THE IMPORTANCE OF HAY SAMPLING– A 'HOW TO' DEMONSTRATION

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ABSTRACT

Hay sampling and analysis is used to estimate hay quality. When laboratories use wet chemistry techniques to evaluate hay quality the influence of the individual sampler is less important than the laboratory selected to conduct the analysis. If laboratories use NIRS analysis the influence of the individual sampler is more important than the laboratory selected to conduct the analysis. Buyers and sellers of hay should consider pooling the data from two or more certified laboratories in an effort to establish the true value of a commercial hay product.

Key Words: hay sampling, hay quality, analysis, laboratories

INTRODUCTION

In the past, and even at the present time, alfalfa hay has been marketed based on visual evaluation, feel, and sometimes taste. During the past 15 years there has been considerable effort in Utah and other Intermountain States to develop an acceptable system for estimating the quality of packaged hay and predicting the potential return when used on the dairy or ranch. Wet chemistry analysis of forages has been popular for many years and continues to be the base-line tool for estimating feed quality. Near infrared reflectance spectroscopy (NIRS) analysis of forage quality has gained in popularity during the same time period because it provides a more rapid analysis and it does not produce chemical waste.

Many laboratories throughout the United States have the capacity to estimate forage quality from wet chemistry and/or NIRS analysis. Laboratories that conduct such tests can become 'certified' through the National Forage Testing Association (NFTA) by participating in an annual evaluation of test samples. When analysis data is compiled and evaluated, laboratories whose evaluations fall within specified parameters become 'certified'.

As alfalfa hay is exported from Utah, we have observed that the forage quality analysis report from a 'certified' laboratory in Utah is almost never accepted by hay buyers. In most cases, the buyer insists on a new analysis from a local 'certified' laboratory. Although both laboratories involved are 'certified', we have observed that the results of the two analyses are often different. If you are the hay producer you would like to use the report with the higher quality analysis, however, if you are the buyer you would like to purchase hay based on the lower analysis.

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We have assumed, because of laboratory certification, that the analysis of the sample is often not the problem. Although there are differences of opinion regarding analyses and procedures, and many states do not accept another state's analysis, we believe that the sample and the sampling process can contribute significantly to the outcome of the forage quality analysis. The objective of this report is to examine forage quality analysis when sampling procedures vary.

PROCEDURES

In January 1997 we organized a hay testing study at the Cleon Chambers Farm, Smithfield, Utah. Mr. Chambers had a 37 ton 'lot' of first crop alfalfa hay from 1996 in a covered barn that he was willing to let us sample. The hay was packaged in two-string tied bales that weighed approximately 70 pounds each. We arranged for four individuals who sample hay to come at different times during the day to the Chambers barn, and instructed them to bring their own sampling equipment and to collect a hay sample according to their standard protocol. Individuals were instructed not to talk to other evaluators until all samples had been collected and sent for analysis. A fifth set of samples was collected by Dennis Chandler who conducted the field portion of the sampling project.

Each individual was video taped during the sampling process so we could have a record of the equipment used and the techniques employed. These individuals worked throughout northern Utah and represented various agricultural industries. A brief outline of each individual's credentials and experience follows:

Denny Shupe—Trenton Feed Company, Trenton, Utah. Collects approximately 200 samples per year.

Steve Fillmore—Western Ag Industries, Smithfield, Utah. Collects approximately 100-150 samples per year.

Dennis Christensen---Nutritional Consultant, Tremonton, Utah. Collects approximately 75-100 samples per year.

Don Huber—Cache County Extension Agent, Logan, Utah. Collects approximately 45 samples per year.

Dennis Chandler—Utah State University, Extension Agronomy Technician, Logan, Utah. Collects approximately 400 wet and dry hay samples each year.

Each individual collected one sample from the 'lot' of hay in the Chambers' barn and put the sample in a labeled bag. Samples were ground in a Udy mill with a 1.0 mm screen and subdivided with a straightedge into four equal quadrants after being piled on a flat white surface. One-fourth of each sample was packaged and sent to one of four laboratories that conduct wet chemistry and/or NIRS forage quality analyses. The laboratories were:

Rock River Laboratory, Inc.
N8741 River Road
Watertown, WI 53094
414-261-0446

DHI Forage Testing Laboratory
Northeast DHIA
730 Warren Road
Ithaca, NY 14850
602-257-1272

USU Analytical Laboratories
Utah State University
4830 Old Main Hill
Logan, UT 84322-4830
435-797-2217

A & L Western Agricultural Laboratories
1311 Woodland Avenue, Ste. 1
Modesto, CA 95351
209-529-4080

(Author's note: Although A & L Laboratories analyzed wet chemistry samples for this study they do not conduct NIRS analyses. In order to standardize our reporting process we did not include A & L data in the tables or the discussion.)

