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Dr Jeff Lehmkuhler is Associate Extension Professor in the Department of Animal and Food Science at the UK College of Agriculture Food and the Environment, specializing in beef cattle nutrition. Jeff grew up on a small, diversified farm in Southern Indiana and has advanced degrees from Purdue and the University of Missouri. Dr. Lehmkuhler's work focuses on improving the nutrition of Kentucky's beef cattle herd and efficient utilization of forages as hay and pasture.

He is a patient and insightful mentor for farmers and county agents alike and received the 2016 Southern Section American Society of Animal Science Extension Award for his accomplishments in outreach efforts. Dr. Lehmkuhler developed the Master Stocker Program, is Co-Chair of the Master Grazer Program Committee and is an integral part of many others.

Hay Storage and Feeding: Avoiding Train Wrecks

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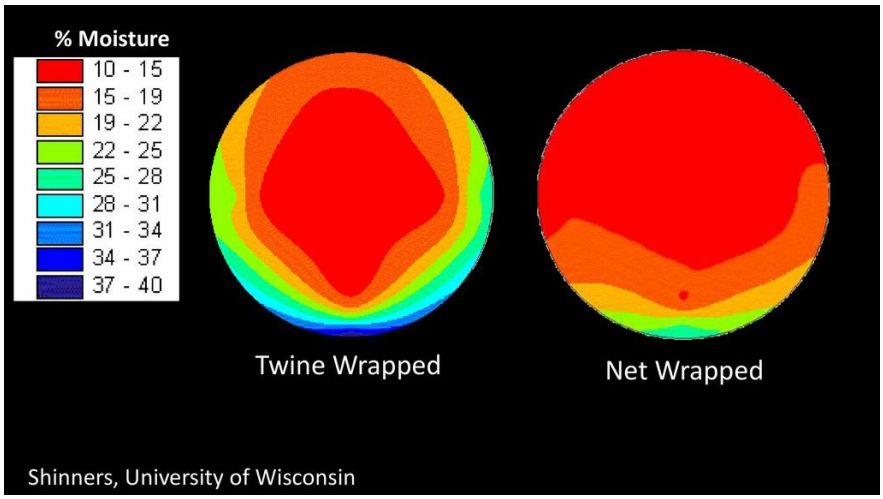
When looking back at the Standardized Performance Analysis data collected from cow-calf operations, the data clearly illustrates that beyond the actual investment in the livestock, feed costs are the major expense in the cattle enterprise. In a report of 135 beef cow-calf operations with an average number of 80 cows/operation in the FINBIN data set, the cost of production was reported to be an average of $169.54/cwt or $847.70 for a 500 lb calf (Nordquist and Van Nurden, 2019). This includes all costs including land, labor, feed and so forth. The profit margin is narrow when all expenses are included for the cow-calf sector currently. In order to increase profit opportunity, operations must have a high weaning percentage (90%+) and low feed costs. As conserved or stored feed is a costly component of the system, attention should be given to improving efficiency of stored or conserved forages in beef operations. This discussion will focus on storage and feeding losses as a means to provide some consideration within your own operation. Perhaps this will provide some insight on opportunities to reduce losses during storage and feeding to enhance profit margins.

First, consider storage of conserved forages and factors that can contribute to losses during storage. Forage quantity and quality losses should be considered. With respect to quality, this is often related to spoilage or heat damage. Hay that is wrapped to wet may go through a heating which can lead to “caramelization”. The process can reduce sugar and protein availability lowering digestibility and thus quality of the forage. Growth of molds on forages stored at high moisture can also lead to the production of mycotoxins that can further reduce the quality and potentially have detrimental impacts on the animal. Therefore, the first step in reducing forage losses starts with proper moisture at baling, whether the hay is put up for dry or high moisture forage.

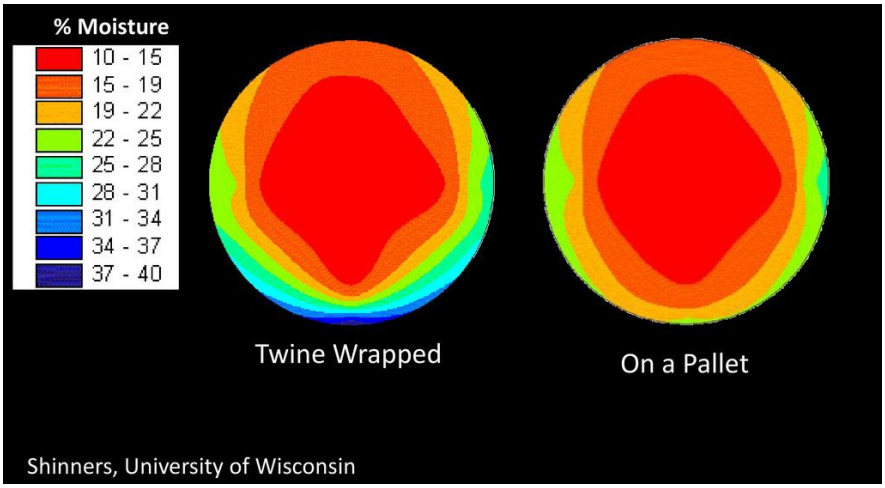
The process of baling can also have impact on storage losses. Smaller bales have greater surface area exposed. When considering a spoilage layer of the outer four inches, the amount of hay lost is a greater percentage for smaller bales than larger bales. Dense bales will have reduced spoilage as water infiltration will be less. Additionally, net wrapped bales will shed precipitation better than net twine wrapped bales (Figure 1).

