

## ***NIRS Forage and Feed Testing Consortium***

**“Dedicated to increasing the accuracy and knowledge of NIRS testing.”**

# **NIRS Consortium Membership NEWS**

May/June, 2001

### **Board Elections 2001**

We have updated our records and have developed a Board election schedule. Steve Peterson, Consortium President, appointed a nomination committee to round out a list of new nominees as well as board members up for re-election. We need to fill three positions, one each from the commercial, seed research, and university/government sectors.

Elections will take place by mailed ballot in July so that those elected may take office by October 1, 2001, which is the beginning of our new fiscal year.

You will receive a list of candidates for each sector by a separate email shortly, with ballots following by mail.

### **Update on Corn Silage NDFd Equation Work**

Paolo has selected 61 samples so far from spectra sent in from labs participating in the Consortium Corn Silage NDFd equation development. UW Soil and Forage Lab in Marshfield already has 36 of these samples in progress and is waiting for more to be delivered. The protocol decided upon by members interested in this equation was to run each sample in four replicates, on 1mm Wiley ground samples, for 48 hours, by in vitro method. We expect an equation to be developed by this fall for the new corn silage season. The Consortium would like to thank

Dairyland Labs, AgSource Coop, UW Soil and Forage Lab, Olson Biochemistry Lab, and Dairy Tech Labs for their participation in sample submission for this collaborative effort.

Any labs with questions or wishing to join the project, please contact Paolo Berzaghi or Patty Laskowski.

### **Effect of Ring Cups on Prediction of Forage Samples**

Paolo has completed a summary from data provided by Nancy Thiex at Olson Biochemistry Lab (SDSU) on ring cups as a source of variation in predictions. Paolo outlines this study and makes recommendations on how to prevent prediction errors due to the ring cup. Please see [Effect of Ring Cups on Prediction of Forage Samples](#).

### **Reminder of Equation Availability**

The Consortium has equation updates available to all Consortium members. Paolo has completed updates on the Consortium scissors cut equation and the Combs NDFd / Hoffman RUP package. Please let Patty Laskowski know if your lab is still interested in these equations.

### **Announcement of New**

## **Milk2000 Release**

Milk2000, a system for evaluating corn silage, was released in the fall of 2000. Now the authors of this program have added a spreadsheet for evaluating grass/legume hay and haylage based on the new NRC Dairy. Just as milk2000 for corn silage calculates milk per ton and milk per acre based on the contents of a corn silage sample and field yield, the new spreadsheet for grass/legume calculates these same items. This new spreadsheet can be accessed by going to the [University of Wisconsin Forage Research & Extension page](#) and looking for the links to milk2000.

## **Equation Updates Reminder**

Paolo is still working on updates to the existing Consortium hay, haylage, and corn silage equations. If you would like updates for these equations, your lab must participate by sending in spectra and reference data.

## **Feedback on Documents**

Please let Patty or the Consortium Board know if you have any feedback on the documents on [Grinding Protocol](#) or [Achieving Uniformity in Forage Testing Reports](#).

## **Forage Check Cell**

New check cells for Commercial labs have all been distributed. Paolo is in the process of repacking your old check cells with a legume/grass forage product. Paolo may ask for further lab participation in collecting a bulk sample with which he will fill the check cells.

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For further information on any of these topics, please contact Patty Laskowski.

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## Effect of Ring Cups on Prediction of Forage Samples

**To: NIRS Consortium**

**From: Paolo Berzaghi**

**Date: July 2, 2001**

Below are results of analysis on a data set provided by Nancy Thiex at Olson/South Dakota State Lab. They took one forage sample and scanned on 21 different ring cups. Each ring cup was re-packed and scanned 3 times. Each scan was used to generate prediction values using a forage calibration I have developed using Consortium samples. The predictions were analyzed by analysis of variance to determine if there was a difference in the predicted values due to the ring cup used.

As you can notice in Table 1, cuvette #21 had a prediction which significantly differed from all the others. For NDF the difference between cuvette #21 and the average of all the others was over 10 units. Despite these large differences there wasn't any indication from the GH and NH values that these predictions were different from the others.

