Standardizing Forage Quality Across Markets – What changes are needed?

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Alfalfa & Forage Blog:

- ucanr.edu/blogs/alfalfa

Recent Posts:
- Hay Exports have Increased Dramatically
- Coexistence of RR alfalfa
- Does Hydroponic Forage make sense?
- Spotted Alfalfa Aphid
- Ground mealybug
- Wide Windrows
- Is it moral to ship hay to China?
- Molybdenum Deficiency
First, Why is quality testing important?

- Forages have zero economic value until they go through an animal
- Not just tons/acre, but milk/lb feed
- Visual evaluation of quality are important but can mislead
- Buyers and sellers need common language
Are we just producing ‘Stuff that cows eat?’

Or specific nutrients that produce milk?
Currently: A Fiber-based Marketing system

- **RFV Method**
  - Essentially 100% related to NDF alone

- **TDN Method**
  - Exactly 100% related to ADF alone

- In the US we have a Fiber-Based Marketing System
IDEALIZED FIBER-VALUE CURVE

Supreme → Premium → Good → Fair → Utility

Decline?

Area of concern

PRICE OR VALUE $/ton

55.9 54.5 52.5 50.5

TDN (%) 34 36 40 44

NDF (%) Supreme Premium Good Fair Utility

ADF (%) 24 26 28 30 32 34 36

$150 $130 $110 $90 $70 $50 $30
**Megatrends:**

Growth in Western Milk Production, 1970-2012

- **Percent of 1970:**
  - Total Milk: 454%
  - Cow Numbers: 215%
  - Production/Cow: 209%

- **Wyoming**
- **Washington**
- **Utah**
- **Texas**
- **Oregon**
- **New Mexico**
- **Nevada**
- **Montana**
- **Idaho**
- **Hawaii**
- **Colorado**
- **California**
- **Arizona**
- **Alaska**

(17.4% of US) (46.2% of US)
Production per Cow

NASS Data - CA

5,870 lbs

23,025 lbs
ALFALFA HAY EXPORTS 2001-2012

- 268% of 2001
- 12.5% of western alfalfa
## Megatrends:

**Results of 381 Responses**

<table>
<thead>
<tr>
<th>Response Description</th>
<th>Percent Respondents</th>
<th>Percent of Acreage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nearly 100% Sold off-farm</td>
<td>51.2%</td>
<td>70.8%</td>
</tr>
<tr>
<td>75% sold, 25% fed on-farm</td>
<td>11.3%</td>
<td>8.2%</td>
</tr>
<tr>
<td>50% sold, 50% fed on-farm</td>
<td>7.3%</td>
<td>2.2%</td>
</tr>
<tr>
<td>25% sold, 75% fed on farm</td>
<td>6.6%</td>
<td>1.5%</td>
</tr>
<tr>
<td>Nearly 100% is fed on my farm</td>
<td>23.6%</td>
<td>17.4%</td>
</tr>
</tbody>
</table>

*(Survey, October, 2011)*
Megatrends

Less alfalfa in the ration

Average Pounds of Alfalfa Hay Fed Per Day to Milk Cows in California, 2002-2011**

Pounds per Day

Year

Source: CDFA Dairy Marketing Branch

** 2011 - First half of year - simple avg.
Megatrends

Low Lignin Trait – 2011-2012 (four locations)

% ADL

Lower % Lignin

NDFD

Improved Quality

No difference in RFV, NDF

-Peter Reisen, FGI Int’l data
Megatrends – impacts on quality:

- Phenomenal increase in production/cow
- Dramatic increase in hay exports
- Competition of alfalfa with silage in ration
- Genetic innovation (lignin, protein)
- Transition from ‘pasture’ to cash crop
The Challenge:

- Markets have demanded low fiber hays (low NDF and low ADF), yet, at low feeding levels, alfalfa is being fed as much for its effective fiber as for its energy.
- High yields are necessary, but not at the expense of quality.
- Current RFV and TDN system will not detect new genetic quality traits.
- Our current ‘low fiber only’ RFV and TDN way of marketing miss important, dynamic aspects of quality—usually at a disadvantage to sellers.
Elements of Standardization:

- Standardization of Sampling
- Standardization of Lab Techniques
- Standardizing what we test
Note: Needs for Testing are Different:

**Markets:**
- Must be Simple
- Within Commodity
- Few Analyses
- Repeatability
- Relation to animal performance
- Between Buyer & Seller

**Ration Balancing:**
- Can be Complex
- Between Commodities
- Many Analyses
- Repeatability
- Must Predict Animal Performance
- Within an economic Unit
Standardization of Sampling:

The lab results are only as good as the sample.

