

Management Tips for Round Bale Hay Harvesting, Moving, and Storage

Robert "Bobby" Grisso, Extension Engineer, Biological Systems Engineering, Virginia Tech

Ray Smith, Forage Specialist, Crop and Soil Environmental Sciences, Virginia Tech

John Cundiff, Professor, Biological Systems Engineering, Virginia Tech

This Extension publication discusses management of hay harvesting with a large round baler. Specific management practices are necessary to maintain hay quality and minimize hay loss during harvest, transportation and storage of large round bales.

Large round bale packaging systems allow one person to harvest, store and feed large quantities of hay for small as well as large acreages. Proper management is required to maximize effectiveness because losses in baling, transportation and storage of large round bales can far exceed the losses of rectangular bales.

Who Considers A Large Round Bale System?

Hay producers select large round balers over small rectangular balers because of their high capacity, lower cost, and lower labor requirements. One person, with properly sized equipment, can usually bale, store and feed all the hay for most average size operations.

When Is A Large Round Bale System A Poor Choice?

Major disadvantages of large round bales include poor saleability on the open hay market, poor long distance transportability, and potential losses from baling, transporting, storage and feeding. These disadvantages can be minimized with proper management.

The round shape and bale dimensions make it impossible to achieve a transport payload equivalent to small or large rectangular bales. Long distance transport of round bales is generally impractical. In addition, there is less demand for large round bales on the open hay

market than for small and large rectangular bales. If you plan to sell or transport large round bales, consider a 4-ft wide round bale that fits better on trucks than wider round bales.

The disadvantage of the 4 ft wide bale is that it tends to topple over when ejected from the baler. The toppling increases with 6 ft diameter bales that are 4 ft wide. When the bales topple over the exposure to rainfall is intensified. Excessive moisture encourages degradation and heating of the bale resulting in significant reduction in feed quality.

Know your hay market and the desired package shape before selecting a haying system.

Dry matter (DM) and crude protein (CP) losses generally are greater with large round bale systems than with small rectangular bale systems. This is particularly true when operating in dry alfalfa or other legume hay. Since legume leaves are two to three times higher in CP and digestibility than the stems, leaf shatter during baling substantially reduces forage quality. Shatter losses are less of a concern when baling grass hays.

For example, in very dry alfalfa hay (less than 15 percent moisture content), leaf losses for large round balers can exceed 25 percent, while a small rectangular baler in the same hay seldom has losses over 5 percent. Thus, timely field operations are more critical with large round bales than small rectangular bales to minimize baler losses. Use equipment and management techniques which are specifically designed for large round bales since baling, transportation, storage and feeding losses of large round bales can be higher than with small rectangular bales.

Selection of Large Round Balers

Several early round balers were “ground roll” types. These balers actually rolled up hay directly on the ground. Compared to balers with distinct bale chambers, ground roll balers tended to make a less dense bale with an irregular surface, and have a higher field loss. These bales did not weather as well and usually did not have a twine wrap.

Most current large round balers have a distinct bale chamber within the machine. This chamber is normally a fixed chamber or a variable chamber.

In a variable chamber, flat belts or chains with slats contain the bale from its initial formation until completion. It can make a relatively dense bale which has uniform density from the center out.

In a fixed chamber baler, hay rolls within the chamber until it fills the chamber. These bales tend to have a soft core. The fixed chamber is normally confined by belts, chains, rollers or drums.

Data suggests that bale chamber losses are less for variable chamber balers with belts than for fixed chamber balers with rollers. However, rollers may require less maintenance than belts or chains.

Large round balers come in a wide range of sizes. The smallest balers produce a full-sized bale approximately 4 ft wide by 4 ft in diameter. The largest balers make bales nearly 8 ft wide by 6 ft in diameter. Bale weights vary from 500 to 2,500 lbs in properly conditioned hay. Bale weights will also vary with regard to the type and/or species of forage being baled (ie., grass vs legume, 1st vs 2nd cutting). Balers with a variable chamber produce uniform density bales in any diameter up to full size. Fixed chamber balers will not produce a maximum density bale until it reaches full size.