Table 2 shows the differences in statistics if we avoid using cuvette #21. The standard deviation and the range decrease dramatically. However, you may see that NDF still has a range of about 2 units. Differences can be reduced using a repeatability file that will make the calibration less sensitive to the effect of the different ring cups.

### **Take home message:**

Check your cells by a method similar to what Olson/SDSU used. See if some cells generate 'bad' predictions. If you find one, look if there is excess glue covering the glass. You can wipe it off with acetone.

A rep file as well as using different cells when making a calibration will reduce the effect of the ring cup on predictions.

Table 1: Mean and standard deviation of prediction of each cup using Lhay1097.eqa

cups	DM		CP		ADF		NDF	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	92.17	0.13	14.84	0.07	34.70	0.19	56.05	0.32
2	92.71	0.12	14.78	0.02	34.39	0.13	54.79	0.27
3	92.57	0.19	15.12	0.13	35.02	0.40	56.39	0.27
4	92.50	0.20	15.12	0.10	35.05	0.37	56.34	0.47
5	92.37	0.14	14.94	0.15	34.87	0.17	55.95	0.03
6	92.49	0.14	14.92	0.07	34.37	0.13	55.06	0.23
7	92.53	0.19	14.93	0.23	34.60	0.39	55.35	0.34
8	92.73	0.13	15.22	0.09	35.29	0.10	56.20	0.14
9	92.60	0.11	15.17	0.03	35.09	0.06	56.04	0.22
10	92.35	0.13	14.83	0.03	34.49	0.23	55.48	0.19
11	92.70	0.11	15.10	0.15	35.18	0.36	55.98	0.49
12	92.62	0.12	15.16	0.02	35.11	0.04	55.95	0.15
13	92.53	0.14	15.00	0.08	34.95	0.04	55.97	0.20
14	92.38	0.00	15.17	0.00	34.89	0.00	56.05	0.00
15	92.58	0.19	15.16	0.08	35.14	0.20	56.12	0.29
16	92.49	0.12	14.92	0.09	34.50	0.08	55.61	0.15
17	92.49	0.19	14.92	0.04	34.48	0.15	55.27	0.29
18	92.56	0.13	15.10	0.08	34.92	0.20	56.29	0.37
19	92.70	0.12	14.98	0.12	35.19	0.13	56.05	0.07
20	92.80	0.20	15.10	0.19	35.24	0.29	55.97	0.21
<b>21</b>	<b>91.04</b>	<b>0.02</b>	<b>18.56</b>	<b>0.03</b>	<b>37.62</b>	<b>0.06</b>	<b>44.80</b>	<b>0.08</b>

Table 2: Mean, standard deviation (SD), minimum and maximum values, with or without cuvette #21.

Trait	AVG	SD	Min	MAX
with #21				
DM	92.27	0.61	91.00	92.98
CP	15.67	1.39	14.74	18.61
ADF	35.38	1.12	34.22	37.71
NDF	53.82	4.32	44.65	56.88
without #21				
DM	92.55	0.19	92.09	92.98
CP	15.02	0.16	14.74	15.32
ADF	34.87	0.36	34.22	35.48
NDF	55.84	0.49	54.49	56.88
without #21 w/ rep file				
DM	92.55	0.17	92.13	92.96
CP	15.52	0.13	15.27	15.76
ADF	35.11	0.21	34.76	35.60
NDF	56.01	0.30	55.40	56.70

# Grinding Protocol

University of Minnesota Forage Quality NIRS Laboratory<sup>1</sup>

Objective: To accurately represent field samples for laboratory or NIRS analysis.

- The entire dried field sample is coarse ground (approx. 150 g) using a Wiley mill # 4 with a 4-6 mm screen. Alfalfa leaves easily break off from the stem making it difficult to subsample a portion of unground material. The larger screen size quickly breaks up the sample.
- Any material left in the grinder is added to the sample. An air hose or vacuum cleaner is used to clean out mill between samples.
- The coarse sample is placed in a large blender for one minute to remove stratification of material after grinding.
- Pour the sample from the blender cup into a tub. Spread out the sample into a uniform layer. Then use a 4 oz. brown plastic bottle to subsample from three different areas of the material.
- Regrind sample using a Tecator cyclone mill with a one mm screen. Pour sample unto tray of grinder and grind back into the same bottle. Use air pressure or vacuum to clean between each sample.
- Sample has become stratified again due to the fine grinding and needs remixing. A 15-gallon plastic drum is used as a sample tumbler.
- Place 70 – 100 samples into tumbler for 15 minutes. The drum rotates at 15 rpm and contains a rod that lifts and drops the bottles to provide a random tumbling.

