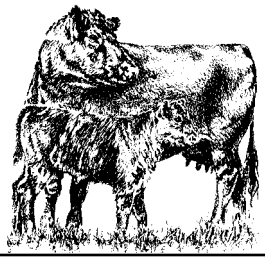

Western Beef Resource Committee *Fourth Edition*

Cattle Producer's Handbook

Nutrition Section 345

Sampling and Interpreting Feed Analyses

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The best use of any feed, whether pasture, harvested forage, grain, or supplement, begins with an understanding of the nutrient content and quality of available feedstuffs along with the target animals' nutrient requirements (see fact sheet 300). Cattle producers can then use this information to develop rations that economically meet their management objectives (see 310 for specific information on ration balancing). Proper sampling of the available feedstuffs and accurate analyses by a certified lab are essential to obtain reliable estimates of the nutrient content of the feedstuffs. A list of certified laboratories, detailed forage sampling procedures, and the most common types of hay probes can be found on the National Forage Testing Associations web site (www.foragetesting.org).

Sampling

The primary reasons to test feedstuffs include: (1) determination of feedstuff value (marketing); (2) comparison of similar feedstuffs (feedstuff selection); (3) economic formulation of rations (lower feed costs); (4) determine potential deficiencies/toxicities/antagonism (animal health concerns); and (5) accurate prediction of animal performance.

Proper sampling is of the utmost importance since the sample that will actually be tested by a certified lab often weighs less than a gram and can represent many tons of feed. Therefore, strict protocols should be adhered to so that a representative sample is obtained. One of the first steps is to identify a lot/stack/load of feed for sampling. Do not mix different lots/stacks/loads as there may be significant variation in quality. Also, it is advisable to sample feeds as close to feeding or selling as possible. The concentration of nutrients can change depending on environmental conditions and length of time that the feedstuff has been stored.

Hay Sampling

Hay bales should be sampled with a probe that takes small "cores" from baled hay. Probe tools may attach to hand drills and/or hand braces or push and auger types. The National Forage Testing Association web site provides a list of recommended hay probes along with information about where they can be obtained.

Core samples should be taken from the end of rectangular bales, between the strings/wires, so that you get a good cross section of material. Always take the core sample from a 90 degree angle or perpendicular to the bale and go at least 12 to 18 inches deep. Do not take samples from the side or top as the core will only come from one "flake" and, therefore, will not be representative of the bale.

For small bales (2- and 3-tie bales) take a single core per bale. For large bales (>500 pounds) take two to three samples from the ends making sure to spread out the sampling locations between the upper portion and the lower portion of the bale. For large round bales, take two to three samples per bale remembering to sample from the round side where the strings or netting are located for a representative cross section.

Sample at least 20 bales from each lot/field to account for possible variability in quality. Loose hay stacks, rake bunches, and windrows need to be sampled by taking handfuls of the harvested forage. Take at least 20 samples (three handfuls per sample) of forage from different areas in the stack/bunch/windrow.

Always handle samples correctly (http://www.foragetesting.org). Place each composited sample of forage in a well-sealed plastic bag and protect from heat and sun. Refrigeration of forage samples may be helpful for dry matter (DM) measurements, especially if

forage is fresh cut. Deliver samples to a testing lab as soon as possible. Also, the producer must determine which tests/analyses to conduct on the feedstuff(s), which is dependent on the feeding objectives and/or nutritional concerns. Certified labs will have a menu of available tests to meet your objectives.

Sampling Range and Pasture Forages

Obtaining a representative sample of standing forage that accurately reflects diet quality/animal selection is challenging. Cattle are selective feeders and it is difficult for livestock managers to know what animals will prefer one day to the next or even at different times of the day. Nevertheless, there are two primary methods to sample standing forage. The first one is "hand-grabbing" that tends to produce a truer measure of livestock grazing because the person sampling can be selective, which is more similar to an animal grazing naturally. To perform the hand-grab method, randomly select a handful of forage and wrap fingers around the forage (about 1 to 2 inches above the ground for short grasses and 3 to 6 inches above the ground for mid/tall grasses) and pull sharply. Move to another random location and repeat up to 20 times. Collect separate samples where there are obvious differences in vegetation, soil type, or other landscape variations.

Another common method is the "clipping" whereby a frame of set dimensions (square foot, square meter, etc.) is used at random areas within a pasture and the forage is clipped to approximately 1 to 2 inches for short grasses and approximately 3 to 6 inches for mid/tall grasses (Fig. 1). Livestock managers should randomly select at least five areas in a pasture and within each area clip about four plots for a total of roughly 20 samples. If the pasture has more than five forage/soil types that represent a sizable proportion of the pasture, then more areas will need to be sampled. One of the drawbacks of this method is that it does not attempt to simulate the selectivity of cattle grazing.