Modern large round balers are available with an assortment of options. Twine tie is available on almost all balers. An automatic twine wrap feature speeds wrapping. Some companies offer a bale monitor system which automatically guides the baler operator across windrows to produce uniformly-shaped bales. Some balers eject the bale and close the tailgate without backing up the baler. When selecting the various type of bale wrapping system options for your baler, it is important to keep in mind what type of large bale storage you will be utilizing for the majority of your large bales. Things to consider would include, but are not limited to, indoor vs outdoor storage, and outdoor and covered vs outdoor with no cover.

Some models have been introduced which contain two bale chambers. This arrangement allows a new bale to be started while a full bale is wrapped with twine and ejected, all without stopping forward travel. A bale counter, full bale warning light, and gate-closed indicator are useful options to help improve safety, the quality of the bale, and effectiveness of the balers.

Power required for large round balers varies with the size of baler, size of bale, density of bale formed, rate of bale forming, and contour of the field. As a rule of thumb, the smallest balers require 40 horsepower and the largest balers require 100 horsepower.

For safety concerns the most important thing to consider when matching a tractor to a round baler is not just horsepower but tractor size. It is important that the gross weight of the tractor be greater than that of the gross weight of the baler when fully loaded with a bale. Tractor weight is one that must be considered when selecting the proper power unit for a baler that will be used on the many hilly slopes.

The cost per hour (\$/hr) to operate a round baler is about the same whether the baler is operated at 60% of design capacity (ton/hr throughput) or 90%. Cost per bale is calculated as:

$$\text{Baling Cost } \{\$/\text{ton}\} = \frac{\text{Cost to Operate } \{\$/\text{hr}\}}{\text{Throughput } \{\text{ton}/\text{hr}\}}$$

It is an advantage to operate the baler at maximum design capacity. However, there are things to consider. Operators must learn not to drive too fast along a heavy windrow. If a baler becomes jammed, significant time is required to correct. Most balers are equipped with a slip clutch on the pickup mechanism. As the slip clutch is engaged due to overloading, the operator can hear the noise and slow forward progress. Most operators need to keep the baler operating at 90% of design capacity.

One has several considerations when comparing twine, net wrap, and plastic wrap. In an attempt to reduce outside storage losses, the circumference of bales are covered with a solid plastic sheeting to shed water. Wrapping bales with ultraviolet (UV) light-stabilized plastic can reduce DM losses to only 7 percent compared with 35 percent losses from unwrapped bales stored outside on the ground. Solid plastic wrap can be applied at baling with the proper attachments to late model balers. Wrapping during baling avoids the additional labor needed with bale bonnets or sleeves. No twine is needed with self-adhesive plastic wrap, thereby offsetting a portion of the cost.

Net wraps are porous materials designed to shed water and permit greater air flow at the bale surface at less of a cost than plastic wraps. Net wraps are applied during baling and eliminate the need for twine. Studies show that net wrap reduces grass hay DM losses by 32 percent compared with bales stored outside on the ground. When comparing losses of bales stored outside, the net wrap is somewhat intermediate between twine-tied and plastic wrap. Before ejection from the baler, net wrap requires two spins to wrap the netting compared to eight times required for twine. Reduction in the stop time to wrap a bale offsets the higher cost of the net. Total baling cost per bale for an efficiently run operation is about the same.

Hay Preparation For Large Round Balers

The moisture content of hay entering the baler will greatly influence the amount of field loss and quality of hay after storage. This is generally more critical with a large round baler than with a rectangular baler. In particular, a large round baler will have excessive field loss when the hay is too dry. *Hay as Part of a Cowherd Production System* (VCE Publication 400-002) reviews a number of factors involved in quality hay production. Generally, harvesting hay during early stages of maturity produces bales that have lower storage losses than late-cut material. Following are management tips to reduce losses and improve quality for the large round bale systems:

Cutting - Hay is usually cut with a sickle-type or disc-type mower, a windrower, or swather. The cutting mechanism must be sharp and properly adjusted to cut the forage cleanly and to minimize shattering. Cut after the dew is gone and when the topsoil is dry to reduce soil compaction and to hasten hay drying. A long stubble keeps the windrow off the soil surface to aid drying and will improve subsequent pickup performance.

