THE FUTURE OF FORAGE QUALITY TESTING FOR MARKETS

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ABSTRACT

While the current 'fiber based' system of utilizing RFV 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. The methods of analysis used for marketing need to change, given changes in the role of alfalfa and the quality attributes that are missing from the current marketing system.

INTRODUCTION

"If we don't change direction soon, we'll end up where we're going"

-Professor Irwin Corey

Change is not always welcome—but we all know that change is inevitable. The only question is whether we participate in changes actively, envision where we are going, or continue to do things 'just the way we used to'—without thoughtfully examining our habits. Our practice of testing, pricing and trading alfalfa hay is one of those habits that require periodic examination.

CHANGES IN ALFALFA PRODUCTION, GENETICS AND FEEDING

Over the past 30 years, there have been profound changes in the way that alfalfa forages are produced, evaluated, sold and fed, and there are likely to be even further (perhaps more profound) changes in the future as well. These include:

- Milk production per animal continues to increase at the rate of about 2 % per year in the US, as it has for the past 30 years, a trend with little chance of relenting.
- Continued restrictions on acreage, water, and alfalfa production systems, which tends to increase the economic importance of yield vs. the value of quality.
- Alfalfa is being fed at a lower % of the diet of dairy cows, with corn and grain silage, grains and concentrates being fed at higher levels.
- Alfalfa hay is increasingly being bought and sold as a commodity over longer and longer distances, including exported hays overseas.
- There has been greater sophistication on the part of nutritionists and buyers who wish to least-cost different feed ingredients using ration balancing programs. Alfalfa must compete with a range of forage and non-forage ingredients.

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- There are new genetic constructs of alfalfa with 'reduced lignin' traits – to the benefit of high producing dairy cows. These are being rapidly commercialized.

Implications. These changes have implications on how hay is tested and evaluated in the marketplace. What are these?

- Continued increases in production per animal will keep focus on the feeding value of forages, and analysis of forage quality for pricing, especially for high producers.
- The fact that acreage and production of alfalfa is limited indicates that farmers will be less willing to sacrifice yield for quality by cutting more frequently. Thus supply of low fiber hay (from frequent early cuttings) will continue to be limited—Growers will try to maximize yield, and digestibility of high-fiber hays will become more important.
- The fact that alfalfa is fed at a lower level in the diet indicates that alfalfa may be fed more for the value of the fiber itself (the role of NDF in alfalfa hay to promote healthy rumen function), rather than energy or protein. However, fiber itself is not currently valued in the marketplace, nor is the digestibility of the fiber fraction. Currently, RFV and TDN marketing systems reward ONLY low fiber hays in the marketplace.
- The fact that alfalfa is being sold over greater and greater distances means that there will be increased need for a science-based, rational quality-analysis system for trading hay.
- The fact that dairy nutritionists are using more sophisticated ration balancing systems, means that the different fractions of alfalfa (protein, energy, fiber, minerals, intake), may have varied economic values based upon the needs of different classes of animals and market conditions. There are also interesting aspects of alfalfa not easily captured by lab analysis (e.g. physical characteristics, CEC).
- Reduced lignin genetics for alfalfa are being commercialized in 2015-2016. However, it is highly doubtful that the current RFV and TDN systems will be able to recognize the economic worth of these innovative genetic strains.

THE NEED FOR CHANGE

All of these trends point to the need to re-examine our forage quality evaluation system, especially what we analyze.

The current 'hay test' consists largely of DM, CP, ADF and NDF (see text box for abbreviations below). From these lab values, RFV and TDN are calculated for marketing purposes. The problems with this are:

- There is no need to analyze both ADF and NDF, since these are highly correlated in pure alfalfa hays common in Western States. One largely duplicates the other.
- The digestibility of the fiber in the plant is a major determinant of its quality, and is completely missed in our current standard hay test.

- Ash, the mineral fraction, contributes ZERO to energy of the feed, and thus high or low-ash forages are not measured or priced properly in the market.

