Baled Silage Production

What is baled silage?

Baled silage is forage that is baled at a higher moisture than forage intended to be stored as dry hay – between 40 and 60 per cent, depending on its use as feed. The bales are sealed with airtight plastic and remained sealed until they are required. The high moisture and lack of air within the sealed bale promote fermentation which preserves forage quality. Baled silage, also known as baleage, may be produced from any forage, grass or crop that would be used for conventional silage.

Baled silage was first harvested in Manitoba at a 1975 Eastern Grassland Society (EGS) demonstration at Rosa, and is now very popular with Manitoba forage producers. It is a practical method of reducing harvest and storage losses in the high-quality forage that our soils and climate can produce.

Feeding Benefits

Baled silage is an excellent feed option, especially for backgrounding calves, because it has improved palatability over most feeds due to the soft texture. The increased palatability of baled silage also results in less waste compared to dry hay when it is fed in traditional round-bale feeders. A Manitoba Agriculture, Food and Rural Initiatives trial found a 25 per cent feed saving over hay when both kinds of feed were used in round-bale feeders.

Baled silage also has a lower incidence of bloat and other digestive problems that commonly occur with fresh alfalfa or alfalfa hay.

Baled silage is readily adaptable to most dry hay systems such as round-bale feeders and can be unrolled in the field with less leaf loss than dry hay. It can also be chopped and fed on its own or used in a variety of feeding systems.

Baled silage can differ greatly in quality depending on the type of forage used, the stage at which it is harvested and how well it has been fermented. A University of Manitoba trial showed vast differences in animal performance and amount of feed required when it compared low-, medium- and high-quality baled silage (Table 1).

Table 1: Baled Silage Performance Based on Forage Quality

	FORAGE QUALITY (RELATIVE FEED VALUE)		
	Low (RFV 78)	Medium (RFV 112)	High (RFV 155)
Initial Weight in lbs.	729	727	727
Final Weight in lbs.	828	864	898
Gain/Day in lbs.	1.96	2.81	3.63
Feed/Lb Gain in lbs.	8.53	6.80	5.39

Note: The trial was conducted by the University of Manitoba for 49 days, beginning April 1997. All baled silage was fed in a chopped form; no grain supplement was used.

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Advantages of Baled Silage

- Uses the same harvesting equipment as dry hay bales.
- Requires less labour and less energy for harvesting than a chopped silage system.
- Allows for easy and inexpensive expansion of production; bale wrapping is not a limiting factor.
- Requires one-half to one-third the drying time of hay – only 13 to 20 hours, as opposed to 40 or more for dry hay.
- Permits harvest at optimum stage for high-quality forage.
- Provides flexibility in amount harvested so that small amounts can be handled.
- Allows for a producer-controlled cutting schedule – first cut at the optimum time and subsequent cuts when quality is highest.
- Provides the opportunity to utilize weeds, green feed or late-cut forage that are difficult to harvest as dry feed.
- Leaf loss in the field is only 5 to 10 per cent as compared to 25 to 30 per cent for dry hay.
- Has less leaf loss than dry hay when fed.
- Decreases feed loss because of better palatability over dry hay.
- Produces less digestive disturbances, such as bloat, than dry hay.
- Can be easily shredded so that it can be used with other feeding systems.
- Increased market acceptance because of potential as a higher quality feed with greater palatability, resulting in increased dry matter intake.
- Retains a more natural green colour than chopped silage (due to lower temperatures during fermentation) – a plus for the horse-feed market.
- Popular with horse farms because it lowers respiratory problems often associated with dry hay.

