Management Tips for Round Hay Bales: System Selection, Harvesting, Moving and Storing

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Research and Extension

Forages Series

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Harvesting hay with a large round baler requires specific management practices to maintain hay quality and minimize loss during harvest, transportation, and storage.

Large round bale packaging systems allow one person to harvest, store and feed large quantities of hay. Proper management is required to maximize effectiveness because losses from baling, transporting and storing large round bales can far exceed the losses with rectangular bales. When considering hay packaging systems, determine the desired package shape for the targeted user before selecting a system.

Selecting 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. With properly sized equipment, one person can usually bale, store, and feed all the hay for an average sized operation.

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 that automatically tells the operator which side of the windrow to guide into the baler to produce uniformly-shaped bales. Some balers contain "kickers" that push the bale away from the baler when ejected (so the tailgate can be closed without backing up the baler). Bale counters, full-bale warning lights, and gate-closed indicators are useful options to help improve safety, the quality of the bale, and effectiveness of the balers.

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

For safety reasons, the most important consideration when matching a tractor to a round baler, is tractor size, not horsepower. The gross weight of the tractor must be greater than that of the gross weight of the fully-loaded baler. This weighting scheme allows the tractor to maintain control of the baler even when operating on slopes.

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

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

It is an advantage to operate the baler at maximum design capacity. However, there are considerations. Operators must learn not to drive too fast along a heavy windrow. If a baler becomes jammed, it may require 30 minutes or longer to correct this problem. 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 knows to slow down forward progress. Most operators need to keep the baler operating at 90 percent of design capacity to obtain maximum efficiency.

Bale Chamber. Most large round balers are designed to minimize hay loss. A typical system will have a dedicated bale chamber and very close belt spacing. The chamber can be a fixed or variable chamber.

In a fixed chamber baler, hay rolls inside the chamber until it is full. These bales tend to have a softer core. The fixed chamber is normally confined by belts, chains, rollers, or drums. In a variable chamber, flat belts or chains with slats contain the bale from its initial formation until completion, and can make a bale with uniform density throughout. Some round baler models have twin bale chambers. The second side of the baler chambers a new bale to start while the previous full bale is being wrapped, tied, and ejected – all without stopping the forward travel of the tractor.

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

Baler Size. Large round balers come in a wide range of sizes. The smallest balers produce a full-sized bale that is approximately 4 feet wide by 4 feet in diameter. The largest balers make bales that are 8 feet wide by 6 feet in diameter.

Bale weights vary from 500 to 2,500 pounds in properly conditioned hay. Bale weights will also vary with the type and/or species of forage being harvested (i.e., grass vs. legume, first vs. second cutting, etc.). 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.

Wrapping Options. When selecting a wrapping system, keep in mind what type of large bale storage you will be using for a majority of your large bales. Considerations include, but are not limited to, indoor vs. outdoor storage and outdoor covered vs. outdoor uncovered. An operator has several options when comparing twine, net wrap, and plastic wrap. Solid plastic sheeting around the bale's circumference will reduce outside storage losses by shedding water. Wrapping bales with ultraviolet (UV) light-stabilized plastic can reduce dry matter (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 by late model balers with the proper attachments. Wrapping during baling eliminates the additional labor needed for bale bonnets or sleeves. Self-adhesive plastic wrap eliminates the need for twine, offsetting a portion of the cost.

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

Harvesting

Hay Preparation. The quality of hay entering the baler will greatly influence the amount of field loss, efficiency of baling, and quality of hay after storage. Hay quality is generally more critical with large round balers than with rectangular balers. In particular, a large round baler will have excessive field loss when the hay is too dry. Harvesting hay during the early stages of maturity produces bales with lower storage losses than late-cut material. The following management tips will help reduce hay loss and improve the quality of large round bales:

Cutting, Hay is usually cut with a sickle or disc-type mower, a windrower, or a swather. The cutting mechanisms must be sharp and properly adjusted to cut the forage cleanly and minimize shattering. Cutting after the dew is gone and when the topsoil is dry speeds drying. Long stubble keeps the windrow off the soil surface, aids drying, and improves subsequent pickup performance of the baler.

Disc mowers allow hay to be cut earlier in the morning or later in the evening, extending the cutting window. Increased leaf moisture will result in less leaf shattering. Research shows an increase in hay quality when hay was cut while the sugar content in the plant was high (which occurs earlier in the morning and later in the afternoon).