Table 1. Proposed Revised standardized hay test.
(100% DM basis except as indicated)
Dry Matter (DM) (as received)
Crude Protein (CP) (based on 100% DM)
Neutral Detergent Fiber (aNDF) (based on 100% DM)
NDF Digestibility (NDFD) (based on 100% DM) at 30 hrs
Ash (based on 100% DM)
Calculated Values (100% DM) as Needed
TDNn (based upon a summative equation utilizing the above analyses)
NEL, ME, RFV, RFQ, TDN residual calculations as needed

A CONSENSUS APPROACH: '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 in alfalfa or other forage crops. However, continual discussions reveal a remarkable degree of consensus about which analyses appear to be the most important for alfalfa hay (Mertens, 2011, DePeters, 2011, Putnam, 2011). Thus, this proposed list is based upon that consensus.

Key core analyses for hays are likely to be:

Dry Matter (DM). The as-received percent moisture is important for determining tonnage of material that is fed. It is not highly relevant to forage quality analysis other than indicating extremely wet or dry forages. All other analyses should be made on a 100% DM basis.

Neutral Detergent Fiber (NDF). NDF generally represents the fibrous cell-wall component of the plant, ranging from 33% to 45% of the dry matter of the plant. Most nutritionists see this as the first analysis of interest for forage quality. NDFom (ash-free NDF) considers only the organic matter of the plant, minus minerals.

Crude Protein (CP). CP is a function of the nitrogen content of the plant and will continue to remain important for hay trading. Eventually, a more careful analysis of protein utilization will likely become important (soluble, rumen undigestible).

NDF Digestibility (NDFD). The digestibility of the fibrous portion of the plant is likely one of the most important missing components of hay analysis. This is accomplished using in-vitro techniques within a defined length of time (e.g. NDFD30, for 30-hour).

Ash. Ash is the mineral content of the forage which remains after combustion. Ash constitutes from 5% to over 20% of the DM of the plant. Since minerals are inert, they contribute zero to the energy of the plant, and limit the ability of the forage to supply energy to the animal. Excessive ash also indicates dirt contamination. Measurement of ash enables measurement of NDF on an organic matter basis (aNDFom).

Although more analyses may be of more detailed interest to nutritionists, this small sub-set is of strongest interest for prediction of quality for marketing purposes.

Subjective (visual and olfactory) determinants of quality continue to be important, and will always be important, since weeds, molds, poor leaf attachment, poor texture and other faults are not easily measured by laboratories.

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

BEHAVIOR OF DATA

It is instructive to examine the behavior of data to attempt to understand the potential value of these analyses (all data presented here from western-grown alfalfas, courtesy of Cumberland Valley Analytical Services). Examination of this data reveals several trends:

- **ADF and NDF** are highly correlated in western alfalfa hays. Thus it is highly questionable as to whether testing both ADF and NDF is necessary. Since NDF is more highly valued by most nutritionists, this is the preferred analysis.
- **TDN and RFV** are also highly correlated, which is not surprising since TDN is based upon ADF alone, and RFV is most closely related to NDF. They both reward the lowest fiber content possible, with no consideration of the digestibility of the fiber fraction, a major fault of our current system of analysis.
- **NDF digestibility** is not at all closely related to the % of NDF in the forage crop. Thus NDFD reveals a separate quality feature of hay. High NDFD is generally desirable. NDFD ranges from about 25% to about 55% of the DM of the plant – these differences are likely to create genuine differences in animal performance.

- **Ash** or mineral content of forages is not at all related to the % NDF of the crop. Thus mineral content reveals a separate quality feature of hay. Low ash is desirable, usually indicates higher energy values – feeding less dirt. Ash ranges from a low of 5% to a high of over 20%.

SUMMARY

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 1). 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.

