

SELECTING, STORING AND FEEDING ROUND HAY BALES TO HORSES

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Introduction

Forage is a major component of the equine diet. Pasture and hay provide an economical supply of energy, protein, vitamins and minerals. Fiber, provided by forages is critical to normal digestive tract function in the horse. The mature horse, two years of age and older, will consume an average of 2% of its body weight in dry matter daily. In all production situations, the horse must consume more than 50% of its daily dry matter intake as long-stem hay or pasture to minimize the occurrence of colic and founder (Lewis, 1996).

Selecting Round Bales

The traditional form of feeding hay in the horse industry has been square or small rectangular bales. Although they are easy to handle with an average bale weight of 45 to 65 pounds, they are more labor intensive to bale, resulting in a higher cost per pound of forage. Since the baling process requires more labor and time to transport baled hay to storage facilities, the hay is marketed at a higher price, and since hay growers already face the environmental challenges of high humidity and unpredictable weather patterns, many of them are opting to produce round bales to reduce labor and baling time. Farm equipment companies report more round and large package balers are being sold when compared to conventional square baling units. Consequently, the availability of round bales has surpassed the supply of “horse quality” square bales.

Like square bales, round bales must be properly cured and harvested at an immature growth stage to provide horse quality hay. Under ideal harvesting conditions, round bales should be:

- Free from dust, weeds, and contaminants.
- Harvested at an early growth stage with a high ratio of leaves to stems; limited blooms (legumes) and seedheads (grasses) should be present and stems should be soft, pliable and flexible.
- Baled at 15% moisture or less:
 - Hay harvested at higher moisture levels will heat up and bind nutrients making them unavailable for the horse to digest.
 - Under extreme heating the hay will change from a rich green color, indicative of proper curing, to a brown shade.
 - A high moisture content, above 20%, may be associated with Mold will appear, in tightly packed areas within the bale, as a white/gray color with an associated musty odor.
 - Moldy hay should not be fed to horses!
- The most success in selecting high quality round bales for horses is achieved when a nutrient analysis is conducted in conjunction with a visual evaluation of the hay. The North Carolina Department of Agriculture and Consumer Services offers an excellent feed and forage testing program through the Food and Drug Protection Division Forage Laboratory (919-733-7366) in Raleigh (www.agr.state.nc.us/fooddrug/feedprog.htm). Free forage testing kits and sampling recommendations can be obtained from each North Carolina Cooperative Extension Service county office. The analysis cost is \$10 per sample and provides extensive information on the nutritive value including:
 - Dry Matter Content
 - Adjusted (available) Crude Protein
 - Acid Detergent Fiber (ADF)
 - 6 Macro-Minerals:

Calcium (Ca)	Magnesium (Mg)
Phosphorus (P)	Sodium (Na)
Sulfur (S)	Potassium (K)
 - 4 Trace Minerals:

Copper (Cu)	Iron (Fe)
Zinc (Zn)	Manganese (Mn)
 - Digestible Energy
 - % Nitrate Ion (Requires a veterinarian request)
 - 4 Mycotoxins:

Don	Zeralenone
T-2	Aflatoxinmold formation

When selecting the hay for horses, the ADF (which is a measure of the indigestible portion of the hay) and the available crude protein (which represents the protein actually available for the horse to absorb) are critical components. Mature hays that are high in ADF (greater than 40%) are considered poor quality. Forages with ADF values from 35-40% are considered moderate in quality. Immature forages with ADF values 34% and lower are considered to be high quality. Additional information on the interpretation of forage analysis can be obtained in Horse Feeding Management Fact Sheet AG-558-5, Interpreting Horse Feed Analysis.

Hay that is unprotected when stored will lose nutritive value due to weathering of the outer layer. Soluble carbohydrate levels will be leached out by moisture and the percent of indigestible fiber will increase. The increase in indigestible fiber will cause the horse to reduce the amount of digestible forage consumed.

