MANAGEMENT

Ridin' Herd

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Test forages to save dollars

As producers strive to reduce feed costs by investigating avenues to increase grazing days, many still have to use harvested forages in a year-round feeding program. Sampling and testing forages for quality can make designing a feeding program easy and economical.

Average not always accurate

Nutrient concentration can vary considerably in feeds, especially forages. Protein in alfalfa hay can range from 10% to 25% of the dry matter, and grass hay will contain between 4% and 18% protein. Beef cattle are most productive when consuming a diet balanced according to their nutrient needs.

When designing diets using harvested feeds, many rations are balanced using average values for each feedstuff. These "book values" often result in over- or underfeeding certain nutrients. More economical and better-balanced rations can be formulated using nutrient concentrations determined from feed analysis.

From a forage standpoint, fiber concentration increases as plants mature. Fiber is less digestible than other plant parts, and fiber digestibility declines as plants mature. Both of these factors cause the concentration of energy in plants to decline as maturity advances.

In addition, as plants mature, the increase in fiber and bulkiness reduces the amount of the forage an animal can consume. Cows don't quit eating straw because they don't like it; they quit because they can't stuff any more into their rumen because of straw's low digestibility due to the high fiber content.

Protein concentration also declines as plants mature. I have heard it said more than once that the three factors affecting forage quality are:

1) maturity at harvest,
2) maturity at harvest, and
3) maturity at harvest.

Getting a representative sample, packing it properly for transport, knowing what to test for and understanding the numbers in the analysis are critical.

Sampling and packing

In testing forages, it is important that samples closely resemble the entire "lot" of forage, and each sample must represent only one lot. A "lot" of forage consists of forage harvested from one field at the same cutting and maturity. All forage from the same lot should be similar for type of plant(s), field (soil type), cutting date, maturity and variety. Variation in any of these characteristics can cause substantial differences in the nutrient value of the forage.

Sample baled hay after curing (usually 17 to 21 days after baling), using a core sampler or probe. Such an instrument is essential for collecting a representative sample, and most commercial labs will not accept a "grab sample" of hay.

For large round and square bales, the probe should penetrate at least 18 inches (in.) into the bale and have an internal diameter of at least ⅜ in. If the probe is 18-in. long or longer, 15 large round bales should be adequate if the lot size is 30-40 bales.

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► Sample baled hay after curing (usually 17 to 21 days after baling), using a core sampler or probe.

Collect one sample from each bale by coring straight in from the center of the end of square bales and from the wrapped circumference of round bales. Place the entire sample into a plastic bag and seal tightly.

For loose or compressed haystacks, use a hay probe at least 24 in. long to collect 15 or more samples from each lot. Sample loose hay stacks from the top and from the side. Compressed loaf stacks require six sampling locations: top front, top middle, top rear, lower front side, lower middle side and lower rear side.

For chopped or ground hay, collect about 10 small samples during the grinding process, place all the samples into one plastic bag, and seal tightly. If you are sampling previously ground or chopped hay, collect about one-fourth of the samples from the top half of the pile and the rest from the lower half. Avoid allowing fines to sift between fingers.

Label the bag with your name, address, lot identification (ID) and type of material. Most testing labs provide a description sheet to report this information and to request the desired tests. Place samples in polyethylene freezer bags, squeeze the air out of the bag, and seal tightly. Double-bag silage samples for extra protection. Use extra caution if subdividing a large hay sample because subsampling dry hay can result in loss

Table 1: NIR analysis, alfalfa hay

Item	As-received	DM basis
Moisture, %	17.4	0.0
DM, %	82.6	100.0
CP, %	17.9	21.6
Heat-damaged protein, %	1.2	1.4
Available protein, %	17.9	21.6
ADF, %	30.0	36.3
NDF, %	38.7	46.9
TDN, estimate, %	49.5	59.9
ENE, estimate, therms per cwt.	41.8	50.60
NE_l, Mcal per lb.	0.51	0.61
NE_m, Mcal per lb.	0.49	0.59
NE_g, Mcal per lb.	0.28	0.33
DDM, %	50.10	60.63
Phosphorus (P), %	0.29	0.35
Calcium (Ca), %	1.20	1.45
Potassium (K), %	2.36	2.86
Magnesium (Mg), %	0.25	0.30
RFV		120.3

of fines and leaves. Freeze samples containing more than 15% moisture until shipping; store dry samples in a cool location.

Methods of analysis

Until recently, nutrient analyses were most commonly done by chemical analysis in a laboratory. When representative feed samples are tested chemically, accurate predictions of animal performance usually can be made because the nutrient requirements were determined using chemically tested feeds.

Now there are many forage samples tested using near-infrared reflectance (NIR) spectroscopy. NIR is a rapid, reliable, low-cost, computerized method to analyze feeds for nutrient content. It uses near-infrared light rather than chemicals to identify important compounds and measure their amounts in a sample (see Table 1).

Feeds can be analyzed in less than 15 minutes using NIR, compared to hours or days for chemical methods. This rapid turnaround and the resulting cost savings in labor make NIR an attractive new method of analysis.

Because the NIR method uses a library to compare the reflectance collected for the sample to the reflectance spectra collected for a known sample in its library, it is very important to label the sample correctly (alfalfa, cool-season grass hay, millet, corn silage, etc.) so the computer knows what library to use.

If the library for a feedstuff is large, NIR does a good job of determining the nutrient content. However, while NIR will give you some estimates of major minerals, it doesn't do a good job of determining mineral content. The reason: NIR is based on light reflectance from organic material in a sample, and minerals are inorganic. So, if you need a mineral analysis, consider using the chemical method.

Components of an NIR analysis

Percent **dry matter** (DM) is the percentage of feed that is not water. In contrast, moisture is a measure of the amount of water in the feed on an "as is" or "as fed" basis. Moisture dilutes the concentration of all nutrients. This is an important number because most diets are formulated on a DM basis. Then, using the DM percentage, they are converted to the amount of feed needed to be fed.

Percent **crude protein** (CP) measures nitrogen (N) concentration, which is a component of protein; usually approximately 16% of the protein is nitrogen. However, CP will measure both true protein and nonprotein nitrogen because the actual measurement is percent nitrogen. Therefore, there is little distinction between actual protein and nonprotein nitrogen sources such as urea or whether the protein is utilized by microbes in the rumen or bypasses ruminal fermentation.

The new **metabolizable protein** (MP) system, which was introduced in the 1996 National Research Council (NRC) *Nutrient Requirements for Beef Cattle,* incorporates degraded intake protein (DIP) and undegraded intake protein (UIP, or bypass protein). The DIP and UIP percentages must total 100% of the protein and are normally expressed as a fraction of the CP. So, if the DIP of a forage is 70%, then UIP is 30%. If the CP of that same forage is 10%, then DIP is 7% of DM (10% × 0.7 = 7% DIP), and the UIP is 3% (10% × 0.3 = 3% UIP).

DIP and UIP are normally measured via in vitro digestibility, but can be based on

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animal performance models comparing known protein sources. It is probably best to use book values for DIP and UIP, because most commercial labs are not set up to make these determinations.

Insoluble crude protein (ICP), acid detergent insoluble nitrogen (ADIN), unavailable nitrogen and heat-damaged protein all refer to nitrogen (or CP) that has become chemically linked to carbohydrates to form an indigestible compound. The overheating that causes this reaction is most common in silage stored at less than 65% moisture and in hay bales or stacks that contain more than 20% moisture. Heat-damaged feeds often have an amber, tobacco brown or charcoal discoloration and a caramelized odor, but sometimes no discoloration occurs.

Some ICP normally is present in feeds. In an NIR analysis, when the ICP/CP ratio is above 0.1, excessive heating probably has occurred, causing reduced protein digestibility. When this occurs, CP values should be adjusted downward to more accurately balance rations for protein.

Adjusted crude protein (ACP) is a calculated protein value corrected for heat damage. It should be used in place of CP to balance rations whenever ICP/CP exceeds 0.1. Most laboratories will compute and report the ACP for forages analyzed for both protein and ICP. If the ACP number is not the same number that is reported as %CP, then use the ACP number. If the CP and ACP numbers are not the same, it indicates that there has been some heat damage in the forage.

Digestible protein (DP) is reported by some laboratories. Although potentially useful in specialized situations, nearly all common ration formulations, as well as approved nutrient requirements, are based on CP and have been adjusted for digestibility. Do not use DP values except with guidance from a reputable nutritionist.

Crude fiber (CF) is an old, well-known fiber determination. Newer fiber methods are much more useful measures of nutritional value. Use acid detergent fiber and neutral detergent fiber analyses instead of CF to evaluate forages and formulate rations.

Neutral detergent fiber (NDF) measures the structural part of the plant, the plant cell wall. NDF gives bulk or fill to the diet and, as a result, limits intake. Because NDF can be used to predict intake, it is one of the most valuable analyses to have conducted on forages for dairy rations, and can be useful for beef rations that primarily rely on forages. Low NDF usually is desired. As maturity of the plant at harvest increases, cell wall content of the plant increases, and NDF increases.

Acid detergent fiber (ADF) primarily consists of cellulose, lignin, silica, insoluble CP and ash, which are the least digestible parts of the plant. Because ADF percentage in forages negatively relates to digestibility, it is used to calculate energy values. ADF is one of the most common analyses made, particularly on forages. Low ADF usually is preferred because it means higher net energy. As the plant matures, ADF increases.

Digestible dry matter (DDM) estimates the percentage of forage that is digestible. It is calculated from ADF using an equation. This number is not used in balancing diets for beef cows.

Net energy (NE) is the energy available to an animal in a feed after removing the energy lost as feces, urine, gas and heat produced during digestion and metabolism. NE is the most useful energy estimate for formulating rations. NE includes net energy for maintenance (NE_m), net energy for growth (NE_g) and net energy for lactation (NE_l).

Total digestible nutrients (TDN) represents the total of the digestible components of crude fiber, protein, fat (× 2.25) and nitrogen-free extract in the diet. This value is calculated from ADF. Most rations now are formulated using NE; however, TDN is still used to calculate beef cow rations where the diet is primarily forage.

Relative feed value (RFV) combines digestibility (ADF) and intake (NDF) into one number for a quick, easy, effective way to evaluate the quality of alfalfa and/or haylages. It is used primarily with legume or legume/grass forages. RFV is most valuable for formulating diets for dairy cows. It provides an index to rank a forage according to its digestible energy intake potential. RFV has also been used widely in hay marketing.

What nutrients to measure

The primary nutrients for which cow-calf producers should analyze a forage are moisture (or DM), percent CP, and a measure of energy (TDN, NE_m or NE_g). Because beef cow diets are typically balanced for energy using TDN, get an estimate of TDN. If the forage is going to be used to formulate development diets, then make sure the sample is analyzed for NE_m and NE_g as well. NIR will give estimates of four minerals: calcium (Ca), phosphorus (P) potassium (K), and magnesium (Mg). If the mineral profile that an animal is consuming is a concern, then a full mineral profile using wet chemistry may be warranted.

Table 2: Potentially toxic levels of nitrates using different reporting methods

Method of reporting nitrate	% of DM	ppm*, DM basis
Nitrates (NO_3)	1.00%	10,000 ppm
Nitrate nitrogen (NO_3N)	0.22%	2,200 ppm
Potassium nitrate (KNO_3)	1.60%	16,300 ppm

*ppm = parts per million.

Nitrates

High nitrates could be a problem for cattle producers planning to feed or graze annual forages such as corn, cane, grain sorghum, millet and Sudan grass. When plants are growing normally, they absorb nitrates from the soil, but stress factors, such as drought or hail, interrupt plant growth, reducing photosynthesis and conversion of nitrates to plant proteins.

High nitrate levels in forages can cause nitrate toxicity in cattle, which can kill the animal or cause abortions in pregnant cows. Weeds such as pigweed, lamb's-quarter, ragweed and, to a lesser extent, Russian thistle, have the potential to be high in nitrates.

When reading a nitrate analysis report, producers should look at how the nitrate levels are expressed (see Table 2). The method used in expressing nitrates will determine what level is toxic to an animal.

With proper management, high-nitrate forages can be fed safely. Dilute high-nitrate feeds with low-nitrate feeds. Also, adapt cattle to diets that contain nitrates. Most losses from nitrates occur when hungry cattle are exposed to feeds that are high in nitrates.

Some producers may feed drought-stricken corn as "green chop." If you do this management practice, set the chopper head up to avoid the bottom 6-8 in. of the cornstalk. Most of the nitrates reside in the lower portion of the stalk. Assume that there are nitrates present, so adapt slowly. Chop only what will be fed in one feeding and do not let green chop sit in the wagon overnight to feed the next day. In green chop that contains nitrates and sits overnight, the nitrate will be converted to nitrites, which are more toxic to the animal than nitrates.

Final thoughts

Testing forages for nutrients is a management tool that cow-calf producers need to use because quality can vary tremendously. Because the main expense of a cow-calf enterprise is feed, these analyses can help you determine if additional protein or energy supplements are needed.

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Editor's Note: *"Ridin' Herd" is a monthly column written by Rick Rasby, professor of animal science at the University of Nebraska. The column focuses on beef nutrition and its effects on performance and profitability.*