



Baleage: Frequently Asked Questions

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Introduction

As producers seek to maximize the efficiency of forage harvesting and storing systems, baled silage (commonly called baleage) is emerging as a possible alternative technology. This publication and publication AGR-173 (“Baling Forage Crops for Silage”) will help producers better understand and utilize a baleage forage harvesting and storage system.

Common Questions About Baleage

Why should I consider making baleage?

Baling forage at higher moisture levels than what is required for dry hay offers some advantages. Typically, a small grain crop such as wheat or a first cutting of cool-season grass is difficult to harvest for hay at the proper maturity stage. Excessive spring rainfall makes it nearly impossible to dry down forages into the 15-18% moisture range necessary for hay. As a result, these crops are often over-mature when baled as dry hay. However, such crops would work well in a baleage system, which requires a higher moisture range (40-60%) and shorter field-drying time. Many producers who want to harvest high quality small grain crop have found baleage to be a good fit for their operation.

What happens during the baleage ensiling process?

If high-moisture forage (40-60%) is baled like normal hay, it will soon be rendered useless by explosive microbial activity. However, if this forage is baled and wrapped in plastic, anaerobic microorganisms will ferment some of the carbohydrates in the forage to lactic acid, which will inhibit the growth of detrimental microorganisms. This process consumes some dry matter and digestible energy (mainly water soluble carbohydrates), but this loss is small compared to dry matter losses that result from raking, baling, tedding, and storing round bales outside as hay.

What equipment will I need?

A baleage system requires much the same equipment as a conventional hay system, with some additions. The minimum requirements are a mower, possibly a rake, a baler capable of baling wet forage, a tractor of sufficient horsepower to carry these bales safely, a bale spear, and a wrapper. Some balers have a chopping mechanism that aids in increasing bale density as well as reducing particle size for ease in mixing rations, but this is not necessary in situations where no mixing is needed. Bale spears are inexpensive ways of moving the bales prior to wrapping and just before feeding. Wrappers range in cost from \$6,000 to \$25,000 or more and differ considerably in labor and equipment requirements. Some custom operators wrap silage, and many local entities (County Extension, conservation districts, cattlemen’s groups, etc.) may have wrappers available for rent.

What should I use to mow?

Mower-conditioners are the most popular and easiest-to-use mowing implement for the baleage system. This is mainly due to faster wilting and evenly formed swaths. Raking can be avoided if a narrow swath is formed. Using a mower-conditioner exposes more of the forage’s surface area to the microbes involved in fermentation and can result in a faster pH drop and better fermentation earlier in the ensiling process.

However, other types of mowers can also be used very successfully.

When do I cut?

Cut the forage crop at the maturity stage that combines yields and quality sufficient for your feeding requirements. In general, cut legumes at 10% bloom and grasses at the boot stage or just as the head emerges. Cut other crops such as oats, rye, triticale, and barley before the boot stage. (These crops are difficult to dry at this stage but lose feed value quickly as they mature.) In general, early-maturity forage has much higher sugar content (essential for proper ensiling), while coarse, stemmy, and over-mature forages have a reduced sugar content and will not ferment well. Cutting at earlier maturity stages will produce good baleage and optimal feed value per acre.

Can my round baler handle high-moisture hay?

Most modern variable chamber balers (belt balers) are capable of baling wet forage into a dense package. However, special silage models are recommended because they are specifically designed to bale wet forage—they have scrapers on the belts and rollers to prevent buildup of material, and they have heavy-duty bearings to help handle the increase in bale weight. Several baler manufacturers offer “silage kits” which can be added to older balers that will enable them to handle baleage. Such kits range in price from

\$400 to \$1500 (2012 prices) depending on brand. Consult your local equipment dealer for specific information regarding your particular round baler brand.

Fixed chamber and variable chamber balers will both work well; however, variable chamber balers are much more popular because they allow the control of bale size and maintain uniform density in the bales. Fixed chamber balers can make dense bales but usually form only one bale size. In either case, it is important to drive slowly and maintain a high PTO speed.

