

INTERPRETING FORAGE QUALITY TEST REPORTS

*Donna M. Amaral-Phillips, Ph.D.
Department of Animal and Food Sciences
University of Kentucky*

Forages are the foundation for building diets for beef and dairy cattle, horses, sheep and goats. The quality of these forages directly impacts forage intake, animal performance, and, ultimately, the profitability to their owners. As the quality of forages decline, consumption of that forage decreases and the amount of grain or byproducts which must be fed increases. The cost for a unit of performance increases and/or the animal can not perform (i.e. milk or gain) to the optimum level thus lowering profitability to the animal owner. These relationships are especially true with young and high performance ruminants, such as high producing dairy cows and stocker beef cattle with expected high rates of gain. To determine the quality of forage and its best use, a representative sample of the forage needs to be analyzed for its nutrient content by a forage testing laboratory. These results then can be used to not only market this forage but also to balance rations for livestock for optimum and profitable performance.

Why Test Forages?

One question often asked is, “Why should I test my forage before I sell or feed it to my livestock?” The answer to this question depends on whether you are the grower of the forage or the livestock owner. These reasons can be described as the following:

Livestock Owner: Forage analysis results are used to balance rations to support an expected level of animal performance. You want to purchase forages based on a forage analysis so that the forage matches the needs of your livestock and that you pay an appropriate price for that forage.

Forage Grower: First, forage analysis results are used to target the sale of specific lots of hay or other forages to specific animals that the quality will support expected performance. This can improve the satisfaction of the buyer and improve chances for future sales of your product.

Secondly, results from forage analyses should be used to evaluate a grower’s cropping methods. Specifically, the question becomes, “Are there ways to improve the quality of the hay or other forages being sold?” Often times, we use the weather as the reason for lower

quality forages being harvested when the more pressing reason is lack of timely harvest irrespective of the weather.

Representative Samples Are Critical

To determine the quality of a forage, representative samples must be collected and these samples need to be analyzed by a forage testing laboratory. For bales of hay, 15 to 20 separate bales from each lot of hay should be cored using a hay probe. (A lot of hay or silage is defined as forage from the same field that has been cut, handled, and stored under similar conditions.) For square bales of hay, the hay probe should be inserted between the string or wire in the center of the bale on the butt end. For round bales of hay, a sample should be taken from the curved side with the hay probe perpendicular to the side. The entire half pound sample (approximately a quart of material) should be packaged in a “zip lock” plastic bag and sent to a forage testing laboratory for analysis.

Grab samples or flakes of hay will not provide uniform samples for analysis and will not indicate the true nutritive content of the hay when fed to livestock. As shown in table 1, samples collected from a single “flake of hay” are higher in fiber (ADF) and lower in crude protein than the hay sampled using a hay probe. The nutrient content of grab samples reflects the percentage of leaves and stems which are retained in the sample submitted for analysis and do not reflect the quality of the forage available to livestock.

Table 1. Effect of sampling technique on the nutritive values of alfalfa hay.

Sample Technique	Dry Matter (%)	ADF (%)	Crude Protein (%)
22 bales sampled with hay probe	86.6	29.9	16.4
Flake of hay	85.6	34.2	14.5
Grab sample - mainly stems	84.9	39.7	11.6
Grab sample - mainly leaves	83.8	23.1	20.8

Coleman and Milligan, 1989

For silage samples, 15 subsamples should be collected from various locations across the face of a bunker or pile or throughout the unloading process. The samples should be mixed within a bucket and approximately a quart of material should be double bagged and sent for analysis. Samples should be sent at the beginning of the week to ensure they arrive at the laboratory in a timely manner.

Wet Chemistry Versus NIR Method of Analysis

Forage samples are analyzed by forage laboratories using either wet chemistry or near infrared reflectance spectroscopy (NIR) method of analysis. With wet chemistry methods, forage samples are analyzed by a series of chemical methods to determine their nutritive content. In contrast, NIR methods utilize light to quickly determine the nutritive content of a forage. NIR machines are calibrated with equations developed from data collected by wet chemistry methods. For traditional forages raised under “normal” growing conditions, either method is accurate in determining the nutritive content of a forage.

