Interpreting Your Forage Test Results

Forage analysis can be a valuable management tool. However, the information can only be as good as the sample taken, and only bring value when viewed with a good understanding of what the numbers mean and how they were obtained.

First, it is important to understand the practical precision of the values reported. There will be some variation between labs, due to technique, equipment and people. Over the long term, it is best to always use the same lab to remove this potential discrepancy when comparing different reports. There is also a limit to how precisely the analytical procedures can measure the items of interest. We typically assume actual crude protein (CP) of a sample is within plus or minus 0.5 percentage units of what is reported, NDF within 0.8, and ADF 0.7.

Also keep in mind that only some of the values given in a forage analysis are actually measured. The others are calculated by plugging measured value(s) into equations that have been designed to estimate various items that may be of practical interest.

MEASURED VALUES

Dry Matter (DM)	*All moisture is removed from the sample, typically in a forced air oven; % DM is determined by dividing the dry sample weight by the received sample weight.* Dry matter is important: ▪ When purchasing feed, so you can calculate cost per unit of nutrients; ▪ When balancing rations and determining how much 'as-fed' feed to deliver; and, ▪ As a possible flag for potential storage issues. Hay that is too wet can heat and mold, and haylage with too much or too little moisture will not preserve its nutrients well. Divide 'as-fed' values by %DM to get 'DM basis' values; Multiply DM basis X %DM for as-fed.
Crude Protein (CP)	*Nitrogen content is directly measured, a process now automated by use of specialized equipment in many labs. %CP is determined by dividing the %N by .16, since proteins found in feeds are typically 16% nitrogen.* ▪ CP includes 'true' complete amino acid proteins, peptides, and non-protein nitrogen ▪ Most hay proteins are true proteins; an exception is high nitrate accumulation ▪ Because protein is a relatively expensive essential nutrient, CP is a key indicator of value
Neutral Detergent Fiber (NDF)	*Samples are placed in filter bags and 'digested' with a standard NDF solution. %NDF is determined by dividing the weight of the remaining sample by the original weight.* NDF includes hemicellulose, cellulose and lignin – components of the forage cell wall that are slowly broken down in the rumen. It is used primarily as an indicator of voluntary intake. When high, it also signals an opportunity to increase forage utilization with supplemental soluble protein and energy from appropriate sources.
Acid Detergent Fiber (ADF)	*Samples are placed in filter bags and 'digested' with a standard acidic ADF solution. %ADF is determined as with NDF.* ADF includes cellulose, which is poorly digestible, and lignin (and any silica found in the sample) which are not utilized by cattle. Thus it is considered an indicator of the overall digestibility, or potential energy yield, of a forage. As ADF increases, energy estimates decrease.
Minerals	*Samples are 'digested' with chemicals and heat, then read with a spectrometer.* ▪ Macro minerals (calcium, phosphorus, magnesium, potassium, sodium and sulfur) are expressed as a %. The micro minerals (iron, zinc, copper, manganese, and molybdenum) are present at such low levels they are express in parts per million (PPM). ▪ It is possible to have too little or too much of most minerals in the diet. ▪ The primary value in testing mineral level in forages is to monitor for significant variation from typical concentrations for a particular feed. If found, the supplemental mineral program can be altered accordingly.
Chloride Ion	*Concentration determined by titration.* Needed for accurate calculation of DiCad (see below). Also, because cattle have a specific appetite for salt, it is included in many supplements at a prescribed level calculated to drive a specific level of intake. If the chloride content in the forage is significantly higher or lower than assumed, then supplement intake may vary from expected.

CALCULATED VALUES

Non-Fiber Carbohydrates (NFC)	*Calculated as 100% - %NDF - %CP - % fat - % ash. If any component of the equation was not requested for analysis, standard values for the feedstuff are used.* NFC is considered to represent starch, sugars, pectin, and any fermentation acids (i.e., in silage). These are all energy sources that are digested more easily and rapidly than fiber. However, they can vary greatly in rate, site and extent of digestion, limiting the practical usefulness of NFC – especially when comparing diverse feeds. The reported value will reflect the cumulative errors of the four measures or assumptions used.
Total Digestible Nutrients (TDN)	*Historically calculated from ADF only; current equations take values (measured or assumed) for potentially available fiber, fat, protein, and other carbohydrates. Each is multiplied by an assumed digestibility factor, and summed.* TDN functions as a usable estimate of the energy content of a feed, and the starting point for other energy calculations. It is adequate for comparing and valuing forage energy content. It cannot precisely predict energy-driven animal performance.
Net Energy (NEm, NEg)	*Further calculations, tied to TDN, have been established in an attempt to more precisely predict a feed's ability to meet needs and support production.* NEm and NEg are typically used in balancing beef cattle rations. They are two different ways to express the energy concentration in a feed, not two distinct fractions. In the real world, they are not static, but are impacted by the total feeding program (*see below*).
Relative Feed Value (RFV)	*Combines ADF and NDF in a formula to give an indexed energy value for dairy cows.* Seldom used in beef cow nutrition. Beef cows use energy differently than dairy cows, and the formula was not designed with consideration for the type of forages typically fed to beef herds.

Another word on energy values…

Net energy values attempt to account for the portion of dietary energy lost to manure, urine, gas, and the actual process of digestion, leaving the energy truly available to the animal for maintenance, milk production, and growth. While we can express net energy as NEm or NEg (Net Energy for maintenance or growth), these are both terms for the exact same potential source of usable energy. The difference is simply expected efficiency of use. A cow will use energy for critical maintenance, pregnancy and milk production more efficiently than an animal would use that same energy for growth or tissue deposition. In practice, a cow or calf would use a portion of their dietary energy at the higher NEm yield rate to fuel essential life functions. Any additional energy available above these maintenance requirements would be used to put on weight, but those processes would transfer energy from feedstuff to body tissue at the NEg efficiency level.

To further complicate things, the actual amount of energy freed from a given feedstuff for potential use is directly impacted by animal, environment, and total diet factors. From a management standpoint, the dietary role can be significant. If a limiting nutrient (say protein or readily available energy) is added to the diet, the subsequent increase in rumen fermentation activity can effectively increase the NE of the forage. On the other hand, moderate levels of starch supplementation can lead to negative effects on fiber-digesting bacteria, which in turn lowers the NE yield of the roughage portion of the diet.

A lab report may also contain additional Net Energy values. NEl was historically used when dealing with the energy needs of lactation in dairy cows. It is generally assumed NEm values adequately represent energy efficiency of milk production in beef cows. There may also be values for DE (Digestible Energy), ME (Metabolizable Energy), or NE at specific levels of nutrient intake (i.e., "3X" symbolizing a diet containing 3 times the energy needed for maintenance only). These have been developed specifically for modern dairy animals, and do not provide any additional information for applied beef cattle nutrition.

Dietary Cation-Anion Difference (DCAD)	*Calculated balance between major positive (Na, K) and negative (Cl, S) ions in feeds.* While there is limited research in beef cattle, acidic diets may negatively impact intake and reproduction.