UC CE
COOPERATIVE EXTENSION
UNIVERSITY OF CALIFORNIA, DAVIS

Interpreting Your Forage Test Report

P.H. Robinson & D.H. Putnam
Cooperative Extension Specialists
University of California, Davis, CA 95616-8521

California laboratories participate in the California Hay Testing Consortium, which is sponsored by the University of California to increase the consistency and quality of forage testing in California. There may be changes in forage test reports from time to time as labs throughout the state continually upgrade their methods to provide greater consistency in the lab results that they report. Labs participating in the California Hay Testing Consortium use methods recommended by the Association of Official Analytical Chemists (AOAC) or the National Forage Testing Association (NFTA) for DM, CP, NDF and ADF. Traditional 'wet' chemical procedures and Near Infrared Spectroscopy (NIR) methods are currently approved by both AOAC and NFTA. The following information will assist you in interpreting forage test results.

IMPORTANCE OF SAMPLING

Analytical results are meaningless if the forage sample submitted to the laboratory did not represent the lot of hay or bunker of silage. Often the greatest source of inconsistency in forage test results is poor sampling procedures. A minimum of 20 randomly selected cores per lot is recommended for sampling hay, where a 'lot' consists of hay of one variety from one cutting from the same field. A sharp bore, 3/8" to 5/8", sampler should be used. The pooled sample, representing all core samples, should be stored and shipped under cool conditions in zip-lock bags. Sampling of silages is difficult due to the inability to access the material and concerns about allowing oxygen penetration through sampling holes. For this reason, sampling at the time of silo filling is recommended. A minimum of one handful per truckload of fresh crop is suggested.

Pool the grab samples to a plastic bag, kept in the shade, and refrigerate until after silo filling is complete. Change sampling bags with day and crop, as well as field if it is considered to represent a significant crop quality difference. The pooled sample(s), should be emptied onto a shaded concrete floor, mixed thoroughly by hand, sub-sampled to a large zip-lock bag, and stored under cool conditions prior to submission to the lab.

Published *In*: California Alfalfa & Forage Review, Summer 1998. (1:2:2-3)

Most analytical values are little affected by ensiling. However values for bound CP, soluble CP and fermentation acids are influenced and must be determined in samples of the silage. To sample the ensiled crop, a minimum of 9 samples from the bunker face representing the top, middle, and bottom as well as the left, center, and right should be collected. Penetrate the bunker face at each sampling site with a core sampling device or your gloved hand. The pooled sample should be stored under cool conditions prior to submission to the lab.

MEANING OF THE TEST VALUES

Forage test reports contain a number of measured and calculated values. Interpretation of these values can be confusing. The definitions that follow describe the most commonly reported lab values.

Measured Laboratory Values

Dry Matter (DM) – This value is used for calculating the nutrient content of a forage on a DM basis. It can also be used to determine the amount of water in the hay or silage as: 100 - %DM. Hay will tend to mold as the %DM falls below 80% and at values above 90% it becomes brittle, is more susceptible to leaf loss, and is less palatable to cattle. Silages will tend to exhibit excessive seepage as the %DM falls below 25% and the fermentation is less stable (i.e., more prone to 'heating') as the %DM rises above 50% (60% for corn silage).

Crude Protein (CP) - CP is estimated from the nitrogen content of the forage based upon the observation that the nitrogen content of protein averages 16%. Protein is important in ruminant nutrition as it provides essential nutrients for both the rumen microbes as well as the animal itself.

Neutral Detergent Fiber (NDF) - NDF consists of the slowly digested hemicellulose and cellulose as well as indigestible lignin in the plant. As such, it estimates the structural carbohydrate in the forage, which is important in ruminant nutrition to both estimate feed intake (i.e., as the total diet NDF level increases above about 35% of DM, its voluntary feed intake tends to decline) and predict the susceptibility of the cattle fed the diet to stomach upsets such as acidosis and displaced abomasum (i.e., as the total diet NDF level declines below about 27% of DM, the tendency to stomach upsets increases).

Acid Detergent Fiber (ADF) - ADF is a sub-fraction of NDF, but only consists of cellulose and lignin. ADF has been widely used as a predictor of the energy value of forages because the proportion of lignin, which is indigestible, is higher in ADF than it is in NDF.