REFERENCES

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What nutritionists look for in alfalfa and other forage products:

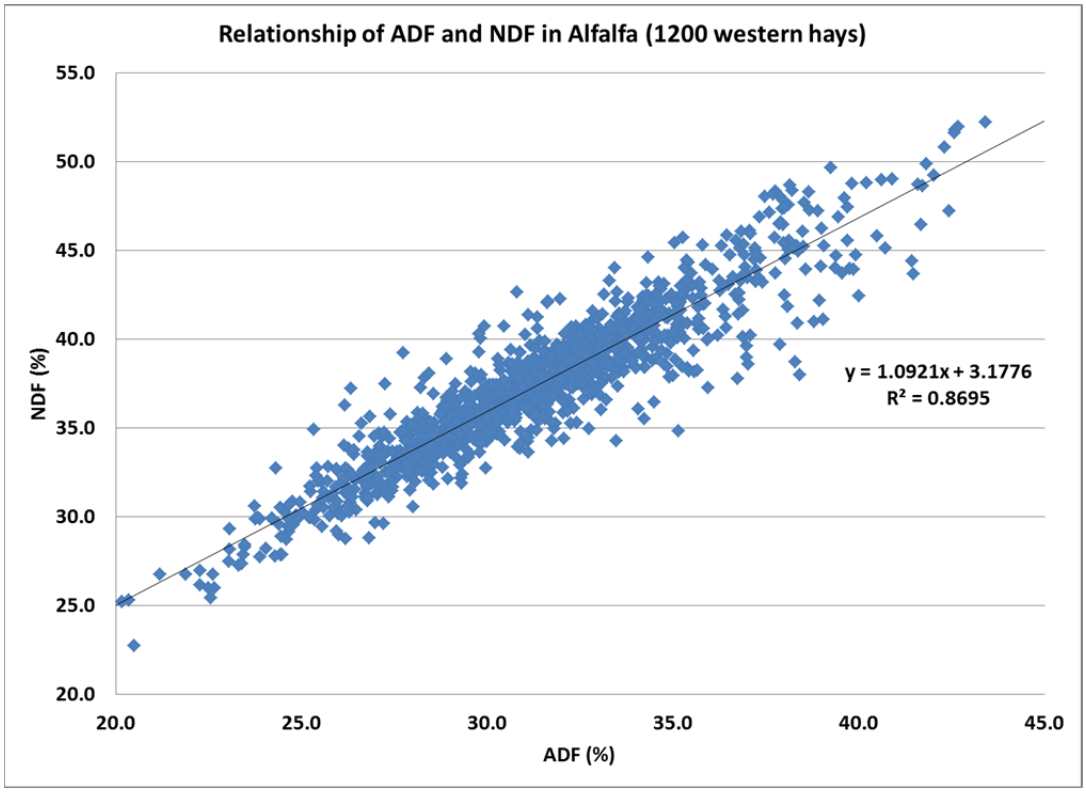
Digestible Energy—the amount of biological energy extractable by ruminants per unit weight of forage

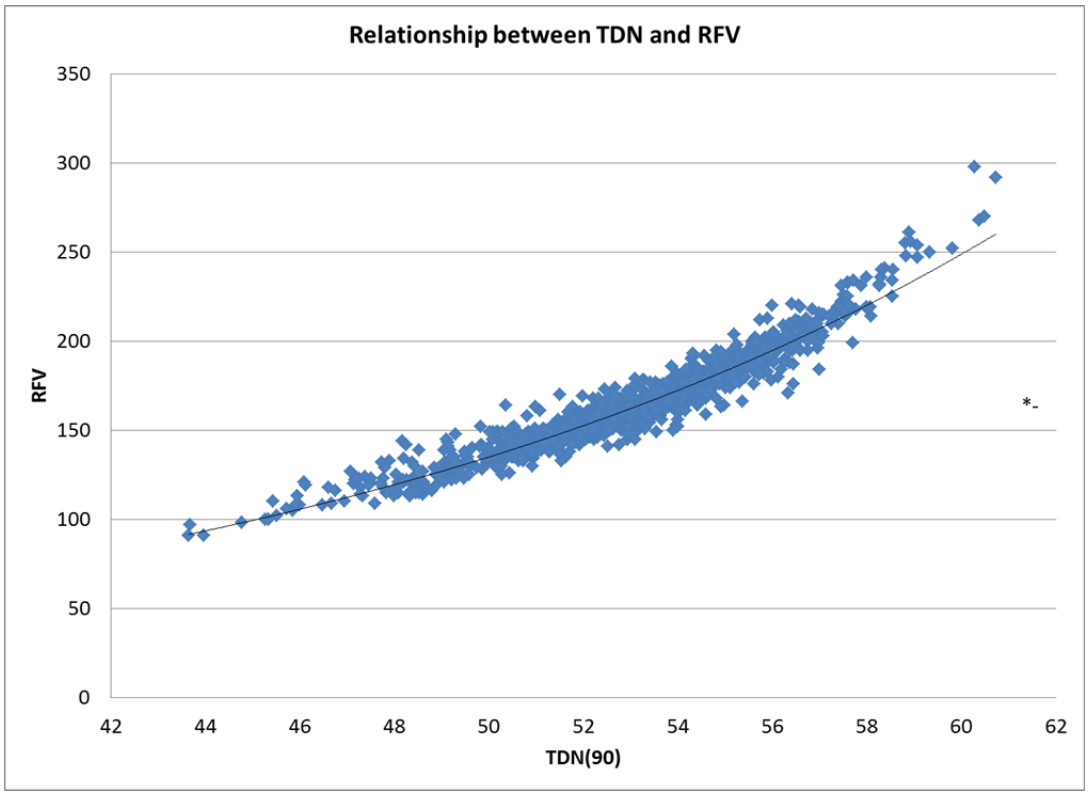
High Intake—The digestibility or nutrients available per unit time

