Forage Analysis Interpretation

A Self-Learning Resource From MSU Extension

MONTANA STATE UNIVERSITY EXTENSION

MontGuide

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Forage analyses are an important tool in livestock nutrient management. Understanding your forage analysis, and how it can impact your ration feeding program, is vital to maintaining herd health, improving productivity, and decreasing forage waste.

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UNDERSTANDING FORAGE ANALYSIS IS IMPORTANT when determining how to balance livestock rations. Forages should be the basis of any livestock or equine diet, and as such, should be sampled to better acheive required daily nutrient intake. The utility of an analysis begins with proper forage sampling. For tips and how to collect material for analysis, refer to the MontGuide, *Collecting a Forage or Feed Sample for Analysis* (MT201610HR).

Once a sample is obtained and sent to a certified forage testing lab, an analysis should be complete in 7-10 days, depending on which lab, time of year, and the selected analysis. For a complete list of certified labs, log on to the Forage Extension web page at http://animalrangeextension.montana.edu/forage. Lab analyses come in many forms, and there are many tests that can be requested. To help interpretation, the available tests are outlined below. This information can then be utilized in a ration balancing program, by a nutritionist, a county Extension agent, or yourself when formulating what and how much to feed animals. Consult Table 1 (page 2) for an example forage analysis with the following nutrients.

As Received Basis

These values represent the nutrient content with the moisture included. This analysis represents the "as-fed" condition of forage. Due to the presence of water, these values are lower than those in the dry matter basis column. These values can be converted to a dry basis by dividing the received values by the sample's percentage dry matter. See the attached forage analysis.

Example:

11.0 (% CP as received) ÷ 0.8515 = 12.9% CP "as fed"

Dry Matter Basis

The values in this column give the nutrient profile after water is removed. These values are greater than those in the "as received" column. The removal of water removes seasonal and storage conditions allowing for direct comparisons to be made between feed ingredients. Using nutrients on a dry matter basis makes balancing rations easier because animal requirements are generally reported on a dry matter basis. Dry matter values can be converted to an as received basis by multiplying the dry matter value by the percentage dry matter.

Example:

42.1 (% ADF dry matter basis) × 0.8515 = 35.8

Moisture

The amount of water in forage. These values may vary based on the season the material is collected (winter range grasses vs mid-summer hay) and storage method (open or covered stack yards).

Protein

Crude Protein (CP)

Labs measure the Nitrogen (N) content of forage to estimate CP (% CP = % N × 6.25). However, this measure includes both non-protein nitrogen and true protein. Thus, CP provides the total protein within forage and does not indicate if any heat damage has

TABLE 1. Example forage analysis recieved from a certified commercial forage testing lab.

Description: Grass Hay	Analysis as Recieved	Analysis dry Basis
Moisture, %	14.85	0.00
Dry Matter, %	85.15	100.00
PROTIEN		
Crude Protien, %	11.0	12.9
FIBERS		
Acid Detergent Fibers, %	35.8	42.1
Neutral Detergent Fibers, %	50.7	59.6
NDFD (digestibility) 48 hr, % of NDF	-	20
IVTDMD (in vitro true digestibility) 48 hr, %	49.6	58.2
ENERGIES		
TDN Est., %	46.5	54.6
Net Energy Lact, MCal/lb	0.4709	0.5531
Net Energy Maint, MCal/lb	0.4359	0.5119
Net Energy Gain, MCal/lb	0.2201	0.2585
QUALITY VALUE		
Relative Feed Value	-	88
Relative Forage Quality	-	85
Starch, %	-	-
MINERALS		
Calcium, % Ca	1.03	1.21
Phosphorus, % P	0.13	0.15
Potassium, % K	1.31	1.54
Magnesium, % Mg	0.12	0.14
Ash, %	1.05	1.23
OTHER ANALYSIS		
Fat, %	10	12
Lignin, %	9.55	11.21
Non Fiber Carbohydrates, %	21.9	25.8
Water Soluble Carbohydrates, %	5.0	5.9

occurred, which could alter the availability of protein. Three protein portions may be analyzed, depending on the analysis selected and what is offered by the lab: degradable, undegradable, and ADICP.

Degradable Protein This is the portion of CP that is degraded within the rumen by rumen microbes to ammonia or amino acids. This portion supplies the rumen microorganisms with N and enables them to make bacterial crude protein which can be supplied to the animal. This portion includes non-protein nitrogen.