Calculated Values

Forage energy estimates, that are used by dairy ranchers and nutritionists, are calculated from the measured values that were discussed above. As energy is not an analyzable fraction of a forage, there are a number of equations used to estimate a number of different energy values of forages. Unfortunately these equations have not been standardized among California laboratories, with the notable exception of alfalfa hay. Thus estimated energy values vary among labs. The most commonly reported energy values follow.

Total Digestible Nutrients (TDN) - TDN estimates the proportion of the forage that can be digested by cattle. Although the definition of TDN has changed slightly over the years with advances in forage testing procedures, it is currently accepted to equal the sum of digestible CP, digestible fat (multiplied by 2.25), digestible non-structural carbohydrate, and digestible NDF corrected for an energy cost of digestion generally accepted to be about 7 percentage units. TDN is often used as an estimate of the energy value of a forage and can be used in ration formulation.

Digestible Energy (DE) - DE estimates the energy in a forage that is not lost in feces. DE, in Mcal/kg of DM, is generally calculated from TDN as: .04409 x TDN. However DE is seldom used in balancing rations for dairy cattle.

Metabolizable Energy (ME) - ME estimates the energy in a forage that is not lost in feces, urine, or rumen gases. ME, in Mcal/kg of DM, is generally calculated from DE as: (1.01 x DE) - .45. ME is sometimes used in balancing rations for dairy cattle.

Net Energy for Lactation (NEl) - NEl estimates the energy in a forage that is available to support energy needs for body maintenance, lactation, and body weight gain. NEl, in Mcal/kg of DM, is generally calculated from TDN as: (.0245 x TDN) - .12). NEl is often used in balancing rations for dairy cattle.

Net Energy for Maintenance (NEm) - NEm estimates the proportion of ME in a forage that is available to support maintenance energy needs. NEm, in Mcal/kg of DM, is generally calculated from ME as: $(1.37 \times ME) - (.138 \times ME^2) - (.0105 \times ME^3) - 1.12$. NEm is often used in balancing rations for growing cattle.

Net Energy for Gain (NEg) - NEg estimates the proportion of ME in a forage that is available to support energy needs for growth. NEg, in Mcal/kg of DM, is generally calculated from ME as: $(1.42 \times ME) - (.174 \times ME^2) - (.0122 \times ME^3) - 1.65$. NEm is often used in balancing rations for growing cattle.

All energy values calculated in Mcal/kg of DM can be converted to Mcal/lb of DM by multiplying them by 0.4537.

REPORTING

Most values in a forage test report will probably be reported on an 'As Received', '90% DM', and/or '100% DM' basis. For most comparisons, the '100% DM' basis values are the most useful and will probably be highlighted on the forage test report. However, many hay growers and buyers are accustomed to looking at the '90% DM' values for comparing hay lots. In contrast, silage growers are accustomed to looking at the '100% DM' values for assessing the nutritive value of silages.

INTERPRETATION

It is generally recommended that forage test values at '100% DM' be used when comparing lots or bunkers of forages. ADF is an important assay as it is often used to predict the energy value of the forage, particularly for alfalfa hay. However nutritionists are using NDF much more often than in the past, making it a good idea to become familiar with its normal range within forage types. CP is also an important value to be familiar with as it contributes to the forage energy value, as well as helping to meet the animals' nutritional requirements for protein.

None of the values reported on your forage test report, either measured or calculated, should be considered to be absolute. Often laboratories will report an 'error range' with each assayed value to represent the laboratory error of that value. Normal lab variation, not including errors associated with poor sampling of forages, are considered to be: CP (+/- 0.5), NDF (+/- 0.9), ADF (+/- 0.7) and TDN (+/- 0.7) percentage points. Thus a reported value of 20% CP could actually be anywhere between 19.5 and 20.5%, although most values will cluster around 20%.

CONCLUSIONS

Laboratory assays can provide an accurate guide to the potential nutritional value of a forage. However, always visually inspect lots or bunkers of forage to assess the presence of molds, noxious weeds or other defects that will not be determined by laboratory assays.

* * * *

Peter Robinson is a Cooperative Extension Specialist responsible for dairy cattle nutrition and nutritional management. He can be reached at: (530) 754-7565(voice) or (530) 752-0172(fax) or phrobinson@ucdavis.edu. Dan Putnam is a Cooperative Extension Specialist responsible for forage production and quality assessment. He can be reached at: (530) 752-8982(voive) or (530) 752-4361 or dhputnam@ucdavis.edu.