

STANDARDIZING FORAGE QUALITY AND TESTING ACROSS MARKETS

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ABSTRACT

Elements of forage testing as it relates to markets include 1) Standardization of Sampling, 2) Standardization of between-lab variation, and 3) Standardization of what is analyzed. None of these elements can be ignored. While the current 'fiber based' system of utilizing Relative Feed Value and TDN has been useful, incorporation of more dynamic analyses are needed. A 'core alfalfa test' consisting primarily of DM, NDF, NDFD, CP, and Ash is suggested, with NDF and NDFD given priority as marketing tools.

INTRODUCTION

Typically greater than 90% of western hays are marketed off-farm; thus a price must be determined between buyer and seller. Price is primarily a function of supply and demand, but forage quality is a secondary but critical component of pricing. Most western hay destined for dairies is tested, often more than once. Marketing has been based primarily on TDN and RFV, which are in term calculated from ADF or NDF concentrations from lab tests. Subjective (visual) determinants of quality are also important, as is CP to some degree (see explanations for abbreviations below).

Milk production per animal is has been increasing at the rate of about 2 % per year for the past 30 years, a trend with little chance of relenting. There is little question that demands for high quality forage for the dairy sector will continue and even intensify in the future. However, the role of alfalfa and other forages in rations is rapidly changing. It is increasingly clear that the marketing system in relationship to quality testing needs to change as well.

THE MULTIPLE ROLES OF FORAGE CROPS AND THE CHALLENGE OF QUALITY COMPLEXITY

What nutritionists look for in alfalfa and other forage products:

Digestible Energy—the amount of biological energy extractable by ruminants per unit weight of forage

High Intake—The digestibility or nutrients available per unit time

Protein – Both rumen digestible and rumen 'bypass' protein

Functional Fiber—Forages function to keep rumens healthy and pH normal

Mineral Balance—Balance of ions which may affect pregnant animals

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Unlike other feeds, such as soybean meal or corn grain, hay has a more complex role in diets. Nutritionists frequently prioritize digestible energy and high intake potential over other traits in hays (see text box). However, hay, particularly alfalfa contributes significant protein to diets, both rumen available, and rumen unavailable (but still digestible) protein. Mineral balance is sometimes important for pregnant cows to prevent milk fever (DCAD).

However, In addition to energy, minerals and protein, hays provide what is called ‘functional fiber’ or effective NDF. The fiber itself is critical to healthy rumen function and to prevent acidosis. A major quandary of our marketing system is that it rewards only low fiber in hays (high RFV and TDN is determined by low NDF and ADF), yet nutritionists fully understand its value in rations. It is not at all desirable to eliminate NDF or ADF in hay, or even to necessarily minimize it in all cases. The digestibility and physical nature of the fiber fraction is perhaps more critical than its percentage. While NDF percentage is a very useful predictor of quality, its digestibility is perhaps equally important, within a certain range. This is perhaps the major limitation of current marketing system used for alfalfa hay.

Although it is tempting to boil forage quality down to one or two factors, it is clear the multi-faceted nature of forage quality resists simplification.

Class of Animals and Markets Determine Quality. Further, different classes of animals will require different aspects of quality. While high intake is important for high producing dairy cows, medium fiber hays with lower intake are completely acceptable for dry cows, horses, beef animals or (for example) camels. The value of different analyses will also depend upon the behavior of markets—for example when protein becomes relatively less or more expensive to purchase.

