# Guard Against Unnecessary Losses in Hay Value

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Source: www.farmerwife.blogspot.com

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## Value Your Hay

How many times have you or someone you know stacked hay out in the lot without protection from the elements or ground moisture? Most people probably go through some consideration of the costs for materials, time and labor of protecting the hay, as well as the estimated length of storage until the hay is fed. Have you ever considered the additional losses you may be taking on simply because your hay isn't stored right?

The price of hay across the nation has been on the increase over the past three years with averages for 2006, 2007, and 2008 being $110/ton, $128/ton and $157/ton respectively. The total US values of production for the same years are $13,633,837,000, $16,842,233,000, and $18,777,138,000 respectively (USDA & NASS, 2009). These values represent a huge investment on the part of the producer and purchaser, so why not maximize the return to the operation?

Most people associated with hay are seen as producers, purchasers/consumers, or both. Producers/consumers may grow and harvest vast quantities of hay for sale and/or personal use or they may deal with smaller volumes of hay. These producers/consumers may focus on producing high quality hay that would be used, for example, in a dairy; large volumes of hay with less focus on quality; or a combination of both with various niches of hay production in between.

Purchasers strictly purchase hay for their operations. Hay purchased may range from high to poor quality, "cow hay", and large to small volumes acquired. They may purchase hay as needed so that its storage period is not a long length of time, whereas other operations purchase hay ahead of time where it may be stored for up to 6 months or more. These characteristics with the production

values mentioned show that people depend greatly on their hay for some part of their operation. So why not use some type of storage method that minimizes any additional losses that can occur?

## Storage Effects on Losses of Dry Matter and Quality

Any resulting DM losses resulting from storage method are due to plant respiration and microbial activity as well as weathering. In respects to forage quality, changes in total crude protein and soluble carbohydrates are the main concern. Losses in total crude protein due to storage method can be greater than 14%.(Ball, 2009) Losses in total digestible nutrients can be greater than 25% due to storage method. (Ball, 2009) Lower forage quality ultimately reduces palatability and thereby consumption, which may directly affect animal performance. This could also include the formation of Maillard products due to prolonged periods of temperatures over 100 degrees, which usually is indicative of a decrease in protein and DM digestibility. (Guerrero, Lopez, & Cervantes, 2005) Lastly, these decreases in quality may cause animals to refuse feed, which leads to increased feed waste (Ball, 2009) as well as decreased animal performance.

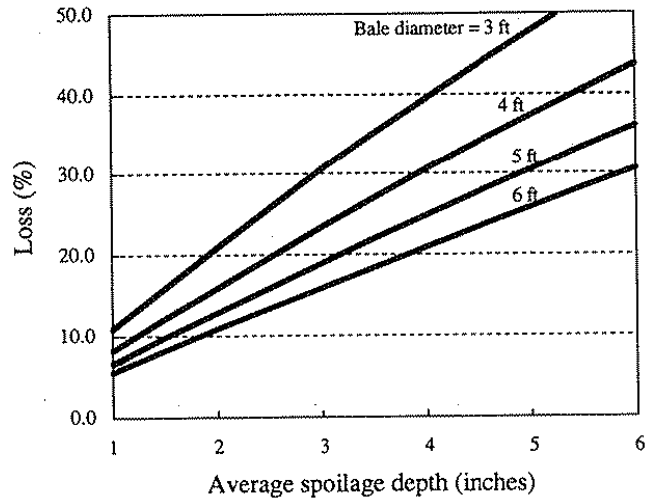
There are four factors which directly affect DM and quality losses associated with storage:

1) **Method of Storage:**
   - DM losses can range from less than 5% up to 60 %, depending on the storage method used (Quarberg, 1999).
2) **Length of Storage Period**
   - Longer storage periods translate into increased levels of losses under most storage methods.
3) **Weather Conditions encountered during storage**
   - At least 50% of storage losses are due to moisture drawn into the bottom of the bale (Ball, 2009).

**4) Type, size (Table 1) and shape of forage being stored** (Wilcke, Cuomo, & Fox, 1999)

- Large and small round bales: **Fig. 1**
  - Fig. 1 shows how DM losses are directly related to the average spoilage depth of a round bale of different sizes.