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

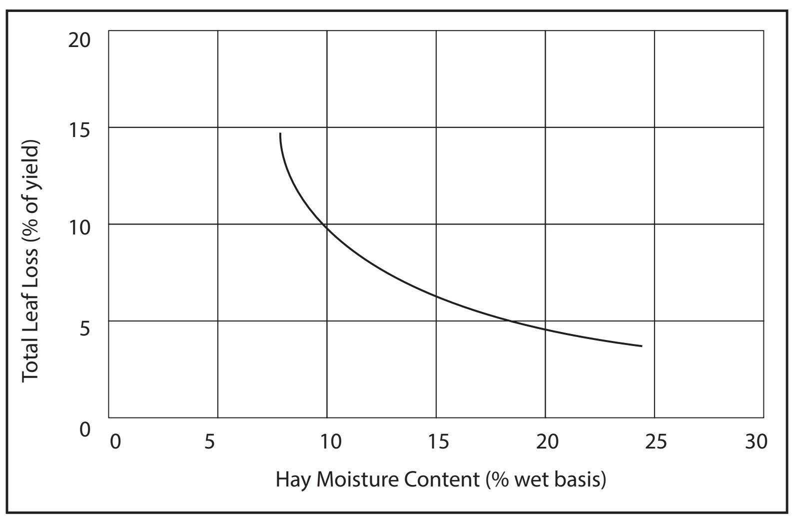

Figure 1. Leaf loss during baler operation. Accumulation of data for several large round balers over a range of hay moisture contents in fields of mixed alfalfa, crested wheatgrass and bromegrass. Data source: Prairie Agricultural Machinery Institute.

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 and the dew softens the baler impact and reduces shattering. Dew-moistened hay can be baled at a slightly higher moisture level than internally wet hay (at the same moisture level) because surface moisture is more easily released than internal moisture.

Hay plants with 80 percent moisture content must lose about 6,000 pounds per acre of water to produce a ton of hay at 20 percent moisture. Conditioning accelerates 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 rollers that crush or crimp the stem. Avoid flail type conditioners because they cause excessive shattering and leaf loss, especially on legumes. Correct operation means adjusting conditioners to maintain adequate and uniform roll pressure across the entire length of the stem. Sufficient roll pressure must be applied to cause a noticeable breakage of the stem skin, but not so much pressure that leaves are broken. Keep rollers clean and free of wrapped material. Replace rolls that have worn more in the center than at 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 the hay immediately prior to cutting. Chemical and mechanical conditioning can be used together with best results occurring under favorable drying conditions. Some chemicals used for conditioning may also 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, invert, and/or fluff the windrow. All these actions may improve drying, but can also increase leaf loss when the tedder is too aggressive or the hay is already somewhat dry. With alfalfa and clover hay, it is important to realize that hay must be somewhat moist when tedded 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 used to lift, invert and fluff the windrow so the bottom side is exposed to the sun. With good drying conditions, turning will speed the drying of the windrow. Handling with a turner is about equal to re-raking with a side-delivery rake. Many consider windrow turning to be gentler on the hay.

Raking. A rake is used to assemble a mowed swath into a windrow or accumulate two or more windrows into one. Some producers eliminate raking by using a windrower. A windrower may reduce time of field operations and in-field losses. Windrowed hay will dry slower and less uniformly than hay in a wide swath. Raking causes more leaf loss than any other harvest operation. 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, which will cause less 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 in the chamber. Make windrows as large as possible within the capacity of the baler pickup to minimize baler losses. Maximum windrow width 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 may be 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. Unnecessary field loss occurs as the bale turns in the bale chamber with no hay feeding into the chamber.

Loss Reduction Techniques. DM and crude protein (CP) losses are generally greater with large round bales than with small rectangular bales. This is particularly true when harvesting dry alfalfa or other legume hays. Since legume leaves are two to three times higher in CP and digestibility than the stems, leaf shatter during baling substantially reduces the forage quality of these hays. Shatter losses are of less 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 small rectangular bales, seldom lose more than 5 percent. Therefore, timely field operations to minimize baler losses are more critical with large round bales than with small rectangular bales.

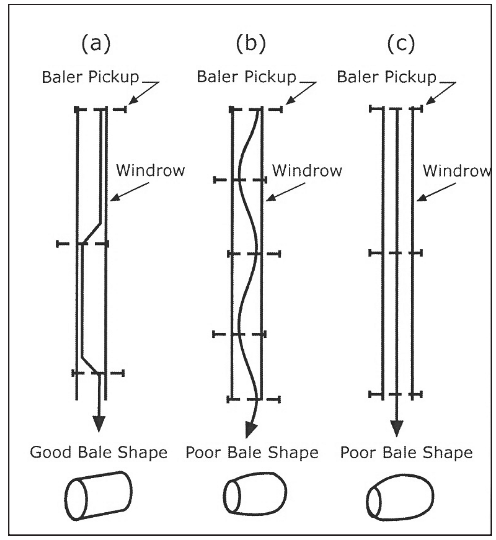

Figure 2. Pickup pattern for narrow windrows. Cross-over the windrow (a) and hold for 10 to 12 seconds. Then cross sharply back to the other side and hold for 10 to 12 seconds. Do not weave uniformly from side-to-side (b) or drive straight down the windrow (c).

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 specifically for alfalfa, baling losses of 1 to 5 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. Minimizing moisture content in the hay and using a baler with well-designed pickup and chamber mechanisms will reduce potentially high losses.

