7kg more silage DM per bale being retained for feeding compared to 4 layers. The residual sugar content of the silage was greater with increased wilting, and also in response to the application of more film layers.

IBERS assessed the financial returns of applying both 6 layers and 8 layers of film based on balewrap prices at the time of the trial. The extra cost was calculated at €0.89 per bale for 6 layers and €1.79 for 8 layers. The cost saving achieved in terms of the value of the extra DM and sugar recovered was calculated at €1.72 and €3.16 respectively which means that the applications of 6 layers gives a return on cost of 92% for 6 layers and 76% for 8 layers.

The use of 6 layers of film on the bale, in preference to the normal 4 layer application will have significant economic benefits. This was outlined in studies carried out in 2004 by The Centre for Dairy Research (CEDAR) at the University of Reading in England which showed that the losses incurred to an 800kg+ bale of silage wrapped with 4 layers was almost 9% of its total feed value,

Table 1. The effect of film cover on silage composition and mould growth

No. of layers	DMD (g/kg)	pH	NH_3N (g/kg N)	Visible mould (% area)
4	764	4.7	86	1.7
6	775	4.7	84	0.7

compared to less than 1% for a bale wrapped in 6 layers. The 8% saving in feed value amounts to almost the entire cost of the film used to wrap it in 6 layers.

Handling & Bale Transport

Bale handling continues to be a potential source of damage to the bales. Every effort must be made to avoid damage caused by careless work or using unsuitable bale handlers. In general, the following advice should be adhered to:

1. Firm, well-shaped bales should be produced and any handling carried out before wrapping should not loosen the bales.
2. If possible, bales should only be handled once from the time they are wrapped until they are placed in storage. Transporting bales to the storage site area before wrapping will facilitate this.
3. Only purpose-built well-maintained handling equipment should be used to handle wrapped bales.
4. Self-loading trailers can be used on unwrapped bales. Extreme care must be taken when these are used to lift and transport wrapped bales.
5. For transport relatively short distances a double bale handler fitted to both the front and back of a high HP tractor is a very efficient way to move bales.

The baled silage system can be quite labour intensive as large numbers of bales must be transported from the field to storage. Despite problems lifting wet, well-packed bales with smaller tractors, generally, the greater the density, the better, as it reduces costs and may make the bale less prone to extensive spoilage from minor film damage. The aim must be to have the greatest content of DM in the bale by wilting rapidly to 30% or more DM content and baling dense bales.

In addition, slow transport often results in the bales being left in the field overnight, where they are prone to bird attack, and may become more difficult to handle without causing damage. The transport operation is a particular constraint where large numbers of bales are involved (>100) and where there is considerable distance between the field and storage site.

Self-loading multi-bale transporters are available and can speed up the transport operation. In a Teagasc trial at one site, a 5-bale self-loading trailer had a work rate of about 30 bales/hour with a 500 m transport distance which would equate to the output of 3 single bale transporters. This trial was carried out with unwrapped bales. Today self-loading transporters that carry 8 to 12 bales are increasingly being used. Alternatively, flat bed trailers and loaders can be used but loading and unloading does present a damage risk.

Important Role of Silage Contractors

While much of the technology development associated with baled silage increases the capital costs of the machinery, the use of contractors for some or all of the service brings the necessary economies of scale to most users. Short chopping, high density balers, Film on Film wrapping, high speed wilting and efficient bale transport and stacking services can all be supplied by a contractor, usually as part of a flexible service. In particular they can reduce or eliminate the need for the farmer to provide labour and machinery for baled silage production.

These valuable cattle are very content and thriving on top quality mould free high DM baled silage.

McHale Baled Silage Machinery

McHale manufactured its first round bale wrapper in 1987 and quickly built a reputation for producing robust efficient machines. McHale introduced the Fusion 1 to the market in 2002. In 2005, the company launched a standard fixed chamber baler and in 2009, they launched the V660 variable chamber belt baler targeted at drier climates around the world where there was demand for larger bales.

Over the years, there has been constant pressure on farmers and silage contractors

to reduce costs. In response to this McHale launched the Fusion 3 integrated baler wrapper in September 2012. This is unique as it has been specifically designed as a high output Integrated Baler Wrapper. In 2015 McHale widened its grass line range to include its Pro Glide range of front, rear and combination mowers. Two years later at the 2017 Irish National Ploughing Championships McHale unveiled two models in its Centre Delivery Rake Range – the R62-72 and R68-78.

Today McHale has four balers in the Fusion Integrated Range, four balers in the F5000 Fixed Chamber Range and 4 balers in their Variable Chamber Range. They export 90% of sales and their products are working in 55 countries around the world. Indeed, they are now the world market leaders in baled silage grassland machinery.

Numerous Awards for Baled Silage Machinery

As well as being recognised by contractors and farmers for their robust design and efficient operation, McHale have won many Agri show awards and accolades including:

- **2002** Smithfield Show: Innovation Award for the McHale Fusion Integrated Baler Wrapper
- **2005** Royal Show: RASE gold medal for the McHale Fusion Integrated Baler Wrapper
- **2007** The Dr Alban Davies Perpetual Trophy for the McHale Fusion 2
- **2014** Irish Farmers Journal Toplink.ie Rosette Award for the McHale Fusion Vario
- **2014** FIMA Agricole in Spain for the McHale Fusion 3 Plus
- **2014** Cereals UK award for the McHale Fusion 3 Plus
- **2014** Royal Highland and Royal Welsh show awards for the McHale Fusion 3 Plus
- **2015** SIMA innovation award for Film on Film technology on the McHale Fusion 3 Plus
- **2015** National Ploughing Association and Irish Farmers Journal-innovation award for McHale Pro Glide Mower Range
- **2016** Czech TechAgro Show award for the McHale Orbital bale wrapper
- **2018** Heaviest bale at Royal Welsh Show
- **2018** Heaviest bale in the Irish Farmers Journal combination baler test

Useful Information Available

Depending on machine specification, the McHale Fusion 3 Pro and 3 Plus can provide useful information which is available from the machine's control console. This includes the number of bales wrapped, weight of bales, bales chopped or unchopped and moisture content. This can be printed out for the customer upon job completion. The information on the bales makes the sale of baled silage much easier as the customer now finds it much easier to assess the value of the bales.

Separate baling and wrapping does still have a role however as it allows:

- Lighter equipment to be used in wetter conditions or on slopes.
- Bales to be removed from the cut field for wrapping to reduce bird damage risk.
- Bales to be transported to the storage area before wrapping to reduce handling of wrapped bales.

Baled Silage Conservation in Chile

Most of the beef and milk production is concentrated in Patagonia, southern Chile, where around 80-85% of milk and dairy production takes place. The bovine productive area is circa 2.5 m ha, (1.5m for milk production and 1 m for beef. As of November 2020, milk produced for processing was 2.030 m litres and 870 thousand cattle (source: Odepa Chile).

McHale started to make its name in Chile by having outstanding reliability, onsite service, timely supply and support, and is recognized today as the market leader in Chile. During the season, the number of balers made per machine ranges from 7,000 to 25,000 bales. To date, there are more than 500 McHale machines working in Chile and some of them have handled more than 200,000 bales without any major issues. Now that is what we call lifetime value.

Due to Chile's wide variety geography, there are several different climates, and types of pastures. Species being ensiled in bales are as follows: Meadow Soft Grass (Holcus lanatus), Brown Patch (Agrostis sp), Orchard Grass (Dactylis glomerata), Clovers (Trifolium repens, T. pratense), Perennial Ryegrass (Lolium perenne, L. multiflorum, etc.), Brome grass (Bromus valdinvianus), Italian Ryegrass (Festuca sp.) and Alfalfa (Medicago sativa) among others.

Also, some cereals are seeded to be used in silage production. Some of the

species used are as follows: Wheat (Triticum sp.), Triticale (Triticosecale sp), Oats (Avena sativa), Barley (Hordeum vulgare), Rye (Secale cereale) or associated to ryegrass.

Generally speaking, baled silage is prepared with any forage available. When all or the majority of the stages are done correctly, a high-quality forage is achieved. These steps are; cut/mow, wilt, rake, bale and finally storage of the bales.

1. Pasture Mowing

Ideally, the mowing should be done when the plant has 3 leaves for ryegrasses (4 leaves in Orchard grass)

to be able to opt for regrowth in a short period of time. This stage of growth is ideal for animals with high nutrition demand (Cows in lactation or finishing beef cattle).With other animals that do not require a high level nutrition, you can let the grass grow higher, increasing the bales per ha though with a higher fibre content, less Protein and Energy, and probably only just one heavy cut per season.