**Figure 1: Dry Matter Loss vs. average spoilage depth in round bales of various diameters** (Buckmaster, 1993)




- Large and small square bales (Wilcke, Cuomo, & Fox, 1999)
  - The density of large squares is greater then round bales, 16lb DM per cu. ft versus 12 lb DM per cu. ft.(Haag, 2008), allowing for better wicking ability of external moisture. Stacking of square bales also allows for minimal surface area exposure.
  - C.R. Evans, a retired Colorado hay producer who operated from 1976 to 2005, presented the following comparison of large square and round bales when they received the same amount of precipitation. As seen in Fig. 1, round bales which receive a spoilage depth of 6" will have a DM loss of approximately 30%. A large 4x4x8 square bale will receive a spoilage depth of only 3" from the same precipitation, due to its higher density minimizing penetration, thus resulting in a DM loss of approximately 6%. Evans estimates that small squares will have results in between that of large squares and round bales because of their small size, lower density, and an increase in the surface area exposed.

A bale's ability to store well, large round or square, depends greatly on the climatic conditions of the region it is being stored in. Kevin J. Shinners states that large square bales formed in arid regions typically have lower moisture leading them to be more stable for storage. Problems tend to arise when they are stored in more humid regions.

Large squares show greater storage losses when they are formed at the same moisture (greater than 16%) as a round bale, which is due to greater density and volume per bale (Shinners, 2000). Large square bales contain 16lb of DM per cu. ft.; whereas round bales contain only 12 lb of DM per cu. ft., which is due to the baling equipment used. This higher density is said to restrict the movement of moisture from inside the bale to the outside. (Haag, 2008) This becomes a larger issue if hay was baled at greater than 20% moisture and then stored, leading to molding problems and increased risk for fire.

From another perspective, Wilke et. al., noted in a study that there is no significant difference in the average DM loss of the two bale types over an 8 month storage period. While large square balers have greater productivity and ultimately have lower field losses then other types of bales (Shinners, 2000), the climatic condition of the region, how the hay is harvested and stored, as well as using a bale that works best for your operation needs to be consider so that losses in DM and quality are minimized.

This paper presents data primarily from studies associated with round bales due to minimal access to studies that looked at square bales, small and large alike. However, much of this information can be used successfully as a guideline when dealing with square bales. Please refer to Table 1 for data on potential DM loss in round bales of various diameters when moisture damage is sustained at various depths.

**Table 1. Amount of dry matter in outer layers of large round bales**

**Table 3. Amount of dry matter in outer layers of large round bales.**

| Bale Dia., ft. | Outer Layer Depth 2" | 4" | 6" | 8" |
|---|---|---|---|---|
| | % dry matter loss | | | |
| 4 | 16 | 31 | 44 | 56 |
| 5 | 13 | 25 | 36 | 46 |
| 6 | 11 | 21 | 31 | 40 |
| 7 | 9 | 18 | 27 | 34 |
| 8 | 8 | 16 | 23 | 31 |

(Huhnke)

Tables 2 and 3, (Rogers, 2008) represent values associated with weathering and feeding losses in 1000 lb round bales. Table 2 represents weathering losses in terms of depth weathered in a round bale and costs associated with the resulting losses. Table 3 represents feeding losses associated with round bales and the value of that loss with a corresponding bale price. These tables can be used as guidelines for assessing the potential value lost due to storage losses.

**Table 2. Value of weather loss** (Rogers, 2008)

Base cost = $50 per 1000 lb round bale

| Weathered Depth | Percent Weathered | Lbs Weathered | Cost $0.05/lb | Adjusted bale cost |
|---|---|---|---|---|
| 2" | 13 | 130 | $6.50 | $56.50 |
| 4" | 25 | 250 | $12.50 | $62.50 |
| 6" | 36 | 360 | $18.00 | $68.00 |
| 8" | 46 | 460 | $23.00 | $73.00 |

**Table 3. Value of feeding loss** (Rogers, 2008)

| | Price per 1000 lb round bale | | | |
|---|---|---|---|---|
| Percent Feeding Loss | $20.00 | $25.00 | $50.00 | $75.00 |
| 5 | $1.00 | $1.25 | $2.50 | $3.75 |
| 10 | $2.00 | $2.50 | $5.00 | $7.50 |
| 15 | $3.00 | $3.75 | $7.50 | $11.25 |
| 20 | $4.00 | $5.00 | $10.00 | $15.00 |
| 25 | $5.00 | $6.25 | $12.50 | $18.75 |
| 30 | $6.00 | $7.50 | $15.00 | $22.50 |
| 35 | $7.00 | $8.75 | $17.50 | $26.25 |
| 40 | $8.00 | $10.00 | $20.00 | $30.00 |
| 50 | $10.00 | $12.50 | $25.00 | $37.50 |

Table 4, can be used as a guideline by operators to roughly determine and/or estimate the value of DM lost in storage. Essentially, the higher your hay price and the greater DM loss expected or incurred, the greater the value lost per bale.