Undegradable Protein Undegradable protein is the portion of CP that is not degraded within the rumen. This portion is often referred to as bypass protein or escape protein. Undegradable protein may be degraded in the small intestine which can provide unaltered amino acids to the animal.

ADICP (Heat Damaged Protein) This is also known as the insoluble crude protein fraction. This occurs during overheating when forage is baled at greater than 20% moisture or when silage is stored with less than 65% moisture. The fraction is rendered insoluble due to the N (amino acids) binding to carbohydrates, and is unavailable to the animal. When this fraction is greater than 10%, the CP needs to be adjusted to actually estimate the amount available to the animal. If adjustments need to be made, then the adjusted crude protein should be used for ration formulation. This is an additional forage test that can be conducted at an additional cost, and it is highly recommended if heating is suspected.

FIBER

Lignin

Lignin is a component of cell wall structure and is responsible for plant structure and rigidity. Lignin is poorly digested within the rumen by microbes, or by mammalian enzymes. As forage matures, cell walls will become more lignified and less digestible. High ambient temperatures also increase lignification of forages. The higher the lignin content the lower the amount of nutrients available to the animal.

Acid Detergent Fiber (ADF)

The acid detergent fiber encompasses the cellulose and lignin portions of the cell wall. This number is crucial in determining forage digestibility. As ADF increases, forage digestibility decreases. Crude fiber, net energy, total digestible nutrients (with most lab analyses), and digestible dry matter are calculated using ADF.

Neutral Detergent Fiber (NDF)

The NDF includes the ADF portion plus hemicellulose. The NDF value is important for determining forage dry matter intake. As NDF increases in forage, dry matter intake decreases.

Non-fibrous Carbohydrates (NFC)

These are also known as non-structural carbohydrates and are carbohydrates that are not part of the cell wall or structural fiber. The NFC includes carbohydrates such as starch and sugars that can be broken down by mammalian enzymes, and are an energy source to the consuming animal. Lignin, cellulose and hemicellulose are not included in the NFC value.

ENERGY

Fat

This may also be labeled as ether extract. This is the crude fat content of forage. Fat has 2.25 times the energy density of carbohydrates or proteins. These are oils and other compounds that are naturally found in forages.

Total Digestible Nutrients (TDN)

This is the sum of the digestible fiber, protein, fat, and carbohydrate components of the forage. In most laboratory analyses, TDN is usually calculated based on ADF and NDF and can vary by region and diet type. Typically, high quality forages like alfalfa range from 50 to 60% TDN while low quality forages like mature grasses range from 40 to 50% TDN. Using TDN in ration calculations is best for rations that are primarily forage. In contrast, the net energy system should be used in diets that include high concentrations of grain because TDN tends to underestimate the feeding value of concentrate feeds.

Net Energy of Maintenance (NEm), Net Energy of Lactation (NEl), and Net Energy of Gain (NEg)

The Net Energy system accounts for the energy losses from digestion of feeds and forages. Net energy estimates the portion of energy in a forage that meets maintenance and production requirements. Net energy is partitioned into the net energy of maintenance (no body weight gain or loss), net energy of lactation (milk production), and net energy of gain (body weight gain). The net energy system should be used for diets containing high concentrations of grains or high quality alfalfa hay. Unlike TDN, NEg tends to overestimate the energy value of concentrates relative to forages. Net energy values are usually calculated from TDN values, which are calculated from ADF. Therefore, as ADF increases in forage, net energy values will decrease.

Example:

NEl, Mcal/lb = (% TDN × 0.01114) – 0.054

NEm, Mcal/lb = (% TDN × 0.01318) – 0.132

NEg, Mcal/lb = (% TDN × 0.01318) – 0.459

Relative Feed Value (RFV)

Relative Feed Value is an index that utilizes the fibrous portion of the forage to compare similar forages. Focus on the fiber portion means RFV is calculated from ADF and NDF. The RFV index scale varies above and below a base index value of 100, which represents an alfalfa forage at 100% bloom. Forages with an RFV greater than 100 are considered to be higher quality forages than alfalfa at full maturity, and those with an RFV less than 100 are considered to be lower quality forages. As NDF and ADF increase, the RFV will decrease. Grasses provide good nutrition to animals, but are higher in fiber than legumes. However, the fibrous portion of grasses is usually more digestible than that of legumes; therefore, grasses will be undervalued by the RFV system. While RFV is not useful for ration formulation, it is an effective measure to compare hay lots. The utility of this measure is lowered if used to compare a legume to a grass hay, or a mixed hay to grass hay. One main limitation of the RFV system is it assumes a constant relationship between NDF and intake and between ADF and digestibility. The NDF, ADF, and RFV may be identical between two forages, but the two forages can have widely different intakes and digestibility.