Table 1. Quality of Weathered and Unweathered Portions of Grass and Grass-alfalfa Hay in Round Bales¹

Hay Type	Bale Portion	Digestibility (Cattle)	Acid Detergent Fiber
Grass	Unweathered	58.8	44.4
Grass	Weathered	42.5	49.4
Grass-legume	Unweathered	56.5	45.0
Grass-legume	Weathered	34.2	48.7

¹Lechtenberg et al., 1979

Unprotected round bales stored outside will form a thatch on the outer layer of the bale due to moisture and rainfall. Over time, mold will form in the thatch, which may produce mycotoxins that can irritate the lungs causing heaves and could be deadly for the horse. Forage in the outer thatch may also heat up, which results in a binding of nutrients to indigestible fiber. Protein is especially sensitive to such binding action. Fortunately horses consume round bales through the ends of the bale and avoid the less palatable, more weathered tops and sides. Horses will hollow-out the bale, eating from the center outward. Eventually the weathered outer surfaces will cave-in. Horses, not provided another source of clean forage, will consume the weathered, potentially harmful outer thatch. This represents a portion of the round bale that should not be fed. Horses should not be forced to eat the weathered portion of the bale. The thickness of the outer thatch depends on the amount and intensity of the initial rainfall and the location of the round bales during storage. Ideally, round bales should be stored and fed under cover. If hay is fed unprotected, the stocking rate (number of horses per amount of hay) should be increased to ensure consumption of all hay in less than one week.

Round bales are available in a variety of different sizes (Table 2). There is a trend nationwide for the use of the larger hay balers. However, in North Carolina the 4'x5' or 4'x4' balers are more typically used to produce round bales for horse owners.

Table 2. Estimates of the Round Bale Weights, Based on a Soft-Core Baler^{1,2}

Hay Variety	Bale Diameter	Bale Length			
		4'	5'	5.5'	6'
Alfalfa Hay	4'	490 lb.	610 lb.	675 lb.	735 lb.
	5'	765 lb.	960 lb.	1055 lb.	1150 lb.
Mixed Hay	4'	450 lb.	565 lb.	630 lb.	680 lb.
	5'	705 lb.	885 lb.	970 lb.	1060 lb.
Grass Hay	4'	415 lb.	520 lb.	575 lb.	620 lb.
	5'	650 lb.	810 lb.	890 lb.	970 lb.

¹From D. Tasse. Ontario Ministry of Agriculture and Food. Ontario, Canada.

²Add 20 to 30% increase on bale weight to convert from soft-core to hard-core baler

Hay balers can be manufactured to produce a soft-core or a hard-core bale. The hard-core balers produce bales that are 20 to 30% heavier than the soft-core balers, while still having the same dimensions. However, regardless of manufactured specifications, bale weight, not bale dimension, will also vary depending on the forage specie, stage of maturity, RPM's of the power-take-off (PTO) and tractor speed while baling. Legumes, such as alfalfa hay, pack tighter in the baler and produce heavier bales with the same bale size compared to grass forages. Legume-grass mixed forages will have bale weights mid-way between the pure legume and pure grass hay bales. Hay can be baled at a higher moisture content with a soft core bale, but they typically do not store as well uncovered as hard core bales. Consequently, round bales should be purchased on a weight, not bale, basis. If purchasing a large shipment of round bales, weigh several bales on a vehicle of a known weight to determine an average bale weight.

Storage of Round Bales

The cylindrical shape of round bales provides some natural drainage when rainfall occurs. The amount and intensity of the first rainfall on unprotected round bales affects the depth of the outer weathered layer, typically referred to as the thatch. As much as 16% of the total volume of a 4-foot by 4-foot round bale can be lost in a two-inch outer weathered layer (Table 3). Smaller round bales lose relatively more total volume at a given weathering depth than larger-sized hay bales. The outer thatch of unprotected bales could contain molds and associated mycotoxins and should not be fed to horses.