2. Drying Forage & Preparation for Baling

At this stage, the grass is dried and the forage dry matter (DM) is increased, and the crop is raked/ windrowed for baling. Depending on the season/time of year, a Tedder is used in one or several passes to air the forage. Another alternative is using a conditioner mower at the time of cutting. Ideally, the forage is at 35-45% DM when baled. Finally the forage is raked into a wide windrow at least the width of the baling chamber to enhance the subsequent pick-up.

3. Baling the Forage

Best to use a high density machine for baling the silage. This machine should have a pre-cutting system with sharpened knives with an adjustable system for producing a high-density bale with an appropriate weight (750 kg. with 40% DM content). The speed of operation will depend on the harvesting conditions therefore the operating speed must be regulated depending on volume, type and maturity of the forage.

Silage must ferment in anaerobic conditions, thus the wrapping must be done within 2 hours after baling, at the latest. The speed of baling and wrapping depends on the machines available (Integrated such as the McHale Fusion, single baler, wrappers with one or two film dispensers). The stretch film used needs to preserve the forage for at least 4 to 8 months in Chile. For this, the film must have the appropriate UV protection for Chile (over 180ª kLangley).

4. Storing Baled Silage

Once wrapped the bales, should be taken off the paddocks and stored, for the pastures to have a homogeneous regrowth. It is recommended to do this as soon as possible and use handlers without sharp edges equipped with an overpressure valve so as to avoid film breakages when handled. In addition, any breakages after handling should be repaired with suitable patches.

The storage site, ideally must be over a stabilized area, clean without weeds, tall grass, branches or any sharp elements and clear of trees. It must be fenced at least with a 1.5 metres distance between fence and bales to avoid access by cattle. It is recommended to stack bales no more than two high, with enough space in between the bales to avoid rodents nesting between them (aprox. 10 cms)

This information was kindly supplied by Eduardo Benavides, Agricultural Engineer., Dr. Jordan Sotelo, Veterinarian and Carlos Sotelo-Sorribes, Mechanical Engineer.

Making Baled Silage In Brazil

Herbage dry matter (DM) accumulation is a balance between growth and senescence. Agronomic practices may influence both processes in different ways and, therefore, alter the quantitative and qualitative patterns of DM production. The same principles and relationships originally described for herbage accumulation in temperate grass pasture species are also valid for tropical areas.

For a better understanding of herbage conservation; we need to point out that no matter where you are, forages and grasses do not have an equal growth pattern throughout the year. This behavior leads to what we call "Seasonality Production Curve".

There are three main environmental factors that have a deep impact on this forage status, all related to climate conditions: water; temperature and luminosity (hours of light during the day). Whenever one of these factors have some restriction, growth changes, resulting in a total unequal herbage accumulation rate.

On the other hand, animals forage demand is the same every day, forcing the farmer to take some strategies so the availability of DM meets the herd demands. That is why forage conservation is so important anywhere in the world. What varies is the intensity of these three main climate conditions, but the end result is the need for silage, hay, haylage or grain, to supply the feed required by the herd.

Brazil is a tropical country and the climate determines the potential for herbage accumulation. But there are some impacts on high forage production. One is the great concentration of forage during the growth season.

For tropical grasses this happens during spring and summer; the same as temperate grasses, but with a higher level of accumulation. The second impact is that, whenever you have a high growth rate, it will always be combined with a high senescence rate.

This means that the more it grows, the more it dies. The objective is to harvest this forage; either by grazing or cutting, when the sward has the least difference between growth and senescence, or Net Herbage Accumulation (NHA). The more leaf, the more quality in the forage.

Herbage accumulation has an enormous impact depending on the sward height management. Our studies showed that the exact time for harvesting the forage (grazing or machinery) is related to 95% of light interception by the sward surface height. Higher pastures intercept this light; but the higher shading as well, leads to a higher senescence rate. In another words, as the NHA drops; so, does the quality.

Light Interception

Another important issue is that when we manage pastures to a right light interception, all of our studies showed

a higher forage accumulation, with a slighter slope of the Seasonality Production Curve. So, this leads to a higher number of harvest events, better NHA and a more even production within the growing season.

The costs of feeding have a great impact on livestock production profitability. Between 1998 and 2000, we focused on the plant behavior within 4 different grazing heights; 5, 10, 15 and 20cm that were all kept stable under a continuous stocking rate. The grazing heights that allowed the highest rates of forage accumulation were between 15 and 20 cm.

The stem component of the pasture contributes significantly to the production of forage and needs to be better studied with regard to its qualitative characteristics for the purposes of animal production. The classic balance described for growth and senescence undergoes significant changes when the limiting factor for the development of plants becomes water and not light.

The climate where we are situated in southern Brazil is defined as subtropical, with a very hot summer and a cold and rainy winter. It's a 30% amount of rain during spring and summer and 70% rain from autumn to winter time. So we can work with C4 and C3 tropical and temperate grass species; Tifton-85 and perennial hay grass; black and white oats. This allows us to have forage in storage over the whole year.

But because of the actual market, and knowledge of our customers, it's very important to distinguish the difference between hay and haylage. For haylage there is a range of 40 - 60% moisture, with the need for wrapping because the fermentation processes and without the presence of air inside the bale.

During the summer the heat is so high that the loss of internal water on stems and leaves is very fast. For haylage cutting starts the previous night so we can rake the crop early the next morning. It all starts with cutting. With a mower conditioner the drying time is reduced and quality increases significantly.

Tedding will spread the forage and make it more uniform so the crop dries more uniformly in the field. This equipment combination is ideal for high-quality work, overall efficiency, time savings, great forage quality with a low fuel consumption.

Managing the moisture frequently, the next processes is raking. The more uniform the rake the better the bale shape. Another key element is the bale density. High density reduces costs as you have less bales/Ha. This has a big impact on net; film and diesel required; and finally, lower transport costs.

Although the herbage forage growth is huge, good management of the grass is important. The main point of harvesting a forage is related to the percentage of light interception from the sward. This is a new concept of management that increases DM production, improves forage quality and reduces the slope of this "Seasonality Production Curve".

Information kindly supplied by By Felipe Moura M.Sc, FENO & PUNTO.

Baled Silage Tops Swedish Silage Trial Results

Major research resources have been allocated to improve the ensiling process. The ultimate objective is to accomplish a secure preservation of the ensiled material with limited changes in nutrients and a high hygienic standard of the end-product. However, the problem of silage heating up after opening and during feeding out is evident on many farms. This problem leads to rapid deterioration of feed quality, large losses and sometimes where a considerable amount of silage must be discarded.

Heating does not always occur, but takes place in a seemingly haphazard way on different farms and in different years. Presence of air in the silo is a prerequisite for heating and yeast starts the process in most cases (Wilkinson & Davies, 2013), which always leads to losses of organic matter and the production of carbon dioxide and heat.

Experiments, funded by the Swedish Farmers´ Foundation for Agricultural Research, have been carried out in laboratory scale silos to study the effect of air ingress during fermentation (Spörndly & Persson, 2015a) and during unloading silos (Spörndly & Nylund, 2016) as well as the effect of yeast prevalence on crops at commercial farms (Spörndly & Persson, 2015b).

Temperature measurements have also been performed in full-scale bunker silos to monitor ongoing processes during the ensiling and unloading phases (Spörndly & Nylund, 2016). The present study reports dry matter (DM) losses measured by silo balances and chemical analyses from different types of silo structures at commercial farms.

Losses during ensiling, storing and unloading of mainly grass-clover crops were studied on 12 farms. During the study, a total of 12 bunker silos, 6 tube silos, 3 tower silos and 60 round bales in duplicate were monitored. The DM content in the bunker silos was in average 33.0%, and 53.9% in the round bales. Results showed that the round bales had considerably lower DM losses than all the larger silo constructions.

Conclusions: The main difference between DM losses among silo types was a considerably lower loss in round bale silos (< 1% losses), compared to large bunker, tube and tower silos, which all averaged over 10% losses. The reason to the difference is suggested to be aerobic conditions during long unloading times of large silos. It was also suggested that the high seal integrity achievable with stretch film packages of round bales enables ensiling at high DM contents and also at moderate densities.

Source: Proceedings of the 9th Nordic Feed Science Conference reference Swedish University of Agricultural Sciences (SLU), Department of Animal Nutrition & Management.

Baling Forage Crops for Silage-Kentucky, USA Research

Forage may be stored for winter feeding when pasture production is limited, for use in confinement feeding systems, or for cash sale. However, baled silage (baleage) may be more suitable in situations where hay curing is difficult. It is possible to make high quality silage or haylage using long (unchopped) forage crops baled with large round balers, although balers may need modification to handle wet material. (Note: McHale balers have choppers and do not need modification.)