Once collected, the sample should be identified as it pertains to the owner, location, forage type (grass species, species mix if known, or native range), and date sampled. The entire sample should be cooled after collection and stored in a refrigerator or freezer until shipped to the lab.

Fig. 1. Example of a quadrat, clippers, and sampling bag used for determination of pasture forage quality and production.

Sampling Silage, Haylage, and High Moisture Grain

Sampling of silage, haylage, and high-moisture grain should be done after the product has been ensiled for at least 30 days. Taking fresh samples before ensiling may lead to erroneous results for some variables; however, crude protein and fiber fractions (NDF and ADF) normally do not change with proper fermentation/ensiling.

High moisture feeds are usually sampled by grabbing handfuls from at least 10 locations in the pit or bunker, or by taking samples directly from the feed bunk as it is being fed. If the silage comes from a silo that has a mechanical unloader, allow the equipment to run for a short while before taking the sample to assure fresh product. More detailed information concerning sampling of silage/haylage can be found at http://www.foragetesting.org/files/UnderstandingForageQuality.pdf.

Forage or grain stored in heavy-duty plastic bags requires cutting a small hole in the side of the bag and digging into the material several inches to obtain a sample. Six to eight samples are satisfactory from large bags, while two to four samples will suffice from small bags. The hole in the bag should be closed and taped shut immediately after the sample is withdrawn. This will allow sampling with minimal damage to the contents.

Place high moisture samples in a plastic bag or other container and label with crop identification, owner and location, and date sampled. It is best to place the sample in a freezer immediately; however, if this is not possible, cool the sample down and get into a freezer to prevent spoilage of the sample. If shipping a distance that will require over 2 days transit time, place a freezer pack like one that often accompanies vaccines into the shipping carton to assure the product arrives in good condition. Also, remember to schedule shipping so that the sample will not be in transit over a weekend.

Sampling Grain, Concentrates, or Supplements

Sampling grain and "meals" is best done using a grain probe. However, grabbing samples by hand is also acceptable. Pellets, cubes, or cake may also be sampled by grabbing handfuls. More specific and detailed information concerning sampling of grains can be found in the USDA Grain Inspection Handbook available at http://www.gipsa.usda.gov/publications/fgis/handbooks/gihbk1_insphb.html.

Products delivered in bulk should be sampled from at least five locations in the pile, feed bunk, or as it is delivered from the truck. All samples should be combined and stored in a clean, dry, container before delivery to the lab. Identify the product, owner, sample location, and date.

Bagged or block products require that several containers be opened and sampled. A good practice is to sample 10 percent of the bags or blocks in question. Take at least one handful from each bag. Sample blocks by slicing or chiseling a chunk from each block. Use the same protocol as mentioned previously in identifying the product, owner, sample location, lot number (if available) and date.

Liquid supplements are best sampled by placing a clean 1-quart container under the stream as it is being delivered from the truck. The sample should be made up of product near the beginning, middle, and end of the delivery. Identify and store the sample in a cool location.

Supplement analysis may vary quite a bit depending on the nature of the product. Before sampling it is extremely important to determine why the analysis is being conducted, what nutrients will be tested, and how the information will be used. An extension educator or professional nutritionist can help answer these questions.

Where, What, and How to Analyze

When choosing a lab to analyze your feed samples, only use laboratories that have been certified by the National Forage Testing Association. This organization provides a list, annually, of the labs that successfully complete their certification. This list can be found at http://www.foragetesting.org/.

Determining which analysis to have conducted can seem intimidating to someone not familiar with nutrient testing. However, your local extension agent, state beef specialist, or nutritional consultant can help answer any questions that may arise. In addition, testing labs have knowledgeable customer service representatives who can answer questions related to sample care and preparation, specific nutrient analyses, and costs. Feed testing labs have numerous options that can be customized depending on the specific need; nevertheless, most labs have a basic analysis option that is often sufficient for the majority of requests.

These "basic" options routinely include tests for dry matter, crude protein, neutral detergent fiber, acid detergent fiber, nonfibrous carbohydrates, relative feed value, total digestible nutrients, net energy for lactation, net energy for gain, net energy for maintenance, and digestible energy. However, if different information is needed concerning other tests, such as minerals, nitrates, mycotoxins, fiber digestibility, degradable protein, fat, etc. these tests can be added individually or as a "specialty package" to meet the demands of the requestor.

