WHAT DO YOUR HAY TEST RESULTS MEAN AND HOW MUCH CAN YOU TRUST THEM?

Mary A. Jacobs[1] and Michael Wolf

Alfalfa hay is an important agricultural product in the state of California. The price paid or received for the product is often based on its nutritive value. That nutritive value is determined by laboratory tests. The most popular method in use today is the University of California method which uses dry matter (DM) and modified crude fiber (MCF). From these two figures a calculation is made to arrive at total digestible nutritients (TDN). Equations have also been developed for calculating TDN using acid detergent fiber(ADF) and dry matter. We are seeing a very gradual shift to the use of the ADF and DM to estimate TDN. The TDN value is often also used in ration formulation.

The final test results can be no better than the sample received. Invariably, every hay season we have a situation occur where two different people have sampled the same stack of hay and have received different results. The implication usually is that the lab made an error, and sometimes we have. Most often however, we have found other possible reasons.

Differences in sampling are often the cause. It is important to follow the guidelines set up by the University of California. An adequate sample consists of at least 20 cores taken at random throughout a stack. The sample should be comprised of hay from one field, one variety, one cutting, and processed at one time. Bales should be probed in a uniform manner with the probe traveling 12 to 18 inches into the bale. The core samples should be placed into a plastic bag that can be tightly closed. The entire number of cores should be submitted to the lab. Studies have shown that you cannot get accurate results by hand mixing a bag of hay and then taking a portion of it for the final sample submitted to the lab. If for any reason, you want to submit the sample to more than one lab, always have one of the labs grind and split the sample after it has been ground.

Another source of variation occurs due to the type of core sampler used. Again, studies have shown that a probe needs to be at least 3/8 inch in diameter. The tip of the core sampler must also be kept sharp.

Occasionally we will have customers bring in a flake from one bale or a handful of hay from the windrow before baling. We always try to discourage people from wasting their money and or time analyzing such a sample. These just are not adequate samples.

Another source of error or misunderstanding occurs in the interpretation of the report received from the lab. The sample description on the report should include the cutting, the field, the grower and the number of tons or bales. The report should clearly state what method of analysis was used to estimate the TDN. MCF, ADF or NIR could be used. It

[1]Corresponding Author: Mary A. Jacobs, JL Analytical Services Inc.,
P.O.Box 576185 Modesto, CA 95357

should also clearly state whether the answers are on the as is, 90% or 100% dry matter basis. Some labs currently report out all three. It should also indicate which of the analytical results are from actual testing and which are arrived at by calculation.

Another source of misunderstanding occurs when the buyer and the seller have not clearly defined at what dry matter level they are going to evaluate the lab data. For example an alfalfa with a dry matter of 92% and a TDN of 54% on a 90% dry basis would have a TDN of 55.2% on an as received basis. The buyer indicated that he wanted 55% TDN hay. Is this hay acceptable? This problem occurs regularly.

The value of hay testing depends not only on how well the sample represents the hay stack but also upon the quality of the analysis performed on the sample. Unlike purchasing a car, where you can see the quality of the workmanship, the workmanship of lab testing can not seen by looking at a lab report. The purchaser of lab services needs to have some assurance that the decisions that are made based on lab results, are based on quality workmanship.

The Quality Assurance Program of a laboratory exists to assure that the testing done by a lab is of high quality. A Quality Assurance Program is a complete program that is designed to monitor the quality of testing and to correct any problems that develop in the lab. We have an extensive quality assurance program in place in the laboratory. Since the major concerns of the hay customers are Modified Crude Fiber (MCF) and Crude Protein (CP), we will limit our coverage to those particular tests.

Every sample of alfalfa that we run a MCF on is also scanned by our research grade Near Infrared Spectrophotometer (NIR). The NIR is calibrated with California and other western states' alfalfa hays to predict both MCF and CP. If there is a significant difference between the NIR result and the wet chemistry, the sample is reanalyzed both by NIR and wet chemistry. This method of analysis of a sample by procedures based on completely different physical principles is among the most rigorous quality control practices possible.

In order to assure the quality of analysis by the NIR following procedures are used. The same sealed quality control sample is analyzed at the beginning of every batch of samples run on the NIR and compared with previous analysis. The electronic noise and stability of the instrument is tested every day. All samples scanned on the NIR are checked for spectral outliers, if one is found it is reanalyzed. The instrument is physically isolated from the rest of wet chemistry laboratory to minimize humidity and temperature changes.