Disadvantages of Baled Silage

- Annual cost may be higher than chopped silage due to the cost of the plastic. However, total capital cost can be similar as it is the only harvesting system required since no extra equipment is needed for another system.
- Tube and bale-wrapping equipment requires additional capital expenditures. However, a smaller operator can custom contract wrapping services.
- Used plastic must be hauled to a landfill site, although some local governments are now developing recycling programs. Plastic should not be burned, as it produces toxic fumes.
- Bale weights increase drastically as moisture increases.
- Bale size may be too large for handling equipment, particularly for smaller equipment such as front-end loaders, so bale size must be adjusted accordingly.
- Can spoil if air leaks into the plastic. Rodents, birds, pets, wind and hail all have the potential for producing holes in the plastic wrap.
- Low-moisture forage (less than 40 per cent) will not ferment and has a fairly high risk of developing mould.
- High-moisture forage (above 70 per cent) will produce sour silage and has the potential for producing harmful by-products.
- According to some research, animal performance may not be as good as with chopped silage, as baled silage is more digestible.
- Storage life is shorter than that of chopped silage.
- Bales with high moisture or minimum fermentation have higher potential for freezing.
- If used in outside feeders, open bales must be used up within three days to avoid freezing in cold weather.

The Fermentation Process

The production of silage depends upon fermentation, which requires moisture and must take place in an airtight environment. Fermentation breaks down the plant material making it more palatable and more easily digestible by the animal.

Moisture – The Critical Factor

One of the most important factors in a baled silage system is to bale the cut forage at the correct moisture content. A minimum of 40 per cent moisture is required for fermentation – although moisture content can range from 40 to 60 per cent, with a targeted average of 50 per cent.

Most farmers prefer forage to be on the drier side, as the bales are lighter and easier to handle. However, the drier the forage, the more difficult it is to produce a firm, dense bale without air pockets. Excess air in the bale will result in minimal fermentation and increased risk of mould. If the moisture content is below 40 per cent, an airtight seal is critical if the silage is to be maintained until feeding time with minimal reduction in feed quality. Generally, a bale of this type should be used before spring and the return of warm weather, as it has the potential for heat damage.

Moisture in excess of 60 per cent will result in heavy bales (Table 2) that have a potential to sour and freeze in storage. There will also be more effluent (liquid waste from the fermentation process) at the bottom of the silage bags or stack, increasing the loss due to spoilage.

The wilting period of the cut crop – the time between cutting and baling – is very important in achieving the right moisture level for fermentation. Bale the crop as soon as it drops from 80 per cent moisture (the usual moisture content of a standing crop) to 50 or 55 per cent. This will happen very quickly, especially in warm weather. Delays will result in dry matter losses, as well as leaching of soluble carbohydrates if it rains. These carbohydrates are important to the fermentation process.

Moisture for good quality silage should come from the plant – and not from dew or rain. Forage that has been dried for hay, and then received rain before it has been baled, will usually produce poorer quality silage.

Table 2: Bale Weight at Varying Moisture Levels

	MOISTURE LEVEL			
Bale Diameter (round bales)	20%	40%	55%	65%
4 ft (1.2 m)	800 lbs	1,060 lbs	1,400 lbs	1,800 lbs
5 ft (1.5 m)	1,000 lbs	1,300 lbs	1,700 lbs	2,300 lbs
6 ft (1.8 m)	1,250 lbs	1,600 lbs	2,200 lbs	2,800 lbs

Proper Sealing

It is extremely critical that plant respiration (use of oxygen by the plant to produce carbon dioxide) – called the aerobic phase – be stopped as soon as possible. This is achieved by making firm, dense bales that are then wrapped air-tight. Mould will develop if air gets into the system during this phase through tears in the plastic, or because of loose bales.

Once respiration has stopped and no air is present, the anaerobic phase begins. Lactic acid bacteria present in the forage ferment the carbohydrates, resulting in lactic acid production. Acetic acid and propionic acid are also produced. These acids are important in inhibiting mould.

The supply of carbohydrates will affect fermentation. For example, crops such as corn or grass, which have high levels of carbohydrates, will ferment easily. Alfalfa, on the other hand, has a lower carbohydrate level and takes longer to ferment. However, a late-fall harvest (second or third cut) of alfalfa will usually contain higher amounts of carbohydrates and will provide more active fermentation.

Fermentation will stop between two to four weeks (depending on the crop), when acid levels increase and pH levels decrease to a point where fermentation is no longer possible. At this point, the stable (storage) phase begins.

