

OHIO AGRICULTURAL RESEARCH AND DEVELOPMENT CENTER
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Making High Quality Baleage

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Introduction

One way to maintain forage quality with short windows to make dry hay is to make silage or baleage instead. Ideal conditions for making baleage are to bale the hay when moisture is between 40 to 65% and then to wrap within 2 hours of baling. Once wrapped, the hay is preserved by fermentation under anaerobic conditions in which the pH of the forage becomes acidic and stable. Baleage ferments slower than haylage, often taking 6 weeks to complete. Baleage can be utilized as a plan or as a backup, but the best baleage is a plan and not a rescue when hay does not dry fast enough, and a rainstorm is coming. When forage is baled dryer between 25 to 40% moisture, it will not ferment properly and should be considered as temporary storage. During such situations, preservation is primarily a function of maintaining anaerobic, oxygen-limiting conditions. Mold is very likely at this moisture; higher bale densities and more wraps of plastic are required to better seal out oxygen. Baleage made at lower moisture levels will not maintain quality very long in storage, and thus, it needs to be fed as soon as possible. In late fall with cooler temperatures you have more time to feed the poorly fermented feed but still would not want to keep it until spring.

Plan Ahead

Baler consideration

Many modern variable chamber balers are capable of making dense wet bales as baleage. However, special silage balers are available that have scrapers on the belts and rollers to prevent build of material and heavier bearings to handle increased bale weights. Many manufactures sell silage kits for older balers that include scrapers. For square balers, plastic liners in the bale chamber and pick up can help improve crop flow and bale density. Plastic twine or net wrap should be used instead of sisal

twine, especially treated sisal twine since the oils applied as part of the treatment can degrade the plastic film.

Bale wrapper selection

If you are thinking baleage might be a needed option for you, either as planned or when your dry hay window disappears, start your plan before you are calling around to find a bale wrapper. The first consideration is how fast will you be able to feed the forage? This should be a a major consideration when selecting the type of bale wrapper you will buy or rent. There are two wrapper options available are individual wrappers and in-line wrappers. Individual wrappers are usually ideal if feeding 50 head or less from these bales. These machines can usually wrap 20 to 30 bales per hour and use twice as much plastic as an in-line wrapper. In-Line wrappers can wrap 40 to 50 bales per hour using less plastic, but they require uniformity between bales. When bales aren't uniform, oxygen is captured between bales, often leading to spoilage within the tube of bales where bales meet. In-line wrapped bales require higher feed-out rates of ideally two bales per day. With an in-line wrapper, the end of the next bale is exposed to oxygen when you remove the previous bale to feed and the spoilage clock begins.



Storage Location

Determining where you will be storing bales ahead of time is very important. Bales should ideally be wrapped where they will be stored to minimize damage to the plastic wrap. Make sure that bales are stored where the plastic is at low risk of being punctured, allowing oxygen to enter and spoil the forage, is critical. Ideal storage is in a well-drained location with year around access. Stone pads can work well as long as they don't puncture the plastic. Be wary of storing on stubble, grassy areas, or under trees. These areas often attract rodents, lead to plastic damage, or have sticks that fall and puncture the plastic. Stored forage should be checked weekly for damage and holes taped as soon as they are found.

Plastic Selection

There are three common colors of plastic utilized, white, green, and black. A few things that often differ between brands is UV radiation resistance, tear strength, and tack (stickiness of the plastic). Most plastic is one mil (25 microns) to 1.5 mils thick. White plastic is the most common film color for baleage since it reflects sunlight better and reduces radiational heating. Oxygen barrier (OB) film wrap are designed to have lower oxygen permeability than traditional Polyethylene (PE) wrap. At the same thickness OB films will have lower DM losses and mold spoilage than PE film. OB film wrap is often more expensive allowing for more mils of PE to be used with similar result at the same cost. Black plastic may work better for dry hay. The black plastic absorbs heat and hay under 20% moisture can be preserved with 2 mils of black plastic stopping mold growth on the bales surface.



For storage of dry hay

While not a common practice, hay below 20% can be wrapped as an outdoor storage strategy. For dry hay, 2 mils of black plastic are recommended, absorbing heat and evaporating condensation within the bale. At the bottom between each bale a vertical slit should be made to allow for some ventilation. In many cases, a layer of white mold may develop on the outer edge of the bale, but the losses due to the white mold are much less than storing bales outside uncovered. One method to decrease white mold is to store bales inside for 2 weeks during the sweating process prior to wrapping them.

Plastic handling during feed out

Plastic film can only be used once for making baleage. Disposal of the plastic can potentially cause environmental concerns. Currently, there are limited options for recycling plastic. Contact your local landfill to see if they will dispose of it. A few recycling centers will collect baleage plastic that is clean, however they often want it to be kept dry and sometimes pre-compressed.