Benefits

Storing wet forage as baled silage will allow more timely harvest and less leaf shatter loss, resulting in consistently higher quality. University of Kentucky research (Table 1) compared baled alfalfa silage at three moisture levels with field-cured hay (stored outside on the ground). Baled silage retained initial protein and in vitro digestibility levels of the fresh forage better than the field-cured hay. Field-cured hay declined significantly in digestibility and had large dry matter (DM) losses compared to baled silage.

Round bale silage is the product of cutting forage crops, allowing the forage to wilt to between 40 and 60 percent moisture, baling the forage into tight bales, and quickly wrapping the bales in film to exclude oxygen. The forage in the bale undergoes anaerobic fermentation fermenting soluble sugars and yielding volatile fatty acids such as lactic and acetic acid which preserves the forage and limits growth of undesirable microorganisms.

The ensiling process does result in gaseous losses, but this loss is small

Table 1: Forage quality and DM losses of alfalfa baled silage and hay, pre- and post-storage.

	Protein		Digestibility		Bale Weight		DM Loss
	Pre-storage	Post-storage	Pre-storage	Post-storage	Pre-storage	Post-storage	
	% Dry Matter				Dry Matter (lb/Kg)		%
Silage 46% DM	23.7	22.6	63.0	63.8	548/248	554/251	Negligible
Silage 51% DM	23.1	22.3	62.0	65.0	537/243	541/245	Negligible
Silage 57% DM	22.1	21.0	65.1	64.4	587/266	583/264	Negligible
Hay	18.2	17.5	67.2	51.9	609/276	495/224	18.7

Mike Collins. 1995. University of Kentucky, Unpublished Research. Storage Period: May to December. Hay is stored outside on the ground.

compared to DM losses that result from tedding, raking, baling and particularly storing round bales outside as hay (Table 2).

Forage Requirements

All of the major forages grown in Kentucky can be harvested effectively as baled silage. To do this, cut at the proper stage of maturity so that the forage contains adequate levels of fermentable carbohydrates for proper ensiling. In general, harvesting forage crops in the transition stage between vegetative (leafy, immature) and reproductive, or flowering stage, will produce the best compromise between yield and quality.

Harvest losses (usually from leaf shatter) are greatest for very dry forage but are low for herbage handled immediately after cutting. However, silage baled too wet is subject to excessive storage losses due to seepage and deterioration. Storage losses arise from microbial activity in high moisture forage (above 70% moisture) and therefore are generally minimized by harvesting at moderate moisture levels. Minimum combined field and storage losses are achieved by harvesting forage from 40 to 60 percent DM.

Field losses in mechanical harvesting are due to respiration, leaching, and some leaf shatter loss. The moisture levels recommended for baled silage are generally between 40 and 60 percent. Fermentation of round bale silage is better when the moisture content is in the upper half of the recommended range (50 to 60 percent). In this range, fermentation is sufficient to produce desired levels of lactic acid (2 to 3 percent on a DM basis), heat damage is minimized and detrimental secondary (clostridial)

Table 2: Advantage and disadvantages of baling round bale silage.

Advantages	Disadvantages
Film cost per bale is low (around €3.34 per bale). **Capital investment required is lower than conventional silage storage.** **Baled silage allows more timely harvest and higher quality feed.** **Harvest and storage losses are lower.** **Weather damage is less than hay stored outside.** **Individually wrapped silage bales are more portable.** **Small amounts of forage can be ensiled.** **Baled silage feeding does not require specialised machinery.**	**Long (unchopped) forage crops are harder to ensile than chopped forage. (Use a McHale chopper baler to overcome this)** **Some balers cannot handle high moisture (50 to 60 percent) forage. (McHale balers are designed to handle wet heavy crop.)** **Bales can be very heavy, leading to larger tractor requiremets.** **Film wrap material can tear or puncture, leading to spoilage so use good quality film.** **Disposal of used wrap is necessary.**

fermentation is inhibited. In producing bales for wrapped silage, it is important to remember that forage in the 50 percent moisture range will weigh about twice what the same size bale of hay would weigh. Bale size is frequently reduced to restrict bale weight to 0.75 to 1.0 ton. Heavier bales may be difficult to transport.

Machinery Requirements

The equipment for making baled silage is mostly the same as for dry hay. Conditioning mowers usually have the ability to vary the width of the swath behind the mower, which can help manage drying time. Conditioning mowers will crush the stems of tall-growing summer annuals like sorghum sudan grass hybrids, increasing the access of fermenting bacteria to soluble carbohydrates.

Wheel rakes have the advantage of being able to consolidate larger swaths of a field into a windrow. However, they are driven by contact with the forage and have been shown to incorporate more ash (dirt) into the windrow, especially when it is set so the tines are too low and contact the ground. Rotating-bar rakes typically cover less area per pass than wheel rakes and will incorporate less ash when the rake height is properly adjusted.

Bales should be formed as tightly as possible. The ground speed of the baler should be lower than used in making hay. Downshifting one gear should help to guarantee a tighter, denser bale. A DM density of 10 pounds per cubic foot is considered ideal. A typical silage bale (4 feet/1.23m in diameter by 5 feet/1.53m in length)should weigh 1,300 to 1,500 pounds (590 to 680 kg) and contain 600 to 650 pounds (272 to 295 kg), but it may weigh as much as a ton.

Since the forage is wet and heavy, bale diameters generally range from 42 to 48 inches (1.07m - 1.22m) to avoid overloading either the baler or the transport equipment. Fixed-chamber hay balers lack the flexibility of variable-chamber balers to vary bale diameter as a means of reducing bale weight. Fixed chamber silage bales have smaller diameters.

Some recent models of both fixed and variable chamber balers include knife mechanisms to chop the forage, allowing increased density. University of Kentucky research found that using a “chopping” fixed-chamber baler increased silage bale weights by about 300 pounds (136kg) at the same bale diameter.

Time Between Baling & Wrapping

The interval between baling and wrapping is critical to the success of the ensiling process, ideally, within 12 to 24 hours. Prior to wrapping, high-moisture forage is subject to very high respiration rates and to the growth of undesirable microorganisms. Respiration reduces forage quality by consuming readily digestible carbohydrates and by significantly increasing bale temperature.

Consider moving freshly baled forage to the storage area. This allows wrapping to be done on more level, uniform ground. Bales can “walk off” the wrapping platform if the machine is not level. Minimizing movement of

wrapped bales will reduce tearing of the film. Consider identifying different types of baleage and different cuttings by marking with spray paint. Different colors could represent the various crops while the number of marks could indicate the cutting (for example: one dot for first cutting, two dots for second cutting, etc.).

Wrapped Bales

Although four layers can be sufficient, six layers are recommended against problems like punctures. Wrapped bales can be moved to diverse locations for feeding or storage; they are also more easily transported (on their flat side), stacked for storage, and provide more marketing opportunities.

Damage to film during handling or storage allows oxygen to enter the bale, causing spoilage. Repair any holes in bales as soon as possible. Holes allow oxygen to enter and increase the risk of feeding problems like listeriosis and botulism. Even well-wrapped bales will allow slow infiltration of oxygen. For this reason, plan to utilize all supplies of round bale silage before the next growing season.

Do not feed silage that has significantly deteriorated or has a bad or rotten odor. Wet silage that improperly ferments will have a much greater risk of botulism. Reduce the risk of clostridial fermentation and botulism toxicity by keeping moisture content at baling below 70 percent.

The ability to make baled silage allows the harvest and storage of the fall growth of alfalfa or other forages that can be produced in some years during October and November. In most years, this forage goes unused unless these fields can be grazed since hay making conditions are too difficult.

Ensiling conditions are not ideal during this time (low temperatures and low numbers of ensiling bacteria), and fall baled silage should be fed first during the winter. Silage inoculants have been shown to improve the ensiling characteristics of fall forage crops.

Summary

Baled silage offers a convenient and inexpensive way for farmers to produce silage. The benefits of making baled silage come from more timely harvest, lower DM losses during harvesting and storage, less chance for rain damage, and better retention of leaves in high quality forage crops like red clover and alfalfa. Disadvantages include handling heavy bales, keeping bales airtight, handling wet forage, and film disposal.

The authors wish to acknowledge the significant contributions of Drs. Michael Collins, David Ditsch, and Garry Lacefield. Their applied research has greatly advanced the adoption of round bale silage in Kentucky.

