



# Baling Forage Crops for Silage

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Forage may be stored for winter feeding when pasture production is limited, for use in confinement feeding systems, or for cash hay. Dry hay is the most popular storage method since it stores well for long periods and is better suited to cash sale and shipping than high moisture forages. However, silage 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.

## Benefits

Storing wet forage as baleage 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 losses compared to baled silage.

Round bale silage (or baleage) is the product of cutting forage crops with conventional hay harvest equipment, allowing the forage to wilt to between 40 and 60 percent moisture, baling the forage into tight bales, and quickly wrapping the bales in plastic 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 lowering the dry matter recovery, but this loss is small compared to dry matter losses that result from raking, baling, tedding, 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 baleage. 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 (see AGR-62: *Quality Hay Production* for more information on specific cutting recommendations for Kentucky forage crops).

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 in the middle of the moisture range, from 40 to 60 percent moisture.

### Key Points

- Baleage allows for timely harvest when curing conditions are not ideal.
- Baleage has minimal losses when stored outside.
- Cut grasses at the boot to early head stage and legumes at early to mid-bloom.
- Make mower swath wide to speed up wilting.
- Wilt forage to 50 to 60 percent moisture before baling.
- Make a dense bale by reducing ground speed during baling.
- Make uniform bales when using a tube type wrapper.
- Reduce bale diameter to keep bales from becoming too heavy.
- Wrap bales the same day as baling.
- Use a minimum of six layers of UV stabilized plastic film designed for baleage.
- Wrap bales at storage site to avoid damaging plastic during transport.
- Monitor bales for holes in the plastic and patch immediately with a UV stabilized tape designed for silage film.
- Allow bales to ferment for 4 to 6 weeks prior to feeding.
- Always test baleage prior to feeding to ensure that it will meet the nutritional needs of the livestock.
- Feed baleage the same season.

**Table 1.** Forage quality and dry matter (DM) losses of alfalfa baleage 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)		
Baleage 46% DM	23.7	22.6	63.0	63.8	548	554	Negligible
Baleage 51% DM	23.1	22.3	62.0	65.0	537	541	Negligible
Baleage 57% DM	22.1	21.0	65.1	64.4	587	583	Negligible
Hay	18.2	17.5	67.2	51.9	609	495	18.7

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

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

Advantages	Disadvantages
<ul style="list-style-type: none"><li>• Plastic cost per bale is low (around \$4 per bale).</li><li>• Capital investment required is lower than conventional silage storage.</li><li>• Baleage allows more timely harvest, producing higher quality feed.</li><li>• Harvest and storage losses are lower.</li><li>• Weather damage is less than hay stored outside.</li><li>• Individually wrapped silage bales are more portable.</li><li>• Small amounts of forage can be ensiled.</li><li>• Baled silage feeding does not require specialized machinery.</li></ul>	<ul style="list-style-type: none"><li>• Long (unchopped) forage crops are harder to ensile than chopped forage.</li><li>• Some balers cannot handle high moisture (50 to 60 percent) forage.</li><li>• Bales can be very heavy, leading to larger tractor requirements.</li><li>• Plastic wrap material can tear or puncture, leading to spoilage.</li><li>• Disposal of used plastic is necessary.</li></ul>

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 dry matter basis), heat damage is minimized and detrimental secondary (clostridial) fermentation is inhibited. In producing bales for bagged or 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 packages may be difficult to transport.

### Machinery Requirements

The equipment for making baled silage is mostly the same as for dry hay. Conditioning-type mowers are not necessary but they can provide advantages in certain situations. 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-type or rotating-bar, side delivery rakes can be used. 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 speeds used in making field-cured hay. Downshifting one gear should help to guarantee a tighter, denser bale. A dry matter density of 10 pounds per cubic foot is considered ideal. A typical silage bale (4 feet in diameter by 5 feet in length) should weigh 1,300 to 1,550 pounds and contain 600 to 650 pounds of dry matter, 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 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 in wetter crops. Fixed chamber silage bales have smaller diameters.

Some baler manufacturers recommend retrofitting older balers with kits that aid in baling wet forage. These kits usually involve modifications which prevent wrapping of the wet forage on the rollers of the baler. Many manufacturers produce balers designed specifically for making baleage. 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 at the same bale diameter.

### Time between Baling and Bagging or Wrapping

The interval between baling and wrapping or bagging is critical to the success of the ensiling process and should be as short as possible; 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 temperatures.