In tests using NIR, subsamples from the same bottle were nearly identical. Standard errors for laboratory chemical procedures also decreased due to the more uniform subsampling from the tumbler.

Whirlpaks can also be tumbled by sealing open end with tape and providing an air space for sample movement.

If samples sit longer than 4 weeks before analysis, retumbling is repeated due to possible moisture stratification within the sample.

- Grinder maintenance: We grind only a few thousand samples each year and therefore sharpen the Wiley blades once a year. On the cyclone mill we change screens once a year or whenever the holes appear oblong. We change the grinding rings every other year. This noticeably improves grinding speed and may be cost effective to replace every year. We

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replace seals quite often and we would like to find an alternative that is cheaper than original equipment.

## Achieving Uniformity in Forage Testing Reports

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### ABSTRACT

Information on laboratory reporting forms can be a source of confusion or additional information for clients. It can be confusing when laboratories use different names or abbreviations for the same analysis, use similar names for different analyses, or report results on different dry matter (DM) bases. Conversely, by providing additional information about the analytical methods used, the equations used for calculated results, and the potential reproducibility of results, laboratories can assist their clients in understanding and interpreting results. The National Forage Testing Association (NFTA) is proposing recommendations that would improve the uniformity in reporting results among laboratories. It is proposed that one column of results be reported on a 100% DM basis, with additional columns for reporting results on an as-is (as-received) or air-dry (90% DM) bases. It is also proposed that calculated results, such as NEL, TDN, RFV, etc., be reported in a separate section clearly identified as "Calculated results:" after analytical results are presented. The most important recommendation, but perhaps the most difficult to adopt, is to provide more information about the method used to obtain analytical and calculated results. For example, there are at least three modifications of the method for measuring neutral detergent fiber that obtain slightly different results. If laboratories would indicate which modification was used, confusion among clients would be reduced. Likewise, soluble carbohydrates can be measured directly or determined by difference as total nonstructural carbohydrates (TNC), non-structural carbohydrates (NSC), non-fibrous carbohydrates (NFC) or neutral detergent soluble carbohydrates (NDSC), yet the abbreviations are often used interchangeably on reports without a clear indication of the method used. Also, if the source of the equations used to calculate results were indicated on reporting forms, it would be easier for clients to interpret results and make reasonable comparisons among laboratories. The NFTA has no authority to enforce uniformity in reporting analytical results, but hopes that proposed recommendations will be adopted by laboratories as a way of reducing controversy and confusion in the forage testing industry.

### INTRODUCTION

Although diversity is the spice of life, it can also result in stress and confusion. Feed analysis laboratories have the right to present their results in any way they determine (insofar as the information is truthful), but they also bear the responsibility for clarifying any confusion that is created. It is becoming more common for a feed to be analyzed by more than one laboratory. When results do not agree, it is important that results are reported so that direct and accurate comparisons can be made. No one benefits when controversy arises because results are misunderstood due to poor, incomplete, misleading or dissimilar reports. We have observed that clients of forage testing labs are often confused when results were not presented on the same dry matter basis, when the same nutrient name or acronym was used to describe two different methods, or when different names or acronyms are used for the same analysis. A level of uniformity in reporting analytical results would help the clients of forage testing laboratories in interpreting information and drawing correct conclusions about the data. It would also prevent laboratories from becoming involved in controversies that could be easily avoided. The NFTA cannot regulate standards for reporting results, but it can and should make recommendations about uniformity in reporting feed analyses that would benefit everyone in the forage testing industry and their clients.