**Table 4. Value of hay DM lost in storage** (Holmes, 2004)

| | Hay Price ($/T of hay at 16% moisture) | | | | |
|---|---|---|---|---|---|
| | 40 | 60 | 80 | 100 | 120 |
| Storage Loss (%) | Value Lost (/T Hay) | | | | |
| 5 | 2 | 3 | 4 | 5 | 6 |
| 10 | 4 | 6 | 8 | 10 | 12 |
| 15 | 6 | 9 | 12 | 15 | 18 |
| 20 | 8 | 12 | 16 | 20 | 24 |
| 25 | 10 | 15 | 20 | 25 | 30 |
| 30 | 12 | 18 | 24 | 30 | 36 |
| 35 | 14 | 21 | 28 | 35 | 42 |
| 40 | 16 | 24 | 32 | 40 | 48 |
| 45 | 18 | 27 | 36 | 45 | 54 |

Lastly, DM losses and Feeding losses are directly connected. When animals are allowed free access to hay, expect to see a feeding loss that is similar to storage losses. If DM loss is less than 5% than there will be less than a 5 % loss associated with feeding (Rotz C. A., 2005). When considering that there can be losses up to 60% due to minimal or no storage method used, utilizing some type of storage method provides a double benefit to the producer. Not only are you minimizing direct losses from the bale, but one will be minimizing feeding losses as well. In addition to reducing the losses in two areas, quality of hay consumed may be improved because cattle typically reject hay of lower quality (Rotz C. A., 2005).

## Outside, Uncovered Storage

Storage of hay outside without cover, even with implemented recommendations, has shown to have the greatest losses of all possible storage methods. Dependent upon the four factors of hay storage mentioned earlier, DM losses can range from 5-40% (Buckmaster D. R.). Dave Sanson of Louisiana State University notes an average DM loss as 25-30% when associated with a 1,150 lb round bale. This level of loss would have been capable of meeting the energy requirements of a 1,000 lb cow for 16 days (Burt, 2007). Please note that by providing a surface that prohibits the bales from touching the ground, DM losses can be decreased by as much as 38%. (Burdine, Overhults, & Trimble, 2005)

## Outside, Covered/Elevated Storage

Three principles apply when hay needs to be stored outside, but the operator wishes to decrease the amount of DM loss by covering the hay and/or elevating the storage area. The following principles apply to both square and round bales (Burt, 2007):

1) Protect the top of the bales.
2) Prevent rain/moisture from being soaked up through the bottom of the bale.
3) Stack hay and utilize coverings that allow the stacks to breathe.

Coverings available for storing hay include individual bale covers and plastic sheeting as well as tarps. These materials, if cared for and maintained correctly, can potentially be used for more than one season. Dave Sanson of Louisiana State University used tarps for approximately 7-8 years before a hurricane damaged them (Burt, 2007). Make a point of checking the condition and tightness of coverings being used for hay storage on a regular basis. Sanson recommends doing this as often as

once a week, especially because a stack will settle within the first two weeks of storage (Burt, 2007). Lastly, Glen Knopp of Inland Tarp and Cover recommends purchasing high quality tarps that are UV resistant, waterproof, and are designed for covering hay. He agrees with Glenn Shewmaker of the University of Idaho that the higher quality tarps will cost less in the long run than tarps of lesser quality(Haag, 2008).

Inland Tarp and Cover presented data that suggests spoilage loss in the top two rows of an uncovered small square stack 16 bales high can constitute 5-10% of the stack. If the stack is only 7-9 bales high, the spoilage loss can be as high as 25%. Inland Tarp and Cover make available two examples for small squares and large round bales that calculate the yearly savings by utilizing a tarp. For small squares, Table 5, Inland Tarp and Cover assumed 1,288 bales at 70 lbs and $125/ton to be valued at $5,635 with an assumption of 11% spoilage loss valued at $619.85. With a purchase of one of their tarps, in three years they estimate a savings of $1,414.64 due to the reduction in spoilage losses.