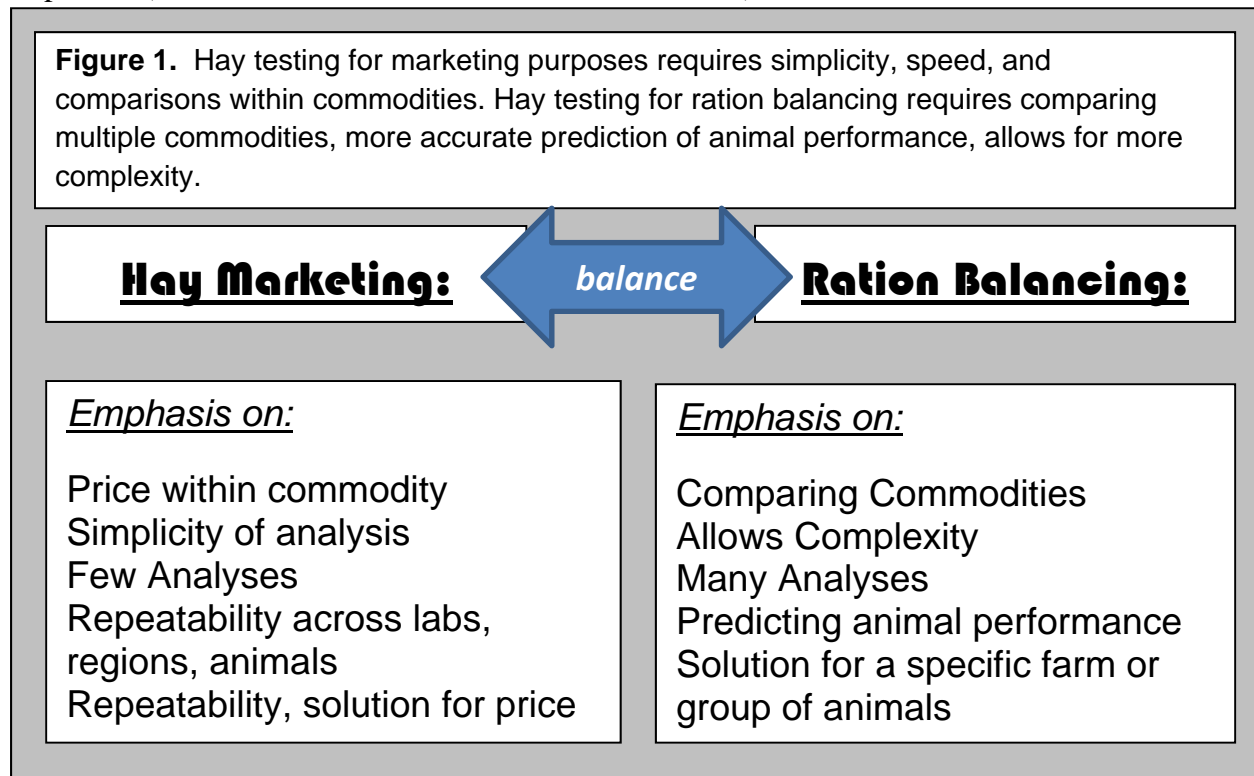
Changing Rations. Dairy diets have included a smaller and smaller component of alfalfa hay in recent years, due primarily to cost of hay, which has been high. Consequently, the role of quality analysis in the value of the crop has changed significantly. While historically, nutritionists were interested in minimizing ADF and NDF to maximize energy (TDN or NEL), alfalfa hay is increasingly being fed not for digestible energy, but for its functional fiber itself. It is ironic that the market continues to reward only low fiber hays, but at the same time, alfalfa is being included primarily for its functional fiber in many rations. There is a need to shift the conversation from minimization of fiber to the digestibility of the NDF for marketing hays.

Changing Genetics. Innovations in alfalfa genetics is also likely to challenge our way of testing hay. The ‘low lignin’ trait (McCaslin and Reisen, 2012) is projected to be released in 2016. Improved lines are projected to have similar fiber contents (NDF), but significantly improved in digestibility. Improved digestibility is likely to significantly improve dairy production at the same NDF level. Other emerging quality traits, such as superior utilization of protein through inclusion of tannins or other traits will also challenge our way of thinking about protein. Thus

there must be ways for markets to recognize these traits, whether from conventional sources, or from new genetics.

A CONSENSUS APPROACH TO 'WHAT TO TEST'

Nutritionists are essentially the arbiters of quality for dairies and thus the 'rule makers' for determinants of quality for markets. Dairy and ruminant nutritionists rarely are in 100% agreement about what is important to test in alfalfa or other forage crops, nor about the interpretation of forage quality data. This is certainly a problem for standardization. However, continual discussions reveal a remarkable degree of consensus about which analyses appear to be important (Mertens, 2011, DePeters, 2011, Putnam, 2011).



The role of forage testing for market differs necessarily from the role of forage testing for ration balancing (Figure 1). While greater complexity, multiple analyses, and high degree of predictability are required for nutritionists to balance rations, greater simplicity is necessary for marketing of forages. Comparisons within commodities are of primary interest for markets, while mixing commodities is the norm for ration balancing. Recently, I conducted a survey of nutritionists and asked essentially 'if you had only one measurement for hay evaluation, what would it be? The second, etc.? Here are the key results:

- Nutritionists see NDF or ADF as the first cut for evaluation of quality
- NDF Digestibility is important for predicting performance
- CP remains important for evaluation of hay

- Hay should be evaluated on 100% DM basis
- Neither RFV nor TDN is of interest for evaluations of hay quality for markets

The latter point is of strong interest, since RFV and TDN are the standard methods currently used for pricing hay based upon quality. We should note that ADF 100% predicts TDN, while NDF 99% predicts the RFV value, but nutritionists seem to do quite well to interpret the fiber values themselves. What is clearly missing from current marketing systems is an analysis of digestibility of the fiber fraction (e.g. NDFD).

STANDARDIZATION VS. INNOVATION?

