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Agriculture and Natural Resources

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Test Hays for Nutrient Composition Before Feeding

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Variation in Hay Quality

Developing a least-cost winter feed program begins by having hays analyzed for nutrient content. A forage analysis is necessary because hays can be highly variable in nutritive value due to differences in fertilization and soil fertility, forage maturity at harvest and seasonal differences in forage species composition.

Two very important nutritional components assessed with routine forage analysis are crude protein and total digestible nutrients (commonly called TDN). Total digestible nutrients is a reference for the energy value of the feed and is equally important as crude protein when assessing feed value. Animals require feed that is digestible enough to meet their energy needs for maintenance and production.

Both protein and total digestible nutrients vary within a farm. Figure 1 is an example of how much within farm differences in crude protein and total digestible nutrients can occur within a single year. Farm 3 (+) had one hay lot test below 10 percent protein and close to 50 percent total digestible nutrients and another hay lot test above 20 percent protein and close to 62 percent total digestible nutrients.

Not only do we see differences in quality within a single year, the quality can also vary from year-to-year as illustrated in Figure 2 (next page). It represents seven years of hay samples from a single farm. The box shape associated with each year provides an illustrated summary about all samples analyzed within that year. Without going through excessive detail about the box, examine the

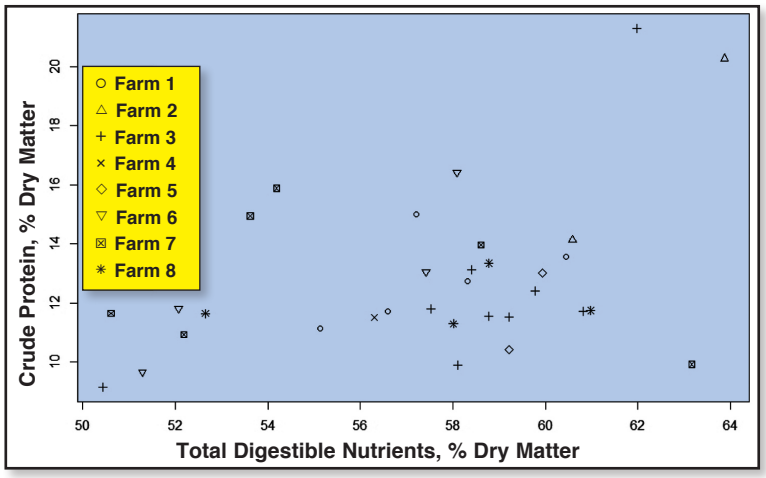

Figure 1. Crude protein and total digestible nutrient content among hay lots harvested within one year for 8 farms.

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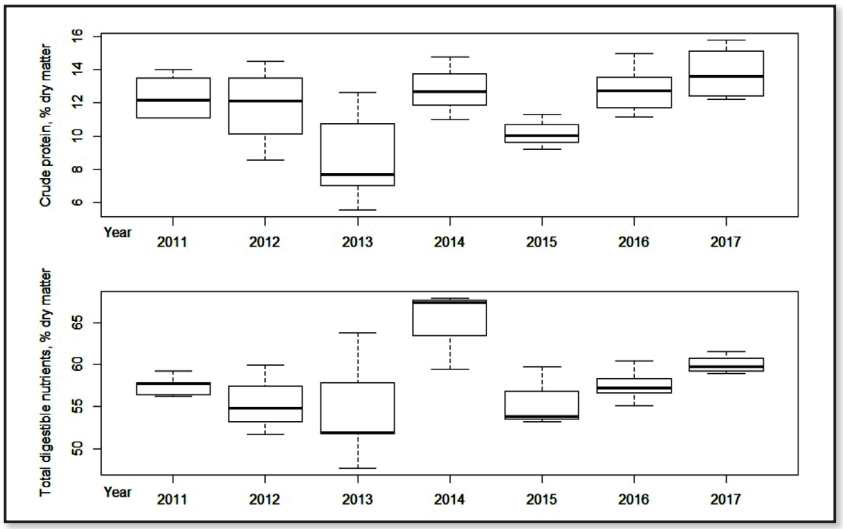

