Feed Analyses for Dairy Producers

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Technology has changed the way and speed with which feeds are analyzed. Reports list a wide range of nutrients; some measured some calculated from other measurements. Before deciding what and how often to analyze the following should be considered.

1. Nutrient variation – feeds that have a great deal of variation should be analyzed more often.
2. Individual versus mixed feed – usually we analyze the individual feeds for ration formulation but we can check TMR for quality control.
3. Method of analysis – wet chemistry versus NIR.
4. Nutrients to be analyzed – dry matter, protein, and fiber are most common.
5. Need for dynamic measurements – digestion over time is dynamic.

Sample Collection

In order to have an accurate forage test for ration formulation it is important to have a representative sample. The method of sampling varies with forage type. Silages (corn or hay crop) can be sampled either at harvest or at feed out. There should be little change in dry matter, protein, fiber, or energy during storage in most situations. If sampling at harvest it is best to take 3 to 4 handfuls from every third load or more and place in a container with all samples from the same field. After mixing the composite a sub-sample can be taken for analysis. When sampling at feed out it is advisable to take 3 to 4 handfuls at different times, mix the composite, and take a smaller sub-sample for analysis. In upright silos there can be variation from top to bottom. Bunkers are different because common layers are encountered from front to back due to layering during storage.

When sampling hay it is best to use a core sampler. Take 10 to 20 core samples from each hay lot, then composite, mix and sub-sample for analysis. Small rectangular bales should be sampled by coring from the end. Large hay bales should be sampled from the front or back (not the sides) in order to get a cross section of the rolled hay. See the link below for more detailed sampling protocol.

Sampling protocol: http://www.vtdairy.dasc.vt.edu/pdf/sampling.pdf

Wet Chemistry vs NIR

There are two ways that forages are analyzed for nutrient content. Wet chemistry uses established laboratory tests to quantify protein, fiber, fat, and minerals. Near infrared reflectance spectroscopy (NIR) has been perfected to accurately and quickly measure nutrient content. To do this, the NIR instrument must be calibrated to wet chemistry which is the standard. Most typical forages can be analyzed with NIR but unique forages may not be appropriate because no calibration set is available to standardize the equipment. Also, total mixed rations are difficult with NIR because the composition of the mix can vary greatly from farm to farm. Laboratories will advise about which feeds can be analyzed with NIR based on the calibrations available to them. Also, NIR technology uses light reflectance and works best with large compounds such as those that compose protein and fiber. The minerals are smaller and more difficult with the NIR. It is generally recommended that minerals should be run with wet chemistry if precise levels are needed.

Basic Wet Chemistry Tests

When a sample is received at a forage testing lab a portion of it is weighed and dried in an oven to eliminate the moisture. It is then reweighed and the dry matter content determined. The dried sample is then ground for analysis. A portion of the sample is weighed into a tube for a Kjeldahl or nitrogen determination. The sample is digested with acid and then distilled with a base solution to convert nitrogen to ammonia, a form that can be trapped and analyzed. We convert nitrogen to crude protein by multiplying by 6.25 due to the fact protein is 16% nitrogen (100/16=6.25). Crude protein measures all nitrogenous compounds present in the sample and does not distinguish true protein from nonprotein nitrogen. This is fine for ruminants (cattle, goats, and sheep) but can be a concern for chickens, because poultry can't utilize nonprotein nitrogen.

There are two types of fiber determinations typically run in forage testing labs. One uses an acid detergent solution to digest the dried feed sample and the other uses a neutral detergent solution. The digested solution is filtered and the residue on the filter is the fiber. These fibers are termed acid detergent fiber (ADF) and neutral detergent fiber (NDF). NDF is larger than ADF in plants and is considered to be the cell wall component. NDF is used to predict intake while ADF is used to predict digestibility. Both can be used to estimate energy.

Fat is commonly referred to as ether extract because it is removed with ether from feeds. Most forages are low in fat but they can have 2 to 3%. Other feeds vary but the oil seeds such as cottonseeds and soybeans contain up to 20% fat. Elevated fat increases the energy in the feed.

Energy is not typically measured in forage testing labs. It is dynamic and changes with animal physiological conditions unlike crude protein, fiber or fat. Energy can be estimated based on fiber content and there is an inverse relationship with high fiber being associated with lower energy. Different labs will many times report different estimates for energy because the equations used are different. Energy is usually expressed as kilocalories (1,000 calories) or megacalories (1,000,000 calories) of net, metabolizable, or digestible energy. Also, total digestible nutrients or TDN is an indicator of energy content.

Expression of Results

When expressing concentration of nutrients it is necessary to define if the results are expressed on an actual ("as is" basis) or dry matter basis. Nutrient concentrations expressed on "as is" basis are less than when expressed on dry matter. In species such as cattle and horses that eat high moisture feed, rations generally are calculated on a dry basis. Chickens eat feeds that are dry and have approximately the same dry matter (88 to 92%) and will sometimes use the "as is" nutrient concentration. The feed industry uses "as is" basis to express nutrient concentration on feed tags unless stated otherwise. Therefore it is important to know what basis nutrients are expressed before it is possible to use the results.

Crude protein, fiber, fat, and macrominerals (calcium, phosphorus, etc.) are usually expressed as % (either "as is" or dry matter). However, microminerals (zinc, cobalt, etc.) are usually parts per million or mg/kg. Energy will be as TDN (%) or calories, kilocalories, or megacalories per lb. Vitamins are expressed as international units of activity per lb. Therefore, it depends on the nutrient type as to what units will be used.

The bottom line is forages should be analyzed regularly (every 4 to 6 weeks) for dry matter, protein, fiber, and energy.

Digestibility is Important

Sometimes even if intake is acceptable rations do not support expected milk production. The problem will then likely be decreased digestibility of certain components of the diet. Digestibility considers what is consumed minus what appears in the feces. For instance if 50 lbs. of dry matter is consumed and 17.5 lbs. appears in the feces the digestibility is 65% (50-17.5 = 32.5; 32.5/50 * 100 = 65%). In this case 32.5 lbs. of dry matter disappears from that consumed to what appears in the feces. This 32.5 lbs. is considered available to the animal although some nutrients will be excreted in the urine. Most rations for high producing cows will be greater than 65% digestible. It is possible to do an in vitro dry matter digestibility in a laboratory.

Fiber digestibility in corn silage and other forages is also important. Since most fiber digestion occurs in the rumen we are mainly concerned with digestibility in rumen contents. Typically a 48 hour in vitro NDF digestibility is conducted. Results indicate there are differences in fiber digestibility in corn varieties. Also year to year variation most likely occurs in fiber digestibility due to more lignification during certain growing seasons. Michigan State University research (Oba and Allen, Journal of Dairy Science 82:589, 1999) indicates that a 1% increase in ration neutral detergent fiber digestibility will result in a .17 kg/cow/day increase in dry matter intake (digestibility and intake are related) and .29 kg. more 4% fat corrected milk.

If silage is harvested at a mature stage the kernels will be hard and difficult for the cow to digest. Corn silages above 40% dry matter many times will have kernels that are hard and less digestible. Kernel digestibility will be reduced but an analysis on the silage might indicate high energy content. The reason for this is the lab grinds the feed and breaks the kernels and they are considered digestible. Therefore, a general lab analysis will not detect reduced digestibility of kernels. This is also true for reduced digestible fiber unless the lab incubates the sample over time and determines disappearance of the fiber. The University of Wisconsin software program (MILK2006) uses dry matter content to estimate starch digestibility, but also allows an actual digestibility to be used. Both starch and NDF digestibility are used in the MILK2006 program to calculate the net energy of the silage.

MILK2006: http://www.uwex.edu/ces/dairynutrition/documents/milk2006cornsilagev.xls

Finally, in hay crop silages and hays there can be heating in the ensiling and storage process resulting in protein that is bound in the fiber. This has been termed acid detergent fiber protein or acid detergent insoluble nitrogen. There is a direct relationship with reduced protein digestibility and should be accounted for in balancing rations. There also appears to be a reduced amount of energy in heat damaged forages. Some laboratories will calculate a reduced protein digestibility based the amount of heat damage measured as acid detergent insoluble nitrogen.

Reduction of digestibility of forage fiber, silage kernels, or forage protein can result in failure of the ration to meet expectations. Year to year variation in corn silage quality can many times be related to fiber and/or kernel digestibility. Laboratory tests do not always detect these changes unless the more refined in vitro or in situ measures of dry matter, fiber, or protein digestibility are used.

The following is a list of laboratories that analyze forage samples for nutritional quality. This list is not an endorsement, nor should it be considered all inclusive. It is for informational purposes only

- A&L Eastern Laboratory
  7621 Whitepine Road
  Richmond, VA 23237
  (804) 743-9401
  www.al-labs-eastern.com/

- Brookside Laboratories, Inc.
  308 S. Main Street
  New Knoxville, OH 45871
  (419) 753-2448
  www.blinc.com

- Cumberland Valley Analytical Services
  14515 Industry Drive
  Hagerstown, MD 21742
  (800) 282-7522
  www.foragelab.com

- Dairy One Forage Lab
  730 Warren Road
  Ithaca, NY 14850
  (800) 496-3344
  www.dairyone.com/