"Hay Storage Approaches"

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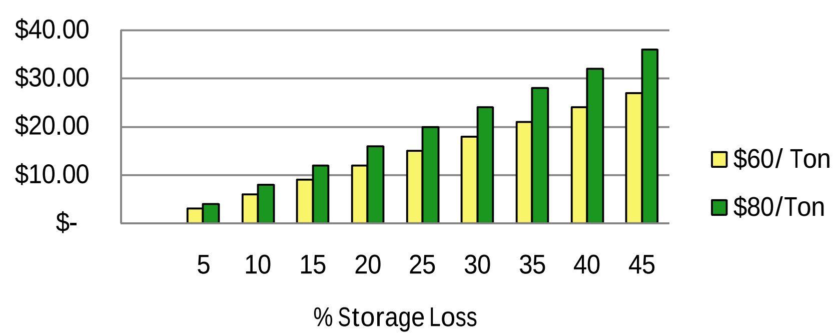
The Value of Hay

Hay is an incredibly valuable crop, the 3rd most valuable crop in Iowa. Producing baled hay uses a large amount of resources (land, labor, seed, fuel, fertilizer, equipment). The way you store that hay after baling can have a big effect on losses in hay quality, so it's worth investing additional resources (money, labor, equipment) in hay storage to preserve the value of the hay and to ensure a good return on your initial investment.

Because of its many merits, hay is the most commonly used stored feed on livestock farms across the nation. Unfortunately, losses of hay during storage and feeding are often high, particularly with round bales stored outside in high rainfall areas such as Iowa the last couple of years.

Storing hay inside a building results in minimal DM losses of 1-5%. Hay should be stored so as to reduce the exposure to moisture. Bales will absorb moisture from the soil if left outside on the ground yielding the highest DM losses (DM loss = 5-20% up to 9 months storage and 15-50% DM loss for 12-18 months storage). Even when covered by plastic tarps, contact with moist soil increases the DM loss compared to bales not in contact with the soil. (DM loss = 5-10% up to 9 months storage and 1—15% DM loss for 12-18 months storage). Higher density bales tend to have lower loss values in the DM loss ranges listed above. Lower density bales will have higher losses in these ranges as they tend to absorb more moisture than higher density bales. Elevating the bales above the soil breaks the wicking action of moisture from the soil. This practice can reduce DM losses by an additional 2-15%. Uncovered round bales touching on the sides will hold water as it runs off and is directed into the bales. The worst case of DM loss occurs when low density bales rest on the ground, are not protected from the precipitation, and are stored for a long period of time in a wet warm climate. Round bales shed water better than square bales which should not be stored outside without a cover. Small square bales tend to have a large surface-to-volume ratio. Since outside storage exposes surfaces to high loss rates, large bales will have lower DM loss than smaller bales.

Table 1. Value of hay DM lost in storage (courtesy of R.L. Huhnke).



Most of the dry matter and quality losses that occur during storage are due to molds and bacteria that consume nutrients contained in the hay. These microorganisms generate heat that cause chemical reactions and additional nutrient loss. In extreme cases, the heat generated by molds and bacteria can result in fires, destroying the hay and the surrounding structures. Molds and bacteria grow and reproduce faster if the hay is warm, and moist, and, of course, the more time they have to work, the more damage they can do.

In general, micro organism-caused losses are lower at lower temperature and moisture, and are lower for shorter storage periods. Since most hay is stored outdoors or in structures that are not heated or cooled, storage temperature follows outdoor temperature and is beyond your control. Hay harvested late in the season and consumed during the winter months is stored for a relatively short time at relatively low

temperatures and should have minimal losses. Hay harvested early in the season and stored into winter will be subject to some warm temperatures before winter
arrives and is likely to have greater losses. The greatest losses can be expected for hay that is stored through winter into the following spring and summer. Oklahoma State University publication #1716, *Round Bale Storage*, indicates you can expect losses after 12 to 18 months of storage to be twice as great as losses after 9 months of storage.

Steps to Optimize Hay Feed Quality

1. **Bale at proper moisture**

Some ways to optimize your bale's feed quality is to bale at the proper moisture, make quality bales, and choose a storage approach that works for your operation.