Making High-Quality Baled Silage-Ohio & Wisconsin USA Research

One way to maintain forage quality with small, dry weather windows is to make silage or baled silage instead of hay. The ideal conditions for baled silage is to bale the forage between 40% and 65% dry matter (DM) and wrap within two hours of baling. This process uses anaerobic conditions, and the acids produced in fermentations preserve the forage.

Baled silage fermentation is slower than in haylage, often taking six weeks. When forage is baled between 25% to 40% DM, it will not ferment properly, and baled silage at these DM levels should be considered as temporary storage. During such situations, preservation is primarily a function of maintaining anaerobic, oxygen-limiting conditions.

Mould is very likely at this DM; higher bale densities and more wraps of film is required to better seal out oxygen.

Baled silage at this DM will not maintain quality very long in storage, so, it needs to be fed as soon as possible.

If you are thinking of making baled silage the first consideration is how fast will you be able to feed the forage? This is a major consideration when selecting the type of bale wrapper you will use.

Determining where you will be storing bales ahead of time is very important. Making sure the wrap is not punctured, allowing oxygen to enter and spoil the forage due to storage site selection, is critical. Ideal storage is in a well-drained location with year-round access. Stone pads can work well as long as they don't puncture the film.

Be wary of storing on stubble, grassy areas or under trees. These areas often attract rodents, lead to film damage, or have sticks that fall and puncture the film. Stored forage should be checked weekly for damage and holes taped as

Wrapped bales of silage in Crawford County, Ohio.

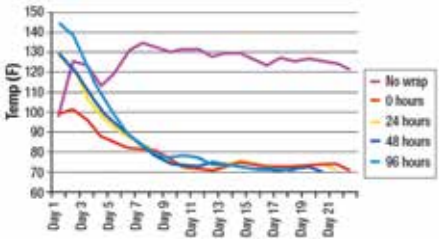
soon as they are found.

While keeping oxygen out is the most important part of making high-quality baled silage, it starts with mowing. Your harvest capacity-limiting factor will be how many bales you can wrap an hour, ideally within four hours. Based on research done at University of Wisconsin – Madison, they recommend laying swaths as wide as the mower will allow, helping preserve forage quality and speeding up drying to 65% DM by 10.8 hours. When baling, make the highest density bales possible.

A study from Penn State University in Pennsylvania shows that by increasing bale density from 6 pounds per cubic foot to 8 pounds per cubic foot (96kg/m^3 to 128kg/m^3), you gain an extra 12 hours of bunk life in the haylage, due mostly to better bale fermentation. It is important to wrap bales as soon as possible after baling to avoid spoilage.

The temperatures of bales that were wrapped each day from at baling to four days after baling are provided in Figure 1 (data from University of Wisconsin), with the temperature on day one representing the actual day of wrapping. This data shows that just 24 hours after baling, the bales that are not wrapped were over 120°F (48.8 Celsius). While wrapping bales even four days after baling stopped the heating process, the quality of these bales still declined.

Figure 1: Effect of timing of bale wrapping on bale tempeature.



Most bale wrap is 1 mm low-density polyethylene, and bales need a minimum of 5 mm of film to seal out oxygen, requiring a minimum of six wraps. Types of bale wrap vary greatly in their stretchiness, which can reduce thickness by up to 25%. Some stretch is necessary so that the film stays sticky and seals well between the layers of wrap. Be cautious when wrapping in the rain as this will reduce the stickiness and allow more oxygen to penetrate, causing spoilage. Also, be cautious when wrapping forages that poke through the film, which will require more layers.

Figure 2: Effect of film wrap thickness on bale tempeature.

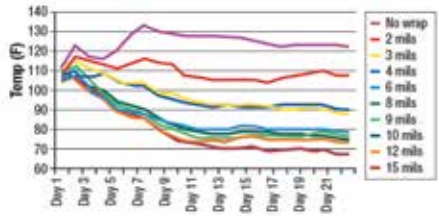


Table 1: General recommendations for layers of bale wrap.

Moisture (%)	Fermentations	Layers of film
<30%	Possible, but not ideal for fermentation. Some mould growth likely.	8 layers minimum to ensure oxygen exclusion.
30 to 45%	Possible, but not ideal for fermentation. Some mould growth could occur.	8 layers minimum to ensure oxygen exclusion.
45 to 60%	Ideal for baleage production and fermentations.	Use 6 layers of 1 mm film.
60 to 70%	Possible, but high moisture can result in spoilage and low palatability.	8 layers of wrap to ensure oxygen exclusion.
>70%	Too wet for proper fermentation, baleage production is not recommended.	Wait for the forage to dry further before baling.

When oxygen enters the bales, they start to heat, and quality declines when temperatures are over 120ºF. (48.8 Celsius). The amount of time until bales are wrapped and the number of mm of wrap significantly affects internal bale temperature. Figure 2 shows that 6 to 12 mm of film maintained similar bale quality. With less wraps than this, bale spoilage is often prevalent. The general recommendations for layers of bale wrap are provided in Table 1.

After bales are wrapped, handle them carefully using a squeeze so that wrap is not torn. If the film is torn in storage, the tears should be taped as soon as you notice them. For this reason, bales should be inspected weekly in storage. Never use bale spears to move wrapped haylage until the day you are going to feed it. It is recommended that bales be fed within a year of wrapping. Haylage that is too wet, over 60% DM, should be fed within three months, and haylage that is below 40% will not ferment well and should be fed within six months.

Most of the time, when we make baled silage as a salvage crop, it needs to be fed within six months. When done right, baled silage can last a year and make excellent feed that often has 5% better quality than dry hay. When poorly conserved, haylage can spoil, mould and grow organisms that sicken your stock; use your eyes and nose to be sure the forage you are feeding is of high quality. Do not force animals to eat forage they do not want.

Information kindly supplied by Jason Hartschuh, an extension educator for agriculture and natural resources, at Ohio State University, USA. Jason has a Master's Degree in Agriculture and Natural Resources in Plant Health Management.

Make Great Pasture Baled Silage - New Zealand Dairying Advice

Producing high quality pasture silage requires the combination of a quality pasture or crop; an excellent fermentation; excellent harvest, storage and feed-out management. Your ultimate goal for your stack of bales is to completely eliminate oxygen and keep it out, creating an environment where a good fermentation can take place. During good fermentation plant sugars are converted into lactic acid by the right strains of lactic acid producing bacteria working in oxygen-free conditions. Yeasts and moulds grow in the presence of air. They make silage heat and decrease the quality and the quantity of the silage available for feeding. Oxygen-free conditions are achieved by compacting air out of the silage and keeping it out.

Why is Silage Quality Important?

1. Time of feeding. High energy, high protein pasture silage can be fed year-round and is an excellent feed for milkers. If you make poor quality silage it is at best a filler for dry cows.
2. Milk response rate. Research conducted by Kevin MacDonald at DairyNZ showed that high quality pasture silage fed in the spring, summer or autumn produced an average of 0.22 kg Milk Solids/cow/day more than poor quality pasture silage.
3. Palatability/wastage. Wastage is a big cost associated with supplementary feeds. Feedout wastage is the most costly form of wastage because you have already paid for the feed, paid to store it and paid to feed it out. Silage that is badly fermented (e.g. butyric and smells like vomit) will have higher wastage rates.
4. Animal health concerns. Some silage moulds can produce toxins and cause ill thrift, fungal abortions, pneumonia and reduced production. A little bit of some moulds can cause a big problem and large animal health bills.
5. High quality pasture silage costs about as much to make as poor quality pasture silage. High quality silage has a lower cost per MJ of ME and gives a much better return.

Key Steps to Making High-Quality Pasture Silage

1. Harvest at the correct time. Harvest no later than 35-40 days after the last grazing, or when a maximum of 10% of the ryegrass seed heads have emerged.
2. Wilt to at least 30% dry matter for bales. Wilting concentrates the sugar and increases the chance of a good fermentation. It also decreases the risk of silage effluent losses. Silage effluent contains valuable nutrients and is also a powerful agricultural pollutant. Where possible wilt within 24 hours.
3. Avoid getting dirt in the silage. Avoid effluent application to paddocks that have been closed for silage. Make sure the cutter bar does not scalp the paddock.
4. Research has shown inoculants can give good returns because they reduce fermentation losses and produce higher quality silage.
5. For baled silage use a quality film and the recommended number of wraps.
6. Handle bales carefully to avoid puncturing the wrap. Mend holes that develop in the bale wrap immediately.