One week after the original sampling was completed, Denny Shupe was asked to come back to the hay stack and take a second hay sample. The second sample was prepared in the same manner as the first set of samples and sent to the laboratories for analysis.

RESULTS AND DISCUSSION

Each individual who collected hay samples had a different hay probe and each took a different number of core samples from the 'lot' of hay. To characterize 37 tons of hay, Denny Shupe collected 22 core samples, Dennis Christensen 40, Steve Fillmore 21, Don Huber 26, and Dennis Chandler 20. No individual collected less than 20 core samples regardless of the size of the sampling device that was used. In earlier work conducted by Utah State University (Dallas A. Hanks, 1990 "A Proposed Method to Evaluate Packaged Alfalfa by Physical Inspection and Near Infrared Reflectance Spectroscopy Analysis. MS Thesis): "The number of cores influenced the outcome of the consolidated method of analysis. In this study, the same level of precision could be obtained from the consolidated method using 5, 10, 20, or 40 cores/sample in a given lot. The 1 core/sample treatment was significantly worse in predicting hay quality than were all other coring treatments." The consolidated method uses a number of parameters in addition to NIRS analysis and was able to predict hay quality from an unusually small number of samples. The consolidated method requires more time, skill, and effort than does the collection of more core

samples and it was generally concluded that the precision of the hay quality evaluation does not increase enough to justify the effort after approximately 20 core samples were collected per lot of hay.

Samples analyzed by wet chemistry showed a general tendency for greater variation among laboratories than among individual samplers for acid detergent fiber but results were similar for crude protein. Tables 1 and 2. When an individual sampler went back to the haystack one week later and took a second sample (Shupe repeat) there was increased variation between the samples but the trend was still the same for greater variation among laboratories for ADF % than among individual sampling dates. Table 3.

When samples were analyzed by NIRS analysis a reverse trend was observed. There was greater variation among individual samplers and less variation among laboratories for crude protein and acid detergent fiber. Tables 4 and 5. When an individual sampler (Shupe repeat) went back to the haystack one week later and took a second sample for NIRS analysis, there was no difference in crude protein evaluation but acid detergent fiber values showed slightly greater variation among sampling dates than among laboratories. Table 6.

When hay samples were analyzed by using wet chemistry the influence of the individual sampler was not as significant as the difference between laboratories for acid detergent fiber. This was also true for repeat samples collected by the same individual but separated by time. The range in results (difference between the highest reported value and the lowest reported value) was greatest for laboratory variation in ADF % and smallest for individual sampler variation when wet chemistry was the tool for estimating hay quality. Table 7. This was true when all individuals were pooled and when a single individual collected data over time. Variation in wet chemistry analysis for CP% was similar for laboratory or individuals.

When hay samples were analyzed by NIRS methods the influence of the individual sampler was slightly greater than among laboratories. Although the range in results does not appear to be as great as for wet chemistry data, and in some cases the results are the same (NIRS repeat sample CP%), the trend is for individual samplers to introduce more variation into the analysis than that which is contributed by using different laboratories. Table 7.

Hay sampling is important in the determination of hay quality. From these data it appears that there is greater variation among laboratories than multiple individual samplers if hay samples are analyzed for ADF% using wet chemistry analysis techniques. If laboratories use NIRS analysis it appears that the influence of the individual sampler is more significant in affecting hay quality analysis for ADF% than is the laboratory used for the analysis. It should be noted that the splitting of samples in order to send a representative sample to several laboratories can introduce variation into the evaluation process. Every attempt was made in this study to obtain a representative sub-sample from each hay sample collected. The potential influence of the sub-sampling process on the outcome of this study cannot be ignored.

When hay enters commercial channels, and two or more certified laboratories draw a sample and conduct an analysis, buyers and sellers should consider pooling the data from the separate

analyses in order to more appropriately characterize hay quality. It may be important to know the type of analysis that will be or has been conducted, wet chemistry or NIRS, in order to estimate the influence that the individual who collected the sample may have had on the outcome of the analysis.