- **Concept:** <200 tons of hay must be represented in a thumbnail sized sample!
How much variation in hay?

A "uniform" stack:
- CP: 17.9 to 23.2
- NDF: 34.7 to 48.5
- ADF: 27.7 to 38.9
- RFV: 112 to 180
- TDN: 47.9 to 55.4
Take enough samples:

1 SD = 68% of results
2 SD = 95% of results

NDF- Effect of Sampling

Number of Samples

NDF Result (%)
Take enough samples

Crude Protein - Effect of Sampling Variation

+/- 2.6 pts

+/- 0.23 pts
Certify Your Hay Sample!

- On line Protocol, test yourself
  (http://foragetesting.org)
- Assures markets that proper sampling methods were used
- Set up in 2002 - Free
- Currently 1863 certified samplers (as of December 6, 2013)
Sample Question:

- What is the first and important step in sampling a hay stack?
**Answer:** Define and Identify the hay lot (<200 tons, one cut, one field)
Does compression affect quality sampling?

Preliminary Results:
- No (from simple compression)

Table 1. Results from Sampling project-HayDay Farms, Blythe, CA.

<table>
<thead>
<tr>
<th>Lot 1 (Higher Quality Lot)</th>
<th>CP %</th>
<th>ADF %</th>
<th>aNDF %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressed (Average of 20 cores separately)</td>
<td>22.4</td>
<td>26.9</td>
<td>32.5</td>
</tr>
<tr>
<td>Non-compressed (Average of 20 Core Separate)</td>
<td>22.0</td>
<td>27.5</td>
<td>33.4</td>
</tr>
<tr>
<td>Compressed (20 cores Composite)</td>
<td>22.0</td>
<td>27.1</td>
<td>33.0</td>
</tr>
<tr>
<td>Non-compressed (20 Core Composite)</td>
<td>22.8</td>
<td>26.4</td>
<td>32.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lot 2 (Lower Quality Lot)</th>
<th>CP %</th>
<th>ADF %</th>
<th>aNDF %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressed (Average of 20 cores separately)</td>
<td>18.8</td>
<td>32.4</td>
<td>40.9</td>
</tr>
<tr>
<td>Non-compressed (Average of 20 Core Separate)</td>
<td>18.3</td>
<td>34.4</td>
<td>43.0</td>
</tr>
<tr>
<td>Compressed (20 cores Composite)</td>
<td>18.7</td>
<td>32.6</td>
<td>41.2</td>
</tr>
<tr>
<td>Non-compressed (20 Core Composite)</td>
<td>19.3</td>
<td>32.2</td>
<td>40.4</td>
</tr>
</tbody>
</table>
Variation – the name of the game:

The point of Proper Sampling:

- Minimize (not eliminate) variation
- Sample to represent an Average feeding value for a stack
Standardization of Labs

- Within-lab variation is less than between labs

- Steps for choosing a good lab:
  - Are they NFTA Certified?
  - What was their Grade? (A,B,C labs)
  - Do they have internal quality controls
  - Do they make efforts to standardize wet & NIRS samples?
  - Test them with ground split samples, duplicates
Commonly- Observed Variation in Hay Testing

<table>
<thead>
<tr>
<th></th>
<th>Sampling Variation</th>
<th>Between Labs</th>
<th>Within Labs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Probe-Probe Lab</td>
<td>Lab-Lab</td>
<td>Run-Run</td>
</tr>
<tr>
<td>ADF</td>
<td>3.0 - 8.0</td>
<td>0.7 - 3.0</td>
<td>0.3 - 1.6</td>
</tr>
<tr>
<td>NDF</td>
<td>4.0 – 9.0</td>
<td>1.0 – 4.0</td>
<td>0.4 – 2.0</td>
</tr>
<tr>
<td>CP</td>
<td>2.0 – 6.0</td>
<td>0.5 – 2.0</td>
<td>0.2 – 1.0</td>
</tr>
<tr>
<td>TDN</td>
<td>2.0 – 6.0</td>
<td>0.3 – 2.0</td>
<td>0.2 – 1.5</td>
</tr>
</tbody>
</table>
Standardization: What to Test?