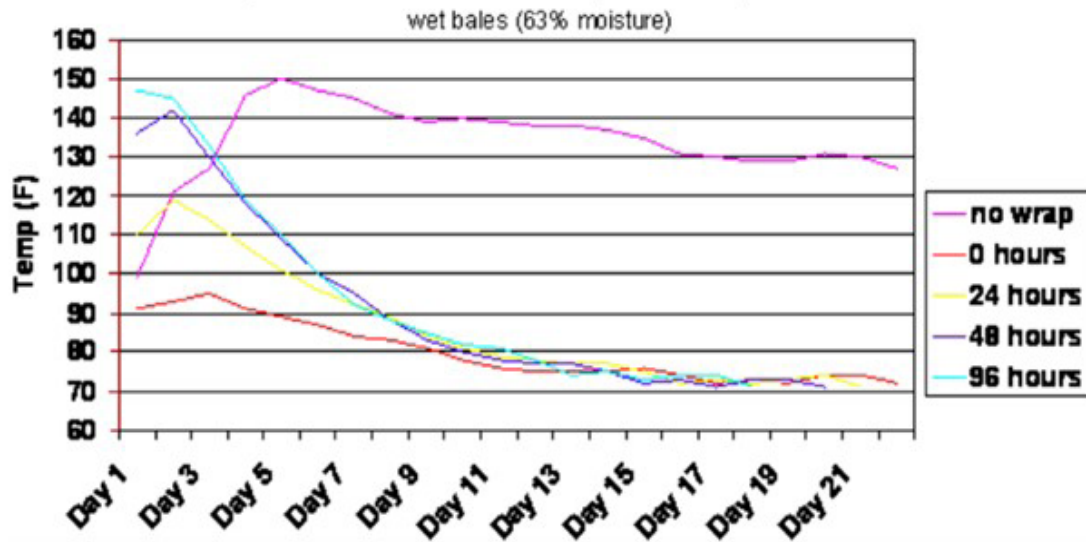
Planning Oxygen exclusion

While KEEPING OXYGEN OUT is the most important part of making high quality baleage, the process starts with mowing. Based on research done at the University of Wisconsin-Madison, laying swaths as wide as your mower will allow, will help preserve forage quality and speeds up drying to 65% moisture by 10.8 hours. When baling, your goal needs to be for the highest density bales that you can make. A study from Penn State shows that by increasing bale density from 6 lb/ft³ to 8lb/ft³, you gain an extra 12 hours of bunk life in the haylage due mostly to better bale fermentation.

Wrapping Timing

When planning to make baleage, the capacity-limiting factor will be how many bales you can wrap an hour. Ideally, baleage should be wrapped within 4 hours after baling to avoid spoilage. Spoilage occurs when the internal temperature of the bale rises after baling. Figure 1. (data from University of Wisconsin) show the effects of wrapping on internal bale temperature at different points up to 4 days post baling. With the temperature on day 1 representing the actual day of wrapping. The data shows that just 24 hours after baling, that the temperature of unwrapped baled had increased to over 120°F. With the bales wrapped 4 days after baling being over 50°F warmer than those wrapped day of baling. While wrapping bales up to 4 days after baling stopped the heating process, the feed quality of these bales was still reduced compared to wrapping the same day as baling.

Fig 1. Effect of Timing of Bale Wrapping after Bailing on Internal Temperature of Bale over Time. Lancaster, WI 1998



Amount of Bale wrap

To seal out oxygen with one mil low-density PE, a minimum of 6 wraps of plastic is required. Types of plastic vary greatly in their stretchiness, which can reduce thickness by up to 25%. Some stretch is necessary so that the plastic stays sticky and seals well between the layers of plastic. 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 thick stemmed forages that poke through the plastic, requiring more layers. Figure 2 shows that bales (30% moisture) wrapped with 6 to 12 mils of plastic maintained similar bale quality during storage. With fewer than 6 mils of plastic, bale spoilage is often prevalent. Recommendations for moisture content and layers of bale wrap are provided in Table 1. Determining where you will be storing bales ahead of time is very important. Bales should ideally be wrapped where they will be stored to minimize damage to the plastic wrap. Make sure that bales are stored where the plastic is at low risk of being punctured, allowing oxygen to enter and spoil the forage, is critical. Ideal storage is in a well-drained location with year around access. Stone pads can work well as long as they don't puncture the plastic. Be wary of storing on stubble, grassy areas, or under trees. These areas often attract rodents, lead to plastic damage, or have sticks that fall and puncture the plastic. Stored forage should be checked weekly for damage and holes taped as soon as they are found.