Characteristics of high-quality baled grass silage in New Zealand

Silage characteristic	Target levels
DM content (%)[1]	40 - 50
Metabolisable Energy (MJ ME/kg DM)	>10.5
Crude Protein (%)	>15
Neutral Detergent Fibre (%)	<50
pH (between 40% – 50% DM)	5.0 – 5.2
Ammonia – N (% of total N)	<10, preferably <5.0

Advice for Better Quality Silage

McHale Orbital High Speed Round Bale Wrapper which is capable of applying 4 layers of film in 18 seconds and 6 layers in under 25 seconds.

- Tedding with certain dual purpose tedders/rakes can make poor swaths that impede baling. Use tedders and rakes carefully.
  If possible, ted within 0.5 - 2 hours after mowing while plant stomata are still open to substantially increase rate of wilting.
- Leave the swath of the conditioned forage as wide as possible (moisture evaporates quicker from thin, wide swaths). Do not over wilt as field losses increase and silage is harder to compact.
- Silage destined for bales can be wilted to 35-45% DM. Drier crops are lighter, but are more prone to moulds and are used less efficiently by livestock. -
- Grass should be baled within 48 hrs of cutting. Wrap as quickly as possible and within 12 hours of baling. Ensure there is a minimum of 4 layers on the entire bale and ideally within 2 hours of baling.
- Aim for dense, well-shaped bales to produce heavier but fewer bales per hectare, thereby reducing baling and wrapping costs.
- Ensure the wrapper is set up properly. The aim is to apply the film to the centre of the bale. In other words, have the distance from the top of the film to the top of the bale similar to the distance from the bottom of the film to the bottom of the bale.
- Move wrapped bales to the store site as quickly as possible, preferably within hours of wrapping. Use high quality film with 70% pre-stretching and ideally use six layers of a good quality wrap. If using mantle/NRF film then four layers of balewrap may be adequate with 6 layers being ideal for good quality bales.
- Handle and store silage bales carefully to avoid damage to the wrap. All bale handlers should be used on unwrapped bales first or wire brushed and sanded to remove rust prior to handling wrapped bales.
- Net and bait the stack to prevent bird and rodent damage. Rat bait should be laid near the livestock proof fencing away from the bales.
- Bales must be brought to the storage point as soon as possible after wrapping. This must be done prior to sun rise in the morning after wrapping to reduce bird damage.
- Great care should be taken when

storing bales on concrete, as film is easily damaged on this surface. Take care not to place bales too close to hedges or ditches.

Please note Ryegrass quality in table below from the Tasmanian Institute of Agriculture (TIA) at different stages of growth

Description	Metabolisable Energy (MJ/kg DM)
Leafy tiller	11.5 - 12.5
Stem starting to develop, nodes <5 cm from ground	11.5 - 12.5
Flag leaf appearing, nodes >5 cm from ground	10.5 – 11.5
Seed head developing, 1 cm long	10 – 11
Seed head starts to emerge	9 - 10
Seed colour changes, seed starts to fill	8 – 9
Seed shedding	6 - 8

Research Advice on Silage Quality

Farmers must maximise silage quality, irrespective of the production systems they are following, according to the Agri-Food and Biosciences Institute (AFBI) in Northern Ireland. They say that forage quality is a key driver of dairy profitability across the board. Every additional 1,000L of milk secured from forage equates to an extra €12,500 of profit per 100 cows. Where silage quality is concerned, each week's delay in cutting will bring about a 3% fall-off in the digestibility and milk output levels from forage will fall by 1.3 Litres/cow/day.

AFBI have carried out an extensive review of the analysis results from their commercial silage testing laboratory. A total of 80,000 samples were assessed, going back over a number of years. The work confirms that silage DM has increased by 5%; crude protein figures have fallen a little. However, D-values have flat-lined.

According to their research for each unit increase in silage digestibility (D-value), milk yield increases 0.3 to 0.4 litres/day per cow. However, a week delay in cutting from mid-May typically results in a D-value reduction of three – or a fall of 1-1.2 litres a day per cow.

It suggests farmers should target high-quality grass with a D-value of 70-73. This means cutting before any seed heads appear, which is normally in early to mid-May. If about 50% of the sward is showing seed heads, the D-value will be closer to 67, according to AFBI.

It adds that delaying harvest for too long for a good yield only produces more stem of lower quality and reduces the yield of the second cut. However, this silage might be ok for dry cows or cows out grazing and getting some supplementary silage.

The Importance of making good quality silage so as to optimise livestock performance is clearly demonstrated from this silage analysis (ref Teagasc Grange, November 2017

Beef Cattle – Teagasc Grange				
Digestibility (DMD %)	75.0	70.0	65.0	60.0
Intake (kg/day)	9.0	8.3	7.6	7.0
Liveweight Gain (kg/day)	0.83	0.66	0.49	0.31
Carcass Gain (kg/day)	0.51	0.39	0.27	0.15
Feed Efficiency (DM Intake/ Carcase Gain)	17.6	21.3	28.1	46.7

The above table shows how silage quality affects intakes and weight gains.

It takes 17kg Dry Matter of 75 DMD silage to put on 1kg of carcass as opposed to 46kgs of DM of 60 DMD to put on 1 kg of carcass weight.

Your Target Silage Quality Should be as follows:

- **Autumn calving cows and finishing animals 75 DMD**
- **Spring Calving cows and young breeding stock 70 DMD**
- **Suckler cows 65 DMD**

There is clear evidence from AFBNI research that contamination of crops with either slurry residues or soil can have an adverse effect on silage quality, with this identified as having a large to very large effect on silage quality on just under 25% of farms.

In studies conducted at Teagasc Athenry, feeding high DMD silage to housed ewes was found to have a positive impact on ewe body condition at lambing and lamb birth weight. Each 5% rise in digestibility improved ewe bodyweight immediately after lambing by 6.5kg.

Lamb birth weight increased by 0.25kg which in turn resulted in lambs being on average almost 1kg heavier at weaning time (Keady & Hanrahan 2011, 2012). Chopped silage increases the DM intake and is also more suitable for feeding to ewes on slatted floors.

Preparing for Silage

One key requirement if producing highly digestible baled silage is to avoid the presence of dead vegetation at the base of the grass crop. Experiments by Teagasc found that accumulation of dead vegetation reduced overall digestibility by about 7%.

Grazing swards down to a 5cm stubble height in autumn or in early spring avoids this problem. Slow or intermittent wilting (e.g. due to prolonged, heavy rain on partially wilted grass), poor preservation or imperfect sealing of the bales will reduce the potential digestibility of the baled silage.

Ryegrass-dominant swards are inherently much easier to preserve as baled silage compared to grass swards dominated by non-ryegrass species. This is because ryegrasses have a much higher content of sugar which is needed to fuel the preservation process. However quick and adequate wilting can largely overcome this potential limitation with non-ryegrass swards.

Soil & Weed Contamination

Do not select uneven or poached fields for silage. All silage ground should be rolled. Slurry and dung should be applied well in advance as they can host undesirable bacteria. Do not cut swards too bare; leave a stubble on which the sward can sit. If you have a newly reseeded ground generally you will need to cut higher because the swards are less dense. When tedding, check that tines are not rooting soil onto the sward.

Listeria is a bacteria that lives in the soil and can be ingested by livestock if forages become contaminated with soil. If it is not spotted early enough it can be fatal and infected animals should be isolated from other animals. Listeriosis is treated with antibiotics and treatment may take up to six weeks or more.

In ruminants, Listeriosis can cause inflammation of the brain, abortion or blood poisoning. Signs include depression, loss of appetite, fever, lack of coordination, salivation, facial paralysis, and circling. Disease is more common in younger animals (1 to 3 years old).

Infection can also cause mastitis in cows.

Listeriosis is primarily a winter-spring disease of feedlot or housed ruminants. The less acidic pH of spoiled silage enhances multiplication of Listeria monocytogenes. Outbreaks may occur around 10 days after feeding poor-quality silage.

Removal or change of silage in the ration often stops the spread of Listeriosis; feeding the same silage months later may result in new cases. It is particularly problematic in poorly fermented silages where the pH isn't acidic enough.

Listeria grows in good silage around mouldy areas, so make sure you remove more than just the mould. If you identify a listeria problem, stop chopping bales or mixing a TMR diet as this will contaminate the entire feed.

High levels of weeds in grass swards not only reduce pasture's nutritional value, but restrict grazing areas and restrict valuable grass growth, particularly in newly sown leys. As well as the physical impact of weeds on your grassland fields, you are obliged to control certain weeds as part of your EU Cross Compliance obligations.