Figure 2. Boxplot summary for crude protein (top) and total digestible nutrients (bottom) from a single farms hay harvests over a 7-year period.

year-to-year difference in the dark horizontal line for each box. This line is the median value (50th percentile) which is usually close to the average value. As you can see, protein and total digestible nutrient content decreased from 2011 to 2013, increased in 2014, dropped in 2015 and increased in 2016 and again in 2017. In some years, the best quality hay was lower in quality than the worst hay for a different year. The most informed feeding management decisions are made when hays are properly sampled from each hay lot, every year.

Tips for Collecting Forage Samples

The analyzed nutrient composition of hay is only as accurate as the sample sent. Begin by accurately identifying the dominant forage species of the field harvested to get an accurate estimate of total digestible nutrients (TDN).

Test each lot of hay. A lot represents hay harvested from each cutting within a single field under similar harvest conditions. Harvest date, plant species, fertility and weather can all result in variations within and between fields and cuttings. If testing each lot of hay is impractical, testing across hay lots is the next best approach. For mixed lot sampling, the combined sample should contain each lot's proportion relative to the whole. If lot 1 contains 15 percent of the total number of bales, then it should also represent 15 percent of mixed lot sample. Otherwise, forage quality will be interpreted inaccurately. For example, sampling the same number of bales from lots 1, 2 and 3 (Table 1) would result in an overestimate of TDN and result in underfeeding beef cattle during early and mid-lactation.

TABLE 1. EFFECT OF SAMPLING ACROSS HAY LOTS ON TOTAL DIGESTIBLE NUTRIENTS.

NUMBER OF LOTS	BALES	PERCENT OF TOTAL BALES	SAMPLE SIZE BALES/LOT (30%)	TOTAL DIGESTIBLE NUTRIENTS
1	30	15%	9	64%
2	30	15%	9	58%
3	140	70%	42	52%
			Non-weighted Average[1]	58.0%
			Weighted Average[2]	54.7%

[1]Non-weighted average TDN reflects an inaccurate estimate of TDN that could occur if the same number of bales were sampled from each lot.

[2]Weighted average TDN reflects a more accurate estimate of overall hay TDN because the hay sample is proportional to the size of each lot [(64 x 0.15) + (58 x 0.15) + (52 x 0.70)].

Core samples are preferred over grab samples. Even with hay that is not weathered, multiple core samples will contain a better distribution of plant material, which will result in a more accurate assessment of nutrient composition. Hay sampling probes (Figure 3) are available for use through county Extension offices in Arkansas. Samples should be taken from the end of square bales and from the side of round bales and stacks.

Twenty to thirty percent of the bales must be sampled to accurately estimate the nutrient composition of the hay. A demonstration project at the University of Arkansas showed differences of 5 percent TDN when as few as 5 percent of bales were sampled within a single hay lot (Figure 4). A minimum of six individually core-sampled round bales are necessary to have sufficient sample size for an analysis. Sample size should represent the larger of the two, either six bales or 20 percent of the number of bales in a lot.

Hay that is stored outside should be sampled just prior to the feeding period. Angle the core sampling

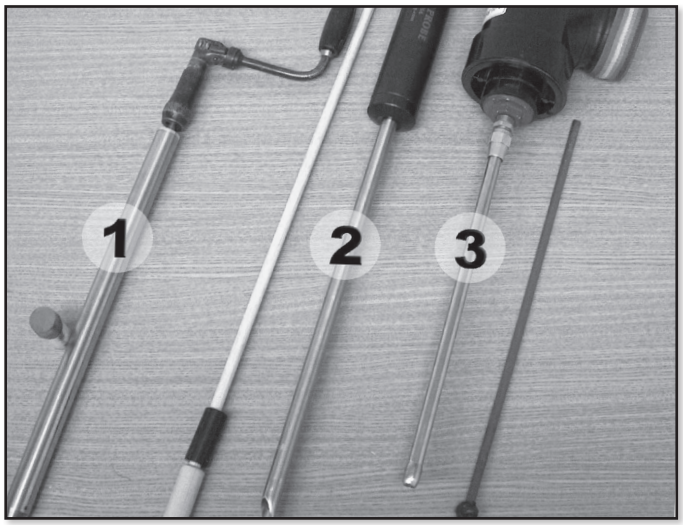

Figure 3. Core sampling devices: (1) Penn State Forage sampler, (2) Colorado Hay Probe and (3) Star Quality Multi-sampler.

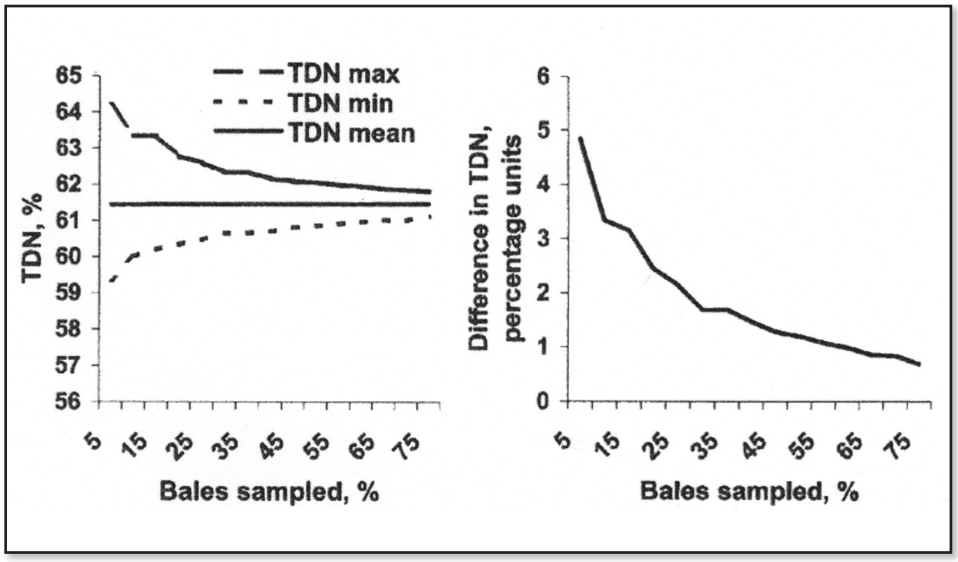

Figure 4. Effect of sample size on bermudagrass TDN (Milliken et al., AR Animal Sci., 2003).

tool in an upward direction when sampling large packages stored outside. This will help avoid creating a hole for water to penetrate the inside of the bale. Avoid sampling excessively weathered material. The sample submitted should reflect what the cattle will be eating, not wasting. Hay that is stored inside can be sampled at storage or prior to feeding, with the exception of hay that was harvested wet. Hay quality diminishes rapidly during storage if harvested at less than 80 percent dry matter.

Using Results

Upon receiving the results from a forage analysis, the next step is to interpret the results. Figure 5 is an example routine hay analysis report. The results are separated into two columns – AS RECEIVED and DRY MATTER BASIS. When comparing a forage analysis to animal requirements, the values reported under dry matter basis should be used. The following information is reported when a forage sample is submitted for routine analysis through the University of Arkansas Cooperative Extension Service.

- Moisture – water content of a feed.
- Dry Matter – 100 minus the water content. Used to convert AS RECEIVED to DRY MATTER. Example: 6.6 ÷ 86.3 x 100 = 7.7 for conversion of protein from AS RECEIVED to DRY MATTER BASIS.
- Crude Protein – a measure of plant nitrogen multiplied times 6.25.
- Acid Detergent Fiber – a measure of plant cellulose and lignin. Acid detergent fiber is commonly used to estimate digestibility (TDN).
- Neutral Detergent Fiber – a measure of plant hemicellulose, cellulose and lignin. Neutral detergent fiber may also be used to estimate digestibility and is highly correlated with forage intake.
- Total Digestible Nutrients (TDN) – an estimate of the supply of energy. The number for total digestible nutrients is derived from equations developed from feeding trials. Equations commonly utilize acid detergent fiber to estimate TDN but may also include crude protein and/or neutral detergent fiber.
- Net Energy for Lactation – an estimate of the supply of energy commonly used for balancing dairy cow rations.