Optimum moisture for baling is in the range of 15% to 20% moisture (wet basis). Baling at lower than 15% moisture will result in greater harvesting losses, especially for alfalfa, because leaf loss increases as moisture decreases.

2. **Maximize productivity of equipment and make quality bales**

Proper setup of your baler will optimize baler performance and hay quality. Densely packed bales with square shoulders will shed more moisture than low density bales.

John Deere round balers are well known in the industry for making a quality bale. With the

MegaWide™Plus pickup, DiamondTough™ Triple Weave belts, adjustable bale density, variable core kit, #80 Drive Chains, Chromed pin starter roll chain, CoverEdge™ net wrap, and XL high flotation tires, John Deere makes it easy to make the "perfect" bale. With all these features John Deere makes it easy to setup and adjust your baler to make a quality bale.

To start with, refer to your baler OM for proper drawbar setting on your tractor. Then use the baler decals as a quick reference to running level in the field. They should either be level or have a slight

down/forward angle to the tractor. Note: tractor tire pressures should be checked.

The XL tire option (shown above) has only one spindle position. Adjustments would be to turn an offset tractor drawbar over or adjust tractor tire inflation pressure.

Pickup Height

Position the baler on a level surface and measure the distance from the pickup teeth to the ground. Make adjustments with the pickup crank lever to achieve desired height, about ½" above stubble.

Gauge Wheels

Adjust the gauge wheels to run in contact with the ground (MegaWide™ or MegaWidePlus™ pickups)

If your baler is equipped with a regular or MegaTooth™ pickup (same width as bale chamber) the gauge wheels should be set with a gap between the wheels and the ground in operating position.

Adjusting Float

Float springs are located on both sides of the machine and should be adjusted so there is equal distance from the top of the nut to the bottom of the bracket on both springs. (see OM)

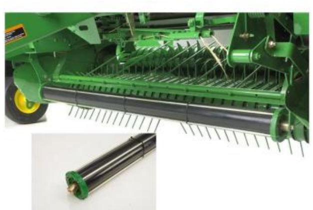
Compression rack & rods

The compression rack is attached to the floating roller baffle assembly. As the crop flow varies, the compression rods move with the roller baffle to control and deliver crop directly to the rotor feed system.

As the whole assembly raises with crop volume, the rear of the compression rods maintain the same relative position between the rotor and starter roll improving crop control.

Note: If you are baling cornstalks, we now have a cornstalk compression rack. See your John Deere Dealer for details.

Roller baffle



The Self-Adjusting Roller Baffle is:

- Standard on all balers equipped with a MegaWide™Plus pickup
- Self-Adjusting
- Floats independently of the pickup
- Provides smoother crop flow across the pickup
- Patented design exclusive to John Deere

The roller baffle was developed to assist in light crop baling. Often, in light crop conditions, the pickup teeth will flip the crop ahead of the pickup. This causes the crop to pile up and clump feed. The roller baffle keeps crop from flipping forward, keeping it in contact with the pickup teeth. The result is better feeding in light crop conditions but also heavy crop conditions.

The John Deer roller baffle is self-adjusting to various windrow and crop conditions. Field tests have shown not only better crop flow in light conditions, but remarkably better crop control in heavy windrows. Increased crop handling capacity means greater productivity. You can handle faster ground speeds or larger windrows without plugging.

DiamondTough™ Triple Weave Belts

DiamondTough™ Triple Weave Belts have:

- Greater tear and puncture resistance than any baler belt on the market.
- Diamond pattern gently grips the crop to reduce fine material loss
- Faster bale starting
- Self-cleaning

Bale Density Adjustment

Bale density can be controlled using this adjustable valve on six foot tall balers. After break-in period we recommend running the baler at maximum density unless baling cornstalks.

Note: in cornstalks we recommend that the operator back the valve out two to three turns from the maximum setting (all the way in). This is a starting adjustment point. The operator can increase or decrease density as desired.

Variable Core

John Deere balers can also be equipped with an optional variable core valve. If equipped, the operator can activate and set the diameter of soft core using +/- keys.

Note: Primary usage in hard to start crops such as corn stalks or any unconditioned crop (cane, sorghum, etc)

80# Chain

#80 chain on upper and lower drive rolls and chrome pin chain on starter roll drive increases service life, strength, and dependability.