The National Forage Testing Association (NFTA) has been involved with standardization of forage quality testing since the 1970s. The primary focus has been to address the lab-to-lab variation problem with the analysis of DM, ADF, NDF and CP. It would be tempting to be highly conservative and simply attempt to continue to standardize ADF or NDF – but the future of forage testing will demand more innovative approaches. ADF and NDF are highly correlated in alfalfa hays, so it makes little sense to promote both, especially if one of the goals for marketing is simplification. Standardization should also allow continual innovation with technique. NDFD appears to be a very useful number –but also requiring further work on standardization between laboratories. Other innovations, such as further development of the gas method, understanding an in-vitro or in-situ indigestible NDF, and practical evaluation of rumen undegradable protein should be encouraged. We should not think of forage testing as set in one time or place, but continually changing to improve its utility.

HAY QUALITY GUIDELINES

USDA has utilized guidelines for many years based upon RFV and TDN (which are in turn based upon NDF and ADF) as well as CP. What is missing is the digestibility estimate, e.g. NDFD or similar analyses. This is a major oversight since it is well known that within a range of fiber values (e.g. about 33-36 NDF), digestibility is likely to make a larger difference in animal performance than small changes in fiber content. **Figure 2** reviews the hay quality guidelines, including NDFD. Key elements are the following:

- Subjective descriptions of quality remain important
- Categories are discrete, but definitely overlap, with a ‘fuzzy area’ between categories.
- Optimum quality may not necessarily be ‘Supreme’ for all classes of animals
- Analyzed values (NDF, CP, NDFD) should be prioritized.

Table 1. Hay quality guidelines commonly used in western states.

Hay Quality Guidelines	
Definitions of Hay Product Categories	
Alfalfa Hay	- Consists of a minimum of 90% alfalfa hay
Mixed Alfalfa Hay	- Consists of greater than 50% and less than 90% alfalfa
Grass Hay	- Consists of a minimum of 90% grass hay, designated by species
Mixed Grass Hay	- Consists of greater than 50% and less than 90% grass
Rained on Hay	- May be any of the categories listed above, but must be designated as such
Hay Quality Descriptions for Alfalfa and Mixed Alfalfa Hay	
Supreme	Vegetative, prebud, or early bud, low in fiber, high in fiber digestibility, soft stems, very high energy and intake potential. Very good leaf attachment, free of grasses and weeds, no noxious weeds, no molds, well cured.
Premium	Prebud, bud or early bloom, low fiber with soft stems high energy and intake potential, good leaf attachments. Mostly free of grasses and weeds, no noxious weeds, no mold, well cured.
Good	Prebloom to mid-bloom, low to medium fiber with medium to soft stems, medium fiber and protein content, fair leaf attachment, can contain some palatable grasses weeds, no noxious weeds, well cured.
Fair	Mid to late bloom, medium to high fiber with coarse stems, low to medium energy and protein content, fair leaf attachment, low to moderate grass and weed content. No noxious weeds.
Low or Utility	Hay with serious fault or faults. This could be to conditioning problems, rain damage, high or noxious weed content, mold, poor curing, very high fiber, or other serious faults. These hays are generally not described by test.

Range of Hay Quality Analysis for Alfalfa Quality Marketing Groups				
Supreme				
Premium				
Good				
Fair				
NDF%	<33	35	39	>42
NDFD%	>48	42	38	<35
CP	>22	20	18	<16
ADF%	<27	29	32	>35
Calculated Values:				
RFV	>180	150	125	100
TDN (90%)	55.9	54.5	52.5	50.5

SUMMARY

Industries change only slowly. However, it is clear that a revised ‘core’ set of analyses are necessary to move forage testing ahead to be more effective for the future. The dropping of ADF, the standardized use of NDF and NDFD in addition to CP and DM are recommended (Table 2). Standardization of sampling and labs, and movement in our core analysis is needed. A more ‘nimble’ approach which allows continual experimentation with new methods while standardizing methods to stabilize markets is required.

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DM – Dry Matter
ADF – Acid Detergent Fiber
NDF – Neutral Detergent Fiber
TDN – Total Digestible Nutrients
NEL—Net Energy for Lactation
RFV – Relative Feed Value
DCAD-Dietary Cation-Anion Difference
Ash – Mineral Content

<p>Table 2. Revised standardized hay test.</p> <p><i>(100% DM basis except as indicated)</i></p> <p>Dry Matter (DM) (as received)</p> <p>Neutral Detergent Fiber (aNDF) (100% DM)</p> <p>NDF Digestibility (NDFD) (100% DM)</p> <p>Crude Protein CP (100% DM)</p> <p>Ash (100% DM)</p> <p><i>Calculated Values (100% DM) as Needed</i></p> <p>TDNn (based upon a summative equation utilizing the above analyses)</p> <p>NEL, ME, RFV, RFQ, TDN as needed</p>
