BEYOND RFV/Q: WHAT ARE YOU MISSING WITH YOUR HAY QUALITY TESTS?

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ABSTRACT

A variety of measures including Relative Feed Value (RFV), Relative Feed Quality (RFQ) and Total Digestible Nutrients (TDN) have been used to set the value of alfalfa hay for sale. However, components or characteristics of alfalfa in addition to these measures may prove useful in determining the real market and feeding value of alfalfa compared to other feeds.

Key Words: alfalfa, composition, value

INTRODUCTION

Digestibility and intake. Predictions of both of these feed characteristics have been used to set the market value for alfalfa hay because they help to describe how well a feed supports animal production. Three main systems for describing the quality of hay, TDN, RFV, and RFQ, all use some estimation of digestibility, and the latter two include an estimate of intake of the hay if it was the only feed fed. However, in the dairy forage market, there are challenges to using these indicators: 1) there are many other feeds in the ration in addition to hay, so the quality of the hay needs to complement the rest of the ration, 2) the other feeds in the ration may change the digestibility of the hay, and 3) feed characteristics beyond digestibility and intake per se may be the key reasons for feeding the hay. If digestibility and intake don't provide the whole story on the value of alfalfa hay, the question then becomes: what feed characteristics should we measure and how do we place values on them?

FEED COMPONENTS AND THEIR VALUES

Feed Fractions. Dairy cattle nutrition is becoming more focused on specific fractions we can analyze for in feeds and how these combine in the total ration to keep animals productive and healthy, while reducing nutrient flow to the environment. We are getting a better understanding how different feed fractions can change the utilization of other portions of the diet, altering production, feed efficiency, or health. Although digestibility and effects on intake are still important for evaluating feeds, selecting which feeds to include in a diet also takes into account other feed characteristics that are likely to improve performance/ reduce risk on a ration. Some examples of characteristics or fractions beyond energy and digestibility that are important to the success of dairy rations include:

- Physical effectiveness of the fiber in a ration: Effective fiber maintains rumen function, improves feed efficiency, is important for animal health. Finely ground feeds have little effectiveness, larger particles that require more chewing to break them down have more.

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- Degradability of the protein: The proper balance of ruminally degradable protein (used by rumen microbes) and undegradable protein (used by the cow if it's digestible) is important to meet protein requirements of the cow.
- Mineral profile: For example, low potassium forages may be important and saleable as dry cow forage.
- Carbohydrate profile: The balance of fiber and nonfiber carbohydrates, and the profile of nonfiber carbohydrates (NFC; sugars, starch, pectins, etc.) has drawn more interest as we learn how they affect animal performance and health. The NFC differ in how they affect animal performance and digestion of other feeds. Starch seems to be the NFC source that can increase production, but care must be taken that it is fed and managed so that problems such as ruminal acidosis are avoided. Starch fermentation in the rumen seems to support more production of microbial protein, a major source of protein to the cow, than does sugar (Hall and Herejk, 2001). In some studies, increasing sugar content of diets increased feed intake and butterfat production (Broderick et al., 2000). Sugar can also increase or reduce fiber digestibility, apparently depending in part on how much degradable protein is in the ration (Heldt et al.,1999).

So, when we consider feed factors that can change animal performance, digestibility and intake covers only a slice of a larger picture. They may not adequately describe attributes that are as important, if not more important, for describing the value of a particular feed.

Feed Valuation. The nutrient-based systems used for setting prices on feeds typically use feeds such as corn or soy as reference feeds, or assume that each increase in digestibility/intake index gives an increase in value. Especially in the case of reference feeds, the basic assumption is that they are perfectly priced for each unit of energy and protein they contain. That is usually not a good assumption (or else those feeds would never be a good buy relative to other feeds!).