Ask the cow

Ask a nutritionist
Ask a nutritionist...
But don’t ask too many nutritionists
Changing Concepts of Forage Quality Prediction

Subjective Evaluation (color, odor)

Proximate Analysis, Crude Protein

Crude Fiber, Modified Crude Fiber

Detergent Fiber System (CP, ADF/NDF, TDN, RFV)

Summative Equations – Using Rate Related or Digestibility estimates
Sun bleaching—is color important?
# Effect of Sun bleaching on Forage quality

<table>
<thead>
<tr>
<th>Treatment</th>
<th>ADF</th>
<th>NDF</th>
<th>CP</th>
<th>dNDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunbleached</td>
<td>32.8</td>
<td>38.1</td>
<td>20.2</td>
<td>39.1</td>
</tr>
<tr>
<td>Unbleached</td>
<td>32.6</td>
<td>38.5</td>
<td>19.7</td>
<td>38.8</td>
</tr>
<tr>
<td>Frozen</td>
<td>32.2</td>
<td>38.6</td>
<td>20.0</td>
<td>43.1</td>
</tr>
<tr>
<td>Harvest (cut)</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Bleaching</td>
<td>Ns</td>
<td>Ns</td>
<td>Ns</td>
<td>***</td>
</tr>
<tr>
<td>H x B</td>
<td>Ns</td>
<td>**</td>
<td>**</td>
<td>***</td>
</tr>
</tbody>
</table>

*2 Years Data, 2010, 2011. 4 cuttings*
A consensus approach

- Not all nutritionists agree what’s important.
- However, their opinions make up the sum-total of demand based upon quality.
- Seek the key analyses which are the highest priority in most, (not necessarily all) nutritionist’s minds.
Ask a nutritionist: What is Quality Hay?

Most Nutritionist would say:

1. Total **Digestible Energy** (TDN, NEL, Total potential biological energy of forage)
2. Energy per unit time (**Intake Potential**)
3. Effectively Absorbed **Protein** (both rumen available and rumen undegradable)
4. Nutritionally Effective **Fiber** (physical value)
5. Mineral Content (ion balance)
Normand St. Pierre & Bill Weiss, Nutritionists (Ohio State)

- NEL (energy) is 65% of total value of alfalfa
- NDF, lignin and ash are most important measurements
DM, Ash, aNDF, and NDFD, and CP are the key analyses to consider.

- Effective fiber (eNDF)

- Indigestible NDF (iNDF) may be of interest, and the future is digestion kinetics.
Low NDF hays are still important

However, need fiber and particle size for good rumen function and health

NDFD and lignin are helpful
Survey of Nutritionists:

33 Respondents: Ave. 62,000 animals

9 States, predominately Western – all reported multi-state duties

They said:

- 81% economic value should be based upon lab value, rest upon visual observation
If you were to be allowed only 1 analysis, what would it be?

- NDF or ADF (a fiber measurement)

What about #2, #3, etc.?
The key analyses for alfalfa were seen to be:

- DM
- NDF or ADF
- CP
- NDFd
- Ash
Alfalfa:

- Should an actual lab value be used for marketing, or a calculated value (e.g. RFV, TDN, RFQ)
  - Actual Lab Value (75% of respondents)
  - Calculated Value (25%)
Alfalfa:

What is the Best Option?

- Use Existing RFV (7% of respondents)
- Use Existing RFQ (3%)
- Use Existing TDN (0%)
- Use a single lab analysis (e.g. NDF) (0%)
- Use a combination of lab analyses (e.g. NDF, CP, NDFD) (59%)
- Use a new TDN or calculated value based upon a widely-used nationally-recognized summative equation w national (31%)
Alfalfa:

- Would it be useful to have ONE national calculated value used primarily for the marketing of alfalfa hay?
  - Yes it would help (32%)
  - Maybe, Depends upon how it’s done (42%)
  - No, not necessary (26%)
ALFALFA:

Is it a good idea to use digestibility data (NDFD or IVDDM) for marketing of alfalfa hay? (choose the answer closest reflects your view)