### IMPROVING UNIFORMITY IN REPORTING RESULTS

**Laboratory identification.** The name and address of the laboratory should be clearly identified at the top of the results reporting form with telephone and fax numbers (see example reporting form at the end of this paper). If available, the email and website addresses of the laboratory should be provided. It is also desirable to have the name of the laboratory manager indicated so the person in charge can be contacted if there are questions or concerns. If analytical services are subcontracted through another individual or firm, it is desirable that both the party providing analytical and interpretative support and the laboratory actually conducting the analysis be reported on the results form. It is also important to indicate any certification of proficiency or accreditation on the form.

**Client identification.** All pertinent information about the client should be included on the form to help ensure that the information is reported to the correct individual. It is also appropriate to indicate the name of any other individual that will be sent copies of the report.

**Feed description.** To aid the interpretation of analytical results and ensure that the correct description of the feed is used when calculating or assessing some nutritive values, it is crucial that accurate and detailed information be obtained from the client or submitter of the sample. The client should provide some type of name or identifying code for the sample. Sometimes the client's identification may not provide the laboratory with adequate information to determine the proper preparation and analysis of the material. Therefore, it is desirable to ask specific questions about the feed to ensure that it is properly classified. In the future, this information may be important in providing more accurate estimates of nutritive value. We are currently developing an enhanced feed evaluation system that will use information supplied by the client with the analytical information reported by the testing laboratory to provide more accurate and site-specific estimates of nutritive value in the future.

To provide guidance to the client as to the information desired and to simplify and standardize data input, it may be beneficial to provide multiple choice responses that can be easily coded. Feed type can be used to identify the correct equation(s) to use to estimate derived or calculated nutritive values such as total digestible nutrients (TDN) or net energy (NE). Choices of feed type could include: alfalfa, grass, corn silage, small grain cereals, warm-season grass, cool-season grass, legumes, mixed mostly legume (>50% legume), mixed mostly grass (>50% grass), etc. The grower or feed origin and field location can be used to more clearly identify the sample. When combined with the ZIP code or a global positioning coordinates of the feed's origin, this information can be used to identify the soil and weather conditions under which the crop was grown and may be used in the future to improve feed evaluation. Likewise, cutting (first, second, third, etc. or regrowth in the case of grasses) and harvest date information can be used to verify results and provide specific information that may be used to improve feed evaluation and interpretation of results.

Preservation and storage information (fresh, wilted, ensiled, sun-dried hay, dried hay, etc.) can also be used to verify and interpret results. Although feed description information may be used to enhance feed evaluation in the future, it can be used immediately by laboratories to classify and summarize results and to develop acceptable ranges for nutrients for various classes of feeds. This information could easily be used in-house to identify questionable results before they are reported. If questionable results are verified by additional tests, this historical data could be used to document for the client that the data are inconsistent with similar feeds and the results should be used with caution or additional samples should be collected and analyzed.

**Sample description.** It should be obvious that a representative sample is necessary to obtain reliable results for the client, however, it is not uncommon to receive samples that are clearly inadequate or questionable. We must begin to emphasize to clients that what happens before the sample is submitted to the lab is important, if not crucial, to the validity of the results that are provided. By drawing attention to how the sample was obtained and to the condition of the sample when it was received by the lab we can indicate that this is a important part of good feed analysis. The name of the sampler should be provided as well as the date the sample was taken and how it was prepared for shipment. The date the sample was shipped and received would indicate to the laboratory and client any potential problems related to shipping time. Laboratory observations about the condition of the sample and any problems in handling it in the lab should be recorded and reported. To simplify this process some type of coding should be developed (1=large submitted sample that had to be subsamples before analysis, 2=submitted sample was difficult to subsample, 3=sample was moldy, 4=sample was segregated, 5=sample may not be representative, etc.). To assist in tracking the sample, the laboratory sample identification or other codes should be reported.

**Analytical results.** It is recommended that all results be reported on a 100% dry matter (DM) basis with additional columns for reporting results on an as-received (as-is) or air-dry (90% DM) bases (for example, in California, TDN of alfalfa hay is routinely compared on a 90% DM basis). In addition, the units of measurement must be provided to eliminate confusion. For example, protein solubility and soluble protein are often used interchangeably. Whereas protein solubility implies that the proportion of protein that is soluble is being reported (units = % of crude protein), soluble protein could indicate either the proportion of protein that is soluble (units = % of crude protein) or the proportion of DM that is soluble protein (units = % of DM). Neither expression is incorrect, but accurate interpretation of results requires that the units of measurement be recorded clearly on the results reporting form.