When should I bale?

Baling at the proper moisture content is a key to success in producing baleage. Forage containing less than 40% or much above 65% moisture should not be baled for silage in order to avoid excessive molding or spoilage. Producing bales with too much moisture reduces forage quality, increases the chance of undesirable butyric acid fermentation, and reduces the amount of dry matter stored per storage unit—each of which greatly increases storage costs. Baling with inadequate moisture reduces fermentation and increases mold production, which greatly increase storage losses. Considering all factors, the optimum moisture for baled silage is in the 50-60% range.

How should I make the bales?

A slow ground speed during baling helps make tight, dense bales that are less likely to spoil. Plastic twine is recommended, but net-wrap or untreated sisal twine can be used successfully. Avoid treated sisal twine since the oils applied during the manufacture process often degrade the plastic film and can result in large storage losses.

The most popular bale size is 4 feet wide and 4 to 5 feet in diameter. These bales will weigh 900-1300 lbs. (depending on forage type, bale density, and moisture level) and are best for handling and feeding. Larger bales require less film per ton but can be very hard to handle. These bales can easily weigh in excess of 2000 pounds.

Should I apply additives?

Experimental work has shown that excellent baleage can be made without the use of additives. Additives are not necessary even when ensiling legume crops which have more difficulty reaching the pH range of stabilized fermentation. That being said, inoculating with *Lactobacillus buchneri* strains can accelerate the rate of fermentation and improve the stability of the silage during feed out. The latter is especially important if the baleage is to be fed during the summer months or in warm climates.

How soon should I wrap the bales?

Delay between baling and wrapping lowers the quality of the bale due to undesirable microbial activity and excessive heating. In addition, waiting too long to wrap allows time for the bale to sag, and a sagging bale is difficult to wrap, uses more plastic film, and wastes time. Ideally, wrap forage immediately after baling but may be delayed up to 12 hours without losing quality.

Where should I wrap?

Wrapping at the storage site minimizes handling of wrapped bales and reduces the potential for damaging plastic. Mishandling wrapped bales risks damage to and spoilage of the bale. However, bale squeeze attachments are readily available for transporting and stacking individually wrapped silage bales.

Individually wrapped bales can be stacked on their sides or ends. It has been suggested that stacking bales on their flat ends reduces the potential for UV degradation of the plastic since the ends have more layers of film. Patch small holes in the bale's plastic using a repair tape treated to resist degradation from ultraviolet (UV) light. UV deterioration of other types of tape, such as duct tape, makes them unacceptable for repairing holes.

Store bales on a well-drained sod and away from trees or weeds that might harbor rodents and insects that attract birds and lead to plastic damage. Avoid locations with excessively coarse stubble that may cause small punctures.

What kind of wrap should be used?

The plastic wrap used in making baleage is a polyethylene plastic film that is pre-stretched 50 to 70% by the wrapper as it is applied to the bale. The plastic must be able to withstand the local environmental conditions such as UV radiation and changes in ambient air temperature. Tear strength and tack (stickiness) may also vary among brands of wrap. Most farm supply stores either carry or can obtain stretch-wrap plastic for baled silage. Check with the supplier and/or local producers to see which brands promote proper fermentation in your area.

Plastic film may be white or black. White plastic is most common in this region since it reflects sunlight better and reduces radiational heating of the plastic. In more northern climates, such heating might be desirable to improve the environment for fermentation or help prevent freezing of the silage that makes feeding more difficult.

What type of wrapper is best?