Fig 2. Effect of Plastic Wrap Thickness on Internal Temperature of Bale over Time, Lancaster, WI 1998

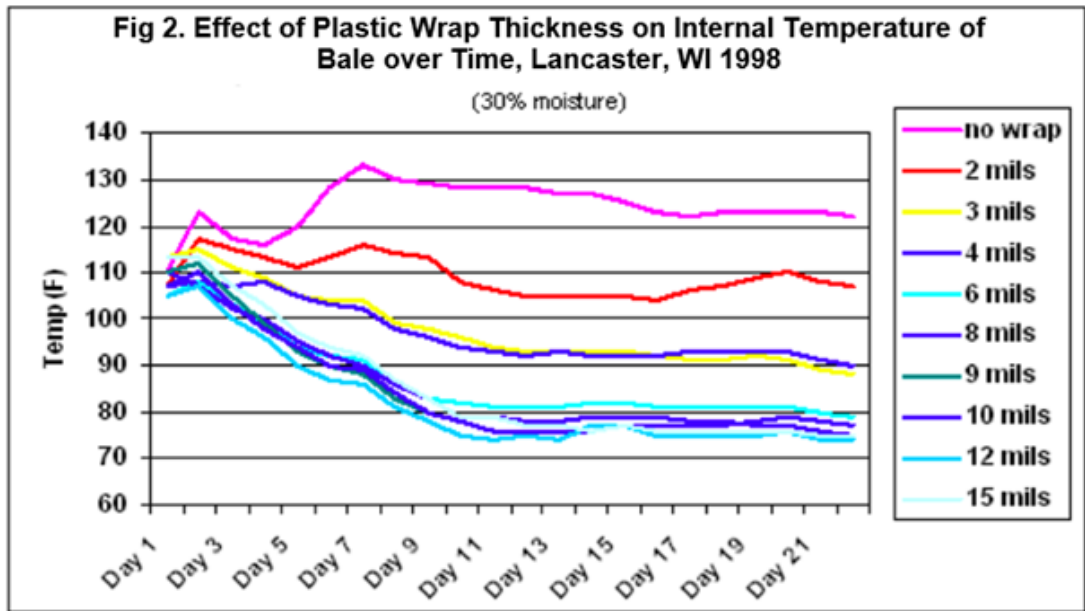


Table 1. General recommendations for layers of bale wrap.

Moisture (%)	Fermentation	Layers of Plastic
<20%	Bales will not ferment, the goal is to keep the hay dry similar to barn storage	2 layers of black plastic, with small vertical cuts between bales
20 to 30%	Possible, but not ideal fermentation. Some mold growth likely	8 layers minimum to ensure oxygen exclusion
30 to 40 %	Possible, but not ideal for fermentation. Some mold growth could occur	8 layers minimum to ensure oxygen exclusion
40 to 60%	Ideal for baleage production and fermentation	6 layers of 1 mil 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 down further before baling

Considerations after wrapping

After bales are wrapped, handle them carefully using a squeeze so that plastic is not torn. If plastic 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. Haylage that is too wet, over 60% moisture, should be feed within 3 months, and haylage that is below 40% will not ferment well and should be fed within 6 months. Most of the time when baleage is made as a rescue option, it falls in the range of needing to be fed within 6 months. When done right, baleage can last up to a year and make excellent feed that often has 5% better quality than dry hay due to decreased harvest loss. When done wrong, haylage can spoil, mold, and grow organisms that will make your animals sick; use your eyes and nose to be sure that the forage that you are going to feed is of high quality. Do not force animals to eat spoiled forage. Some baleage can be very toxic and not be moldy (listeria and botulism). Do not just trust your eyes and nose. Because during the baling process you generally pick up more soil which can contaminate the feed increasing botulism risk. Baleage doesn't ferment as much as silage so it may not kill off listeria. Baleage with a pH greater than 5 is at risk for listeria issues.

Economics of baleage

Each roll of plastic film costs about \$85 for PE film, with a typical range of \$80-95 depending if it is purchased pre-season or in season. A roll of plastic will cover 25-30 bales with an in-line wrapper with a cost of \$3-4 per bale. Individual bale wrappers use more plastic almost twice as much for round bales costing \$5-8 per bale in plastic. The study "Economics Returns and Risk

Analysis of Forage Wrapping Technologies" conducted in the southeast portion of the USA found that for herds with over 50 head of beef cows that bale their own hay can improve farm profitability by owning a bale wrapper. Baleage often reduces storage losses compared to dry hay with less losses during harvest and maintains quality but cannot improve quality. The real economic benefit of baleage is that it provides the opportunity for producers to harvest forage during shorter hay making windows when forage is still of higher nutritional value. Making baleage also allows producers to utilize summer and winter annual forages that are often harvested when it is too cool to make dry forage. The study found that when baleage was used to harvest forage at high quality versus average quality the farms profitability increased 97.6 percent of the time or 100 percent of the time average quality was able to be made instead of poor quality. This is due to the ability to harvest forage in a shorter time window with baleage compared to dry hay. When adopting baleage technology to allow for forage to be harvested timely for higher quality the farm profitability increased by at least \$90 per cow. Current rate for custom baling and hay wrapping can be found at the OSU Farm office: <https://farmoffice.osu.edu/farm-mgt-tools/custom-rates-and-machinery-costs>

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