In normal circumstances, low levels of weeds in pasture are of no consequence and their removal may not be cost effective. Certain grassland weeds have high levels of trace elements and also have environmental benefits as food sources to birds, invertebrates and small mammals.

However, when weeds reach density levels of 10 to 20 per cent of the total sward, they will impact on silage quality or productivity. It is difficult to accurately assess the damage that weeds do, except where animal death or severe sickness is the result of plant poisoning (e.g. ragwort etc).

Small numbers of ragwort can be effectively pulled or dug up and safely removed. For larger numbers, sprays such as MCPA etc applied in the early spring, provide good control but measures must be taken to avoid stock eating any dying or dead ragwort present.

Creeping thistle is the most widespread and troublesome thistle. Yield losses of up to 15% have been recorded but they cause most damage by preventing animals grazing around them. Chemicals such as MCPA etc reduce top growth. For more persistent control use a spray such as Thistlex, but follow-up sprays will be needed.

Docks are one of the most common and troublesome weed in grassland. Also in silage fields, the level of potassium may be in over-supply for grass requirements thus favouring the higher needs of the dock. Teagasc recommends that soil potassium levels should be maintained at index 3 (101-150 mg/l). Where a heavy infestation of docks occur, silage yields could be reduced by up to 20%. Docks are unpalatable and animals will only eat them if nothing else is available.

Late April/early May is a good time to spray docks as there are plenty leaves on the dock plant and silage won't be cut for at least 30 days. There are a variety of sprays for docks and the choice depends on season and the importance of clover. Depending on the product used one spray application in early May followed by another 10/12 days after cutting silage gives very good control.

Silage Inoculants

Do They Work?

Silage inoculants contain specially selected strains of lactic-acid producing bacteria. When applied to the crop at harvest time these bacteria outcompete the naturally-occurring bacteria improving the speed and quality of fermentation. There are a number of things you must consider when purchasing an inoculant:

- Always look for a product that provides 100,000 colony forming units (cfu) per gram of forage.
- The bacteria must be live – so ask for product-specific trial data – not all products work.
- Choose a company that understands silage making and can provide comprehensive technical back-up.

Additives for Baled Silage

Excellent high DM baled silage can be made without the use of additives as baled silage is invariably wilted to some extent. Additives are not necessary even when ensiling legume crops, which have more difficulty reaching a stable, low pH. However, inoculants can enhance fermentation, reduce storage losses under challenging crop moisture conditions, and can improve aerobic stability.

They should be considered as a risk management strategy for crops low in sugar or DM. Grass sugars are the main consideration for crop preservation and according to Teagasc can range from 1.5 to 3.5%. The target for good preservation is at least 2.5% (3% if wilting is not possible). Older swards with less ryegrass and weed grasses such as Yorkshire Fog also show lower sugar levels.

There are trial results to show that the use of lactic acid bacteria such as MTD1 (Ecosyl & DA Ecobale) can give a more efficient fermentation with lower DM losses resulting in improved animal performance. Often the reason for using an inoculant additive is to get a more uniform fermentation, which may be more beneficial to sheep and horses. Treating can in some instances be effective against mycotoxins and listeria. If the use of an inoculant improves ensiling efficiency, this will result in higher animal performance from forage.

The use of a preservative such as potassium sorbate (which is found in DA Ecobale) may keep bales prone to aerobic deterioration, fresher for longer and help reduce the losses on damaged bales. This is of particular importance where animals are slow to clear the bales such as sheep and young stock, or when fed to horses where the bales are too large to be cleared quickly, resulting in the bale warming up and going mouldy before it's finished.

Table 1. Digestibility (mean values in %) for DM, the fibre fractions NDF and ADF and crude protein haylage (timothy) harvested at 4 different stages of maturity

Date	21 June (stem elongation)	5 July (flowering)	28 July (seeding)	17 August (late seeding)
Dry matter (DM)	72	63	51	46
NDF	77	65	52	44
ADF	75	63	48	40
Crude protein	92	78	47	50

DA Ecobale has been shown to reduce the number of mould spores, which is important for the equine market. There are also additives that contain a Buchneri type bacteria that will have a similar effect.

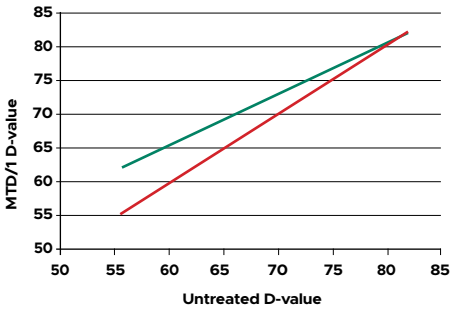
Accumulation of acetic acid in silages treated with L. buchneri has been suggested by research data as the primary reason for improvements in aerobic stability in silages i.e. less heating when exposed to air at the time of feeding.

Treating bales with a proven silage additive offers two main areas of improvement;

Nutritional Benefits

Bales are improved through a faster more efficient fermentation, As the quicker the pH falls the less time inefficient spoilage organisms have to influence the final nutritional quality of the bale, leaving more sugar (energy) and reducing protein breakdown (Proteolysis) so more "True" protein retained. Trials on Ecosyl (MTD1) have shown that animals also digest more of the treated silage worth around 0.5MJ/kg/DM

The Effect of MTD/1 (Ecosyl) on Digestibility at Different Crop Maturities
(Statistical Regression Analysis: 26 trials)



Other advantages of treating is that the bales from different fields will have the fermentation dominated by the same bacteria, resulting in them smelling and tasting far more uniformly which is especially important for fussy eaters such as sheep, resulting in improved silage intakes and animal performance.

Listeria is also hugely reduced by an improved fermentation, so Listeriosis and "Silage Eye" are also massively reduced by treating

Keeping Quality

Bales treated with a specialist combined bale additives such a DA Ecobale have all the same nutritional benefits, but combining the bacteria with a preservative (Potassium Sorbate) gives far more protection to the bale once exposed to air. So punctured and damaged bales are far less prone to losses with mouldy areas being far smaller and penetrating far less into the bale. Reducing health risks to the animal particularly from mycotoxins.

Heating and moulding on bales once opened can also be a problem if bales are slow to be cleared. DA Ecobale keeps the bales "Fresher for Longer" with some trials showing ten days before heating became noticable. This is particularly useful for sheep and horses, where bales often have a long open time before being cleared.

Which type of additive is right for you? An additive such as Ecosyl is designed to give the best fermentation. So if the bales are used up within a couple of days of opening and bale storage is good with few damaged bales, Ecosyl will be the cheaper option and should be the additive of choice. Where bales are eaten more slowly DA Ecobale should be the choice. Often dairy farms will treat most of the bales with Ecosyl and just have a small stack treated with DA Ecobale for the youngstock.

Wrapping, Storing, Handling & Feeding

Where Should Bales Be Wrapped & Stored?

Wrapping at the storage site minimizes handling of wrapped bales and reduces the potential for damaging film. However nowadays because of the dominance of combined balers/wrappers and the speed of baling and wrapping, most bales are wrapped in the field and later moved to a storage site usually for stacking two or three high depending on the ground conditions. Stacking and netting protect most bales from bird damage.

Some farmers leave bales on the headland and only move these at feeding time. Ideally these bales should be stored on their ends as this maximises the protection from potential bird damage. Another option to protect bales stored on their sides is to use a grease gun to grease bales on top of a stack. According to some silage contractors this can be quite effective at deterring birds.

One roll of silage net 8 x 25m can cover at least 150 round bales and protect the valuable crop from badgers, birds, cats, foxes, poultry etc. Place tyres on top of the stack to ensure the net is raised off the stack and birds cannot land on the polythene. Birds that attack bales include crows, jackdaws, magpies, ravens, rooks, seagulls, starlings etc. In a Teagasc trial, the use of red and transparent films reduced bird damage significantly when birds were offered a choice of bales to land on. After 72 hours, the number of bird holes per bale was 31.9 on the black (control) bales compared to only 6.5 on the bales wrapped in red and only 5.5 on the transparent film. This may because on a hot day insects or flies get stuck on the tacky black film and are an attractive feed for birds.

Stacks provide ideal nesting sites for rodents near on-farm feed sources, such as compound feed. Rats burrow and nest in the bottom of bales, tearing through the wrapping and letting air into the outer layers of silage. This causes aerobic spoilage which can create moulds and conditions for listeria to proliferate.

Baiting when the stack is being built offers the best protection from vermin damage as this is your only chance to place bait evenly across the site. You don't need to go any higher than the second layer as rats will spend most of their time at the bottom.

Sachets of palatable rodenticide are the most effective way of baiting. They are robust enough to be handled but easily broken into by the rats.