Four major types of wrappers are available and all four can produce good baleage. The main wrapper types are 1) platform, 2) swinging arm, 3) in-line, 4) bale spear. Platform wrappers simultaneously rotate and revolve the bale on a platform to feed plastic from a stationary roll. Swinging arm wrappers have rollers that open to enclose and pick up the bale before wrapping. The plastic roll swings around the bale on an arm. More recently, integral baler-wrapper designs have become available that wrap the bale just after it is formed. In-line wrappers place bales end-to-end in a row while dispensing plastic from rollers that travel around the bale. Bale-spear wrappers have a hydraulic motor to rotate a bale on a spear while the operator moves the plastic along the bale length. Wrappers that make rows of continuously wrapped bales use less plastic per bale since no plastic is needed for the ends of bales.

Trailer-type wrappers place less weight on the tractor than three-point-hitch wrappers, and may allow use of a smaller tractor since horsepower requirements for wrapping are relatively low. Smaller tractors can handle some three-point-hitch wrappers that are moved empty and lowered to the ground before wrapping the next bale. A few wrappers have loader arms to elevate the bale onto the platform and eliminate the need for a loader attachment to lead the bales.

The most common type of wrapper available today is the in-line wrapper due to quick wrapping rates, reduced plastic consumption, and ease of use. Many have automatic wrapping features with remote control options that allow the producer to operate the machine from the tractor thereby reducing labor requirements.

How much plastic needs to be applied?

Stretch-wrap plastic is usually one mil (0.001 in) thick and comes in rolls of 5,000 or 6,000 ft. The plastic is typically pre-stretched 50 to 70% on the wrapper's film dispensing unit to get the correct tension on the bale surface. Always ensure that the tension of the wrap (tacky side toward bale) is such that film is stretched uniformly on the bales. Apply at least four layers should be applied to each bale. For an individual bale wrapper, the preferred method is the 2+2 system whereby two layers of wrap are applied during one rotation of the bale by a 50% overlapping of

successive layers. Keep in mind that some types of wrappers dispense plastic differently than others. In-line wrappers can be purchased to dispense 4 rolls at a time rather than the standard 2 roll types. The 4-roll system increases wrapping speed. Some in-line wrappers also allow extra plastic to be applied at the joints between bales. If this option is available, apply 2-4 extra layers at these joints. Use the high end of this range if bales lack uniformity or do not match up well at the joints. Do not apply too little plastic or oxygen will penetrate the bale and cause spoilage, mold growth, and feed losses.

The plastic used in baleage does not create an airtight seal. Low-density polyethylene plastic such as that used in silage films is four times more permeable to carbon dioxide gas than it is to oxygen gas, allowing the bales to vent excess carbon dioxide gas as fermentation begins.

How many bales can be wrapped per hour?

Using an individual bale wrapper, experienced workers can wrap 25-30 bales or more per hour. This is approximately the same number of bales covered by a 20 in. x 6,000 ft. or 30 in. x 5,000 ft. roll of stretch-wrap plastic. Experienced workers can wrap 40-50 bales per hour with an in-line wrapper.

How much does it cost?

Since each plastic roll costs approximately \$80 (2012 prices) and will cover 25-30 bales, the average cost per bale is \$3-4. Because the cost of the wrapper varies and the type of wrapper determines the amount of labor and plastic that will be required, the total cost of baleage per ton of dry matter (DM) is highly dependent on the type of wrapper used. The more expensive wrappers (in-line) are usually less labor intensive and can use less plastic than the cheaper models. Producers should use a wrapper that will minimize the capital investment, the amount of plastic used, and labor costs for their system. The cost of baleage, therefore, will vary from \$10-15 per ton of DM. This is much less expensive than conventional silage methods and is very competitive with the cost of conventional hay when the losses associated with making and storing hay are taken into account.

What if I feed a molded bale?

Despite the best efforts of the producer to limit the amount of mold growth in silage bales, many bales develop some mold. This usually occurs on the flat ends of the bale and around previously undetected pinholes in the plastic. This type of mold is usually just surface mold caused by entry of sufficient oxygen to support some fungal growth, and it rarely penetrates more than an inch into the bale. The animal usually eats around or even discards this portion. Even if ingested, this type of mold will not significantly harm the animal.

Should I be concerned with Botulism?