- Yes, it helps to differentiate quality (17%)
- Yes, but labs need to work on standardization (70%)
- No, the lab analysis is too variable (0%)
- No, there is not enough biological variation compared to analytical variation to make it useful (13%)
### Current USDA Hay Quality Guidelines*

<table>
<thead>
<tr>
<th>Category</th>
<th>ADF</th>
<th>NDF</th>
<th>RFV</th>
<th>TDN (90)</th>
<th>CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supreme</td>
<td>&lt;27</td>
<td>&lt;34</td>
<td>&gt;180</td>
<td>&gt;55.9</td>
<td>&gt;22</td>
</tr>
<tr>
<td>Premium</td>
<td>27-29</td>
<td>34-36</td>
<td>150-180</td>
<td>54.5-55.9</td>
<td>20-22</td>
</tr>
<tr>
<td>Good</td>
<td>29-32</td>
<td>36-40</td>
<td>125-150</td>
<td>52.5-54.5</td>
<td>18-20</td>
</tr>
<tr>
<td>Fair</td>
<td>32-35</td>
<td>40-44</td>
<td>100-125</td>
<td>50.5-52.5</td>
<td>16-18</td>
</tr>
<tr>
<td>Utility</td>
<td>&gt;35</td>
<td>&gt;44</td>
<td>&lt;100</td>
<td>&lt;50.5</td>
<td>&lt;16</td>
</tr>
</tbody>
</table>

*USDA Market News. Guidelines are based upon Visual Analysis as well as test results.*
Revised Core Tests for Alfalfa:

**Core Quality Analysis:**
- DM – Not for quality – but for yield
- NDF - Neutral Detergent Fiber
- CP - Crude Protein
- NDFd – NDF digestibility
- Ash

**Additional Analyses:**
- Lignin – Many nutritionists value lignin
- DCAD – Close up animals

**Calculate:**
- TDN (new national NEL or TDN).
- RFV, RFQ, TDN, Summative Energy Values, NEL, RFV, RFQ, etc. as needed

**Emphasize:** What is actually measured!

**Remember:** Only as good as the sampling procedure
For high producing dairy cows

- NDF – generally desire lower levels, but not too low
- CP – generally higher levels
- NDFD – generally higher levels
- ASH – generally lower levels
## Hay Quality Guidelines

### Range of Hay Quality Analysis for Alfalfa Quality Marketing Groups

<table>
<thead>
<tr>
<th>Quality Group</th>
<th>NDF%</th>
<th>NDFD%</th>
<th>CP</th>
<th>ADF%</th>
<th>RFV</th>
<th>TDN (90%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supreme</td>
<td>&lt;33</td>
<td>35</td>
<td>22</td>
<td>&lt;27</td>
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<td>&lt;35</td>
<td>&lt;16</td>
<td>&gt;35</td>
<td>100</td>
<td>50.5</td>
</tr>
</tbody>
</table>

Calculated Values:

- RFV: 100%
- TDN (90%): 55.9, 54.5, 52.5
NDF Digestibility and ADF Values - Western Hays in Relationship to hay Marketing Categories

NDF Digestibility (%) vs. ADF Concentration (%)

Supreme | Premium | Good | Fair | Utility

30.0 | 35.0 | 40.0 | 45.0 | 50.0 | 55.0 | 60.0 | 65.0

20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 36 | 38 | 40 | 42 | 44
Ash Content of Alfalfa

RELATIONSHIP BETWEEN ADF AND ASH - 560 Western hay samples

\[ y = 0.0538x + 10.089 \]

\[ R^2 = 0.0128 \]
What about Intake??

![Graph showing dry matter intake over time relative to calving for different groups: Multi - MF, Primi - MF, Multi - HF.](image)
Challenges:

- Buy in by nutritionists, labs, alfalfa hay groups
- Standardization of in-vitro measurements
- NIRS vs. wet chem.
- Standardization….. But allow innovation with other techniques
  - Particle analysis
  - Gas measurements
  - Protein analysis
Summary:

- Quality is a complex trait, not readily reduced to a single number.

- Necessary for markets to have simplicity:
  - Few numbers, standardized, transparent.

- Fiber based marketing systems, while simple and effective, are prone to several abuses and must change.

- For Alfalfa, Changes needed:
  - Emphasis on NDF, CP, NDFD, Ash
  - Use 100% DM values
  - National Energy Equation for marketing?

- Visual Evaluation still important.