Wet Chemistry vs. Near Infrared Reflectance Spectroscopy (NIR)

The two methods to analyze a feedstuff for nutrient content are wet chemistry and NIR. The "gold standard" and most accurate method is wet chemistry; however, this process is more time consuming, more expensive, and requires more highly skilled technicians as compared to NIR. NIR measures the reflectance of infrared light off of specific nutrients in feed samples and compares that to a set of similar samples that have been analyzed via wet chemistry. The NIR values are "calibrated" to the wet chemistry values, and a series of regression equations are developed for the nutrients of interest.

With properly validated regression equations, NIR can yield accuracy similar to wet chemistry while having the advantages of being faster, less expensive, and requiring less labor. It should be noted that minerals do not reflect infrared light; therefore, NIR may not be the most appropriate method to measure feedstuff mineral content. Also, if considering the use of NIR be sure to ask the testing laboratory if they have certified regression equations for your particular feedstuff.

Interpreting Feed Analyses

Fig. 2 contains examples of nutrient analyses from a certified laboratory for low-quality hay (A), medium-quality hay (B), and corn (C). Being able to interpret a feed analysis and use that information to develop a feeding and management plan is an important step in successful livestock production. If assistance is needed in using nutrient analyses to prepare rations that meet management objectives (see 310), you can contact your local livestock extension agent, state beef specialist, or nutritional consultant.

Some terms that are commonly used in feed analyses (definitions obtained and compiled from Ward Labs Inc., Kearney, NE; Dairy One, Ithaca, NY) include:

Acid Detergent Fiber (ADF)—Consists of cellulose, lignin, and heat-damaged protein. It is closely related to indigestibility of forages and is the major factor in calculating energy content of feeds. The lower the ADF the more energy the feed contains and the more digestible it will be.

Acid Detergent Insoluble Crude Protein (ADICP)—Also known as heat-damaged or unavailable protein. Typically caused by heating during fermentation or drying, a portion of the protein reacts with carbohydrates to form an indigestible complex rendering it unavailable for digestion. ADICP escapes ruminal breakdown and represents the portion of the undegradable protein that is not available to the animal.

Adjusted Crude Protein (ACP)—A calculated value adjusting total crude protein for heat-damaged protein. Adjusted crude protein estimates the protein available for animal use and should be used for formulating rations when ADICP is greater than 15 percent of the total crude protein.

As-Sampled Basis—Nutrient results for the sample in its natural state including the water. Also known as as-fed or as-received.

A

Sample Description	Farm	Code	Sample
SMALL GRAIN HAY		171	19739380
DWB HAY B			

Analysis Results		
Components	As Fed	DM
% Moisture	6.6	
% Dry Matter	93.4	
% Crude Protein	4.0	4.3
% Adjusted Crude Protein	4.0	4.3
Degradable Protein%CP		73
% Acid Detergent Fiber	46.6	49.9
% Neutral Detergent Fiber	68.8	73.7
% NFC	14.4	15.4
% TDN	50	53
NEL, Mcal/Lb	.34	.37
NEM, Mcal/Lb	.40	.43
NEG, Mcal/Lb	.17	.18
Relative Feed Value		63
% Calcium	.15	.16
% Phosphorus	.10	.11
% Magnesium	.06	.07
% Potassium	1.37	1.47
% Sodium	.008	.009
PPM Iron	106	114
PPM Zinc	12	13
PPM Copper	4	5
PPM Manganese	125	134
PPM Molybdenum	.6	.7

B

Sample Description	Farm	Code	Sample
MML HAY		101	15980770

Analysis Results		
Components	As Fed	DM
% Moisture	8.3	
% Dry Matter	91.8	
% Crude Protein	12.1	13.1
% Adjusted Crude Protein	12.1	13.1
Degradable Protein %CP		65
% Acid Detergent Fiber	39.5	43.1
% Neutral Detergent Fiber	54.9	59.9
% NFC	19.0	20.8
% Crude Fat	1.7	1.9
% TDN	50	54
NEL, Mcal/Lb	.45	.49
NEM, Mcal/Lb	.42	.46
NEG, Mcal/Lb	.19	.21
Relative Feed Value		86

C

Sample Description	Farm	Code	Sample
SHELLED CORN		436	15980740

Analysis Results		
Components	As Fed	DM
% Moisture	13.3	
% Dry Matter	86.7	
% Crude Protein	8.5	9.8
% Adjusted Crude Protein	8.5	9.8
Degradable Protein %CP		33
% Acid Detergent Fiber	3.4	3.9
% Neutral Detergent Fiber	13.0	15.0
% NFC	59.1	68.2
% Crude Fat	5.3	6.1
% TDN	77	89
NEL, Mcal/Lb	.84	.97
NEM, Mcal/Lb	.89	1.03
NEG, Mcal/Lb	.62	.71

Fig. 2. Examples of nutrient analyses for a low-quality forage (A), medium-quality forage (B), and corn (C) from a certified commercial laboratory.