It can be confusing to clients when laboratories use different names or acronyms for the same analysis or when they use the same name or acronym when different modifications of a method are used. The most important recommendation for improving uniformity and clarifying the reporting of results is to use common terminology and provide more information on the results reporting form about the methods used by the laboratory. In addition, it is important for some clients to know if the analytical results are determined by near infrared reflectance spectroscopy (NIRS) or chemical methods. The terminology of "wet chemistry" is often used, but there is no "wet" versus "dry" chemistry. Methods are either chemical and chemometric (such as NIRS). When describing methods for NIRS both the reference method used to develop the calibration and the source of the calibration equation must be provided to give an unambiguous description of the method used to obtain results. To illustrate the variation in reporting that exists and to make specific recommendations for uniformity, selected analytes will be discussed individually, starting with those used for proficiency testing by the NFTA (see example reporting form). In each case, example abbreviated nomenclature will be suggested for inclusion on the reporting forms to indicate the method that was used to generate the results that are reported.

**Dry matter.** Oven drying is the most common method for determining DM. In the United Kingdom this measurement is currently called "Oven DM" to signify its origin and make clear that volatile dry matter is lost during measurement. The rationale for highlighting this problem is especially important for high moisture silages and other wet fermented feeds in which the volatile losses can approach 10 to 15% of the material. It may be desirable to begin to report DM as "Oven DM" to clarify the method of measurement for our clients. Describing the method for measuring Oven DM on report forms is important because so many different methods are used to measure this analyte. In the initial survey about methods conducted by the NFTA, there were over 140 different combinations of time and temperature used by the approximately 150 labs responding. This illustrates the potential problem in comparing oven DM among laboratories.

This determination is described on reporting forms as dry matter, D.M., or DM. The preferred nomenclature is Oven dry matter or Oven DM reported a percentage of as-received matter. The inverse of dry matter is moisture which is often included on the report. Examples of method nomenclatures and footnote descriptions for Oven DM methods include:

AOAC 930.15	Moisture in animal feed, oven drying at 135 °C for 2 h,
In-house 105-16	Oven dried at 105 °C for 16 h,
NIR ISI equa	NIRS determination using ISI equation LHLGGOSF unadjusted (reference method unknown),
NIR in-house equa	NIRS determination using in-house calibration equations (reference method = oven dried at 105° C for

	16 h),
In-house 2-step NIR	Microwave dried 4 min at 600 watts followed by grinding and NIR determination of residual moisture using NIRS Consortium equations,
In-house 2-step oven	Oven dried at 60 °C for 16 h followed by grinding and oven drying at 135 °C for 2 h (AOAC 930.15).

**Crude protein.** Crude protein is determined by measuring nitrogen (N) in the material and multiplying N X 6.25. This determination assumes that all N in the material is contained in amino acid protein and that the average N concentration in protein amino acids is 16% (6.25 = 1/.16). Because these assumptions are not true for most, if not all, feed ingredients the analyte is called crude protein, instead of protein or true protein. Nitrogen is most commonly measured in feed using Kjeldahl or combustion methods. Kjeldahl methods use acid digests and catalysts to reduce N to ammonia which is measured colorimetrically or by titration. Combustion measurements burn the sample and measure the N in the combustion gasses.

Crude protein is described on reporting forms as protein, crude protein, total protein, C.P. or CP. The preferred nomenclature is crude protein or CP reported as a percentage of DM. Examples of method nomenclature and footnote descriptions for crude protein methods include:

AOAC 954.01	Protein (crude) in animal feed, Kjeldahl method using mercury catalyst,
AOAC 984.13	Protein (crude) in animal feed, copper catalyst Kjeldahl method,
AOAC 990.03	Protein (crude) in animal feed, combustion method,
NIR ISI expand	NIRS determination using ISI expandable equation CSLGOSF adjusted in-house (reference method unknown),
NIR in-house equa	NIRS determination using in-house calibrations equations (reference method = AOAC 984.13).