**Table 5. Value Recaptured by Tarp Use w/ Small Squares (Inland Tarp & Cover, 2009)**

| | | | |
|---|---|---|---|
| **Number of Bales** | 1,288 | **Spoilage Loss** | 11% |
| **Bale Weight (lbs)** | 70 | | |
| **Price/Ton** | $125 | **Value of Spoilage Loss** | $619.85 |
| **Total Hay Value** | $5,635 | **3 year Savings** | $1,414.64 |

**Table 6. Value Recaptured by Tarp Use w/ Round Bales (Inland Tarp & Cover, 2009)**

| | | | |
|---|---|---|---|
| **Number of Bales** | 72 | **Spoilage Loss** | 30% |
| **Price/Bale** | $75 | **Value of Spoilage Loss** | $1,620.00 |
| **Total Hay Value** | $5,400 | **3 year Savings** | $4,570.63 |

When considering large round bales (5'Dia x 4' Long), Table 6, Inland Tarp and Cover assumed a 30% loss on 72 uncovered bales, an equivalent of 22 bales lost yearly. At a price of $75 per bale, this gives a total loss in value of $1,620. In one year, after tarping of the hay, there is an estimated savings of $1,270.63 due to the reduction in spoilage losses. Over three years that will be $4570.63 minus the cost of the tarp. In addition to these examples, remember that feeding losses essentially double the total loss associated with a bale which will roughly double the value not captured due to DM losses.

The Tarp Pricing table, Table 7 seen below only presents 3 different tarp companies, but will give a general idea of the types of tarps available for covering hay along with their cost.

Table 7

**Tarp Pricing**

| Description | Price | Unit |
|---|---|---|
| Inland Tarp & Cover (O'Hara, 2009) | | |
| Performer 33' x 48' small square bale tarp | $444.91 | each |
| Performer 25' x 48' round bale tarp | $379.37 | each |
| guaranteed for 2 years; life expectancy of at least 3 - 5 years | | |
| 6 oz. PolyMax Hay & Storage Tarp (FarmTek, 2009) | | |
| 25' x 33' | $165.00 | each |
| 25' x 54' | $235.00 | each |
| 14mil thickness; reinforced corners and grommets every 18"; recommended for heat & light sensitive storage | | |
| 8 oz. PolyMax Ultra Heavy Duty Tarp (FarmTek, 2009) | | |
| 25' x 33' | $169.95 | each |
| 30' x 40' | $264.95 | each |
| 40' x 60' | $369.95 | each |
| Plastic reinforced corners; UV resistant; Double fabric, reinforced @ grommets | | |

In elevating a storage area, which is focused on protecting the bottom of the bales, a multitude of options are available. This is "limited only by imagination and ingenuity" (Ball, 2009), since all that is required is a method that will keep the bales off the ground, prevent them from soaking up moisture, and improve air flow around the bales. Materials used by operators past and present have included: gravel pads with a moisture barrier, posts, tires, pallets, pipe, as well as guard rails. These materials, when implemented correctly, will successfully prevent the stack from soaking up moisture while also improving air flow below the stack which will assist in the drying of hay if it does sustain moisture damage. This can result in approximately a 70-85% reduction in DM losses due to storage method (Quarberg, 1999).

Table 8

## OUTSIDE HAY STORAGE RECOMMENDATIONS

(Ball, 2009)

- No objects near hay which are likely to attract lightning
- Flat ends of bales butted tightly together
- Bale rows run up and down slope with north/south orientation; a southern exposure is best
- High bale density resists water penetration
- Tops and sides of bales can be protected from rain with any of a number of different types of covers
- Bright, sunny location; no trees or other objects near hay to slow drying after rains
- Storage area located on a gently sloping, well-drained site
- Hay/soil contact avoided by placing bales on rock, wooden pallets, etc.
- Rounded sides of bales not touching; at least 3 feet of space between rows
- Fire risk can be reduced by storing hay in more than one location and by maintaining a no-vegetation zone of at least 3 feet in width around the storage area

## Under Roof Storage

Storing your hay under a roofed structure will allow for the highest amount of retained dry matter in a bale. Using roofed structures is most beneficial when the hay is stored under the following situations: in the same areas annually; maintaining DM and/or quality is a goal; extended lengths of storage periods are required; climatic conditions have a large impact on hay DM losses. Data on bales stored in buildings has been fairly consistent. Brian Holmes, of University of Wisconsin Extension, presented DM losses of only 1-5% (Holmes, 2004). Raymond Huhnke of Oklahoma State University presented DM losses of 2-10% (dependent on length of storage period) and enclosed barn storage is even lower starting at less than 2% up to 5%. (Huhnke) When compared to other methods, such as the ones mentioned earlier, the potential DM loss is dramatically reduced.