Clostridium botulinum is a bacterium that produces one of the most potent classes of toxins known to man. The spores of these bacteria are widespread in the environment (soils in particular) but are dormant. Under anaerobic conditions and with the right nutrients, the spores can germinate and grow, releasing toxins.

Botulism toxicity on dairy, beef, and other livestock farms occurs via ingestion of the toxin. The potent neurotoxin impairs transmission of electrical impulses from nerve to muscle. Tongue weakness is a commonly associated symptom of botulism toxicosis. In most cattle, the tongue will retract into the mouth if it is pulled out to the side. In affected cattle, the tongue may lie limp after being pulled or only slowly retract. Jaw movement and muscle tone is also severely compromised. Cattle with botulism will also drool as a result of having a difficult time swallowing. Botulism toxicity is often first diagnosed as an animal with "downer cow syndrome." When an outbreak occurs, it often affects multiple animals and at any stage of lactation. Animals also usually do not show signs of nervousness or apprehension, which eliminates diagnosis for listeriosis or milk fever. Death in cattle is often due to respiratory failure, dehydration, or complications of being down for prolonged periods of time. Cattle can recover from moderate exposures to botulinum toxin within 5 to 10 days.

To minimize the risk of botulinum toxicosis from baleage, wrap bales at the correct moisture content (50-60%) and store them in areas that will reduce damage to the plastic from the environment or from critters. Type C botulism toxicity is usually associated with decomposing carcasses. This can be a problem if a dead animal is accidentally baled in the baleage or dry haymaking process.

Adapted from Botulism in Cattle by Dr. Limin Kung, Jr., Dept. of Animal & Food Sciences, University of Delaware, Newark

Is baleage higher in quality?

The feed value of the baled silage will be no better than the quality of the forage at the beginning, and can be worse if baled too wet and/or spoilage has occurred. As with conventionally harvested dry hay, quality is a function of forage maturity at harvest, handling during harvest, and storage. Relative to hay, however, the forage going in is higher in quality due to decreased harvest losses, and the resulting baleage will not exhibit the same degree of losses during storage. Therefore, well-made baleage will be higher in quality than comparable hay.

How many bales will I need?

In order to justify the costs associated with storing forage, one should wrap as many bales as possible in a season. However, because of the possibility of less dry matter per bale with baleage, one might be putting up more bales (up to 20% more) of the same size to feed the same number of animals, relative to the number of dry hay bales required. From an acreage standpoint, the number of acres put up as stored forage will be approximately the same.

How soon after wrapping can I feed baleage?

Forage baled in the correct moisture range and wrapped with the correct amount of plastic will undergo the full fermentation process within 6 to 8 weeks and usually in less than 4. Cool temperatures, mature forage, and insufficient forage moisture levels will reduce fermentation rate. To be safe, wait at least 8 weeks after wrapping to begin feeding baleage bales. This time will ensure that the forage is fully ensiled and does not begin to deteriorate or heat when it is fed.

Baleage made with in-line wrappers needs the full to ensile because feeding out these bales exposes the next bales to oxygen and spoilage risks. However, if there is a dire need, one can feed an individually- wrapped bale at any point as long as the bale is quickly (<24 hours) and completely consumed.

How long can baleage be stored before feeding?

The length of storage depends on forage moisture and maturity. Over-mature forage may develop some mold after 3 months. Forage that is baled too wet (>60% moisture) may produce butyric acid during fermentation which reduces feed value after 3 months. Feed baleage made at greater than 60% moisture in three months or less. At 30% to 40% moisture levels, feed value declines after 6 months. In general, forages baled at 40% to 60% moisture will maintain feed value for about 12 months as long as the integrity of the plastic is maintained. However, even where the forage was baled at the appropriate moisture level and the plastic has minimal holes, it is good practice to feed baleage bales within 9 months of when they were made.

What kind of feeding system do I need to minimize losses?