**Acid detergent fiber.** Acid detergent fiber (ADF) is determined by extracting materials in 1N sulfuric acid containing a cationic detergent. The method has evolved very little since its introduction in 1963 with a few exceptions. Some laboratories are ashing ADF and subtracting the fiber ash and some are determining ADF sequentially on fiber residues after neutral detergent extraction. An additional modification is the use of the Ankom filter bag system for measuring ADF, which semi-automates the method and simplifies the sequential determination of ADF after neutral detergent extraction. Because fiber is defined by the method used to isolate it, it is misleading to indicate that these different methods measure the same entity. Thus, it would be most clear to those reading feed analysis reports if each fiber method had a similar, but unique acronym. These new acronyms may create confusion initially with some clients, but this confusion is no more than that created by the use of the same name or acronym to describe the results from different methods.

Acid detergent fiber is described on reporting forms as acid detergent fiber, A.D.F., Adf, or ADF. The preferred nomenclature is acid detergent fiber or ADF for the method described in USDA Handbook 379 or AOAC, ADFom for the ash-free ADF organic matter using the Handbook 379 or AOAC methods, sADF for acid detergent fiber measured sequentially after neutral detergent extraction, and ADF(fb) for ADF determined using the Ankom filter bag method. All ADF results should be reported as a percentage of DM. Examples of method nomenclature and footnote descriptions for acid detergent fiber methods include:

Handbook 379	Acid detergent fiber, crucible method, 1 g sample,
AOAC 973.18	Fiber (Acid Detergent) and lignin in animal feed, crucible method, 1 g sample,
Ankom filter bag	Ankom filter bag method dated 00/00/00 (several modification have been reported by Ankom and the date of the method is important for method description),
In-house ADFom	AOAC 973.18 with ashing of residue to determine ADF organic matter,
In-house seq. ADF	ADF determined using AOAC 973.18 after neutral detergent extraction with amylase and sodium sulfite,
In-house ADF mod.	AOAC 973.18 modified to use filter paper, .5 g sample, and no acetone washes,
NIR ISI equa	NIRS determination using ISI equation MHLGGOSK adjusted in-house (reference method unknown),
NIR in-house equa	NIRS determination using in-house equations (reference method = AOAC 973.18).

**Neutral detergent fiber.** Of the methods used by the NFTA for proficiency testing, neutral detergent fiber (NDF) has the greatest number of modifications in use which also creates the largest differences in the results that are reported. Much of the difference in methodology for NDF has resulted from the evolution of the method to encompass more types of feed ingredients. The original NDF method was developed to isolate the indigestible or incompletely digested cell wall constituents from the completely digestible cell contents of forages. Anionic detergents and sodium sulfite were used to solubilize proteins and fats, heat and EDTA were used to solubilize completely digestible pectins and soluble carbohydrates, and acetone washes were used to complete the extraction of lipids (Goering and Van Soest, 1970). It was discovered that the original NDF method did not adequately remove starch from grains or forages like corn or cereal crop silages. It was also suggested that sodium sulfite might remove phenolic compounds which could affect lignin values. The neutral detergent residue (NDR) modification of the NDF method was developed that include a heat-stable amylase to remove starch and eliminated the use of sodium sulfite (Robertson and Van Soest, 1980; Van Soest et al., 1991). Most recently, the amylase-treated NDF (aNDF) modification was developed that uses sodium sulfite like the original NDF method but also includes the use of heat-stable amylase to remove starch. Sodium sulfite was included in the aNDF method to remove protein contamination from heated feeds and to aid the filtration of fibrous residues during the washing steps in the procedure (Hintz et al., 1996). The Ankom filter bag system has also been used to measure NDF using various modifications of the original method. In addition to these modifications, the ash and protein contents of NDF are sometimes measured and subtracted resulting in the measurement of NDF organic matter or nitrogen-free NDF.

Neutral detergent fiber is described on reporting forms as neutral detergent fiber, N.D.F., Ndf, or NDF. The preferred nomenclature is neutral detergent fiber or NDF for the original method described in USDA Handbook 379 that uses sulfite, but not amylase (Goering 8

and Van Soest, 1970); NDF for the modification described by Robertson and Van Soest or Van Soest et al. which uses amylase, but not sulfite (Robertson and Van Soest, 1980; Van Soest et al., 1991); and aNDF for the method published in the NFTA Forage Analyses Procedure Manual that uses both sulfite and amylase (Undersander et al, 1993). When the Ankom filter bag system is used, it is suggested that the suffix (fb) be included in the acronym, and when results are reported on an ash-free or nitrogen-free fiber the suffixes of “om” and “nf” could be used, respectively (e.g., NDFom or NDFnf). All NDF results should be reported as a percentage of DM.

