Monitoring of outside-stored large round bales in south-central North Dakota

F. Brummer[1], S. Gerhardt[2] and K. Hoppe[3]

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. Losses in dry matter (DM) and total digestible nutrients (TDN) suggest the value of the forage decreases with storage. These losses also suggest the need for testing hay just before feeding because values can change in a six-month window.

Summary

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, bales were monitored during a six-month period from July 2014 to January 2015. The measured moisture at a 20-inch bale depth was from 20.7 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. 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 had an initial heating and drying down (sweating) process, with a loss of DM of up to 6 percent and TDN of 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 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 precipitation (rain or snow), so bales commonly are stored outside.

Common stacking practices include in-line, end-to-end bale placement or stacking in a staggered arrangement with the long end on the ground. 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, 2014). 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 20 percent moisture or greater.

Moist hay at baling in warm weather creates an environment in which 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 and Undersander, 2011). This will be reflected in overall DM loss 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 has shown DM losses in outside-stored hay at 13.8 percent in eight months at the University of Oklahoma, with barn-stored hay losing from 2 percent DM (Huhnke, 1988) up to 50 percent in Wisconsin with rained-on hay at the curing stage (Rankin and Undersander, 2000).

[1]Central Grasslands Research Extension Center, NDSU
[2]Logan County Extension office, NDSU
[3]Carrington Research Extension Center, NDSU

These areas are known to have greater precipitation and humidity, with a longer growing season and less severe weather, than the south-central region of North Dakota. Therefore, our objectives were 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.

Experimental Procedures

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 utilized bales containing a grass/alfalfa blend (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) utilized bales containing alfalfa that were harvested and baled by the producer. Six bales per site were weighed individually in July 2014, with subsequent weights taken at the six-month (January 2015) period.

Bale weighing occurred on a stainless steel cradle mounted on a flatbed trailer with a digital scale attached. Temperature and moisture per bale were sampled monthly with an Agri-Tronix HT Pro Moisture Sensor at the 6-inch and 20-inch depth within 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 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 Stearns DHIA Laboratory, Sauk Centre, Minn. Bales were stored at 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 hay bales from the CGREC were twine wrapped.

Results and Discussion

Bales at all three sites showed a loss with respect to DM and TDN through time (Table 1). The average moisture content as measured on site with the moisture sensor after baling varied by site from 25 to more than 30 percent for moisture. At Site 1, the six-month TDN loss was 2 percent; at Site 2, the six-month DM loss was 2 percent; and at Site 3, the six-month TDN loss 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), compared with the cautionary level of 100,000 cfu/g that is documented by the National Forage Testing Association (National Forage Testing Association. 2009). Mold counts varied by sites but stayed consistently above the cautionary, even when sampled in January.

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

Site Number and Name	Hay Type	Baling Wrap	Storage Method	Sample Date	Average Moisture	Average Temperature (F)	Dry Matter (lbs.)	Total Digestible Nutrients (lbs.)
1: CGREC	Grass 80%, alfalfa 20%	Twine	In line east-west	07/03/14	25%	74	989	528
				01/03/15	13%	39	952	517
				6-month loss			37 (4%)	11 (2%)
2: Producer 1	Alfalfa	Net wrap	Stacked	07/03/14	27%	73	1245	709
				01/03/15	13%	39	1177	692
				6-month loss			68 (5%)	17 (2%)
3: Producer 2	Alfalfa	Net wrap	In line east-west	07/13/14	37%[1]	80	1185	675
				01/03/15	20%	39	1115	605
				6-month loss			70 (6%)	70 (10%)

[1]A reading of more than 30 percent is not considered accurate according to the moisture sensor we used. The bale is assumed to be very wet.

We found a difference (P < 0.001) in bale moisture at 20 inches among the three sites in August 2014 (Figure 1), which was expected due to differences in baling moisture in July, baler type, density of bales, difference in soil type and moisture, and local differences in weather and climate. We did not find differences in the alfalfa hays, but we did observe a difference (P = 0.05) in the grassy hay and the alfalfa hays. Variability at Site 1 for the grassy hay was highest in comparison with the other two sites (Table 3).

Subsequently, we found no difference (P=0.25) in temperatures among the three sites in August 2014, even though individual bales were hottest at the wettest site (Figure 2). Site 3, with the wettest bales, also had the highest variability in comparison with the other two sites, and also had the highest percent of DM and TDN loss in a six-month period for the project.

Monetary implications for producers are based on farm or market value of hay as a feed resource. Based on this project, for Site 1 with the grassy hay valued at $90 per ton, the six-month DM loss of 4 percent would equal a loss of $4.10 per ton, and the 2 percent TDN loss would equal a loss of $4.37 per ton. At $130 per ton, the DM loss would be $5.92 per ton, and the TDN loss would be $6.32 per ton.

Site 2, with alfalfa hay valued at $106 per ton, a six-month DM loss of 5 percent would equal a loss of $7.09 per ton, and the 2 percent TDN loss would result in $4.51 less per bale. At $150 value per ton, a loss of $10.03 per DM ton and $6.39 per ton of TDN would occur.

Site 3, with alfalfa hay valued at $106 per ton, a six-month DM loss of 6 percent would have a loss of $7.09 per ton, and the TDN loss at 10 percent would be $4.51 per ton. At

Table 2. Mold counts (colony-forming units/gram) in outside-stored large bales at three sites in south-central North Dakota.