XL High Flotation 21.5x16.1, 10PR tires

These larger tires absorb greater shock loads and improve ride in rough corn ground, decrease compaction in soft ground, and allow for increased ground speed for greater productivity.

CoverEdge™ Net Wrap

CoverEdge™ net wrap stretches over the edges of the bale to cover 15% more surface area on the bale. This added feature allows better weather-ability by shedding water off the ends of the bale and will increase marketability, due to less crop spoilage and a better-looking bale.

Surface wrap will preserve the quality of hay up to 2.5 times over twine baled hay when stored outside. Surface wrap has 3 advantages over twine.

1. Wrap cycle time is 5 times faster than twine
2. Surface wrap retains the leaves that would be lost while wrapping twine.
3. Sheds moisture and minimizes bleaching when storing outside

3. Choose a storage approach that works for your operation

There are low to high capital cost alternatives for large round bale storage. The low capital cost systems often have high DM loss costs. One should consider both the initial capital investment as well as the annual cost which can include depreciation, interest, repairs, taxes and insurance on the capital investment as well as labor, equipment, fuel, plastic and DM lost.

The question then becomes, what can I afford to spend to prevent the loss of feed while storing large round hay bales? To answer that question, a spreadsheet was developed to do the calculations used for the cost analysis. The assumptions highly influence the results of the capital and annual costs of the various alternatives. One significant factor is the DM loss used for each alternative storage system. The results and conclusions are based on the assumptions used. Using different assumptions can result in different results and conclusions. For your situation, you should use the spreadsheet to enter your own assumptions. The Excel spreadsheet can be downloaded from the UW Extension TEAM FORAGE, Harvest and Storage web site at the URL;

http://www.uwex.edu/ces/crops/uwforage/storage.htm

An example analysis presented below is based on typical DM losses for various storage alternatives used in a humid climate using plastic twine on tightly wrapped bales (Table 2). Use of sisal twine and/or loosely wrapped bales will experience higher losses while location in a dry climate will experience lower losses than those used here.
Dry Climate=Western U.S.
Humid Climate=North Central to Northeast U.S.
Wet Climate=South Central to Southeast U.S., Northwest U.S.

Table 2. Dry Matter Loss assumptions used in the analysis.
Location: humid climate

Storage Time (months)	**6**	**12**
Storage Type	**DM Loss (%)**	
Outside on ground	9.5	13
Outside with crushed rock pad	8	10
Outside - pad and pallets	7.5	8.5
Outside - pad and tarp	4	5
Outside - pad, pallets and tarp	3	4
Inside building	2	2

Note the same 2% loss for a building with hay stored for 6 or 12 months. This means the annual cost for each system will be the same.

Building costs are a function of size and construction type. For this analysis, a builder was asked (in late 2003) to provide the cost of a hay storage shed without walls. The cost for a 30x40 ($8.45/sq ft for 12-ft wall, $9.12/sq ft for 14-ft walls) and the cost for a 40x90 ($5.56/sq ft for 12-ft walls, $5.81/sq ft for 14-ft walls) were provided. This cost was for the building shell only. Site preparation and floor would cost extra. For this analysis, a 16-ft tall building worked best for stacking the bales of Table 3 three high. Consequently, a cost of $6.00/sq ft was used. Recent cost increases for steel and lumber may make these values obsolete.

For this analysis, the assumptions for the hay stored and the building used for storing the bales are listed in Table 3. The bales are assumed to be stored three high in a long axis horizontal position with 8 rows on the bottom layer and 6 rows on the top.

An alternative storage is a pad constructed of crushed stone known as macadam, Table 4. This material allows water to drain away from the bales and not wick up into the bales. This helps to keep the bottom of the bale drier and reduces loss compared to resting on soil. A pad only large enough to support the bales was used. In the analysis, a macadam surface was used alone or in combination with pallets. When combined, the macadam is probably needed to provide a good driving surface for the equipment used to load and unload bales. There is only a slight improvement in DM recovery (from reduced deterioration) when both pallets and macadam are used together. Thus it may be difficult to justify both if a drivable surface can be maintained without macadam.

Pallets are sometimes used to elevate the bales above the ground. The cost of recycled pallets was used in the analysis.

Table 3. assumptions used in the analysis for bales and building.