Examples of method nomenclature and footnote descriptions for neutral detergent fiber methods include:

Handbook 379	Crucible method, 1 g sample, with sodium sulfite and without amylase,
Van Soest (1991)	Crucible method, .5 g sample, without sodium sulfite and with amylase,
NFTA (1993)	Crucible method, .5 g sample, with sodium sulfite and amylase,
Ankom filter bag	Ankom filter bag method dated 00/00/00 (several modification have been reported by Ankom and the date of the method is important for method description),
In-house NDFom	Handbook 379 method with ashing of residue to determine NDF organic matter,
In-house NDFnf	Van Soest (1991) method modified to use filter paper and .5 g sample; Kjeldahl nitrogen determined on the fiber residue,
In-house NDF mod.	Handbook 379 method modified to use filter paper, .5 g sample, and no acetone washes,
NIR ISI equa	NIRS determination using ISI equation LHAYGOSF unadjusted (reference method unknown),
NIR in-house equa	NIRS determination using in-house calibration equations (reference method = NFTA, 1993).

**Other analyses.** The nomenclature, units and method descriptions of analysis other than DM, CP, ADF and NDF are even more variable and confusing. For example, acid detergent insoluble nitrogen (ADIN) is called heat damaged protein, heat dam. protein, bound protein, unavailable protein, ADF-CP, and AD-ICP, and is expressed as either a percentage of DM or percentage of total nitrogen or crude protein. In addition, other reported protein results are adjusted crude protein, available protein, and digestible protein. In many cases, not even experts are sure when different nomenclature is really the same thing or when the same nomenclature means different things among laboratory reports. Lignin is sometime reported and it is unclear whether it was determined using permanganate or sulfuric acid. A complete summary of the other analyses that are included on analysis reporting forms is not available at this time. More work is need to determine how the various components are measured and to propose guidelines that would promote uniformity among laboratories. In addition, it may be helpful to include some indication of precision or reproducibility for each result to indicate to the client that analytical values are not absolute. Finally, labs would benefit if nutritionists and clients could develop a recommended set of analyses to be included on basic or detailed feed analysis reports.

**Calculated results.** There should be a clear distinction between results that are determined analytically and those that are derived or calculated from analytical determinations. It is important to clients that the source of the equations used to calculate the results and, if possible, the actual equation that was used is provided on the reporting form (there are cases in which the equation is proprietary and may not be published, but the source could be provided for clarity). It should be made clear to clients that all digestibility and net energy values that are reported by laboratories are calculated. In addition, forage quality indexes such as relative feed value should be clearly identified as calculated results. Soluble carbohydrates can be measured directly or determined by difference as total nonstructural carbohydrates (TNC), non-structural carbohydrates (NSC), non-fibrous carbohydrates (NFC) or neutral detergent soluble carbohydrates (NDSC), yet the abbreviations are often used interchangeably on reports without a clear indication of how the result was obtained. Calculated soluble carbohydrates values will differ substantially from those that are determined analytically because the components included in the soluble carbohydrate fraction are quite different. Thus, it is important to include the measured value under analytical results and those that are calculated under calculated results to avoid confusion. Using the incorrect value in ration formulations can result in serious health consequences to animals and potential liability for the laboratory.