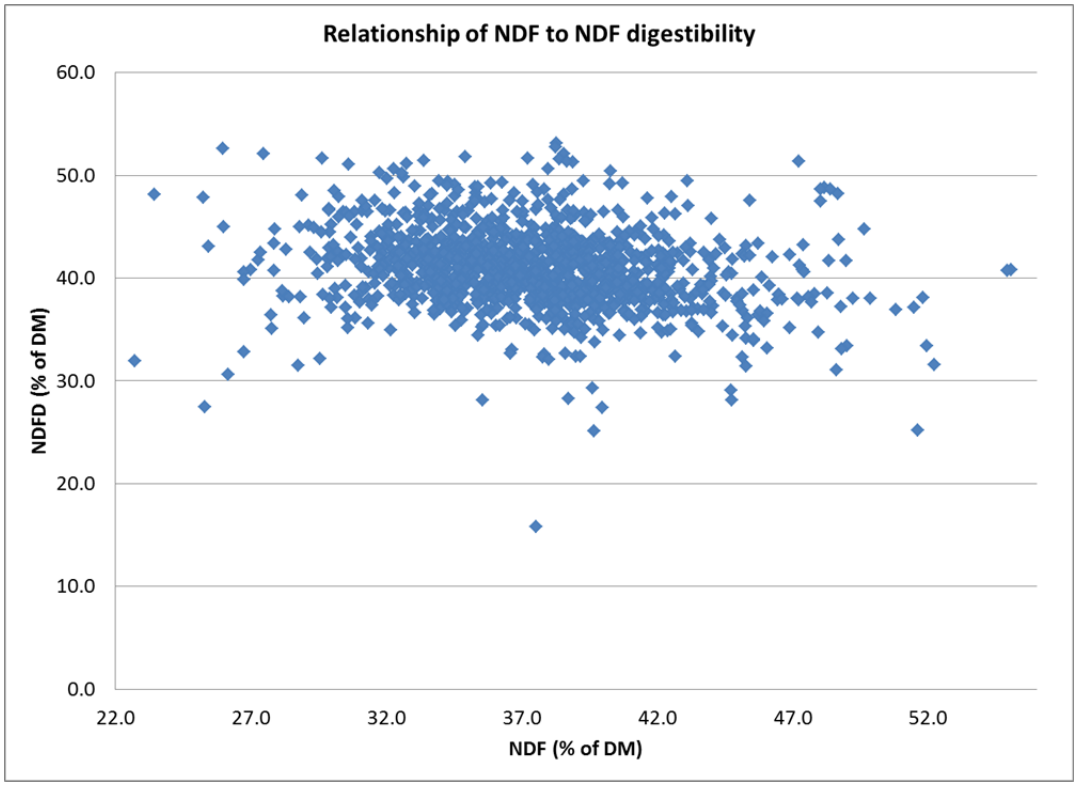
Protein – Both rumen digestible and rumen 'bypass' protein