A more realistic way to estimate and compare feed values is to use a variety of competing feeds and evaluate them on the basis of feed fractions of interest – essentially what we do when we price and select feeds. "*Sesame*" is a feed value evaluation program that allows you to make this sort of comparison (version 3.01, St-Pierre et al., 2004, The Ohio State University). The output gives estimates of the unit value of the nutrients of interest, estimated values of the feeds, and comparisons among the feeds.

The outcomes of the feed evaluation change, depending on what feed fractions and feeds are involved. For example, if TDN and crude protein are used as the basis to compare alfalfa hays against other commodities, you would get one set of results (Table 1 and Figure 1). The "Leg hay imm, <40% contains 22.8% crude protein, 36.3% NDF, 28.6% ADF, and 62.1% TDN. The "Leg hay mid 40-48%" contains 20.8% crude protein, 42.9% NDF, 33.4% ADF, and 59.1% TDN (all on a dry matter basis). The program gives the value of a pound of TDN at approximately $0.084/lb, and crude protein at $0.075/lb. Based on TDN and crude protein, the program predicts that all of the forages are selling at prices greater than what they are worth.

In a different scenario, the feeds were evaluated with a different set of nutrients. In this case effective-NDF (an index of how well the fiber in the feed maintains rumen function), lignin,

Estimate of Nutrient Unit Costs		
Nutrient name	Estimate	
TDN - 1X (2001)	0.083588	**
Crude protein	0.075332	~

- A blank means that the nutrient unit cost is likely equal to zero
- ~ means that the nutrient unit cost may be close to zero
- * means that the nutrient unit cost is unlikely to be equal to zero
- ** means that the nutrient unit cost is most likely not equal to zero

Calibration set				
Name	Actual [/T]	Predicted [/T]	Lower limit	Upper limit
Almond Hulls	112.000	93.291	83.084	103.498
Barley Grain, rolled	140.000	142.788	129.391	156.184
Beet Sugar Pulp, dried	125.000	115.321	104.288	126.355
Canola Meal, mech. ex	170.000	156.923	132.693	181.152
Corn Grain, steam flak	120.000	147.493	130.738	164.248
Cotton Seed, Whole w	180.000	148.215	135.611	160.820
Distillers Dried Grains	125.000	160.218	143.829	176.607
Molasses, Sugarcane	130.000	107.032	93.139	120.926
Soybean Hulls	105.000	121.373	111.623	131.122

Appraisal set			
Name	Actual [/T]	Predicted [/T]	Corrected
Grass Hay, Imm. <55	125.000	111.447	123.435
Leg Hay, imm, <40%	170.000	116.278	143.492
Leg Hay, mid, 40-46%	180.000	109.197	113.070
Oats Hay, headed	125.000	98.496	79.209
Wheat Straw	100.000	80.354	2.532

Table 1. Comparison of feedstuffs based on TDN and crude protein (output of Sesame program).

"Estimate of Nutrient Unit Costs": indicates the cost per pound for each nutrient.

"Calibration set": the feeds used to set the values for the nutrients used in this analysis. "Actual" is the actual feed cost per ton, "Predicted" is the breakeven cost for the feed. Lower and upper limits: gives 75% certainty that the predicted feed value should fall in that range.

The "Appraisal set" are the feeds that were evaluated compared to the calibration set. The "Corrected" value corrects for the effect of forage on production and intake.

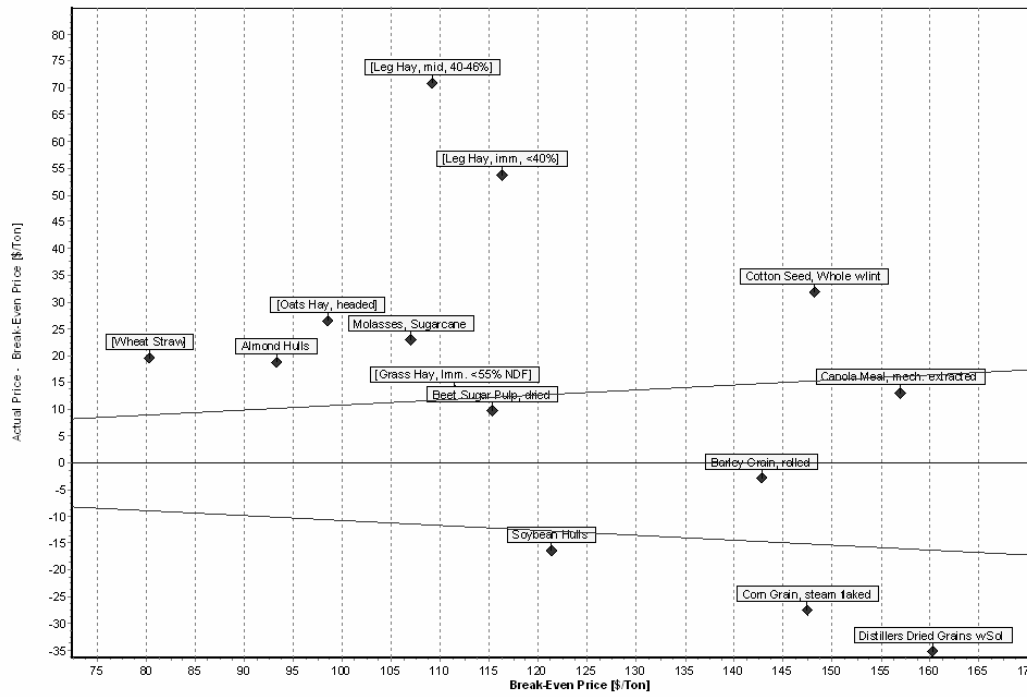

Figure 1. Graph of actual vs. breakeven prices for feedstuffs based on TSN and crude protein. The flat, horizontal line represents the breakeven value. Feeds above or below the line are over or under priced based on a TDN and crude protein basis.

Estimate of Nutrient Unit Costs		
Nutrient name	Estimate	
e-NDF	0.089267	*
Lignin	-0.091550	
NFE	0.107601	**
Crude fiber	0.065060	**
Fatty acids	0.072485	~
Crude protein	0.206256	**

- A blank means that the nutrient unit cost is likely equal to zero
- ~ means that the nutrient unit cost may be close to zero
- * means that the nutrient unit cost is unlikely to be equal to zero
- ** means that the nutrient unit cost is most likely not equal to zero

Table 2. Comparison of feedstuffs on the basis of effective-NDF, lignin, sugar, starch, soluble fiber, and crude protein composition.

		Calibration set		
Name	Actual [/T]	Predicted [/T]	Lower limit	Upper limit
48% Soybean meal M	225.000	243.091	223.083	263.099
Almond Hulls MB	112.000	130.026	110.565	149.487
Barley Grain Rolled M	140.000	132.832	118.615	147.049
Beet Pulp dry MB	123.000	113.680	101.108	126.252
Canola Meal MB	170.000	172.329	156.357	188.301
Citrus Pulp Dry MB	115.000	126.334	107.042	145.627
Corn Silage MB	45.000	48.849	40.853	56.845
Corn steam flaked MB	120.000	127.751	109.069	146.432
Distillers with sol. MB	125.000	119.889	109.177	130.601
Molasses sugarcane	130.000	113.713	91.219	136.208
Soyhulls MB	105.000	72.320	60.634	84.005
Wheat middlings MB	113.000	100.571	90.802	110.339
Whole Cotton Seed M	180.000	170.229	148.198	192.261

Appraisal set				
Name	Actual [/T]	Predicted [/T]	Corrected	Alfalfa Hay Composition
Leg Hay Mid 40-46 MB	130.000	153.164	156.761	5% sugar, 17% soluble fiber
Leg Hay mid 40-46%	130.000	171.884	175.481	12% sugar, 22% soluble fiber
Leg hay imm <40% M	180.000	158.404	183.675	5% sugar, 22% soluble fiber
Legume Hay imm <40	180.000	171.088	196.359	12% sugar, 22% soluble fiber
Oat hay headed MB	125.000	139.394	121.484	
Wheat Straw MB	100.000	129.606	57.343	

sugar, starch, soluble fiber (includes pectins and other non-starch, non-sugar, non-NDF carbohydrates), and crude protein (Table 2 and Figure 2). Sugar, starch and soluble fiber can make up a substantial portion of the TDN in feedstuffs. Yet, using these inputs as well as crude protein and effectiveness of the fiber, the price of feeds relative to the breakeven price is entirely changed from when TDN and crude protein was the basis of the comparison. The fractions in the second evaluation are fractions that can be important in forages. Note that the value per lb of the feed fractions can be either positive or negative, meaning that they can add to or decrease the value of a feed. The legume hays included in this example differed in their sugar content within a range noted for alfalfa (12% of dry matter is on the very high end), and their predicted values change accordingly. The low, corrected price for wheat straw based on the effect of forage on intake and production brings up a good point: even a feed such as straw can have positive effect

if it is used in the right amount to fill a need. That means that knowing the context a feed will be used in also is important to the buyer in determining what price they will pay for what they need.

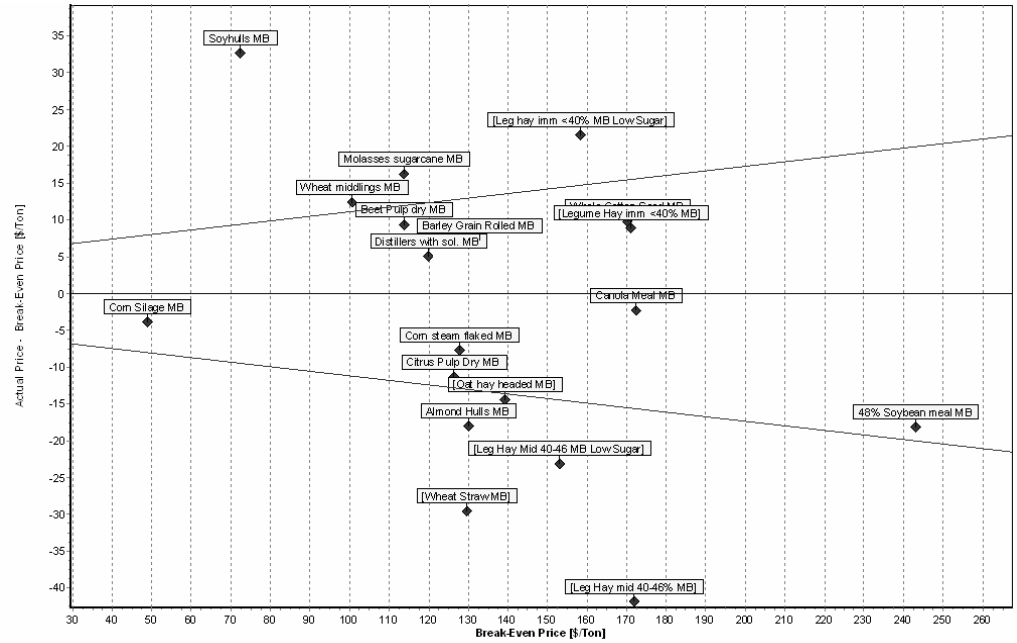

Figure 2. Graph of actual vs. breakeven prices for feedstuffs based on effective NDF, lignin, sugar, starch, soluble fiber and crude protein.

SUMMARY

So, what should we be measuring to define quality in alfalfa hay? Practically, it depends on what the market demands and what is nutritionally useful. People have gotten accustomed to working with TDN, relative feed value and relative feed quality systems, but does a single number adequately describe hay quality? I don't think so, at least not for the buyer. Not for the seller, either, if the hay has some particularly looked-for attribute. Measuring feed fractions that give nutritionally useful information about characteristics that make a feed desirable and allow comparison against other feeds, seems a good additional route to follow.

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