Understanding Feed Analysis

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Feed costs represent the largest annual operating cost for most commercial cow-calf enterprises. In order to maintain an optimum balance between feed costs and production, feeds must be analyzed and these analyses used to formulate rations and (or) supplements. Feedstuffs vary widely in nutrient concentration due to location, harvest date (maturity), year, and other management practices. Tabular values may be used if necessary, but it is important to remember that they are average values and that significant variation exists. On a dry matter basis, energy can easily vary ±10%, crude protein ±15%, and minerals by a much greater margin.

Once a feed sample has been collected properly (see Sampling Feeds for Analysis NebGuide G331; PDF version), it can be analyzed for nutrients. Most commercial laboratories offer standard feed tests for forages, grains, or total mixed rations. Analyzing cattle feeds for moisture, protein, and energy is recommended. Furthermore, you may wish to identify key minerals or minor nutrients of interest. Typically, results are reported on an as-is and dry matter basis. Nutrients should always be balanced on a dry-matter basis because nutrient requirements for beef cattle are reported on a dry-matter basis. After formulation on a dry-matter basis, values can be converted to an as-is basis (using the moisture content of the feed) to determine the actual amount of feed (as-is) that should be fed.

Feedstuffs can be analyzed using traditional wet chemistry technique or near infrared reflectance spectroscopy (NIR). Samples can be analyzed more quickly, and usually cheaper, using NIR. However, NIR is only useful for feedstuffs and ingredients that have been well characterized using wet chemistry. Therefore, be sure to ask the laboratory if their database for your particular sample is extensive enough to ensure accurate results, particularly if you are analyzing less common feedstuffs.

The primary focus of this module is on understanding and applying the results from a commercial feed analysis. Table 1 lists common nutrients and the units in which they are reported.

Table 1: Feed ingredients and their units of measure.

Nutrient	Common Units
Moisture	%
Crude Protein	%
Total Digestible Nutrients	%

Neutral Detergent Fiber %

Acid Detergent Fiber %

Net Energy Mcal / lb

Calcium %

Phosphorus %

Copper, Zinc ppm

Vitamins IU / lb

The following explanations are categorized by nutrient and define terminology that one will receive on a feed analysis.

Moisture

Dry Matter (DM): Dry matter is the moisture-free content of the sample. Because moisture dilutes the concentration of nutrients but does not have a major influence on intake (aside from severe deprivation), it is important to always balance and evaluate rations on a dry-matter basis.

Digestible Dry Matter (DDM): Calculated from acid detergent fiber (ADF; see below); the proportion of a forage that is digestible.

Protein

Crude Protein (CP): Crude protein measures the nitrogen content of a feedstuff, including both true protein and non-protein nitrogen. In ruminants, evaluation of the fraction that is degradable in the rumen, degradable intake protein (DIP), versus the rumen-undegradable fraction, undegradable intake protein (UIP), is also important. However, the rumen degradability of protein is not measured in most commercial labs. Therefore, it is recommended that rations be formulated using analyzed CP values and average values for DIP and UIP that can be found in the 1996 National Research Council Nutrient Requirements of Beef Cattle.

•Degradable Intake Protein (DIP): The fraction of the crude protein which is degradable in the rumen and provide nitrogen for rumen microorganisms to synthesize bacterial crude protein (BCP) which is protein supplied to the animal by rumen microbes. DIP also includes non-protein nitrogen found in feeds or ingredients.

•Undegradable Intake Protein (UIP): The rumen-undegradable portion of an animals crude protein intake. Commonly called "bypass protein" because it bypasses rumen breakdown and is mainly digested in the small intestine. Bypass protein is utilized directly by the animal because it is absorbed as small proteins and amino acids.

•Metabolizable Protein (MP): MP is protein that is available to the animal including microbial protein (BCP) synthesized by the rumen microorganisms and UIP.

Heat Damaged Protein or Insoluble Crude Protein (ICP): Nitrogen that has become chemically linked to carbohydrates and thus does not contribute to either DIP or UIP supply. This linkage is mainly due to overheating when hay is baled or stacked with greater than 20% moisture, or when silage is harvested at less than 65% moisture. Feedstuffs with high ICP are often discolored and have distinctly sweet odors in many cases. When the ratio of ICP:CP is 0.1 or greater, meaning more than 10% of the CP unavailable, the crude protein value is adjusted. Adjusted crude protein (ACP; see below) values should be used for ration formulation.

Adjusted Crude Protein (ACP): Crude protein corrected for ICP. In most nutrient analysis reports, when ACP is greater than 10% of CP, the adjusted value is reported. This value should be used in formulating rations when ICP:CP is greater than 0.1.

Digestible Protein (DP): Reported by some laboratories, do not use without the guidance of a nutritionist. Digestible protein values are not needed for most ration formulation because nutrient requirements and most formulation tools are already adjusted for protein digestibility. Furthermore, protein digestibility is influenced by external factors.

Fiber

Crude Fiber (CF): Crude fiber is a traditional measure of fiber content in feeds. Neutral detergent fiber (NDF) and acid detergent fiber (ADF) are more useful measures of feeding value, and should be used to evaluate forages and formulate rations.