Table 3. Percentage of Bale Volume Affected¹

Bale Dimensions		Depth of Weathered Layer in Inches			
		2	4	6	8
Diameter Width		% of bale volume weathered			
4'	4'	16	31	44	56
5'	4'	13	25	36	46
6'	5'	11	21	31	40

¹Collins et al. Round Bale Hay Storage in Kentucky

Round bales can be stored in a variety of different ways. The ideal storage method would provide the greatest protection of hay from moisture, resulting in less dry matter loss, while being cost effective (Table 4). Storage methods include:

- **Unprotected on the Ground**

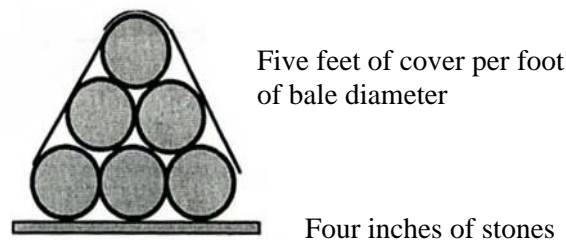
- This is the cheapest method that represents the greatest dry matter weathering loss. Yield losses are greatest where airflow is the least and contact with moisture is the greatest.
- The greatest dry matter losses occur on the bottom of the bale, which could exceed 38%. Elevating the hay off the ground on wood pallets, tires, stones, etc. increases airflow and decreases moisture uptake from the ground.
- Bales are held together with twine. The twine rots making moving difficult.

- **Plastic Wrap**
 - Plastic wrap is a relatively new technology that places solid plastic non-reusable sheeting over the bale during the baling process. It is the preferred cover for outside storage. The plastic repels water and protects the bale from absorbing ground moisture and does not degrade during storage and transportation.
 - The plastic replaces the need for twine to hold the bale together. Dry matter yield losses are typically reduced from 38% for unprotected bales to 7% when using plastic wrap.
 - Plastic is removed prior to feeding.

- **Net Wrap**
 - Net wrap is a porous material, which permits airflow for greater drying and sheds some water.
 - It is applied at baling, is not reusable and reduces dry matter loss considerably compared to unprotected bales stored on the ground.

- **Tarps and Bale Covers**
 - Reinforced tarps and covers have a longevity of more than 5 years and are a cost-effective way to protect hay. The tarps are anchored to the ground and treated to repel ultraviolet light. However, the use of tarps involves more labor and requires multiple laborers to secure the tarps.
 - Non-reinforced plastic tarps, held in place by tires or weighted blocks, wood, etc. provide an affordable short-term 1 to 2 year option.
 - Stacking hay in a pyramid type design (Figure 1) enhances the repelling of water. Hay stacked three layers and higher requires the use of a larger tractor with a front-end-loader. The hay bale stack should be placed on pallets, tires, or stone to elevate the bales off the ground. A 50-foot wide tarp will cover five-foot diameter bales that are stacked three high in a triangular formation.

Figure 1. Three-Stack Round Bale Storage¹

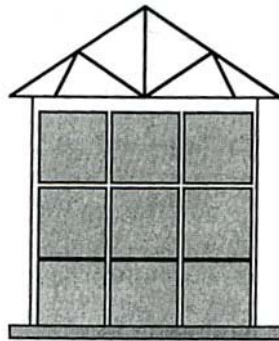


¹Adapted from D.R. Buckmaster, Pennsylvania State University

- **Bale Sleeves**
 - Sleeves are added after the baling process and prior to storage (to correctly sized bales). This is a more expensive process due to additional labor needs to add the sleeve to twine-tied bales.

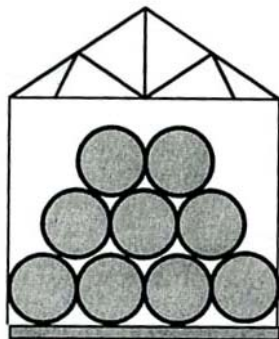
- **Hay Storage Facilities**
 - Facilities should be designed to permit at least a three-layer stack with more than two-feet of clearance above the top stack for ventilation in order to avoid moisture build up.
 - Building costs range from \$5-10 per square foot, resulting in a cost of \$10 per ton of storage capacity, per year. Buildings can either be completely closed or have an open wall facing south.
 - Stacking bales on the end, rather than on the side, reduces weight on the barn walls and maximizes the use of floor and storage space (Figure 2). However, stacking on end requires a fork lift or squeeze attachment on the loader rather than a less expensive spear.