Presented below is pricing from three separate companies that provide either custom buildings or factory direct buildings, Table 9. Both Cleary Building Corp. and Mueller, Inc. quoted prices that include all costs such as materials, labor, concrete and footings, and delivery. FarmTek building prices represent strictly the cost of materials as they are delivered to the site. Joe Villarreal of Mueller, Inc. states that pricing is broken up, roughly, into thirds. 1/3 is the material costs, 1/3 is the labor costs, and the last 1/3 roughly accounts for the concrete and footings required for the building.

The examples above for covering and elevating of hay stacks can be used for utilizing buildings as well. Though the initial cost of a building is much greater and can take up to 10 years to depreciate out, most buildings will be around for decades allowing for a large potential of continued savings and profits.

Table 9

| Building Pricing | | |
|---|---|---|
| **Description** | **Price** | **Unit** |
| Cleary Pre-Engineered Buildings (Cleary Building Corp, 2009) | | |
| Custom Built | $9-$16 | sqft |
| Includes all cost associated w/ building | | |
| Mueller, Inc. Metal Buildings, Roofing & Components (Mueller Inc, 2009) | | |
| Custom Built (Metal Roof, No Sides, 35 lb snow load, quoted for Riverton, WY) 60'W x 20'H x 125'L | $43,000.00 | each |
| Custom Built (Fully Enclosed, Metal, w/ doors, 35 lb snow load, quoted for Riverton, WY) 60'W x 20'H x 125'L | $56,500.00 | each |
| Pricing Includes: All Material Costs, All Labor Costs, All Concrete & Footings Costs, Delivery Costs | | |
| Pony Wall Building (FarmTek, 2009) | | |
| 20'W x 16'H x 24'L | $2,149.00 | each |
| 38'W x 19'H x 40'L | $6,395.00 | each |
| 42'W x 21'3"H x 96'L | $15,795.00 | each |
| Intended for use on wood posts or foundation wall; 6'W skylight; 12.5 oz. cover w/ 15 year warranty; 14 gauge structural steel tubing; height includes 4' of pony wall which is not included; | | |
| Storage Master SolarGuard Buildings (FarmTek, 2009) | | |
| 26'W x 12'H x 48'L | $5,895.00 | each |
| 34'W x 17'4"H x 72'L | $10,895.00 | each |
| 42'W x 17'3"H x 96' | $19,995.00 | each |
| Factory direct; round style; 14 gauge interior pipe; 12.5oz, 24 mil, premium poly cover w/ 15 yr warranty; 6' W skylight | | |

## Matching a Method to Your Operation

Ultimately, the cost effectiveness of a method is going to be the final driving point in deciding which method is best for your operation. The following questions to ask are recommended to assist in the storage process (Haag, 2008):

1) What are the goals of the storage?
    - "I want to maintain the quality of my hay while storing it for up to 6 months at a time"
    - "I want to be flexible in where I can store my hay from year to year"
2) What are the local climatic conditions that will affect storage?
    - Humid and high precipitation versus arid and moderate precipitation
3) What are my storage options?
4) What option makes the best sense for my operation?
5) Does labor impact you're ability to have a certain storage method?
6) What equipment is available to you for handling of hay bales?
    a. Large bales vs. small bales (rounds and squares)
7) Do you need to store large quantities of hay?

## Winter Feed Scenarios

The following example, Tables 10-13, are adapted from "Estimating Winter Hay Needs for Beef Cattle" prepared by Bill Halfman, Extension Agent for University of Wisconsin. Tables 10-13 portray a feeding regimen for 150 days at 25 lbs of hay provided per animal unit per day. An initial "hay available" value is set to represent the use of round or square bales. In the excel program available from University of Wisconsin, average bale weights and number of bales are used to calculate the "initial hay available" value. The tables are meant to present a possible scenario that has multiple options for storage and the range in DM losses that can occur. These DM losses result in either a surplus or shortage of hay which ultimately affects the bottom line of any livestock operation.

The Excel program used, plus other beneficial information and programs can be accessed at The University of Wisconsin Extension's Forage Resources website:

(http://www.uwex.edu/ces/crops/uwforage/storage.htm#Storage%20Sizing%20and%20Management%20(hay).