The concept of incorporating a substance with pest repellent characteristics into bale wrapping has been around for a number of years and a product will be launched commercially in 2020.

Store bales on a well-drained sod and away from trees or weeds that might harbour rodents and insects that attract birds who damage film. Avoid locations with coarse stubble that may cause small punctures. Patch small holes in the bale wrap using a suitable repair tape.

McHale 691 BH with removable rollers.

Handling & Feeding Baled Silage

Forage baled at the correct moisture range and wrapped with the correct amount of film will undergo full fermentation within six to eight weeks and can reach a stable pH in four weeks. Cool temperatures, mature forage, and insufficient forage moisture levels will reduce the fermentation rate. It is best to feed the number of animals who can eat the entire bale within two to three days.

The popular McHale 691 round bale handler (see photo) is a heavy-duty handler with rotating rollers that have tine reinforcement. It can be used to carry one bale of silage or spike two bales of hay or straw.

The McHale R5 round bale handler is ideal for collecting round bales, which have been tipped on their ends in the field. It can also be used to collect round bales, which have been left after a baler and rotate them through 90 degrees and stack them on their ends so that they hold their shape better.

Round bales can be fed in many ways from simply placing an intact bale in a round feeder or against a feed barrier to a chopper feeder or inclusion in a diet feeder.

- Simple front loader or rear spike delivery of bales to the feed barrier or feeder. The front loader can be used to break up the bale if required for better distribution.
- The McHale 994 – Round Bale Splitter can be front or rear mounted and is becoming increasingly popular as they allow the bale to be split making distribution at a barrier easier or loading into a diet feeder.
- Bale Unrollers: These allow the bale to be unrolled and fed to one side using a chain and slat conveyor. They do not chop or meter the material out but they can be useful in feed passages. Many allow the tractor to uncouple automatically to allow the bale to be loaded onto the feeder.
- Bale chopper/feeder: The bale is chopped and delivered via a chute onto the feed area. These are usually dual -purpose machines (E.g. McHale C4 Silage Feeder and Straw Blower Range which can also blow chopped straw for bedding).
- Tub or paddle type diet feeders with bale handling attachments can also be used to feed baled silage. Using a bale splitter to load them can reduce the time needed to process the bales.

The McHale C460 trailed silage feeder & straw blower has the capacity for two 4ft diameter bales. It can be used to distribute bedding material quickly and efficiently leaving a thick aerated bed of straw.

Recycling Bale Wrap

Balewrap can be fully recycled. Indeed silage wrap will be a significant source of raw material for a new Bord na Móna recycling plant located on the site of the former peat briquette factory at Littleton, Co Tipperary.

This material is then shredded and granulated to produce pellets which are reused in the manufacture of bags, boxes, etc. It is intended that the plant will recycle 24,000t of balewrap film per annum. The first customer is Irish Farm Film Producer Groups (IFFPG), which collected 28,000t of farm films last year.

In Britain, RPC bpi recycling process 70,000 tonnes pa of used balewrap, silage covers etc. Products manufactured from recycled polythene there include decking, fencing posts, garden furniture and refuse bags. These products have a long usage life as they do not rot, rust or have to be repainted.

Every tonne of film recycled saves 1.8 tonnes of crude oil, reduces energy usage by two thirds, uses 90% less water and cuts sulphur dioxide emissions by 33%. As regards baled silage the quantity of balewrap used per kg of silage baled is lower where silage is wilted and bale density is increased.

Weather proof garden furniture made from recycled balewrap.

Feeding Haylage to Equines

Grass hay is the traditional conserved forage offered to horses, yet good quality hay is often difficult to make so it can be scarce and expensive. Working or breeding horses frequently require a higher plane of nutrition than that provided by hay, which has a typical digestible energy (DE) value for horses of 8 MJ/kg of DM.

Even good quality hay contains a high level of dust (fungal spores, plant fragments, mites and bacteria which can cause the onset of a debilitating disorder, chronic obstructive pulmonary disease (COPD). Horses that have COPD remain sensitized to such dust for the rest of their lives and cannot be given hay without developing the disease.

The most popular low-dust alternative to hay is Haylage, which is grass conserved under anaerobic conditions at a DM of around 55%. Well-made haylage is 'sweet' and very palatable. Its biggest advantage over hay is that it is generally "dust free". Once it is open, a bale of haylage should be used within four days or moulds will develop.

Haylage contains at least 25% more water

than hay, so feed quantities need to be adjusted. Good quality forage is an essential component of the equine diet.

How well horses can digest forage depends on the cell wall content which are composed of cellulose fibre, hemicellulose, pectins and cell wall protein. The later the stage of plant maturity the digestibility decreases so the nutritive value also decreases.

Table 1 shows the results from an Icelandic digestibility study where four adjacent leys, seeded and fertilized in the same way, were harvested at four different stages of maturity. The results demonstrate how digestibility of DM, the fibre fractions NDF and ADF and crude protein in haylage decreases the later the forage is harvested. This means that the Metabolisable energy and digestible protein becomes lower.

The high performing horse has a high energy requirement and needs a forage of high energy density. However, the little pony has a much lower energy requirement. Besides meeting the horses' nutritive requirements, we also have to consider the horses' need for occupation and the horses' gut health.

Feeding our high performing horse with early harvested forage can cover all or most of the energy and protein requirements. Then no or only little supplementing will be necessary which is beneficial for gut health and performance, and a lot of forage and no/less concentrate has a big impact for the horses' mental health and prevents behavioural disorders.

However, the little pony needs forage of lower energy density, e.g. later harvest. Early harvested forage quickly covers the daily energy requirement and it will be difficult to reach a sufficient amount of kg DM per day. This means less occupation

and risk for behavioural disorders.

Later harvested forage is more suitable for horses performing light work, or no work at all, and has a lower energy requirement. Supplementing with different forages can be useful in stables where you have horses with different energy and protein requirements or for example when you want to increase the forage ration but keep the energy intake down.

The above information was kindly supplied by Sara Muhonen Agr D who has done research in equine metabolism, hindgut ecosystem and exercise response. Sara received her postgraduate education at the Swedish University of Agricultural Sciences (SLU). You can check out her blog at **http://www.grovfodertillhast.se/grovfoderbloggen/**

McHale Machinery Ideal for Baled Silage

The McHale R 62-72 rake is ideal for delivering an even, aerated swath which is perfect for maximum baling and harvesting output. It can be used to combine multiple rows or to rake up grass left on the flat.

A five tine bar cam track pick up is standard on all McHale balers. The pick-up can ride higher and clean the ground so there is less soil contamination. The six-tine bar camless pick up is an optional extra. More tines lifting less weight reduces breakages and there is less soil contamination. It also picks the ground cleaner and feeds the baler quicker.

The McHale Orbital wrapper has two 750mm dispensers so it can wrap approximately 90+ bales/hour. It is a popular with contactors because of its high output and is fully automatic. The McHale 991 B range of round bale wrappers are a contractor or farmer's machine and can wrap approximately 60+ bales/hour.

The McHale W2020 is a high-speed stacking bale wrapper. It is a compact machine, which allows one operator to transport, wrap and stack the bale with one tractor or loader. It can wrap a bale with four layers of film in about 20 seconds and with six layers in 30 seconds.

The McHale 998 High Speed square bale wrapper is ideal for haylage and wraps 80 to 100 bales/ hour. It has the ability to move three bales at one time through its conveyor system. The 998 High Speed square bale wrapper wraps all sizes of bale from 80cm x 70cm to 160cm x 120cm including double square bales (120cm x 70cm + 120cm x 70cm).

The smaller 995TSR square bale wrapper can wrap 40 to 50 round or square bales per hour. Operated from the tractor by remote control, it is a one-man operation for loading, wrapping and stacking.

The McHale R 62-72 rake is an ideal machine for those who want to get the best quality fodder, by delivering an aerated swath. It delivers an ideal swath for maximum baling and harvesting output. It can be used to combine multiple mower rows or to row up grass, which is left on the flat. This rake has 11 tine arms and is suitable for raking a 20-foot swath. The McHale R 68-78 rake has 13 tine arms and it is suitable for raking 30-feet so it is an ideal contractor's machine.

A spoon hitch is an optional extra for the McHale Fusion range of integrated baler wrappers which can also be equipped with airbrakes. A 540 rpm gearbox is standard however a 1000 rpm gearbox is available as an optional extra. This gives more speed, requires less torque, reduces machine wear and tear and results in less blockages. Depending on manufacturers specifications of the NRF barrel wrap, number of rotations being applied and the recommended % of stretch, a roll of netwrap will cover approximately 350 bales while a roll of NRF barrel wrap will cover approximately 120 - 130 bales.