Figure 1. Moisture distribution throughout a round bale wrapped with twine or net wrap.



Once the forage is baled, the next major consideration for reducing storage losses is related to how the forage is stored. For the purpose of this article, the focus will be related to dry hay. As most beef cow-calf operations in the region utilize round bales, the following discussion will focus on large round bales. Large round bales should contain dry hay or hay that is 12% moisture or less in most situations. The dryness of hay results in the bale being a sponge. Precipitation falling on the hay and moisture from the soil surface can be wicked into the bale. Moisture probes placed inside bales has demonstrated significant moisture wicking up into the bottom of bales (Figure 2). Storage should focus on minimizing this wicking process. Hay stored outside uncovered should be placed on a well-drained surface. Precipitation that doesn't soak into the bale will move along the outer surface to the bottom of the bale. Placing a layer of 6-8" of number 4 gravel will provide a surface for moisture to drain away from the bottom of the bale. Rows should be oriented north to south to allow sunlight to reach the bottom of the bales on both sides. A gentle slope will also assist in draining the area. Rows should also be at least three feet apart to allow airflow between rows to aid in drying out bales. Don't store bales in a fence row under trees either as the shading will reduce drying. Bales should be stored with the butt ends tight against each other to eliminate weathering of the flat surface.

Figure 2. Moisture distribution throughout a round bale stored on the ground or elevated on a pallet.



When storing hay bales, consider covering them to minimize storage losses (Table 1). Storing hay in a barn or under a tarp may result in storage losses of 4-7% while storage of twine wrapped hay on the ground outside uncovered could result in dry matter losses of 25-35% (Collins et al.). Hay tarps can be utilized to reduce storage losses at an affordable price. When stacking hay, do not make a pyramid stack unless you intend to cover the stack with a tarp. Hay tarps can be obtained from a variety of places. In addition to regular tarps, used billboards made of vinyl material are also available. Online sites such as billboardtarps.com repurpose billboards to hay tarps for about half the cost of regular hay tarps. When stacking hay in a pyramid with the rows high, the tarp size is approximately ½ foot shorter the diameter of the bale made. If bales were 6'x6' then the square footage for a tarp per bale is 33 square feet or 6' long by 5.5' tall (Hunke BAE-1716). Adding an extra 3-4' on the length will allow one to cinch the tarp around the ends of the stack. Those on a budget might consider such tarps to cover hay. Hay barns will minimize hay losses but are the most expensive option initially. Hoop barns built for hay storage can reduce the investment on a structure and when the lifetime of the building is considered can be an affordable option. When constructing barns be certain the design will withstand snow and wind shear. Properly engineered structures should be built to ensure the barns will withstand storms. Pole-type barns can be utilized as well. Multiple bays in the pole barn allows for different cuttings to be stored and accessed when needed. Consider the bale package size when considering the barn design. For more information on barn size, see the article by Hunke below or contact you extension office to gather additional resources.

Table 1. Hay dry matter losses by storage method (Collins et al. UK AGR 171)

Storage Method	Dry Matter Loss, %
Conventional shed	4-7
Reusable tarp on a gravel pad	4-7
Bale sleeve on ground	4-7
Well constructed gravel pad, uncovered	13-17
Net wrap on ground, uncovered	15-25
Twine stacked on ground, uncovered	25-35

Feeding can also be a source of significant hay loss. The greatest losses will occur when round bales are offered without the use of a feeder or hay rack. Research conducted several decades ago demonstrated that feeding hay without a feeder resulted in 12% feeding losses when the amount of hay offered met the needs for 1 day while losses were cut in half (5.9%) when a feeder was used. When the amount of hay set out was adequate for a full week of feeding, hay losses increased to 43% without the use of a feeder while losses remained similar when hay was placed inside hay rings (Bell and Martz, 1973).

Hay feeder design can impact feeding losses. Michigan researchers demonstrated that the use of a cone feeder that holds the bale up off the ground reduced feeding losses compared to conventional ring feeders with losses being 3.5% versus 6.1% (Buskirk et al., 2003). They also demonstrated higher feeding losses from hay trailers at 11.4%. Missouri work demonstrated that feeders with slanted bars and a tapered design resulted in less waste (13.6%) than a feeder with feeding bars that were straight up and down and chains to keep the bale up off the ground (19.2%) while a conventional slanted bar ring had the least waste (8.9%) when tall fescue was fed (Moore and Sexten, 2015). However, when closely examining their results, the total amounts of hay that was wasted and refused hay remaining inside the hay feeders (orts) were identical being approximately 27% of the bale weight. Additional research has been conducted on bale feeder design by Oklahoma researchers. They found that hay pre-cut using a cutting bar in the baler resulted in 13% feeding loss compared to 8.3% for long-stemmed hay (A Sexten et al., 2013). Additionally, they observed only 6.8% feeding waste for cone feeders compared to 14.5% for conventional ring feeders.

In my personal experience with cone style feeders, they must be managed. There can be approximately 1/3 of the bale in the bottom ring portion of the feeder. If this is quality hay remaining in the bottom of the feeder, it should be consumed before a new bale is put into the feeder. Adding a bale to the feeder with a full ring will only result in hay spilling out over the edge onto the ground. Additionally, cone feeder design should be such that cattle can't pull hay from over the top of the bale ring. These feeders are much heavier weighing upwards of 1,000 lb in some cases. The feeders should be placed on a solid area such as a feeding pad. These hay feeders are typically made from heavier gauge steel and life expectancy will be much longer than conventional feeders.

Changing feeding behavior can be done with design. Slanted bars reduce head removal from hay feeders reducing hay losses. Restricting time access to hay can also reduce hay waste. Purdue research demonstrated that restricting access to only 8 hours reduced hay disappearance by nearly 17% compared to 24-hour ad libitum or free-choice access. Illinois repeated this work decades later restricting time access to hay with mature beef cows. They also found that restricting time access to hay reduced hay waste. This may be a result of cows becoming more aggressive at eating leading to fewer head removals from the feeder. Time restriction should only be applied to dry, mid-late gestational cows in good body condition. Young and/or thin cows as well as lactating cows should not be restricted from consuming hay as a means to conserve hay. Hay must be of good quality as well and should not be moldy or mature with nutrient digestibility.

Many producers get tired of dealing with mud around hay feeders. Several producers unroll hay on the ground for cattle. This provides a means for cattle to be fed in different areas across the farm. Moving feeding areas by unrolling aids in improving manure nutrient distribution. However, unrolling hay can result in excessive losses especially if the ground is muddy or the hay is mature and low quality. North Dakota research found that unrolling hay on the ground led to 11.8% of the hay being wasted while using a ring resulted in only 3.6% waste (Landblom et al., 2003). Unrolling hay was found to lead to 12.9% loss while processing hay and feeding on the ground increased losses to 19% (Yermcio, 2009). The hay that is lost from unrolling or processing will contribute nutrients to the soil and is not a complete loss, however, it is costly.

Bale grazing has become popularized as a result of research and on-farm demonstrations in Canada and northern plain states. This involves strategically placing hay bales in the fields at set distances in rows. Access to hay is controlled with temporary electric fencing. Hay rings or feeders are not used in this region, but it is important to consider the drastic climate condition differences from your region to the cold, semi-arid winter climates where this work was conducted. We have worked with some producers in Kentucky on using a modified version of bale grazing in which hay rings are used. Rings are recommended to minimize hay feeding losses. The goal is to keep cattle moving across the feeding fields distributing manure nutrients more evenly than concentrating them in sacrifice areas. Continued movement to new feeding areas will also aid in minimizing soil compaction and mud conditions around bales. Unrolling hay can also be considered, but the difference is that unrolling of hay is done daily or every few days where bales are placed out only 1-2 times during the entire winter with bale grazing.

From our limited experience, bale spacing of approximately 40-60’ and feeding about 1-2 tons of forage per acre seems to be a reasonable starting place. When ground is frozen density can be increased. Damage around feeders will occur during periods of time when the ground is saturated. For additional farm interviews on bale grazing, videos on YouTube are suggested. We have developed three videos from experiences in Kentucky and additional videos from Canada and the northern plains are available. Just keep in mind that our winter precipitation amounts are much greater than the northern plains and Canada. Mud and severe soil damage can occur if this system is not properly managed. Additionally, having a feeding pad that hay and rings can be used to feed on during times of high precipitation should be considered to minimize field damage.

In summary, there are many areas that management an assist in reducing hay losses. Simply recognizing where losses occur and factors that contribute to these losses will allow you to apply management changes. Not every management change can be applied by all beef operations. Reducing hay storage and feeding losses can improve profitability of beef operations. Don’t overlook the fact that lowering the reliance on hay is a great place to start first through increasing grazing days.