Neutral Detergent Fiber (NDF): Structural components of the plant, specifically cell wall. NDF is a predictor of voluntary intake because it provides bulk or fill. In general, low NDF values are desired because NDF increases as forages mature.

Acid Detergent Fiber (ADF): The least digestible plant components, including cellulose and lignin. ADF values are inversely related to digestibility, so forages with low ADF concentrations are ususally higher in energy.

Energy

Total Digestible Nutrients (TDN): The sum of the digestible fiber, protein, lipid, and carbohydrate components of a feedstuff or diet. TDN is directly related to digestible energy and is often calculated based on ADF. TDN is useful for beef cow rations that are primarily forage. When moderate to high concentrations of concentrate are fed, net energy (NE, see below) should be used to formulate diets and predict animal performance. TDN values tend to under-predict the feeding value of concentrate relative to forage.

Net Energy (NE): Mainly referred to as net energy for maintenance (NEm), net energy for gain (NEg), and net energy for lactation (NEl). The net energy system separates the energy requirements into their fractional components used for tissue maintenance, tissue gain, and lactation. Accurate use of the NE system relies on careful prediction of feed intake. In general, NEg overestimates the energy value of concentrates relative to roughages.

Ether Extract (EE): The crude fat content of a feedstuff. Fat is an energy source with 2.25 times the energy density of carbohydrates.

Relative Feed Value (RFV): A prediction of feeding value that combines estimated intake (NDF) and estimated digestibility (ADF) into a single index. RFV is used to evaluate legume hay. RFV is often used as a benchmark of quality when buying or selling alfalfa hay. RFV is not used for ration formulation.

Relative Forage Quality (RFQ): Like RFV, RFQ combines predicted intake (NDF) and digestibility (ADF). However, RFQ differs from RFV because it is based on estimates of forage intake and digestibility determined by incubating the feedstuff with rumen microorganisms in a simulated digestion. Therefore, it is a more accurate predictor of forage value than RFV. Neither RFV nor RFQ are used in ration formulation.

Example

CLIENT SAMPLE ID: 1st cutting alfalfa

ANALYSIS

	AS RECEIVED BASIS	DRY MATTER BASIS
MOISTURE, %	14.4	0.0
DRY MATTER, %	85.6	100.0

This hay is 14.4% moisture and 85.6% DM. For ration formulation you should always use the dry matter composition. The DM composition can be found by dividing as-is value by the percent DM. For example:

19.8% CP as-is ÷ 0.856 = 23.2 % CP on a DM basis

CRUDE PROTEIN, %	19.8	23.2
HEAT DAM, PROTEIN, %	0.8	0.9
AVAILABLE PROTEIN, %	19.8	23.2

Because the heat damaged protein is not 10% or more of the CP, the ACP is the same as CP. Available protein estimates are generally only reduced when heat damaged (unavailable) protein accounts for greater than 10% of CP. Lets assume you are supplementing late gestation cows with a 38% protein cake. If you feed 2 lb/hd then the amount of CP supplemented is 2 lb/hd x 0.38 CP = 0.76 lb/hd CP. In another context, the NRC tables indicate that 1 month after calving a 1200 lb cow with moderate milk production requires a diet that is about 10% CP. This same cow should have a DM intake of about 27 lb/day. If she is consuming low quality forage that is only 5% CP, how much of this 1st cutting alfalfa do you need to provide to meet her CP requirement?

27 lb/day intake x .10 CP requirement = 2.7 lb/ day CP requirement

27 lb low quality forage x 0.05 CP = 1.35 lb/day CP from forage

2.7 lb/day CP required 1.35 lb/day CP from forage = 1.35 lb/day CP needed from alfalfa

1.35 lb/day CP needed ÷ 0.232 CP in alfalfa = 5.8 lb supplemental alfalfa/day to meet protein requirement

DIG. PROTEIN EST., %	13.7	16.1

Do not use digestible protein for ration formulation.

ACID DET. FIBER, %	27.0	31.5
NEUT. DET. FIBER, %	31.1	36.4

For formulating beef cow rations, ADF and NDF are of limited usefulness. Instead, use TDN, which is calculated from ADF but is easier to use.

TDN EST., %	55.6	64.9

This is a relatively high quality hay with a high TDN value. In the protein example above we calculated that we should supplement 5.8 lb of this hay to meet the protein requirements of our hypothetical cow. Remember this cow calved 1 month ago, weighs 1200 lb, and has moderate genetic potential for milk. At 27 lb/day DM intake, she needs a diet that is about 58% TDN to meet her energy requirements. Will 5.8 lb/day of this alfalfa meet her energy needs if the low quality forage she consumes is only 50% TDN?

27 lb DM intake x .58 TDN required = 15.7 lb/day TDN required

22.2 lb low quality forage x .50 TDN = 11.1 lb/day TDN from low quality forage

5.8 lb alfalfa x 0.649 TDN = 3.75 lb TDN from alfalfa

11.1 lb/day TDN from low quality forage + 3.75 lb/day TDN from alfalfa = 14.85 lb/day TDN

Therefore, we can see that this cow will lose some body condition even when fed supplemental alfalfa.