Terminology Used on a Forage Analysis Report

Dry Matter Content – Amount of forage remaining after all the water has been removed from the sample. The results are reported on a percentage basis. Dry matter percentage plus the moisture percentage equals 100 percent.

Moisture Content – Amount of water contain in a forage sample reported on a percentage basis. Dry matter percentage plus the moisture percentage equals 100 percent.

Acid Detergent Fiber Percentage (ADF%) – ADF refers to the fiber fraction containing the cell wall components of cellulose, lignin and silica. Lignin is indigestible whereas cellulose can be digested by the rumen microbes or bugs. Generally, ADF has been used to predict digestibility and thus energy content of a forage . The lower the ADF content, the higher the digestibility and the higher the energy value of a forage.

Neutral Detergent Fiber Percentage (NDF %) – NDF refers to the fiber fraction containing all cell wall components including hemicellulose, cellulose, and lignin. As the NDF content of a forage increases, the amount of the forage a ruminant will consume generally decreases.

NDF Digestibility – refers to the extent that NDF is digested within a defined time period (generally 30 to 48 hours) when the forage sample is cultured in rumen fluid in a laboratory setting. The greater the NDF digestibility, the more nutrients cattle will receive from a given amount of forage, intake of the forage may be improved, and animal performance may be increased.

Relative Feed Value (RFV) is an index used to compare the quality of a tested hay or balage to full-bloom alfalfa hay which is assigned a value of 100. Only the ADF and NDF content of the hay is used to calculate the relative feed value. The protein content of a hay is not reflected in the relative feed value. Within a type of hay, the higher the RFV, the greater the quality of the forage. Because alfalfa generally contains less fiber, alfalfa hay or balage has a higher relative feed value than grass hay at the same stage of maturity.

Relative Forage Quality (RFQ) – is an index to compare the quality of tested hays. This index takes into account the NDF digestibility of a forage. Again, the higher the index, the higher the quality of forage tested.

Crude Protein Percentage – is calculated by forage testing laboratories by measuring the nitrogen content of a forage and multiplying that result by 6.25 - the nitrogen content of an “average amino acid.”

Ruminally Degraded Protein (RDP) – is the fraction of protein which is broken down to ammonia within the rumen. The rumen bacteria then use the ammonia along with an energy source to synthesize microbial protein. Microbial protein is broken down to amino acids in the small intestine and can supply 60 to 80% of the amino acids or protein needs of cattle.

Total Digestible Nutrients (TDN) – is the percentage of digestible material and reflects the amount of energy cattle can derive from a forage or feedstuff. TDN values are calculated through mathematical equations and are not measured in the forage analysis laboratory. Laboratories calculate TDN and other energy values using ADF values or, more recently, equations incorporating the values for various nutrients such as crude protein, NDF, fat, ash, and non-structural carbohydrate content of forages.

Net Energy for Lactation (NE_L) – the concentration of energy (expressed as Mcal per pound) available to support maintenance and milk production of a lactating cow. This unit is the preferred measure of energy for lactating dairy cows. Like other energy values, laboratories use mathematical equations to generate these values. They are not measured in a forage testing laboratory.

Net Energy for Maintenance (NE_M) – the concentration of energy available to support the maintenance requirements of non-lactating cattle and other ruminants. Equations are used to generate these numbers and they are not measured in the forage testing laboratory.

Net Energy for Gain (NE_g) – the concentration of energy available for body tissue or weight gain in non-lactating cattle and other ruminants. Cattle use energy less efficiently for gain than maintenance thus reflecting the lower value. Equations are used to generate these numbers and they are not measured in the forage testing laboratory.

Forage Quality Reports

The format for presenting results on a forage analysis report varies from lab to lab, but, generally, all contain information on the dry matter, moisture, crude protein, acid detergent fiber, neutral detergent fiber, relative feed value, total digestible nutrients, and net energy for lactation content of forages. Additional nutrients also can be analyzed and the results displayed on the report. Additional nutrients can include content of specific minerals both macro and trace minerals (i.e. calcium, phosphorus, zinc, copper), crude fat or ether extract, non-structural carbohydrates and ruminally degradable protein content to name a few.