**Figure 1.** Individually wrapped bales of silage in Campbell County, Kentucky.



**Figure 2.** An example of an inline bale wrapper making baleage from cereal rye in Bourbon County, Kentucky.

For individually wrappers, consider moving freshly baled forage to the storage area for plastic application. This allows the wrapping process 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 plastic. 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.).

### **Bale-wrapping and Bagging Equipment**

There are many ways to seal freshly baled forage. Older methods involved inserting round bales into individual bags or long tubes and are seldom if ever used. Currently, almost all round bale silage is packaged as individually or in-line wrapped bales. All methods operate on the principle of quickly sealing out oxygen from the bale and keeping the package airtight until the baleage is fed. Use of plastic manufactured to withstand the damage from ultraviolet radiation in sunlight is strongly recommended. Some plastic manufacturers recommend using untreated sisal twine or plastic twine. In some cases, the oil from treated sisal twine breaks down the ultraviolet radiation

inhibitor in stretch-wrap plastic. Net wrapping helps prevent punctures in the wrapping plastic due to stems protruding from the rounded exterior of the bale.

### **Individually Wrapped Bales**

In some areas of Kentucky, individual bale wrappers are common. With these implements, individual bales are wrapped mechanically with multiple layers of stretch-wrap plastic. Although four layers have been proven to be sufficient, six layers are recommended to give an extra margin of safety against problems like punctures. Each layer of stretch-wrap plastic adheres to the previous one, forming an airtight seal. Wrapping machines vary widely in cost (up to \$25,000 or more for platform wrappers), depending on such features as whether they produce a completely wrapped bale and whether they include a self-loading arm. More expensive wrappers elevate the bale onto a rotating and revolving platform. Others require a second tractor with lifting capabilities to put the bale on the wrapper. Individual bale wrappers are slower than in-line or tube wrappers and require larger amounts of plastic to achieve the same number of layers. However, individually wrapped bales can be moved to diverse locations for feeding or storage; they are also more easily transported (on their flat side), can be stacked for storage, and provide more marketing opportunities that bales ensiled in an in-line package.

### **In-line or Tube Wrappers**

In-line or tube wrappers are very common and are available for rental in many locations. In this system, bales are loaded onto the wrapper and pushed through a revolving ring that applies plastic from two rolls simultaneously, advancing so that there is about a 5-inch overlap by each roll. These implements are more expensive (up to \$45,000 and maybe more depending on options) but are faster and require approximately half as much plastic as the individual platform wrappers. They need a large, fairly level and smooth area for best storage results.

### **Other Considerations**

Traditional bale spears can be used to move wrapped round bales of silage, but have the disadvantage of puncturing the plastic. Wrapping the bales after they have been moved to their place of storage will avoid puncturing the plastic. Another more expensive option is the hydraulic bale squeeze that mounts on a front end loader. This implement allows the movement of wrapped bales without making holes in the plastic. Tractors with 50 or more horsepower have sufficient weight and power for safe lifting. Adding counter weights can increase stability of loaders handling round bale silage.

Damage to plastic 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. Silage that improperly ferments from being too wet will have a much greater risk of botulism poisoning. Reduce the risk of clostridial fermentation and botulism toxicity by keeping moisture content at baling below 70 percent.

The ability to make baleage 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 curing conditions are too

poor to get the forage dry enough to bale as hay. Ensiling conditions are not ideal during this time (low temperatures and low numbers of ensiling bacteria), and fall baleage should be fed first during the winter. Silage inoculants have been shown to improve the ensiling characteristics of fall forage crops.

## Cost

Equipment costs per bale would be between \$6 and \$7 to recoup the full cost of a \$20,000 wrapper over 10 years at 300 bales per year (no labor, interest or maintenance costs included). Plastic costs for in-line systems are around \$4

per bale and approximately twice that for individually wrapped bales. Using the equipment example above, the cost per bale would be between \$11 and \$15 (in-line vs individual) or \$22 to \$30 per ton for 50% moisture baleage.

## Summary

Baled silage offers a convenient and inexpensive way for Kentucky farmers to produce silage with present hay-making equipment (adapted to wet forage). The benefits of making baled silage come from more timely harvest, lower dry matter losses during curing and storage, less chance for rain damage, and better reten-

tion of leaves in high quality forage crops like red clover and alfalfa. Disadvantages include handling heavy bales, keeping bales airtight, adapting baling equipment to handle wet forage, and plastic disposal.

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