Example:

RFV = [DMI (% of BW) × DDM (% of DM)] ÷ 1.29

Digestible Dry Matter (DDM; % of DM) = 88.9 – [0.78 × ADF (% of DM)]

Dry Matter Intake (DMI; % of DM) = 120 ÷ NDF (% of DM)

Relative Feed Quality (RFQ)

Relative Feed Quality is a more advanced system to compare forages, as compared to RFV. The system is similar to RFV, but the RFQ system utilizes digestibility in addition to fiber content to estimate quality of the forage. The RFQ system is an improvement over RFV to compare forages because it estimates forage intake and digestibility by incubating the forage with rumen fluid containing microorganisms in a digestion simulation. It accounts for the fact that grasses have higher amounts of fiber when compared to legumes, even though fiber in grasses is usually more digestible. Therefore, the RFQ system is a more accurate predictor of forage value and animal performance than RFV.

Example:

RFQ= [DMI (% of BW) × TDN (% of DM)]/ 1.23

TDN* = (NFC × 0.98) + (CP × 0.93) + (FA × 0.97 × 2.25) + (NDFn × (NDFD/100)-7)

* Or you can use the TDN provided on your forage analysis; FA = fatty acid, or fat content on analysis: NDFn (nitrogen-free NDF) = NDF x 0.93

MINERALS

The most common minerals analyzed for forage analysis include the macro minerals calcium, phosphorus, potassium, magnesium, and sulfur. Trace minerals, such as copper, selenium, iron and cobalt, among others, are typically not analyzed in a standard forage test and must be requested specifically for an additional cost. Trace mineral values are expressed in parts per million (ppm) and macro minerals are expressed as a percentage.

Ash

This represents the total mineral content of forage and typically ranges from 3 to 12% on a dry matter basis. Grain and concentration diets usually range between 1 to 4% ash. Excessive amounts of ash indicate soil contamination.

OTHER ANALYSES

Nitrates

Plants under stress can accumulate excessive amounts of nitrates. Forage crops such as corn and small grains (oats, wheat, and barley) are of highest concern for nitrate concentrations, followed by some weeds and grasses. Legumes are least likely to accumulate excessive nitrate. The greatest concentrations of nitrates are found in the lower stem. Green chop forage has the highest risk of nitrate toxicity, followed by grazing and then hay. Feeding silage is generally thought of as the least risky because most of the nitrate is converted to other compounds during ensiling. This is an additional forage test that can be conducted at an additional cost. For more specific information on nitrates and nitrate toxicity, please refer to the Montguide, *Nitrate Toxicity of Montana Forages* (MT200205AG).

Mold and Yeast Counts

Mold and yeast counts are especially important in forages and grains that have been subjected to increased moisture. Mold and yeast counts are also important for silages, which will determine if microbial changes in a silage will degrade nutrient content. Yeast counts in silage can also be indicative of unstable or hot silage. Mold counts are important in higher moisture forages, and some labs will evaluate the species of molds present. However, identifying the species of mold does not account for any mycotoxin production. Not all hay contains mold, however hay that is baled between 20-35% has an increased risk of mold presence. Also, hay that has been rained on or hay that has come in contact with a wet surface (i.e. wet soil) is at increased risk for presence of mold.

Mycotoxins Mycotoxins are toxins produced by molds. If mold is present in the forage in counts higher than 1,000,000 colony forming units (cfu) for horses and ruminants, it may be necessary to get a mycotoxin screen analysis, which can be expensive. Therefore, it is important to identify the species of mold, which will narrow the mycotoxins to test for. Small concentrations of mycotoxins can be toxic to animals. A few of the common mycotoxins are aflatoxin, vomitoxin (deoxynivalenol; DON), fumonisin, and zearalenone. Submit mold samples to the MSU Schutter Lab (diagnostics@montana.edu or 406-994-5150) for identification before sending to a commercial or private lab for a mold count.

FOR MORE INFORMATION

Visit http://animalrangeextension.montana.edu/forage or http://animalrangeextension.montana.edu/beef/ for more information and resources related to forage quality and animal nutrition.

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