Figure 2. Hay Storage Facility- Stacking Round Bales on End vs. Side¹



Stacked on End

- More difficult to stack
- Lower wall loads
- Average stack height of 3
- Better use of floor space



Stacked on Side

- Easier to stack
- Higher wall loads
- Poorer use of floor space

¹Adapted from D.R. Buckmaster, Pennsylvania State University

Table 4. Comparison of Storage System Life, Approximated Cost per 1,000-pound Bale, and Dry Matter Loss.

Storage System	System Life	Approximate Cost	Dry Matter Loss
	Years	\$/bale/yr.	%
Conventional shed	20	5.00	4-7
Pole structure with plastic roof on pad	4	3.00	4-7
Reusable tarp on pad*	5	3.00	4-7
Bale sleeve on ground	1	3.00	4-7
Elevated stack on pad	20	2.62	13-17
Net wrap on ground	1	1.50	15-25
Stacked on ground (cost is twine)	1	0.75	25-35

*Bales are stacked.

Adapted from M. Collins, et al, University of Kentucky.

Feeding Round Bales to Horses

Protected round bales without a weathered outer layer are preferred for free choice feeding of horses. The use of round bale feeders, designed for equine, not cattle, can reduce hay loss by as much as 20% from trampling into the ground and crowding during group feeding. Placing of round bales in run-in sheds or covered feeders protects the bales from moisture and potential mold formation during the feeding period, but may limit accessibility for the more timid horses if the shed is not open on all sides.

The lower cost of round bales versus the traditional square or rectangular bale is a significant savings. However, a tractor with a hay moving attachment is required. The improper storage and feeding of round bales could result in dry matter losses of up to 50%, which may negate the savings. Table 5 provides a comparison of various feeding methods, which indicates that square bales fed on the ground was the most expensive feeding system. Unprotected round bales fed on the ground (no feeder) and square bales fed in a feeder were 37% cheaper than square bales fed on the ground.

Table 5. A Cost Comparison of Various Feeding Methods^{1,2}

	Unprotected round bales fed free choice on the ground	Protected round bales fed in a feeder	Square bales fed on the ground	Square bales fed in a feeder
Storage loss	25%	5%	5%	5%
Feeding loss	25%	5%	25%	5%
Bales required for feeding period³	17 + (50% of 17) 8.5 + (50% of 8.5) 4.25 = 29.75 bales	17 + (10% of 17) 1.7 + (10% of 1.7) .17 = 18.87 bales	196 + (30% of 196) 58.8 + (10% of 58.8) 5.9 = 260.7 bales	196 + (10% of 196) 19.6 + (10% of 19.6) 1.96 = 218 bales
Cost	(29.75 @ \$22) \$654	(18.87 @ \$22) \$415	(261 @ \$3) \$783	(218 @ \$3) \$654

¹A 90-day winter feeding period for 4 horses fed at 2% of their body weight (1100 lbs.) requiring 8,800 lb. of hay with no dry matter losses

²The required nutrients could be supplied, if there were no feeding or storage losses, either as 17- 4'x5', 520-lb. soft-core grass round bales (cost of \$25 or \$0.42/lb. each) or as 196, 45-lb. grass square bales (cost of \$3.00 or \$0.07 each)

³Storage and feeding losses will require increased hay intake. Example:

- 17 round bales x 50% dry matter loss would require an additional 8.5 round bales
- Fifty percent of the 8.5 bales would also be lost requiring another 4.25 bales
- Total bales required = 29.75 bales

Summary

The selection, storage and feeding of round bales to horses requires close evaluation of the condition of the forage, a method to protect the forage during feeding and storage, and an accurate calculation of the amount of forage required per feeding period. Due to variation in baling equipment and harvesting techniques, round bales should be purchased on a weight (dollars per ton or dollars per pound) basis. A nutrient analysis provides valuable information on the nutrient value, intake levels and quality of the hay. Proper storage of round bales will reduce the dry matter loss of hay and maximize savings. Round bale feeding systems that protect hay from weathering and mold formation reduce labor and increase the amount of consumable hay with a higher nutritive value. The added cost of round bale feeders and protective storage can be recouped in a short period of time before feeding more affordable round bales rather than conventional square bales.

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www.cals.ncsu.edu/an_sci/extension/horse/hhmain.html

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