Table 1. Wet Chemistry Analysis of Crude Protein (CP%) On A Dry Matter Basis

Individual	Laboratory				
	RR	DHIA	USU		*range*
Shupe	14.7	14.4	14.3		
Fillmore	14.9	14.2	14.6		*0.7*
Christensen	14.5	14.1	14.		*0.4*
Huber	14.8	14.4	14.7		
Chandler	14.7	14.3	14.8		*0.5* *(0.5)*
range	*0.5*	*0.3*	*0.7*	*(0.5)*	

RR = Rock River
DHIA = Ithaca, NY
USU = Utah State University

Table 2. Wet Chemistry Analysis of Acid Detergent Fiber (ADF%) on A Dry Mater Basis

Individual	Laboratory				
	RR	DHIA	USU		*range*
Shupe	31.9	34.7	34.1		*2.8*
Fillmore	31.9	35.4	31.		*4.3*
Christensen	31.9	33.6	33.1		*1 7*
Huber	31	33.8	32.7		*2.7*
Chandler	31.1	32.9	31.7		*1.8* *(2.7)*
range	*0.8*	*2.5*	*3.0*	*(2.1)*	

RR = Rock River
DHIA = Ithaca, NY
USU = Utah State University

Table 3. Wet Chemistry Analysis of Crude Protein (CP%) and Acid Detergent Fiber (ADF%) on A Dry Matter Basis From A Single Hay Sampler Collecting Two Samples From the Same Haystack.

	CP%				
Individual	Laboratory				
	RR	DHIA	USU		
Shupe	14.7	14.4	14.3		
Shupe Repeat	15.2	15.0	14.9		*0.3*
					(0.4)
range	*0.5*	*0.6*	*0.6*	*(0.6)*	

	ADF%				
Individual	Laboratory				
	RR	DHIA	USU		*range*
Shupe	31.9	34.7	34.1		*2.8*
Shupe Repeat	30.1	32.1	34.3		*4.2*
					(3.5)
range	*1.8*	*2.6*	*0.2*	*(1.5)*	

RR = Rock River
DHIA = Ithaca, NY
USU = Utah State University

Table 4. NIRS Analysis of Crude Protein (CP%) on A Dry Mater Basis

Individual	Laboratory				
	RR	DHIA	USU		*range*
Shupe	14.7	14.8	15.7		*1.0*
Fillmore	15.0	14.9	14.9		*0.1*
Christensen	14.9	14.7	14.2		*0.7*
Huber	14.9	15.0	14.4		*0.6*
Chandler	14.8	15.0	14.7		*0.3* *(0.5)*
range	*0.3*	*0.3*	*1.5*	*(0.7)*	

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USU = Utah State University

Table 5. NIRS Analysis of Acid Detergent Fiber (ADF%) on A Dry Mater Basis

Individual	Laboratory				
	RR	DHIA	USU		*range*
Shupe	32.0	33.4	33.2		*1.4*
Fillmore	32.2	32.8	31.5		*1.3*
Christensen	31.7	33.5	32.2		*1.8*
Huber	31.5	31.6	32.8		*1.3*
Chandler	31.4	32.4	31.2		*1.2* *(1.4)*
range	*0.8*	*1.9*	*2.0*	*(1.6)*	

RR = Rock River
DHIA = Ithaca, NY
USU = Utah State University

Table 6. NIRS Analysis of Crude Protein (CP%) and Acid Detergent Fiber (ADF%) on A Dry Matter Basis From A Single Hay Sampler Collecting Two Samples From the Same Haystack.

	CP%				
Individual	Laboratory				
	RR	DHIA	USU		*range*
Shupe	14.7	14.8	15.7		*1.0*
Shupe Repeat	15.5	15.3	15.3		*0.2*
					(0.6)
range	*0.8*	*0.5*	*0.4*	*(0.6)*	

	ADF%				
Individual	Laboratory				
	RR	DHIA	USU		*range*
Shupe	32.0	33.4	33.2		*1.4*
Shupe Repeat	29.5	32.0	30.2		*2.5*
					(2.0)
range	*2.5*	*1.4*	*3.0*	*(2.3)*	

RR = Rock River
DHIA = Ithaca, NY
USU = Utah State University

Table 7. Average Range In Results For CP% and ADF% By Analytical Method, Individual, and Laboratory.

	Wet Chemistry	
	Individual	Laboratory
CP%	0.5	0.5
ADF%	2.1	2.7
Repeat Samples		
CP%	0.6	0.4
ADF%	1.5	3.5
	NIRS	
	Individual	Laboratory
CP%	0.7	0.5
ADF%	1.6	1.4
Repeat Samples		
CP%	0.6	0.6
ADF%	2.3	2.0

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