Site Number and Name	Aug. 15, 2014	Sept. 18, 2014	Jan. 15, 2015
1: CGREC	1,363,636	4,318,181	2,181,818
2: Producer 1	1,590,909	1,318,181	713,636
3: Producer 2	1,409,090	2,000,000	4,000,000

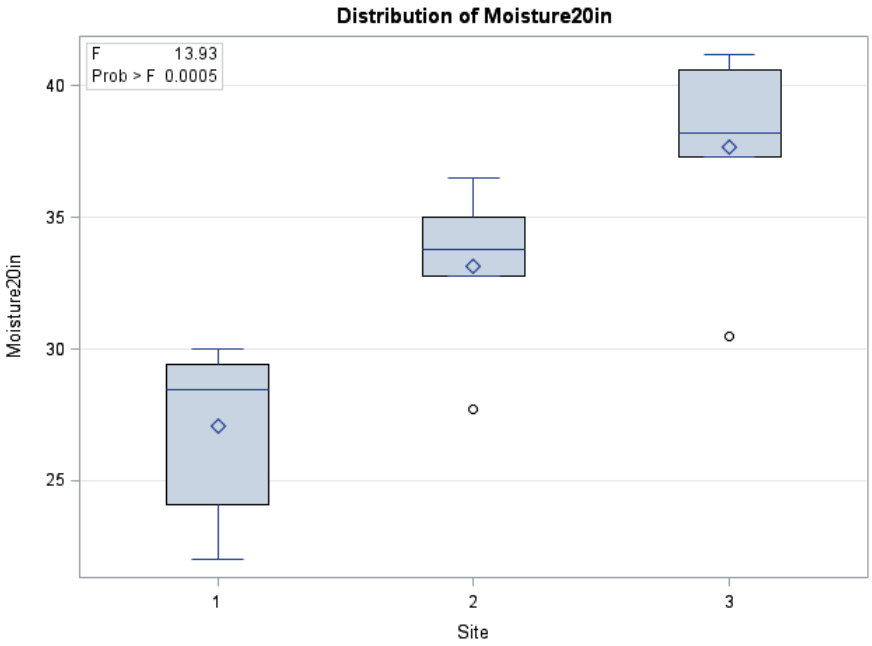

Figure 1. Bale moisture at 20-inch depth in August 2014 in outside-stored large round bales at three sites in south-central North Dakota.

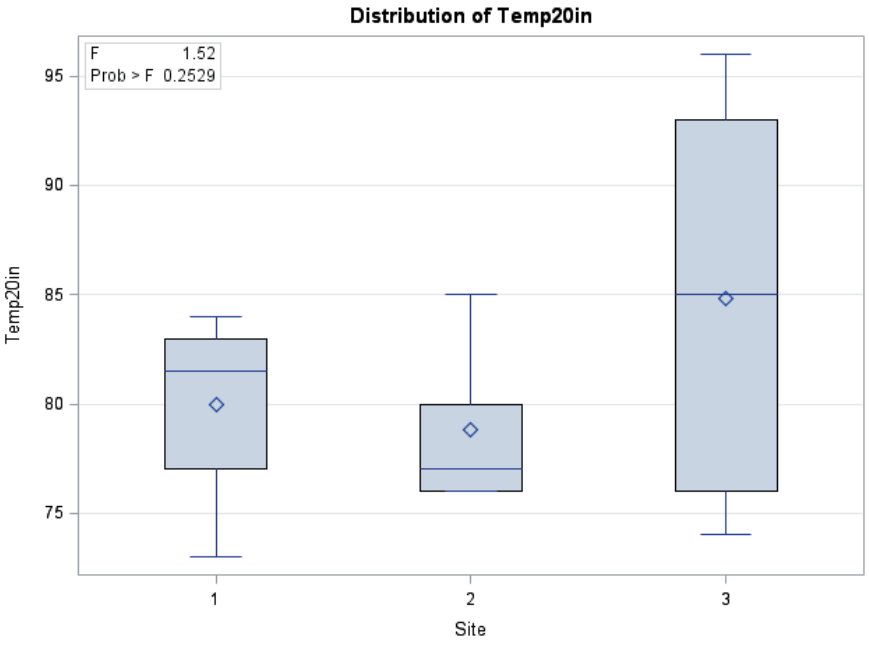

Figure 2. Temperature at 20-inch depth in August 2014 in outside-stored large round bales at three sites in south-central North Dakota.

a $150 value per ton, a loss of $10.03 per ton for DM and $6.39 per ton for TDN would result.

In areas or cycles of agricultural production in which 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 directly before feeding is important to account for losses that occur during outside storage.

Literature Cited

Coblentz, W., P. Hoffman and D. Undersander. 2011. Heat Damaged Forages: Effects on Forage Energy Content. Focus on Forage: Vol. 13, No. 1. University of Wisconsin, Madison.

Huhnke, R.L. 1988. Large Round Bale Alfalfa Hay Storage. Applied Engineering in Agriculture. 4(4): 316-318.

National Forage Testing Association. 2009. Recommended Terminology and Units for Parameters Used in Lab Reports. Revised by Glenn Shewmaker, Tim Snyder and Dan Undersander. April 29, 2009. (Available at www.foragetesting.org/files/RecommendedTerminologyUnitsParametersGES04-29-09.pdf)

Rankin. M., and D. Undersander. 2000. Focus on Forage: Vol. 2, No. 4. University of Wisconsin, Madison.

Undersander, D., and C. Saxe. 2014. Field Drying for Hay and Haylage. 2013. Focus on Forage: Vol. 12: No. 5. University of Wisconsin, Madison.