Figure 1. Example of a forage Analysis Report

Lab #	010		
Identification	Alfalfa-Grass		
		Dry Matter Basis	As Fed Basis
Moisture		0%	10.4%
Dry Matter		100%	89.6 %
Crude Protein		19.3%	17.3%
Acid Detergent Fiber		29.8%	26.7%
Neutral Detergent Fiber		39.3%	35.2%
RFV		155	
Total Digestible Nutrients		66.2%	59.4%
Net Energy Lactation		0.68 MCAL/LB	0.61 MCAL/LB

Compare Nutrients on Dry Matter Basis

On a forage quality report, the nutrient analysis is presented on both an as fed and dry matter basis. The “as fed basis” numbers reflect the concentration of the various nutrients as they were received by the laboratory with all of the water in the sample. The “dry matter basis” column reflects the concentration of the nutrient after all the water is removed from the sample. Because water dilutes the concentration of nutrients, the concentration of a particular nutrient is higher on a dry matter basis. When comparing the concentration of nutrients found in a forage, comparisons should be made using the dry matter column. Making comparisons on a dry matter basis removes the variation caused by differing moisture content of hays, balages, or haylages.

Moisture Content of Hays

Hay should contain less than 14 percent moisture or more than 86 percent dry matter. Wetter hays are prone to molding. In addition, the purchaser will be paying additional money for the water in the hay which does not provide needed nutrients to livestock.

Quality of Hay = Performance and Profitability

With advancing stage of plant maturity, fiber digestibility and protein content of legume and grass plants decreases while the amount of fiber increases. Consequently, less energy is available to livestock when they consume more mature plants. Energy is the

nutrient that most often limits performance in dairy and beef cattle and other ruminants – not protein.

With energy being the hardest nutrient to provide cattle and other ruminants, **the most important numbers on a forage analysis report are acid detergent fiber (ADF) and/or neutral detergent fiber (NDF) content.** These numbers ultimately relate to the amount of energy available to support milk production, growth, and reproduction. The ADF content reflects the digestibility and amount of energy cattle can obtain from the forage. The NDF content reflects the potential intake of the forage. As the fiber content increases (both ADF and NDF), the digestibility, energy content and potential forage intake decreases. These changes ultimately affect performance and profitability. Protein content is a distant second in importance to fiber content when determining which hay, balage, or haylage to purchase or feed to a group of livestock.

Within a type of hay, the higher the relative feed value, the greater the quality of the forage. Because alfalfa generally contains less fiber, alfalfa hay generally has a higher relative feed value than grass hay at the same stage of maturity. Table 2 lists the different quality standards for alfalfa or grass hay and their corresponding nutrient composition.

Table 2. Alfalfa, Alfalfa/grass mixture, or grass quality.

Category	Relative Feed Value	ADF (%)	NDF (%)	Crude Protein
Prime	> 151	< 30	< 40	> 19
1	125 - 150	31 - 35	40 - 46	17 - 19
2	103 - 124	36 - 40	47 - 53	14 - 16
3	87 - 102	41 - 42	54 - 60	11 - 13

Source: *AGR 131, Alfalfa Hay Quality Makes the Difference*

The quality of hay, balage or haylage needed by a particular animal is governed by the animal's nutrient needs. The higher the nutrient demands on the animal, the higher the quality of forage needed to economically support that performance level. Table 3 illustrates this concept as it relates to various qualities of alfalfa hay fed to dairy or beef cattle.

Table 3. Recommended uses for various qualities of alfalfa.

Relative Feed Value	Uses for dairy cattle	Uses for beef cattle
Over 180	Excellent forage but needs to be fed with other forages	
150 to 180	High-producing dairy cows and calves under 3 months of age	
120 to 150	Low-producing dairy cows and young heifers over 4 months of age	Background or stocker cattle, fresh beef cows or heifers
100 to 120	Dry cows (check potassium level in diet of close-up dry cows) and older heifers when fed with corn silage	Dry beef cows 3 months before calving
under 100		Mid trimester beef cows