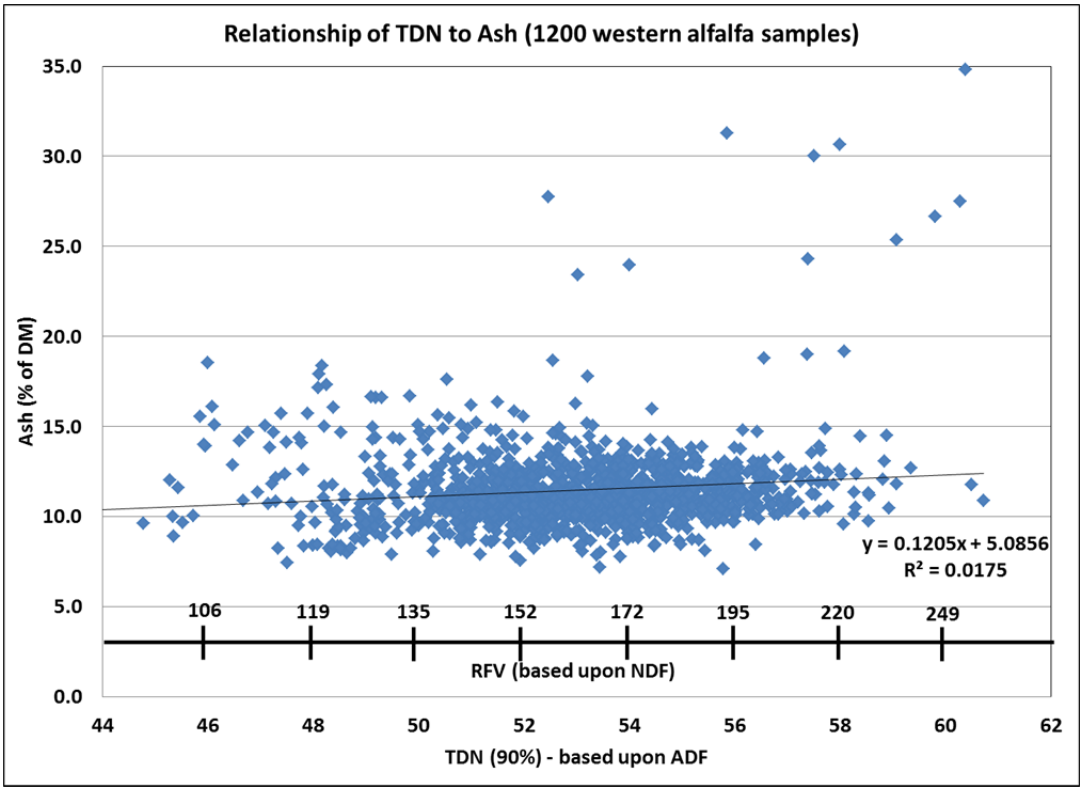
Functional Fiber—Forages function to keep rumens healthy and pH normal