Disc mowers allow hay to be cut earlier in the morning or later in the evening, extending the cutting window. First, you will witness less leaf shattering with increased leaf moisture. Secondly, research has shown that hay quality is increased when hay is cut while the sugar content remains higher in the plant. Cutting later in the morning or early afternoon will result in lower hay quality as the plant sugar content decreases with increased air temperatures.

Conditioning - Hay plants with an 80 percent moisture content must lose about 6,000 lbs per acre of water to produce a ton of hay at 20 percent moisture. Conditioning speeds drying by opening the waxy cuticle layer surrounding the stem and allowing moisture to

evaporate faster. This can be done either mechanically or chemically. Mechanical conditioners pass hay between two rolls to crush or crimp the stem. Avoid flail type conditioners because excessive shatter losses will occur.

Correctly adjusted conditioners maintain adequate roll pressure uniformly along the entire roll length. Apply sufficient roll pressure to the hay to cause a noticeable breaking of the stem skin, but not so much pressure that leaves are broken off. Keep the rolls clean and free of wrapped material. Check to insure that the roll has not worn more in the center than near the ends. A constant diameter roll is necessary to maintain uniform pressure.

Chemicals for conditioning, such as potassium carbonate, partially dissolve the waxy layer and are usually applied by spraying standing legume hay immediately prior to cutting. Both chemical conditioning and mechanical conditioning can be used together. Best results from conditioning occur under favorable drying conditions. Some chemicals used for conditioning also may improve the palatability of the forage.

Tedding - Tedding fluffs, spreads or moves the windrow of hay. Some tedders simply shift the windrow several feet onto a dryer area while others spread out, invert and/or fluff the windrow. All these operations may improve drying, but high leaf loss can occur when the tedder is aggressive or the hay is already somewhat dry when tugged. In alfalfa and clover hay production it is important to realize that hay must be somewhat moist when tugged to guarantee reduced leaf shattering. Proper timing of the tedding process for alfalfa and clover will enhance both drying time and forage quality.

Windrow turning - Machines are designed to lift, invert and fluff the windrow with the bottom side exposed to the sun. During good drying conditions, this will speed the drying of the windrow. Handling by the turner is about equal to a re-raking with a side-delivery rake. Many consider the operation a gentler handling on the hay.

Raking - Raking forms a mowed swath into a windrow, or accumulates two or more windrows into one. Some producers eliminate raking by using a windrower. A windrower may reduce time of field operations and reduce in-field losses. Windrowed hay will dry slower and less uniformly than hay in a wide swath.

More leaf loss can be caused by raking hay than by any other harvest operation. Especially avoid raking

legumes when the forage moisture is less than 35 to 40 percent. If the rake is PTO driven, synchronize field speed and PTO speed to provide a gentle lifting and turning action. This will avoid aggressive handling of the forage and excessive leaf loss.

Windrow formation - The ideal windrow width for round balers is between one-half and near full width of the baler pickup. This width range aids uniform bale formation within the chamber.

Make windrows as large as possible within the capacity of the baler pickup to minimize baler losses. This reduces contact between hay and the baler pickup mechanism, and reduces the number of bale turns within the chamber. Large windrows may not be compatible with other equipment or with drying strategy, so some compromise usually is necessary.

To form bales of consistent density and shape, make windrows uniform in width and uniform in the amount of hay contained. Minimize the number of windrow ends. Field loss occurs as the bale turns within the bale chamber. Do not create unnecessary bale chamber loss by running the baler when there is no hay feeding into the chamber.

Managing Techniques to Reduce Baler Losses

Significant DM losses are associated with the entire harvesting process. Total harvest losses, from the standing crop to storage, range as low as 10 percent for grass hay to as high as 35 percent for legumes. More specially for alfalfa, baling losses of one to five percent have been measured for small rectangular balers operating in typical conditions. Under these same conditions, baling losses of 3 to 30 percent have been measured for large round balers. Minimize this potentially high loss when using large round balers by controlling losses due to: 1) moisture content of the hay, 2) the baler pickup, and 3) the bale chamber.

Hay moisture content

Hay moisture content is the largest single factor contributing to leaf loss. Figure 1 shows the importance of baling at higher moisture contents. Hay baled at a moisture content above 15 percent has much less leaf loss than hay baled below 15 percent moisture.

The upper moisture level depends on the type of hay, density and size of bale, drying conditions after baling, and other factors. The upper limit for moisture for large round alfalfa bales is typically 18 to 20 percent.

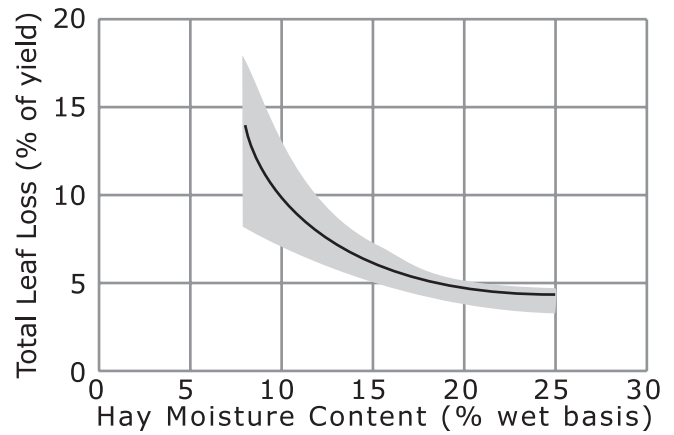


Figure 1. Leaf loss during baler operation. Accumulation of data for several large round balers over a range of hay moisture contents in fields of mixed alfalfa, crested wheatgrass and brome grass. Data source: Prairie Agricultural Machinery Institute.

Hay baled much above 20 percent moisture will usually spoil unless chemical preservatives such as propionic acid are added to the hay. Effective hay preservatives will prevent excessive heating and mold growth when applied uniformly and at the correct rate.

When the hay becomes too dry and brittle and losses become excessive, stop baling and resume in the evening or morning when the leaf moisture level increases. This dew-moistened hay can be baled at a slightly higher moisture level than when it was drying down because dew moisture in the hay is more easily released during curing than internal moisture.

Baler pickup

The baler pickup mechanism of large round balers may cause losses as high as 12 percent, although losses more typically range from 1 to 3 percent. Field speed, size of windrow, hay moisture content and mechanical condition of the pickup mechanism (broken and bent pickup teeth) influence this loss.

Higher moisture content reduces pickup loss. Synchronizing field speed to pickup rotational speed reduces pickup loss. If forward speed is too slow, the pickup device snatches the hay and pulls the windrow apart as it feeds it. If forward speed is too fast, the hay is “bulldozed” in front of the pick-up mechanism. Proper synchronization of forward speed and pickup rotation speed is achieved when the windrow “flows” into the baler with minimum disruption.

A correct speed match will gently lift the hay from the windrow and not push the hay or pull the hay from the

windrow. Heavy windrows reduce pickup loss because the baler operates at a reduced field speed and contact with pickup components is minimized. Do not make windrows so wide that hay is lost at the sides of the baler pickup. Check pickup components regularly for missing or bent tines and to ensure that the windrow is handled gently as it flows into the bale chamber.

Undesirable barrel-shaped bales may occur with narrow windrows and the operator follows a smooth weaving pattern to move back and forth across narrow windrows (Figure 2b) or when driven straight down the windrow (Figure 2c). For more uniform bales, make sharper turns as shown in Figure 2a. First, crowd material into one side of the pickup for 10-12 seconds; then cross quickly to the other side and crowd material into the opposite side of the pickup for 10-12 seconds. Stay on each side more than 10-12 seconds for lighter crops and less than 10-12 seconds for heavier crops.