Total digestible nutrient are reported as %TDN, TDN est., Calc. TDN, Total Dig. Nutrients and TDN. Digestible dry matter is reported as Dig. Dry Matter, Calc. D.D.M., DMD, and DDM. Examples of method nomenclature and footnote descriptions for TDN, DMD, or soluble carbohydrates include:

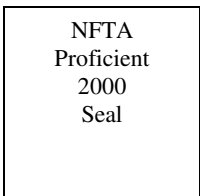
Weiss (1993)	$TDN_{1x} = (e^{-.012*ADIN}) * CP + .98 * NFC + .94 * 2.7 * (EE - 1) + .75 * (NDF_{nf} - L) (1 - (L / NDF_{nf})^{2/3}) - 7,$
Mertens grass ADF	$TDN_{1x} = 97.6 - .974 * ADF;$ NFTA Forage Analyses Procedures. (Undersander et al., 1993),
Rohweder ADF	$DMD = 88.9 - .779 * ADF;$ (Roweder et al., 1978),
Mertens leg. NDF	$NEL_{3x} = 1.054 - .0098 * NDF;$ (Mertens, 1992),
Proprietary ADF	Best Dairy Feeds, Inc.,
Mertens (1988)	Non-fibrous carbohydrates = 100 - aNDF - CP - Ash - EE.
Smith (1983)	Total nonstructural carbohydrates

**Comments and signature.** There should be an area on the results reporting form where technicians, quality assurance personnel, and the laboratory manager can indicate concerns about the sample or results, and can provide feedback to the client about unusual characteristics of the sample or values that would be useful in interpreting results. In addition, the report should be signed by someone who has the responsibility for generating or verifying the results and for providing additional documentation.

## CONCLUSIONS

This report is the first step in developing uniform guidelines for the reporting of nutritive information by forage testing laboratories. It is obviously incomplete in both the list of analytical and calculated results that are currently reported and in the documentation of method descriptions that are comprehensive, yet concise and informative. It is intended to stimulate discussion, offer initial comments <sup>9</sup>

about the magnitude of the problem, and provide a framework for the development of a uniform method of reporting feed analysis data that will be more informative and less confusing to both clients and laboratory personnel. The NFTA, other laboratory organizations, nutritionists, and researchers should continue to gather information and develop nomenclature guidelines that can be finalized within the next year.



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**FEED ANALYSIS REPORT**

ABC Feed Analysis Laboratory  
 Anywhere Street  
 Anycity, ST 00000

Phone: (000) 000-0000 Fax: (000) 000-0000  
 email: ABCLabs@IP.com Website: www.ABCLabs.com

Client Name:	<u>Joe Client</u>	Feed identification:	<u>A-1-720</u>
Address:	<u>123 Anystreet</u>	Feed type:	<u>Alfalfa</u>
City, State ZIP:	<u>Anytown, AS 12345</u>	Grower or feed origin:	<u>Doe Farm</u>

Phone: (123) 456-7890 Field location: South 720  
 email: JC@localnet.com Cutting and harvest date: First, 05/25/00  
 Date sample analyzed: 05/29/00 Feed preservation: Wilted for silage  
 Date results reported: 05/31/00 Sampler: John Doe  
 Lab identification code: 00-000123 Date sample taken: 05/25/00  
 Invoice/accession code: 4567 Date sample shipped: 05/26/00  
 Date sample received: 05/28/00  
 Sampling method and handling: Grab samples of chopped material from 12 loads, frozen before shipment.  
 Sample condition as received: Chopped material of adequate amount in good condition.

Nutrient, units	Method	As-received	100% DM	90% DM
Analytical determinations:				
Oven moisture, %	In-house 105-16	65.0	0.0	10.0
Oven dry matter, %	In-house 105-16	35.0	100.0	90.0
Crude protein, %	AOAC 990.03	8.4	24.0	21.6
Acid detergent fiber, %	Handbook 379	10.2	29.0	26.1
aNDF, %	NFTA, 1993	13.3	38.0	34.2
Total nonstructural carbohydrates, %	Smith, 1983	4.2	12.0	10.8
Fat, %	AOAC 920.39A	1.4	4.0	3.6
Ash, %	AOAC 942.05	3.5	10.0	9.0
Minerals:				
Calcium, %	NIR ISI equa	0.81	2.30	2.07
Phosphorus, %	NIR in-house equa	0.12	0.33	0.30
Calculated values:				
Neutral det. soluble carbohydrates, %	Mertens, 1988	8.4	24.0	21.6
Total digestible nutrients, %	Bath&Marble, 1989	21.2	60.6	54.5
Net energy of lactation, Mcal/lb	Mertens leg.ADF	0.24	0.68	0.61

Comments:

Signature: