Monitoring of Outside-stored Large Round Bales in South-central North Dakota

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Round baling and outside storage are the standards for hay production in the northern Great Plains. Losses in a six-month window can occur in dry matter and total digestible nutrients. Losses depend on moisture at the time of baling, precipitation events and storage systems. In this demonstration project, losses were linked to baling moisture. Monetary losses are dependent on the value of hay as a feedstuff on-ranch or for off-ranch sales.

Summary

The objective of this case study was to monitor outside-stored large round bales in the Coteau region of south-central North Dakota to assess changes in moisture, temperature and forage quality through time. The bales were monitored during a six-month period from July 2014 to January 2015.

Moisture measured at a 20-inch bale depth was from 21 to more than 30 percent directly after baling, and ranged from more than 30 percent in August 2014 to 9.2 percent in January 2015. Internal bale temperatures ranged from 98°F in July 2014 to 35°F in November 2014.

Dry matter (DM) and total digestible nutrient (TDN) losses were determined through bale core sampling and forage quality analyses. All bales showed an initial heating and drying down (sweating) process, with a loss of DM up to 6 percent and TDN up to 10 percent. Mold counts for composite samples per site ranged from 713,636 to 4,318,181 colony-forming units per gram (CFU/g), which may be of concern to producers if hay is the primary source of feed.

Monetary losses are relative in the value of the hay as an on-farm feed resource or a marketable product. The higher the hay is valued, the more the losses will be per ton relative to the measured losses in the stack.

Losses in DM and TDN also support testing hay just before feeding because values can change in a six-month window.

Results of this monitoring project warrant a more complete research-based effort on losses in outside-stored large round bales in North Dakota.

Introduction

Making round bales is a standard practice in North Dakota, where hay is typically an abundant resource and time is of the essence in baling it. Round balers are faster and more cost-effective than square balers. In addition, the shape of the round bale is conducive to shedding rain and snow, so bales commonly are stored outside.

Common stacking practices include bale placement with the long end on the ground and in line end to end or stacked in a staggered arrangement. Also, many producers in North Dakota are utilizing net wrap for baling because baling time is decreased, compared with twine wrap.

The recommended moisture for baling large round bales is 18 percent moisture or less (Undersander and Saxe 2013). Hay, especially first-cut hay in North Dakota, often is baled at higher than desirable moisture levels. Summer storms and short drying windows, coupled with a lack of producer time, often result in bales that are put up at a moisture content of 20 percent or greater.

Moist hay at baling in warm weather creates an environment where aerobic microflora attached to the hay or still-functioning plant cells can utilize sugars and decrease nutritional values with respect to energy through time (Coblentz *et al*. 2011). This will be reflected in overall DM and TDN loss of hay as simple carbohydrates in the hay are consumed. Furthermore, as large round bales are stored outside, rain and humidity can continue to influence DM and TDN losses.

As losses increase, hay value decreases as a feed resource in beef cattle diets. Energy, which is an important component of beef cattle winter diets in the northern Great Plains, may be lost in greater amounts than crude protein, further compromising the hay as a feed resource.

Previous research at the University of Oklahoma has shown DM losses in outside-stored hay at 13.8 percent in eight months, with barn-stored hay losing 2 percent (Huhnke 1988). In Wisconsin, losses of up to 50 percent occurred in hay rained on at the curing stage (Rankin and Undersander 2000). These areas are known to have higher precipitation and humidity, with a longer growing season and less severe weather, than the south-central region of North Dakota. Therefore, we wanted to monitor large round bales (5 by 6 feet) with respect to moisture, temperature and overall hay quality to determine if losses per site may be a concern for producers and if this work warrants further research efforts.

Procedure

Hay bales were monitored at three different sites within 20 miles of each other in the south-central Coteau region of North Dakota. Site 1 was a grass/alfalfa field (20 percent alfalfa) that was harvested and baled at the Central Grasslands Research Extension Center (CGREC) near Streeter. Site 2 (Producer 1) and Site 3 (Producer 2) were alfalfa sites that were producer-harvested and baled on their fields. Six bales per site were weighed individually in July 2014, with subsequent weights after six months, in January 2015.

Bale weighing occurred on a stainless steel cradle mounted on a flatbed trailer with a digital scale attached. Bale temperature and moisture were sampled monthly with an Agri-Tronix HT Pro Moisture Sensor at the 6- and 20-inch depth in each bale. According to product instructions, five moisture readings were taken per bale and the highest was recorded.

Temperature was taken at one point in the bale. Three core samples were taken per bale, for a total of 18 per site, and combined per site for a composite sample that was processed through wet chemistry at the Stearns DHIA Laboratory, Sauk Centre, Minn., for the following measurements: dry matter, crude protein, acid detergent fiber and neutral detergent fiber, with calculated TDN also provided by the laboratory. Mold counts also were analyzed in August and September 2014, and again in January 2015 by the Stearns DHIA Laboratory.

Trailer-mounted weigh scale for round bales.

Bales were stored on their respective sites in an end-to-end pattern at Site 1 and Site 3, and stacked at Site 2. Alfalfa bales at both producer sites were net wrapped, while the alfalfa/grass hay bales from CGREC were twine wrapped.

Results and Discussion

Average moisture content at the 20-inch depth (by site) after baling in July ranged from 25 to 37 percent (Table 1).

Table 1. Sampled bales and measurements at three sites in south-central North Dakota.

Site	Hay Type	Baling Wrap	Storage Method	Sample Date	Average Moisture (%)	Average Temperature (°F)	Dry Matter (lbs.)	Total Digestible Nutrients (lbs.)
1 - CGREC	20% alfalfa/ 80% grass	Twine	In line, east-west	July 2014	25	74	989	528
				Aug. 2014[1]	27	80		
				Jan. 2015	13	39	952	517
				6-month loss			**37 (4%)**	**11 (2%)**
2 - Producer 1	Alfalfa	Net wrap	Stacked	July 2014	27	73	1245	709
				Aug. 2014[1]	>30	79		
				Jan. 2015	13	39	1177	692
				6-month loss			**68 (5%)**	**17 (2%)**
3 - Producer 2	Alfalfa	Net wrap	In line, east-west	July 2014	37[2]	80	1185	675
				Aug. 2014[1]	>30	85		
				Jan. 2015	20	39	1115	605
				6-month loss			**70 (6%)**	**70 (10%)**

[1] Bales were not weighed at this time.

[2] A reading of more than 30 percent is not considered accurate, according to the manufacturer of the moisture sensor.

(Moisture readings in excess of 30 percent are not considered accurate with this type of moisture sensor, and anything in excess of 30 percent is considered very wet).

In August, one month after baling, there was no significant difference in moisture content between the alfalfa hays, but a significant difference was found between the alfalfa/grass hay and the alfalfa hays at P=0.05 (Figure 1). Variability at Site 1 for the alfalfa/grass hay was highest in comparison with the other two sites, which was expected due to differences in baling moisture, baler type, density of bales, difference in soil type and moisture and local differences in weather.

Subsequently, there was no significant difference in temperatures (P=0.2529) among the three sites in August, even though individual bales were hottest at the wettest site, Site 3 (Figure 2). Site 3 also showed the highest variability in temperature in comparison with the other two sites, and also had the highest percent of DM and TDN loss during the six-month period.

Bales at all three sites showed a loss with respect to DM and TDN through time (Table 1). The six-month DM loss ranged from 4 to 6 percent. The six-month TDN loss was 2 percent at two sites (1 and 2), while the six-month TDN loss at Site 3 was 10 percent.

A loss in crude protein did not occur during this project and may be reflective of relatively lower bale temperatures for a sustained period of time.

Mold count levels in sampled hays were consistently high (Table 2) and within the cautionary range of 100,000 to 10,000,000 CFU recommended by the National Forage Testing Association (National Forage Testing Association 2009).

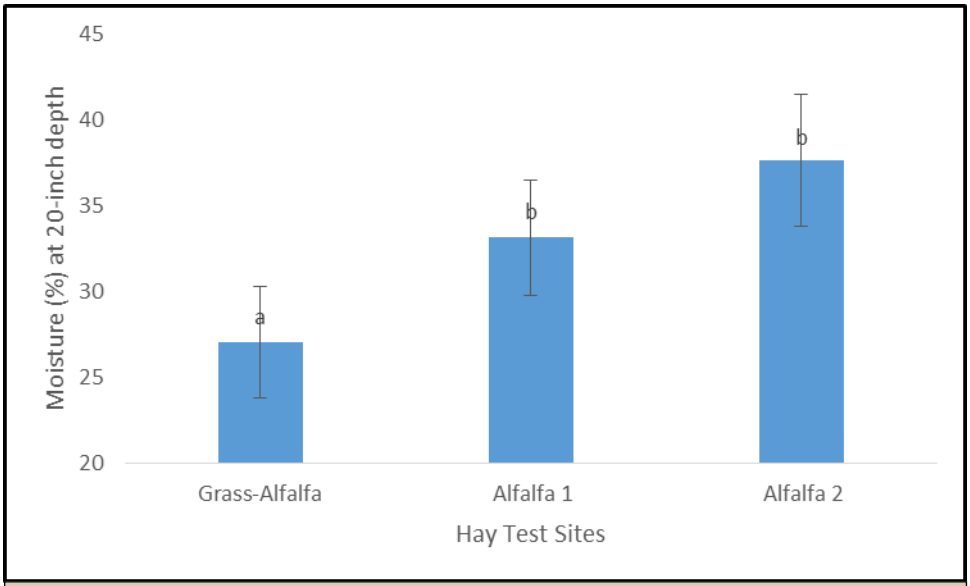

Figure 1. Bale moisture at 20-inch depth in August 2014. Means with different letters are statistically different at $P \leq 0.05$.

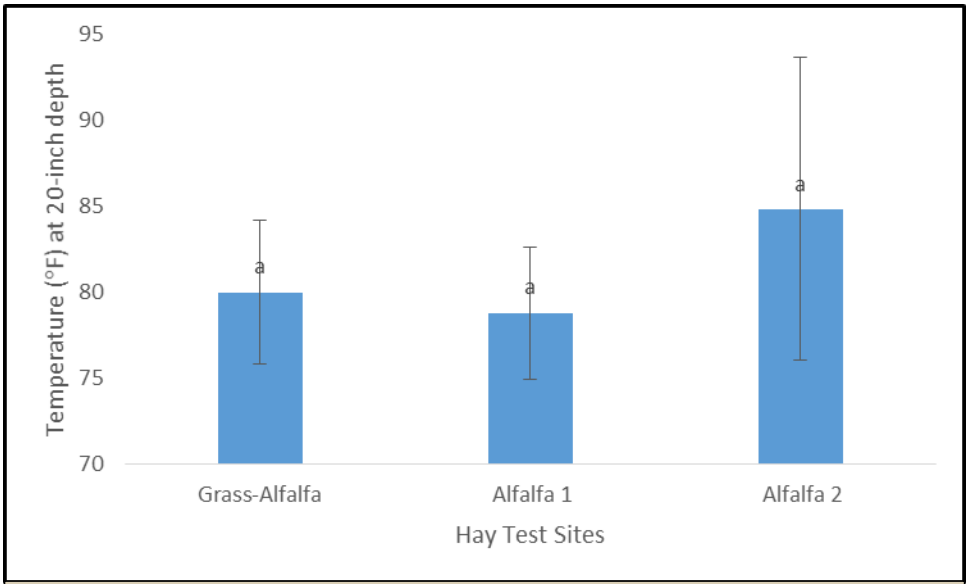

Figure 2. Bale temperature at 20-inch depth in August 2014. Means with different letters are statistically different at $P \leq 0.05$.

Table 2. Mold counts (CFU/gram)[1] in outside-stored large bales at three sites in south-central North Dakota.

Site	Hay Type	Sampling Date		
		Aug. 15, 2014	Sept. 18, 2014	Jan. 15, 2015
1 - CGREC	20% alfalfa/ 80% grass	1,363,636	4,318,181	2,181,818
2 - Producer 1	Alfalfa	1,590,909	1,318,181	713,636
3 - Producer 2	Alfalfa	1,409,090	2,000,000	4,000,000

[1] Colony-forming units per gram.

Monetary implications for producers are based on farm or market value of hay as a feed resource (Table 3).

In areas or cycles of agricultural production where hay becomes a valued product, these losses will become more important to the livestock producer in managing hay as a feed resource. This project also demonstrated that hay testing is important directly before feeding to account for losses that occur during outside storage.

Karl Hoppe cores a bale for a sample with help from Sheldon Gerhardt.

Table 3. Monetary losses in a six-month window based on hay type, dry matter (DM) and total digestible nutrients (TDN).

Site	Hay Type	Hay Value/ton	DM Value Loss/ton	TDN Value Loss/ton
1 - CGREC	20% alfalfa/ 80% grass	$90	$4.10	$4.37
		$130	$5.92	$6.32
2 - Producer 1	Alfalfa	$106	$7.09	$4.51
		$150	$10.03	$6.39
3 - Producer 2	Alfalfa	$106	$7.09	$4.51
		$150	$10.03	$6.39

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