The pH levels, which are an indication of silage storage life, should be requested when feed is analyzed. If pH is above five, storage life will likely be short and forage should be used before spring. On the other hand, pH *below* five will most likely have a longer storage life.

Baled Silage Versus Chopped Silage

Research indicates that baled silage has a slower fermentation rate than chopped silage. This may be because plant juices produced by chopping are more readily available for fermentation, whereas plant juices from the long fibre of the whole plant in baled silage are released more slowly. It may also be that the surface area available to bacteria for fermentation is less with baled silage.

It could take up to 60 days for baled silage to drop to the same pH level as chopped silage can reach in one day (Table 3). This drawback can be improved, however, by using some of the new baling equipment now available, which will slice the forage as it is being baled and increase the fermentation rate.

Table 3: pH Levels – Baled Silage Versus Chopped Silage

Days Fermenting	pH – Baled Silage	pH – Chopped Silage
0	5.7	5.7
1	5.8	5.1
3	5.7	4.9
9	5.5	4.6
60	5.1	4.4

Although it ferments more slowly, long-fibre silage may be more digestible than chopped, short-fibre silage. Research shows 90 per cent digestible energy with baled silage, compared to 69 per cent with chopped silage.

Fermentation Tips

- Ensure bales are dense and well sealed to reduce the amount of air in the system. This will encourage good fermentation and prevent mould.
- Harvest only the amount of forage that can be hauled and sealed in one day. In hot weather, the forage temperature will rise quickly and fermentation of unwrapped forage could begin within a few hours – which could result in heat damage and lower digestibility.
- Avoid manure contamination to keep undesirable bacteria out of the system.
- If possible, avoid raking the swath to prevent contamination by soil organisms.
- Avoid using hay that has been rained on. It has a greater potential to be contaminated by soil organisms, and poorer fermentation potential because of reduced sugar content.
- Avoid mature forage because of low sugar content that will result in poor fermentation. As well, crops at this stage have stiff stems which are difficult to pack and could puncture the plastic.
- Use a lactobacillus bacteria inoculant to improve fermentation, particularly in alfalfa. Agriculture and Agri-Food Canada research has shown this type of inoculant can improve livestock intake by five per cent, and daily weight gain by 11.6 per cent.
- To prevent mould growth in lower-moisture forage (moisture levels 25 to 35 per cent at harvest), apply propionic acid of anhydrous ammonia at amounts of one to two per cent of the dry matter.

Harvest Management

The first hay cut is usually a priority for making baled silage. Using the first cut for baled silage allows the season's hay harvest to begin on time since there is no need to wait for ideal weather or for the first crop to dry. As a result, there is a better chance subsequent harvests will be on time and quality can be controlled. Other priority crops for silage baling include green feed/high-moisture crops which are often difficult to dry and surplus forage not required in a grazing system. Third-cut/late-fall harvests cut under cool conditions and at high moisture levels can also produce especially good silage because sugar levels are usually quite high.

The crop should be cut leaving a high stubble to avoid soil contamination which lowers the feed value. Swath size should be as close as possible to the width of the baler to ensure even bales and to avoid barrel-shaped bales which are difficult to wrap and may allow air leaks into a tube wrap system. If the ideal swath width is not possible, a weaving pattern across the swath when baling should be used to produce even bales. A wide swath size is also important to promote rapid dry-down of the crop. A good crimping system will also promote dry-down.

Plastic twine is preferred over sisal twine for securing bales, as oil-based preservatives in sisal may promote degradation of the plastic covering once the bales are wrapped.

Baling Options

Round Balers

Round balers are most commonly used for baled silage, with hard-core or variable-chamber balers the most popular. They produce firm, dense bales that can be adjusted in size to match forage moisture content and the capacity of the hauling equipment. However, some of these balers cannot deal well with the higher moisture content of baled silage, so check with your dealership. A soft-core baler should be used only if it can produce a firm bale.