Bale:	
Length	5 ft
Diameter	5 ft
Weight	1200 lbs/bale
Number	378
Total Hay Weight	227 T
Building:	
Length	90 ft
Width	40 ft
Height	16 ft
Cost	$6.00/sq ft
Floor	$.30/sq ft
Total Cost	$22,680

Table 4. Assumptions used in the analysis for macadam surface.

Macadam Storage Pad	
Height	3 bales (pyramid)
Width	15 ft
Length	315 ft
Unit Cost	$0.40/sq ft
Labor Rate	$10/hr
Tarp Unit Cost	$0.06/sq ft
Pallet Unit Cost	$0.26/sq ft
Pallet Tractor Rate	$23/hr

Results of Analysis

The crushed rock pad with tarp covering is the most cost effective system for 6-month storage (Figure 1). In the case of 6-month storage, storing the hay on the ground is quite similar to that of storing it on a crushed rock pad. Consider this system for lower price hay only when a tarp cannot be used. The other alternatives are much more expensive and will probably not pay for themselves.

For the 12-month storage period (Figure 2.), the crushed rock base with tarp covering is the lowest cost alternative. The other alternatives are again appreciably more expensive and should probably be avoided.

Generally, 12-month storage has higher annual cost than 6-month because of the higher losses that occur for the longer storage period. The one exception to this is the cost associated with hay stored in a building where the DM loss is the same for 6- and 12-month storage. In this case, the costs are identical and the 6-month line plots on top of the 12-month line.

Figure 1. Annual cost of round bales stored for 6 months

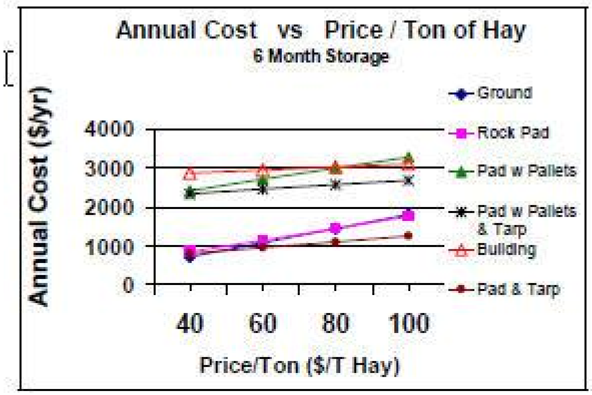
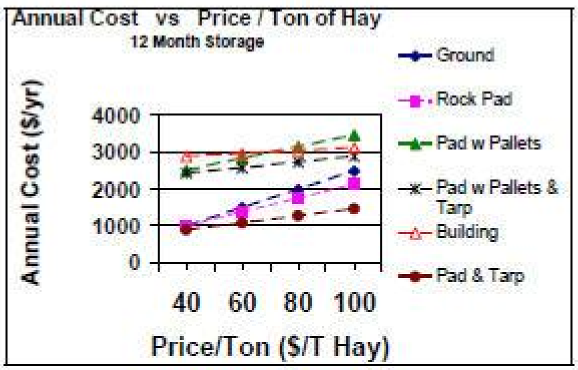


Figure 2. Annual cost of round bales stored for 12 months



The results of this analysis are appreciably affected by the assumptions used for capital costs and DM losses. Various methods of making round bales and the various weather conditions (moisture and temperature) will affect DM losses. Thus, producers should do their own analyses using the spreadsheet to include their own conditions and assumptions before deciding on their choice of storage system.

Using these assumptions, high capital cost systems do not justify their expense for both short- and long-term storage. The rock base with tarp has the lowest cost for most hay values used during a 6-month storage period. The rock base without tarp has a similar annual cost to storing hay on the ground for the 6-month storage period. Thus, one might invest in this alternative to avoid high losses in a wet year vs. on the ground. The other alternatives are much more expensive and are not justified. The rock base with tarp has the lowest cost for all hay values used during a 12-month storage period. The other alternatives are much more expensive and are not justified.

Sources: Minimizing Losses In Hay Storage and Feeding, Dry Round Hay Bale Storage Costs by Brian Holmes, and Preserving the Value of Dry Stored Hay by Cill Wilke, Greg Cuomo, and Cheryl Fox