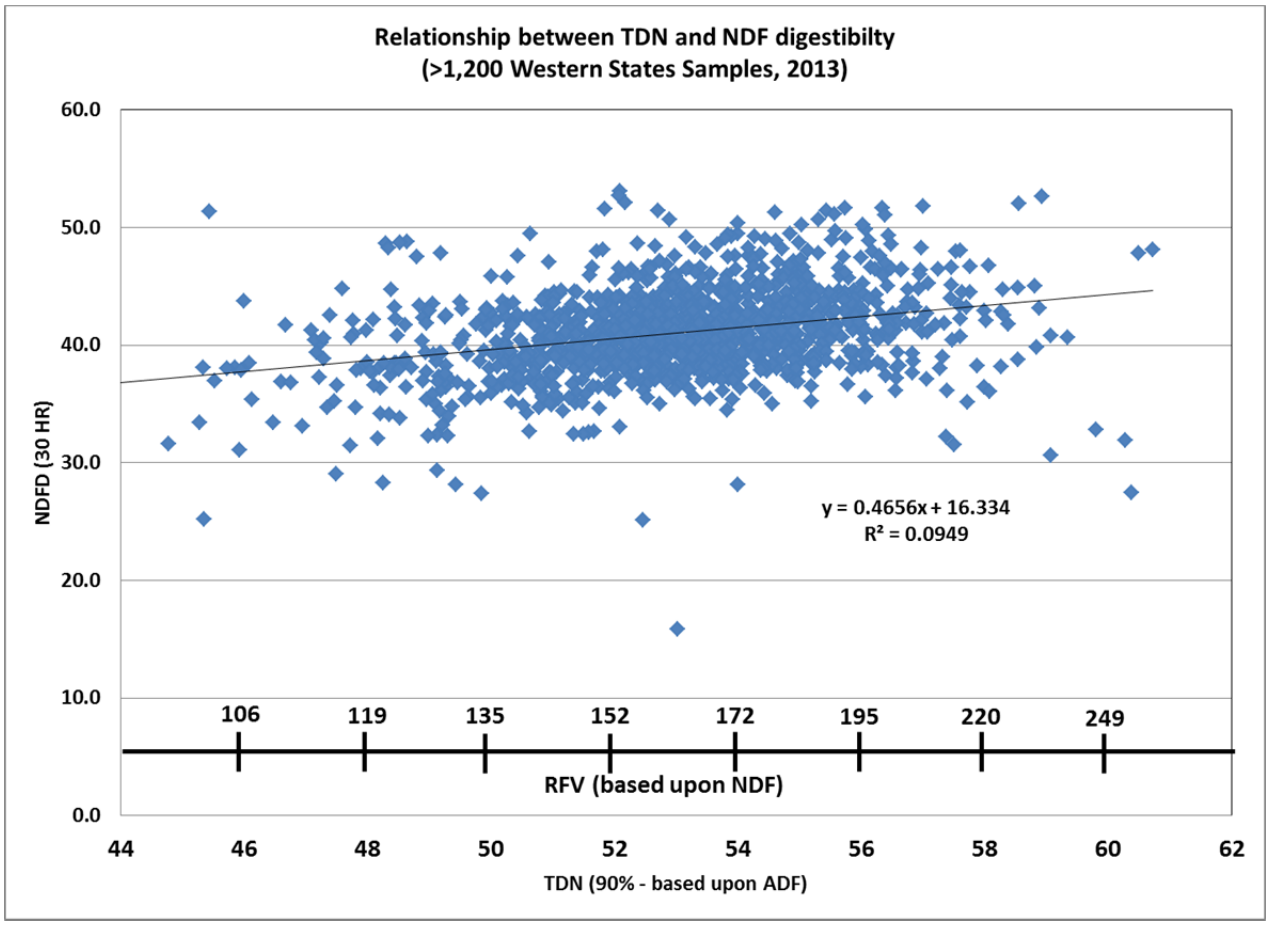
Mineral Balance—Balance of ions which may affect pregnant animals


Relationship of ADF and NDF in Alfalfa (1200 western hays)
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
NDF (%)
20.0
25.0
30.0
35.0
40.0
45.0
ADF (%)
y = 1.0921x + 3.1776
R² = 0.8695


Relationship between TDN and RFV
350
300
250
200
150
100
50
0
RFV
42
44
46
48
50
52
54
56
58
60
62
TDN(90)


Relationship of NDF to NDF digestibility
60.0
50.0
40.0
30.0
20.0
10.0
0.0
NDFD (% of DM)
22.0
27.0
32.0
37.0
42.0
47.0
52.0
NDF (% of DM)


Relationship of TDN to Ash (1200 western alfalfa samples)
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Ash (% of DM)
y = 0.1205x + 5.0856
R² = 0.0175
106
119
135
152
172
195
220
249
RFV (based upon NDF)
44
46
48
50
52
54
56
58
60
62
TDN (90%) - based upon ADF


Relationship between TDN and NDF digestibilty
(>1,200 Western States Samples, 2013)
NDFD (30 HR)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
y = 0.4656x + 16.334
R² = 0.0949
106
119
135
152
172
195
220
249
RFV (based upon NDF)
44
46
48
50
52
54
56
58
60
62
TDN (90% - based upon ADF)

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