Bale chamber

Bale chamber losses have been measured as high as 18 percent for large round balers. Bale chamber losses are normally two or three times higher in a large round baler than a rectangular baler. Windrow size, field speed, hay moisture content, bale rotating speed and wrapping of twine contribute to chamber losses.

To minimize bale chamber losses, the moisture content should be as high as possible that will allow for safe storage. The feed rate should be as high as possible to minimize the number of turns within the bale chamber. A high feed rate can be attained by using large windrows and high forward speeds. Where windrows are small or field speeds must be slow, use a lower PTO speed. This results in fewer revolutions to form a bale. PTO speed must be fast enough relative to field speed to maintain satisfactory pickup performance.

In one study of round balers, bale chamber losses were two percent of yield when the bale was formed in two minutes. When bale forming time was 13 minutes in the same hay, the bale chamber loss was 11 percent of yield. Since bale chamber losses typically exceed pickup losses, it usually is better to accept some pickup loss by driving faster to reduce the time required to form a bale. When wrapping twine, do not rotate the bale more times than necessary to secure the twine. The fines, primarily leaves, which fall from the bale chamber during twine wrapping are an indication of the bale chamber loss. These fines contain the highest level of nutrients, so minimizing these losses is important.

Large Round Bale Moving and Transportation

Losses between 1 and 10 percent of yield have been reported when large round bales were moved from field to storage site. Short turn around time from the baling operation to bale removal from the field will decrease hay waste. Bales moved soon after baling do not begin to lose shape and the various types of wraps, particularly twine, do not deteriorate from UV sunlight exposure. Reduce these losses by spacing twine wraps 6 to 10 inches apart, by making a solid, dense bale with cylindrical form, and by using care in handling the bales.

Round bales can be readily handled by tractor-mounted equipment and special round bale wagons. Tractor front-end loaders can load and move large round bales, but use care to prevent accidents involving tractor tipping or allowing the bale to fall or roll from the loader onto the operator. Single bales can be transported with a pickup. When transporting a large number of bales, single bale handling devices are inefficient. Tractor-powered and self-propelled large round bale loaders and transporters are available for large volume situations.

Long distance transportation of large round bales on public highways is covered by certain highway regulations. These regulations may include the maximum width, height and length of the load, the time of day it can be moved on the highway, and methods of securing the load. Current state law states that the securing device (chain, strap or rope) must be at least 1 1/2 times stronger than the weight of the load it secures. Consult the appropriate officials for the current regulations on the highways you will travel.

Large Round Bale Storage

Large round bales typically have a higher storage loss than small rectangular bales, especially when stored outdoors. Placing round bales outside on the ground represents the cheapest method of hay storage but has the greatest potential for DM weathering loss. Most of the losses that occur during outside storage take place on the bottom of the bales where moisture levels remain highest and air movement is the lowest. There are a number of storage techniques that minimize outdoor storage loss:

Make a dense bale - A dense bale will sag less and have less surface area in contact with the ground. A dense surface layer will shed more precipitation and protect the inner part of the bale from weathering. Bale density is affected by the baling machine, the experience of the operator, and the hay type (fine stemmed hays form

denser bales). The density of round bales should be a minimum of 10 lbs of hay per cubic ft.

Use plastic wrap, net wrap or plastic twine - Twine reduces bale sag, maintains bale shape, and provides a tight, smooth surface. Plastic twine will resist weathering, insects and rodents better than natural fiber twines. Twine should be wound tight and spaced 6 to 10 inches apart for best bale storage.

Store bales on a well drained location - Bales soak up moisture if placed on a wet or poorly-drained site, causing a large layer of spoiled hay on the bottom of the bale. The storage site should drain away in all directions. A well drained, 4-6 in. coarse rock base will minimize bottom spoilage. Other materials that are successful to break the contact between wet soil and provide some air space between the bale and soil surface are: telephone poles, wooden pallets, cross ties, scrap pipe and tires.