Crude Fat—An estimate of the fat content of feeds that is measured by ether extraction.

Crude Protein (CP)—It is termed "crude" protein because it is not a direct measurement of protein but a measurement of the total nitrogen (N) in the feed (N% x 6.25 = crude protein). Crude protein includes true protein and non-protein nitrogen (NPN) such as ammonia and urea.

Degradable Protein (RDP)—Consists of soluble protein and proteins of intermediate ruminal degradability. It is used to synthesize microbial protein in the rumen. RDP can sometimes be referred to as Degradable Intake Protein or DIP.

Digestible Energy (DE)—Equals gross feed energy minus energy lost in the feces.

Dry Matter (DM)—The amount of dry matter in the feed or the percentage of feed that is not water. Generally, hay or grain should have no more than 15 percent moisture to store safely. Haylage and silage must have sufficient moisture to allow fermentation to proceed. Haylage moisture is normally 40 to 60 percent; while silage moisture is 65 to 75 percent.

Dry Matter Basis—Nutrient results for the sample with the water removed. In general, most livestock requirements are expressed on a dry matter basis and these are used to balance rations.

Net Energy for Gain (NE_g)—An estimate of the energy value of a feed used for body weight gain above that required for maintenance.

Net Energy for Lactation (NE_l)—An estimate of the energy value of a feed used for maintenance plus milk production during lactation and for maintenance plus the last 2 months of gestation for dry, pregnant cows.

Net Energy for Maintenance (NE_m)—An estimate of the energy value of a feed used to keep an animal in energy equilibrium (i.e., neither gaining nor losing weight).

Neutral Detergent Fiber (NDF)—The total fiber content of a feedstuff is contained in the NDF or cell wall fraction. This fraction contains cellulose, hemicellulose, lignin, and heat damaged protein. NDF gives the best estimate of the total fiber content of feed and is closely related to feed intake. As NDF values increase, total feed intake will decrease. A low percentage of NDF is desirable. Grasses will contain more NDF than legumes at a comparable stage of maturity.

Neutral Detergent Fiber Digestibility (NDFD)—The proportion of NDF potentially digestible and available to the animal as determined by an *in vitro* incubation. NDFD is expressed as a percentage of the NDF. The NDFD can be used to rank forages on potential fiber digestibility and in energy calculations.

Nonfibrous Carbohydrate (NFC)—An estimate of the rapidly available/digestible carbohydrates in a feed (primarily starch and sugars).

Non-Protein Nitrogen (NPN)—Urea and ammonia are not proteins. However, they contain nitrogen that can be used by the microbial population in the rumen to synthesize protein. They are classified as NPN. Thus, although they are not true proteins, they supply nitrogen which can be used to form microbial protein and, therefore, have a certain value that is equivalent to protein for ruminants.

Metabolizable Energy (ME)—Equals gross feed energy minus energy lost in the feces, urine, and gases.

Moisture—The percent water in a sample.

Relative Feed Value (RFV)—An index for ranking forages based on digestibility and intake potential. RFV is calculated from ADF and NDF. A RFV of 100 is considered the average score and represents alfalfa hay containing 41 percent ADF and 53 percent NDF on a dry matter basis. The higher the RFV the better the quality.

Relative Forage Quality (RFQ)—An index for ranking forages based on a more comprehensive analysis than RFV. RFQ is calculated from CP, ADF, NDF, fat, ash, and NDF digestibility measured at 48 hours. It should be more reflective of the feeding value of the forage. RFQ is based on the same scoring system as RFV with an average score of 100. The higher the RFQ, the better the quality.

Soluble Protein (SP)—Proteins and non-protein nitrogen that are rapidly broken down in the rumen; used to synthesize microbial protein.

Total Digestible Nutrients (TDN)—The sum of digestible crude protein, crude fiber, nitrogen free extract, and ether extract (fat). Multiply ether extract by 2.25 to compensate for the higher caloric value of fats.

Undegradable Protein (RUP)—Rumen Undegradable Protein has a slow rate of degradability and escape digestion in the rumen. RUP is also known as escape or bypass protein and reaches the lower gastrointestinal tract essentially intact. RUP can sometimes be referred to as Undegradable Intake Protein or UIP.

A more comprehensive list of terms for understanding forage/feed quality can be found on the National Forage Testing Association's web site at http://www.foragetesting.org/files/UnderstandingForageQuality.pdf.

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