Round balers with features designed especially for baled silage production are now available. Some of these balers have scrapers that clean rollers when they become clogged with high-moisture forage, and most have cutting attachments that slice the forage as it is being baled. Slicing aids in fermentation and makes the feed easier to include in mixed rations. An eight-inch (20-centimetre) cut is recommended when using this slicing attachment, even though it can usually be set anywhere between four and eight inches (10 and 20 centimetres).

Square Balers

Medium and large square balers are gaining popularity because they produce bales that are a more practical size for transporting and marketing. As well, they have high capacities. Some units have forage slicers that slice the forage as it is being baled.

Small-square balers are seldom used for silage production because the smaller bale is impractical to wrap and store.

Storage Systems

Tube Systems

There are a number of tube storage systems. All involve moving the bales through a hoop and into a pre-fashioned plastic tube attached to the hoop. The plastic must be at least four mils in thickness and should have sufficient ultra violet light resistance.

Most plastic used in these systems is white, often with a black liner for increased strength and protection from the sun.

With a *home-made tube system*, bales are manually pushed through the hoop and into the folded plastic. The hoop is moved forward to accommodate the next bale, creating a tube of wrapped bales behind it. Care must be taken to "anchor down" loose plastic – a common disadvantage with this system. As well, this method is time consuming.

The *tube-o-later system* is an automated version of the home-made system. Specialized equipment uses guides to raise the bales so they can be moved through the hoop and into the plastic tube folded around it. The hoop starts at the end of a row of bales and moves forward as bales are inserted, leaving a long and sealed tube of silage behind. An adjustable ring which allows for a tight fit of the plastic is a major advantage to this system. As well, this equipment can tube bales very quickly – up to 200 bales per hour.

Other tube systems use hydraulic equipment to push the bales through the hoops and into the plastic. There are often hydraulic fingers to stretch the plastic and give it a tight fit.

Round-Bale Individual Wrap

This system uses equipment that individually and evenly stretch-wraps (with controlled tension) each round bale with four separate pieces of plastic. Plastic film must have a 50 per cent stretch factor, be resistant to ultra violet light, have a good tear strength and be able to adhere well. White is used for high sunlight areas and black for lower sunlight areas.

A commonly used system in Europe, it produces minimal silage spoilage because of the tightness of the wrap. Another advantage is that the wrapped bales can be moved for storage and can be stacked in small storage areas.

Square-Bale Individual Wrap

A relatively new system, this uses equipment that stretch-wraps (same type of plastic as used in individual wrapping of round bales) individual square bales. Bale length is adjusted to accommodate desired bale weight and wrapping equipment – usually four to five feet (1.2 to 1.5 metres) in length instead of eight feet (2.4 metres).

Tube-Wrapped System

This system uses equipment that places bales on a platform, hydraulically moving them through a revolving ring that stretch-wraps four layers of plastic around them. The bales are encased in wrap, as opposed to being placed into pre-fashioned tubes. However, like the tube systems, the system creates long tubes of wrapped bales, which can vary in length. Plastic wrap specifications are the same as for the individual bale wrap (stretch-wrap) system.

The tube-wrap is similar to the individual wrap system, but over 70 bales can be processed in an hour. The wrap is just as tight, but it uses one-half of the plastic.

Storage Site Recommendations

- Ensure the storage site is well drained.
- Ensure the site is free of long grass to reduce rodent problems.
- Do not allow debris that could puncture the plastic to collect in the area.
- Locate bale stacks, if possible, in a wind-sheltered area in order to reduce wind damage to the plastic, and the entry of air into the system.
- Align rows or stacks, where possible, in a north-south direction. If they are set in an east-west direction, the sun's warmth on the wide expanse of southern exposure in the winter can cause moisture to migrate to the north side of the tube or stack. As well, the warm south side will attract rodents.
- Check all wrapping regularly to ensure there is no damage to the plastic seal. If the plastic is punctured or torn, use red construction tape to repair the damage.

For more information on baled silage production, contact your local Manitoba Agriculture, Food and Rural Initiatives office or visit us online at manitoba.ca/agriculture/production

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