Store bales end-to-end - The arrangement of large round bales in outdoor storage can significantly influence the amount of storage loss. Pack the bales tight enough to maintain uniform shape and minimize contact with the soil surface. Under most conditions, position bales end-to-end as tightly as possible in long lines on a well drained site. A gently sloping site with a southern or southeasterly exposure is preferable to maximize solar drying and will allow water to quickly drain away from

the hay. Bales should be oriented up and down the slope so that they will not create puddling of surface water. Place the bales near the top of the slope to minimize water flowing around the bales. If more than one line of bales is needed, space adjacent lines at least 3 ft apart. This will increase the air flow and allow the sun to reach the back row. Stacking large round bales usually increases losses. Stacking tends to trap moisture and limits drying action from exposure to the sun and wind. Never store bales under trees. It is highly recommended that large bales that are stacked outside, have some type of temporary cover placed over them for the total duration of the storage period.

Indoor storage and bale covers

If bales are to be marketed or stored for more than one season, indoor storage or bale covers should be considered. Remember that the outer 4 inch thick layer of a 6 ft. diameter round bale contains about 25 percent of the total bale volume. Studies have shown outdoor storage losses range between 5 and 35 percent depending on the amount of precipitation, storage site location, and original condition of the bale. Storage losses are usually reduced by approximately two-thirds with indoor storage and by one-half with good plastic covering outdoors. Beware of the side forces when stacked. A high stack (4 or more bales high) of large round bales can exert a significant load on the walls of storage structures.

Also Review:

“Hay as Part of a Cowherd Production System” 1996. Virginia Cooperative Extension, Publication 400-002, Virginia Tech, Blacksburg, VA <http://pubs.ext.vt.edu/400-002/>

“2000 Agronomy Handbook, Part II: Forages” 2001. Virginia Cooperative Extension, Publication 424-100, Virginia Tech, Blacksburg, VA <http://pubs.ext.vt.edu/agronomy/>

“Large Round Bale Safety” 2002. Virginia Cooperative Extension, Publication 442-455, Virginia Tech, Blacksburg, VA

Acknowledgments:

The authors would like to express their appreciation for the review and comments made by David Moore, Extension Agent, Middlesex County; Jon Repair, Extension Agent, Rockbridge County; David Vaughan, Professor, Biological Systems Engineering Department; and Mark Wahlberg, Extension Animal Scientist, Animal and Poultry Sciences Department.

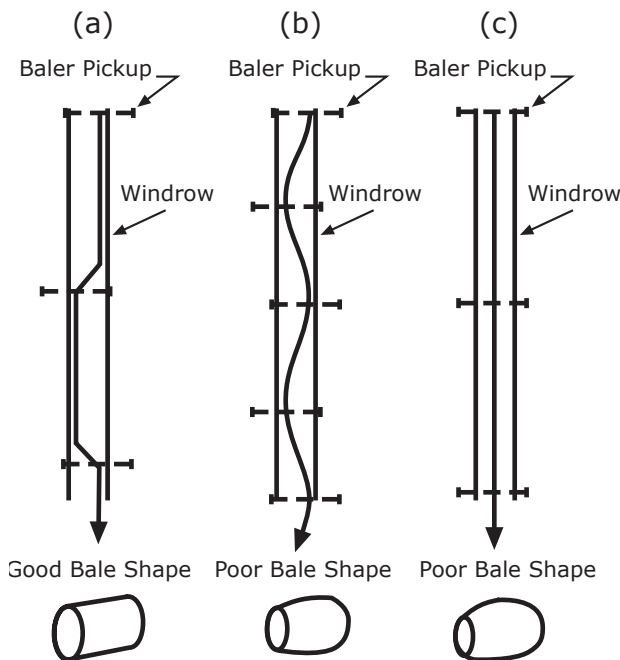


Figure 2. Pickup pattern for narrow windrows. Crossover the windrow (a) and hold for 10-12 seconds. Then cross sharply back to the other side and again hold for 10-12 seconds. Do not weave uniformly from side-to-side (b) or drive straight down the window (c).