A forage test cannot be interpreted without having a set of livestock nutritional requirements to compare against the results. Nutrient requirement tables are available through the county Extension office for many classes of livestock. Table 2 contains

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2019 Certified Chemistry by NFTA

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Date Received 03/27/19 — Date Report Out 03/29/19

LAB #	F90378
Sample ID	1
Feed List Name	LEGUME AND LEGUME GRASS
Species	
Type of Sample	Hay
Payment Received	Chk # cash

Forage Analysis Results	As-Received	Dry Matter Basis
Moisture %	13.7	
Dry Matter (DM) %		86.3
Crude Protein (CP) %	6.6	7.7
Acid Detergent Fiber (ADF) %	36.2	42.0
Neutral Detergent Fiber (NDF) %	54.6	63.2
Calculated Total Digestible Nutrients (TDN) for Ruminants %	41.9	48.5
Calculated Net Energy for Lactation (NEL) for Dairy Mcal/lb	0.41	0.48
Calculated Digestible Energy (DE) for Horses Mcal/lb	0.72	0.83
Calculated Total Digestible Nutrients (TDN) for Horses %	35.8	41.5

Figure 5. Example routine analysis results summary prepared by the University of Arkansas, Agricultural Diagnostic Service Laboratory.

TABLE 2. NUTRIENT REQUIREMENTS OF A MATURE BEEF COW

GROUP	CP % DM	TDN % DM
1100 lb cow, early lactation (20 lb peak milk)	11	60
1100 lb cow, mid-lactation	9	56
1100 lb cow @ calf weaning, mid-gestation	7	47
1100 lb cow @ late gestation	8	52

Adapted from Beef Cattle Nutrition Series, Part 2: Establishing Nutritional Requirements, FSA3079.

TABLE 3. PERCENT OF OZARK BOOTSTRAP SAMPLES MEETING REQUIREMENTS FOR DIFFERENT CLASSES OF BEEF CATTLE.

GROUP	% ADEQUATE
Weaning, mid-gestation	100
Late gestation	96
Mid-lactation	69
Early lactation	34

the nutrient requirements for a mature beef cow during different stages of production. Compared to the example forage test, the hay quality is sufficient to meet the nutritional requirements of both a cow in mid- and late gestation. A cow in early lactation would require both supplemental protein and energy (TDN) because a lactating cow's requirement exceeds the amount in the hay, and a cow in mid-lactation would only require supplemental energy.

Baxter, Boone, Marion and Searcy counties in Arkansas reported approximately 34 percent of the hay samples collected (Table 3) from 23 farms participating in the Ozark Bootstrap (pilot multi-county) demonstration project were sufficient to meet the nutritional requirements of a mature beef cow in early lactation. Nearly all of the forage samples (96 percent) met the protein and TDN requirement for a mature beef cow in late gestation.

Hay is usually harvested at a mature stage, which results in a shortage in TDN for cows in early lactation. Forage test results were used to improve the economics of winter feeding on ABIP and Bootstrap demonstration farms by:

- Matching hay lots with nutritional requirements of cows (feeding the best quality hay to lactating cows and lower-quality hay to gestating cows).

- Identifying which nutrient(s) were inadequate relative to beef cattle requirements and supplementing accordingly. Seventy percent of the hay samples from the Ozark Bootstrap demonstration **were** capable of meeting or exceeding the protein requirement of a mature beef cow in early lactation. However, 70 percent of the hay samples **were not** capable of meeting the energy requirement of a beef cow during early lactation. As a result, supplemental feeding was shifted from emphasizing protein to emphasizing energy.

Summary

The time and money spent forage testing has consistently been shown to be a valuable tool for avoiding costly feeding errors. However, a forage test is of little value if the producer is not willing to interpret the results and make supplemental feeding changes when necessary.

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