By using a scanning monochronometer NIR the complete near infrared spectra from 1100nm to 2500nm is available to the instrument for predictions instead of the partial spectrum as is the case of the filter instruments. By having developed our own calibration using only alfalfa hays from the western U.S., we have a calibration that is twice as accurate as what is available from the manufacturer.

In order to assure the quality of the results from the wet chemistry analysis of fiber, the following steps are taken. Both the acid and the base used for the procedure are standardized against primary standards to within 0.002 normal of the desired value. A known value quality control sample is analyzed daily to verify fiber reagents, burner temperatures and timing of the

analyst. All of our electronic analytical balances are regularly maintained and calibrated with class S weights. Check samples from both the National Hay Testing Association and the Association of American Feed Control Officials are run on a regular basis as further checks on our system.

All crude protein analysis on alfalfa hays are checked against the value predicted by the NIR in the same manner as the MCF test. In addition to assure the quality of results from the Kjeldahl apparatus which is used to determine proteins the following procedures are used. All reagents used to quantitate the protein are standardized to 0.0001 Normal against primary standards. Ammonium sulfate recoveries are determined on each portion of the apparatus to ensure complete recovery of all the protein in a sample. Blank samples are run to ensure that their is no contamination in the system. Samples are spiked with additional nitrogen and the percent recovery determined routinely.

In order to improve the precision of the protein analysis, all titrations are done on the Computer Aided Titrator which is reproducible to an endpoint of 0.02 pH. The Computer Aided Titrator is checked daily to verify reproducibility and that the volumes are correct. The endpoint pH of every sample is recorded and checked. The response of the pH electrode is determined every time that the system is calibrated and compared with the theoretically achievable value.

The analysts record on a chart the values of each quality control sample and other quality control data. The manager of each section of the laboratory checks the quality control graphs of each analytical procedure before the analyst is allowed to record the final results of the procedure on the laboratory worksheets. If the quality control data raises any questions about the quality of the analysis, the manager determines the source of the problem and the entire set of samples that the quality control data represented is analyzed again.

All alfalfa hay results from the laboratory are checked by either the Director of Administration or the Director of Technical Services, both of whom have at least 10 years experience in hay analysis, before the reports are mailed to the customer. This summarizes what we are currently doing to assure that the highest quality data is given to the customer.

Variation is a fact of life. There is variation involved in every measurement done. When you put together a wooden box in the garage using a tape measure, all the measurements are not perfect. The tape measure may have moved slightly, or have stretched, or the mark on the wood may have followed the soft portion of the grain, or the marks on the wood may vary in width.
The same types of variations occur during an analytical procedure. Some procedures have inherently more variation than others. The more steps involved in a procedure, the greater the possibility of variation in results.

The fiber procedures involve many steps. A rigorous Quality Assurance Program can minimize, but not eliminate the variations. We have seen over the years many instances of unrealistic expectations of the fiber procedures. For example a hay broker indicating that his buyer wanted 55% TDN hay and the test results indicated 54.9%. Therefore, the buyer found the hay to be unacceptable. The test results need to be evaluated realistically.

Chemical testing of alfalfa hay has been found to be a very useful tool for evaluating its quality, but the analytical results are only one of many factors that need to be considered. The accuracy and precision of analytical procedures continues to improve with time.

Selected References

Bath, D. L. and V. L. Marble. 1989. Testing alfalfa for its feeding value. University of California Leaflet 21457, or WREP 109.

Marble, V. L. (editor). 1984. Proceedings, National Alfalfa Hay Quality Testing Workshop. Chicago, Illinois. March 22-23 1984. 67 pages. Agronomy Extension, University of California, Davis, CA.

Garfield, Frederick M., Quality Assurance Principles for Analytical Laboratories. 1984. Association of Official Analytical Chemists.

Garfield, Frederick M., Nancy Palmer, and George Schwartzman (editors). 1980 Proceedings, Optimizing Chemical Laboratory Performance Through the Application of Quality Assurance
Principles. Association of Official Analytical Chemists

Windham, Dr. William R., Monitoring Laboratory Performance. Proceedings, Forage Analysis Workshop, May 7-8 1991. National Forage Testing Association