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.

Procedures to reduce loss in the baler pickup include: baling at the proper moisture content (higher moisture content reduces pickup loss) and synchronizing field speed to rotational pickup speed of the baler reduces pickup loss. When forward speed is too slow, the pickup device catches the hay and pulls the windrow apart as it feeds in. When forward speed is to 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. Maintaining the correct speed will cause the baler to gently lift the hay from the windrow and not push or pull it.

Heavy windrows reduce pickup loss because the baler operates at a reduced field speed minimizing contact with pickup components. Undesirable barrel-shaped bales may occur with narrow windrows. In this case, the operator should follow a smooth weaving pattern, back and forth, across narrow windrows (Figure 2b). Also, make sharp turns as shown in Figure 2a, driving straight down the windrow after each turn. This can best be achieved by crowding the material into one side of the pickup for 10 to 12 seconds, then crossing quickly to the other side and crowding the material into the opposite side of the pickup for 10 to 12 seconds. Stay on each side of the windrow for more than 10 to 12 seconds in lighter crops, and less than 10 to 12 seconds for heavier crops. Finger wheels mounted on each side of the baler help direct hay into the baler pickup, which reduces field losses and improves bale shape.

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

To minimize bale chamber losses, the moisture content should be as high as possible to allow for safe storage. The feed rate should be as high as possible to minimize the number of turns within the bale chamber. Achieve a high feed rate by using large windrows and high forward speeds. When windrows are small, or field speeds are slow, use a lower PTO speed. This procedure results in fewer revolutions to form a bale (but 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 2 percent of yield when the bale was formed in two minutes. When the bale was formed in 13 minutes, chamber loss was 11 percent. Since bale chamber losses typically exceed pickup losses, it is usually better to accept some pickup loss by driving faster and reducing the time required to form a bale. When wrapping with twine, do not rotate the bale more times than necessary to secure the twine. The fines, primarily leaves that fall from the bale chamber during twine wrapping, are a good indication of bale chamber loss. Fines contain the highest level of nutrients so minimizing this loss is important!

Transporting Large Round Bales

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

For easier transportation, consider a 4-foot wide round bale that fits better on trucks than wider round bales. A disadvantage of 4-foot wide bales however, is they tend to fall over when ejected from the baler or when speared by a front end loader with a bale spike for moving. Toppling increases with larger diameter round bales (6 feet) that are only 4 feet wide. When the bales topple over, exposure to rainfall intensifies and the excessive moisture encourages hay degradation. Daily heating of the wet round bale results in a significant reduction in feed quality.

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

Round bales can be readily handled by tractor-mounted equipment and special round bale wagons. Tractor front-end loaders can be used to move or load 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 or 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. Kansas law establishes maximum load width, height and length and methods of securing the load. Current state law states that a load must be securely fastened to prevent the load from becoming loose. Consult local law enforcement officials for the current regulations on the highways you will travel, in and out of state.

Storing Large Round Bales

Large round bales typically have a higher storage loss than small rectangular bales, especially when stored outdoors. Placing round bales outside on the ground is the cheapest storage method but has the greatest potential for DM weathering loss. Most 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, have less surface area in contact with the ground, shed more precipitation and protect the inner bale from weathering, and hold more hay inside the bale. Bale density is affected by the baler, the experience of the operator, and the type of hay. Fine stemmed hays form denser bales. The density of round bales should be a minimum of 10 pounds of hay per cubic foot.
- **Use plastic wrap, net wrap or plastic twine.** Twine reduces bale sag, helps maintain bale shape, and provides a tighter, smoother surface. Plastic twine will resist weathering, insects, and rodents better than natural fiber twines. Twine should be wound tight and spaced a minimum of 6 to 10 inches apart for best bale wrapping.
- **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 4- to 6-inch base of coarse rock will minimize bottom spoilage. Other materials that can successfully prevent contact with wet soils and provide some air space between the bale and soil surface are: telephone poles, wooden pallets, railroad ties, scrap pipe, and tires.
- **Store bales end-to-end.** The arrangement of large round bales in outdoor storage can significantly influence storage loss. Pack 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 southeastern exposure is preferable to maximize solar drying and encouraging drainage 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. When more than one line of bales is needed, space adjacent lines at least 3 feet apart. This will increase air flow and allow the sun to reach the back row. Stacking large round bales usually increases losses. Stacking tends to trap moisture between the bales and limits drying action from exposure to the sun and wind. Never store bales under trees. It is highly recommended that large bales stacked outside have some type of temporary cover placed over them for the duration of the storage period.
- **Store indoors.** When bales are marketed or stored for more than one season, consider indoor storage or bale covers. The outer 4-inch thick layer of a 6-foot diameter round bale contains about 25 percent of the total bale volume, so protecting this layer is important! 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 with stacked bales. A high stack (four or more bales) can exert a significant load on the walls of a storage structure.

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