Knowing feeding losses is essential to evaluate any feeding system, independent of type of stored forage. Some studies have shown up to a 50% loss of the forage when large round baleage packages were fed to cattle without placing the bales in a ring feeder. Use of an elevated hay wagon can reduce this loss to 10-20%. Losses can be reduced to below 10% using a ring feeder or a cone type ring feeder. When feeding whole baleage packages to any species, it is best to feed a sufficient number of animals that will eat the entire bale within about two days. Baleage bales may also be integrated into rations by grinding and mixing.

What can I feed baleage to?

Traditionally, baleage has been fed to beef and dairy cattle but can be fed to sheep, goats, or even horses. As with hay, feeding molded baleage bales to horses should be minimized. However, since most of the mold in baleage remains wet during feeding and produces a minimal amount of dust, negative effects on horses will not be the same as the same amount of mold in dry hay.

To ensure the most efficient use of the quality in a baleage bale, it is important to match the bale's quality to the animals' economic productivity. Baleage can and should be tested for nutrient levels in the same manner as dry hay.

What should I do with the used plastic?

Because the plastic can be used for making baleage only once, plastic disposal is a potential environmental problem. Currently, there are no standard policies for collection and disposal of used baleage plastic beyond landfill disposal. In the future, used plastic may be collected for recycling. Such efforts have been successful in those areas that have enough plastic to warrant the collection and recycling of other agricultural plastics. Check with your local government or division of solid waste on applicable statutes in your area for disposal or recycling. Some recycling companies will readily accept used plastic wrap.

Can I wrap dry hay as an alternative to inside storage?

Some producers who have limited inside space for storing dry hay rolls have successfully wrapped dry hay for outside storage. Typically only enough plastic to cover the bale is needed, usually 2 layers with about a 20% overlap at the edges. Black plastic is recommended rather than white plastic since it is cheaper, draws heat, and helps to evaporate condensation within the bale. At the bottom, between each bale, make a vertical cut to allow for ventilation between bales. A 1-2 inch layer of white mold may develop on the outside of each bale, but any losses associated would be far less than unwrapped outside stored hay. Wrapping hay that is higher in moisture than about 20% will mold more significantly.

How do I determine the proper moisture content of my forage?

- 1) "Dish rag" test. Take a handful of forage and wring it out like one would wring out a dishrag. If moisture can be expressed from the forage, it is generally above the 65% moisture range.
- 2) Commercially available testers are an option for measuring forage moisture levels. However, accuracy may be a problem. Obtain at least three moisture readings to create an average value. Commercial testing equipment can be costly (\$200-\$400 range).
- 3) Koster moisture testers are heated, forced-air dryers that are used in silage production to dry down the forage. It takes longer than a microwave moisture test.
- 4) The best method to use is the microwave moisture test (below).

MEASURING THE MOISTURE CONTENT OF FORAGE USING A MICROWAVE OVEN (Adapted from Southern Forages, 4th Edition, Page 303).

1. Chop fresh forage into short lengths (< 1 inch) for ease of handling and uniform drying.
 2. Weigh out at least 100 grams (3.5 ounces) of chopped forage.
 3. Spread forage thinly on a microwave-safe dish and place into microwave. (A cup of water placed in the microwave beside the sample will help prevent the sample from igniting once dry.)
 4. Heat for 1-2 minutes and reweigh.
- If forage is not completely dry, shake and redistribute the sample, and repeat the heating cycle until the sample reaches a stable weight. (Microwaves vary considerably in drying capacity. It is better to dry for short

intervals and reweigh until the last two weights are constant, than to overdry and run the risk of burning and damage to oven.) If charring occurs, use the previous weight.

5. Calculate moisture content using the following equation:

$$\% \text{ Moisture Content} = \frac{(W_1 - W_2)}{W_1} * 100$$

Where: W1 = weight of forage before heating W2 = weights of forage after heating

Dry matter (DM) is the percentage of forage that is not water. DM equals 100% minus the % Moisture Content.