The minimum recommended size of tractor for operating the baler comfortably depends mainly on the crop condition and the required cut length of the forage. On flat ground McHale recommends a tractor size of approximately 67 kW (90HP). On hilly ground or difficult conditions, an additional 10 to 15 kW is advisable.

The minimum recommended size of tractor for operating the wrapper comfortably on flat ground would be approx. 45 kW (60-70 HP). On hilly ground or difficult conditions, an additional 10 to 15 kW is advisable.

The McHale F5500 fixed chamber baler is a semi-automatic baler fitted with 18 rollers in the bale chamber and equipped with a 15 knife chopper unit.

McHale R5 Bale Handler suitable for stacking bales on their ends or rotating them through 90° for stacking on their round.

Broken baler tines should be replaced as part of a winter service. Depending on operating conditions, knives need to be sharpened every 300 to 500 bales.Worn or damaged knives should be replaced. Chopping silage requires extra hp and a slower forward speed which will increase bale density by up to 20%.

All fixed and variable chamber chopper balers are fitted with 15 knives as standard.

However, all machines in the McHale Fusion 3 range have 25 knives as standard with the option of having selectable knife banks to provide 12, 13 or 25 knives.

More knives require more HP but gives a finer chop. Knives are held in position by a set hydraulic pressure which ensures a good, consistent chop and also protects the knives from damage from stones. A secondary protection system is in place on each individual knife.

Haylage bales, 4ft x 4ft (1.23 x 1.23m) in size, usually weigh from 450 to 650kgs while silage bales vary from 650 kgs to one tonne. Haylage and straw bales are now normally sold by weight. Smaller round bales can be made by a variable chamber belt baler. They are easier to handle and remain fresher as their contents are used up quickly and are preferred by many equine customers.

Variable chamber balers use belts and usually make bales from 0.6m to 1.9m diameter. The McHale V6 Variable Chamber Baler has a 3-belt chamber or as an option one single belt. There is less slippage, less belt movement and less crop loss when chopping with a single belt baler.

Depending on operating conditions, these belts are good for up to 100,000 bales providing they are not damaged. These variable chamber balers can increase bale density by 20% or more with high DM haylage compared to a fixed chamber roller baler.

McHale 998 High Speed – High Output Square Bale Wrapper wraps square bales from 80cm x 70cm to 160cm x 120cm including double square bales (120cm x 70cm + 120cm x 70cm)

Diagnostic Guide for Balewrapping

1. Identify brand, record batch and roll number on film core.
2. Take a film sample for analysis by supplier.
3. Check bale and for correct film application (minimum of four layers and 50% film overlap).
4. Check storage application (i.e. stacked no higher than three bales, vermin, small animal and bird damage).
5. Pre-stretch unit (PSU) rollers for build-up of tack, correct setting and 70% pre-stretch
6. Check bale density and forage quality.
7. Has a proven silage additive been used for challenging conditions?

For high DM forage a chopper baler with a wide pick up is recommended to minimise problems with mouldy silage and uneven swathes.

Machinery models/brands, the condition of the PSU /drop mat, operator skills, drivers speed, weather conditions and forage quality will all impact on bale/ silage quality.

For Kaleage, heavy wet bales, high DM or misshapen bales then six layers of a quality film are always recommended. When cleaning the PSU, petrol or diesel should never be used as it exacerbates the problem particularly if rubber rollers are used.

If wrap is available from a faulty bale lift it up, place it over your head and look up. Insufficient wrap or multiple holes in the film will then be clearly visible under daylight conditions.

Bale Wrap Problem Guide

Problem Identified	Tick	Possible Causes	Recommendations
Aquaplaning		Build up of tack on the Pre Stretch Unit (PSU) rollers / film fault	Clean rollers with white spirit only. Check PSU setting, clean rollers with wire brush
Film Over-stretching		Incorrect Pre Stretch Unit (PSU) setting (not 50% overlap on bale). Excessive turntable speeds. High tack-avoid wrapping black film during very hot weather conditions	Check PSU-clean, replace roller or repair unit. Operate bale wrapper as per manufacturer's instructions
Bales Splitting		Insufficient film/PSU Overstretching/handling or Other damage/die lines/heavy bales/ poor quality film	Check PSU/handling equipment. Check for four layers of film Repair physical damage
Holes/ Windows		Bird, stubble or other physical damage caused by cats, dogs, poultry, vermin etc Also caused by impurities in film	Patch bales with silage tape and protect stacks with netting. Repair or replace damaged drop mat/fall damper
Film Breaking		Tack build up on PSU(exacerbated by hot weather)/incorrect stretch adjustment/ edge damage to roll/incorrect core alignment Incorrect overlap Poor quality film	Check PSU and for film abnormalities. Return film to stockist if product is outside specification.
Low/Excess Tack		Film fault/storage problem (too cold/too hot-direct sunlight)	Check storage, adjust as appropriate and contact stockist if necessary
Die/Port Lines, Spiral Tearing, Nibs/Gels		These problems are associated with manufacturing and raw materials used and may cause film breakage.	Do not use unsatisfactory film and return it to your stockist.
Damaged Rolls and Film Cores		Damage on farm or in transit. Careless handling/damp storage/core alignment/collapsed or telescoped cores. Do not use cardboard cores	Check cause and return film to your local stockist.
Mouldy Silage		Insufficient/damaged film cover and poor overlap/vermin damage/holes in film/high DM forage/soil contamination/ balewrapping delay etc	Check film and consider silage analysis. Investigate original forage quality and harvesting conditions. Check mower/ baler pick up settings (too low). Use an additive with a mould inhibiter
Bird, small animal and vermin Damage		Holes appear on top of bales/grease marks along walls indicating rats/ Undergrowth not kept clear of stack /no netting or cover on bales	Patch or re-wrap affected bales and use silage netting raised above stack by tyres. Exercise proper rodent control
Bale handler damage		Careless transport or stacking of bales or using unsuitable equipment can do serious damage to the balewrap	Use suitable, well maintained equipment and handle bales more carefully
Poor Bale Shape		Misshapen-causing stress on film and splits. Do not stack more than one high if low DM and bales are heavy (e.g. Kaleage). Stack on End	Check stack and isolate bad bales if possible. Re-wrap bales if required/possible.
Effluent Leakage		Bales not properly overlapped/film damage/insufficient tack/low DM forage/ bales stacked too high.	If possible, re-wrap or repair bales. Do not stack bales.
Rotten Bales but Wrap OK		Often due to low sugar/low DM forage or due to high nitrates, soil or slurry contamination etc	Analyse silage. Liaise with forage adviser. Check weather conditions for harvesting dates.

HP Required for McHale Machinery

Machine	Minimum PTO Requirement (HP)	Equivalent KW
McHale Pro Glide F3100 Front Mower	80	60
McHale Pro Glide R3100 Rear Mower	80	60
McHale Pro Glide B9000 Combination Mowers	250	186.5
McHale R 62-72 & R 68-78 Centre Delivery Rake range	80	59
McHale V6740 Variable Chamber baler (non chopper)	73	55
McHale V6750 Variable Chamber baler (15 knife chopper)	80	60
McHale V8940 Variable Chamber Baler (non-chopper)	80	60
McHale V8950 Variable Chamber Baler (15 knife chopper)	73	55
McHale F5400 Fixed Chamber Baler (non-chopper)	80	60
McHale F5500 Fixed Chamber Baler (15 knife chopper)	90	67
McHale F5600 Fully Automatic Fixed Chamber Baler (25 knife chopper)	100	75
McHale F5600 Plus Film Binding Baler (25 knife chopper)	100	75
McHale Fusion Vario Variable Chamber Baler Wrapper	114	85
McHale Fusion 3/ 3 Pro/ 3 Plus Integrated Baler Wrapper	107	80
McHale Orbital High Speed Round Bale Wrapper	50	37
McHale 991 High Speed Round Bale Wrapper	40	30
McHale 991 B Range of Round Bale Wrappers	40	30
McHale W2020 Stacking Bale Wrapper	100	75
McHale 998 Square Bale Wrapper	100	75
McHale 998 High Speed Square Bale Wrapper	100	75
McHale 995 TSR Square Bale Wrapper	40	30
McHale C430 Linkage Silage Feeder & Straw Blower	120	90
McHale C460 / C470 / C490 Silage Trailed Silage Feeder & Straw Blower	68	51

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McHale Pro Glide B9000 Combination Mowers comes with unique patented ground following technology.

Notes

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