**Table 10.**

**Assumptions**

| Class | Number of Head | Days Fed | Animal Unit Factor | Animal Unit Days |
|---|---|---|---|---|
| Bulls | 3 | 150 | 2 | 900 |
| Mature Cows | 90 | 150 | 1 | 14,850 |
| Yearlings | 15 | 150 | 1 | 1,125 |
| Calves | 0 | 150 | 0 | 0 |
| Total Animal Unit Days | | | | 16,875 |
| Initial Feed Available DM Basis in Lbs | | | 495,000 | |
| Daily Hay Allocation per AU | | | 25 lbs | |

| Table 11. Type of Storage | Loss Factor |
|---|---|
| Inside on ground | 5 to 7 |
| Inside on crushed stone | 3 to 5 |
| Outside on ground, uncovered | 20 to 35 |
| Outside on ground, covered | 15 to 35 |
| Outside on stone, uncovered | 13 to 20 |
| Outside on stone, covered | 10 to 17 |
| Outside on other base, covered | 12 to 20 |

**Table 12. Outside on Ground, Uncovered**

| | |
|---|---|
| Storage/Feeding Loss Factor | 30 |
| Total Hay Available (lbs) | 346,500 |
| Hay Needed (lbs) | 421,875 |
| Surplus or Shortage (lbs) | (75,375) |

**Table 13. Outside on Stone, Covered**

| | |
|---|---|
| Storage/Feeding Loss Factor | 10 |
| Total Hay Available (lbs) | 445,500 |
| Hay Needed (lbs) | 421,875 |
| Surplus or Shortage (lbs) | 23,625 |

**Table 14. Outside on Ground, Covered**

| | |
|---|---|
| Storage/Feeding Loss Factor | 20 |
| Total Hay Available (lbs) | 396,000 |
| Hay Needed (lbs) | 421,875 |
| Surplus or Shortage (lbs) | (25,875) |

**Table 15. Inside on Crushed Stone**

| | |
|---|---|
| Storage/Feeding Loss Factor | 4 |
| Total Hay Available (lbs) | 475,200 |
| Hay Needed (lbs) | 421,875 |
| Surplus or Shortage (lbs) | 53,325 |

In the University of Wisconsin spreadsheet, the following factors are included.

1) Enter the weight of several bales in lbs. The average weight is then calculated.
2) Know the number of bales available for feed.
3) Input the loss factor from the table provided to account for storage and/or feeding loss.
   ** 1-3 are used to calculate the Total Hay Available in pounds
4) Input data on the Animal Units that will require feed.
   a. Choose the number of days fed
   b. Animal Unit factors assume each 100 lbs of body weight equals 0.1. This allows you to adjust the factors to represent your herd.
5) Input Daily Hay Allocation per Animal Unit
   a. If a balance ration is not already calculated, Bill Halfman recommends using 25-35 lbs for Hay and 50-70 lbs for corn silage

These factors are all required to figure out the final values that present the pounds of hay needed and whether the supply of hay available is enough to cover the requirements of the herd for the stated amount of time. Tools like this excel spreadsheet along with personal contact with hay producers, extension agents, hay equipment/supplies representatives, etc… are extremely beneficial to analyzing a specific scenario so that the best outcome becomes possible.

The example presented, Tables 10-15 by no means represent every scenario possible, but provide a representation of a possible scenario that could occur. All operations function in different ways. Some operations may have pasture available that allows them to minimize the amount of feed they need on hand whether for intended feeding regimes or emergency feed. Other operations may have minimal pasture requiring them to feed more throughout the year. Also the number of cattle in a herd and their requirements obviously impact the amount of feed required.

## Your Hay is Your Investment

Any given operation has multiple investments, which among them includes the purchasing and/or production of hay. By focusing on when the hay is cut, at what moisture and density the hay is baled, how it is stored, as well as how it is fed can greatly reduce the additional costs that hay can take on. This article focused on the different methods of storage available and how these scenarios can impact a given operation. The dramatic ranges in DM and quality losses and their correlation with costs as well as animal performance can be a major drain on an operation's cash flow. Though much of the data presented focused primarily on round bales, it can be used to analyze different situations no matter the size or type of bale being stored.

Under roof storage proved to have the lowest levels of DM losses. However, this may not always be the best economic choice for an operator. An operator needs to consider the benefits and costs associated with their individual situation. Keeping in mind that DM losses also affect feeding losses, some type of cover or improved storage for hay should be strongly considered. Remember that from the moment hay is cut, its losses are increasing. In the short run, and most definitely in the long run, the time and money put into maintaining the value of your hay will pay off greatly.

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