Defining and re-defining forage quality

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Currently, alfalfa quality is primarily defined by fiber content

<table>
<thead>
<tr>
<th>Western hay grade</th>
<th>ADF</th>
<th>TDN, 90% DM</th>
<th>RFV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supreme</td>
<td>&lt; 27</td>
<td>&gt;55</td>
<td>&gt;185</td>
</tr>
<tr>
<td>Premium</td>
<td>27-29</td>
<td>54.5-55.9</td>
<td>170-185</td>
</tr>
<tr>
<td>Good</td>
<td>29-32</td>
<td>52.5-54.5</td>
<td>150-170</td>
</tr>
<tr>
<td>Fair</td>
<td>32-35</td>
<td>50.5-52.5</td>
<td>130-150</td>
</tr>
<tr>
<td>Utility</td>
<td>&gt;35</td>
<td>&lt;50.5</td>
<td>&lt;130</td>
</tr>
</tbody>
</table>

TDN = 82.38 - (0.7515 x ADF)
Why is accounting for forage fiber digestibility important?

New technologies are focused on development of high fiber-digestibility forages

- reduced lignin alfalfa
- high fiber-digestibility grasses
- BMR silage corn and sorghum
Why is fiber digestibility important?

- Management strategies with reduced lignin alfalfa include harvesting later to increase yields/reduce harvest costs.

![Graph showing the relationship between days of regrowth and yield for conventional and low-lignin alfalfa quality.](image-url)
Why is fiber digestibility important?

- Dairy producers are ‘in tune’ with the advantages of feeding forages with higher fiber digestibility

Oba and Allen (1999)

A 1% change in vitro or in situ NDF digestibility (primarily 30-h or 48-h NDFD) was correlated with:

- 0.4 lb increase in dry matter intake
- 0.5 lb increase in 4% fat corrected milk yield
Why is fiber digestibility important?

✓ Dairy producers also recognize the value of highly digestible NDF in a ration.

California dairy producers typically feed alfalfa to bring NDF into the ration (10-25% of ration). FIBER HAS VALUE. FIBER DIGESTIBILITY INCREASES VALUE.

If alfalfa fiber is higher in digestibility, it can displace other high-fiber feeds.
TTNDFD is a prediction of NDF digestibility for a feed (or diet) in 1400 lb cow consuming 53 lb DM of a 28-30% NDF diet.

Why? We can measure fiber digestibility quickly and with little expense.

Feed Analysis Lab Report
Cost of analysis: TTNDFD report (NIR) $26 vs $22 for a standard analysis w/o TTNDFD.
Fiber digestibility varies in forages

<table>
<thead>
<tr>
<th>Forage Type</th>
<th>Range in TTNDFD % of NDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa hay and silage</td>
<td>25-70</td>
</tr>
<tr>
<td>Corn silage</td>
<td>25-80</td>
</tr>
<tr>
<td>Grass hay and silage</td>
<td>15-80</td>
</tr>
</tbody>
</table>

Two units increase in diet TTNDFD can potentially increase milk yield by 1 lb
How variable is alfalfa fiber digestibility?

32% of samples fall outside of +/- 1 standard deviation
Would a 1 SD variation in fiber digestibility affect hay market price?

Market Price vs TDN of Alfalfa Hay in N. California, November 4, 2016

1 SD = 20 $/ton

1 SD = 2 TDN units
Why does fiber digestibility vary?  
Maturity

<table>
<thead>
<tr>
<th></th>
<th>NDF</th>
<th>Lignin</th>
<th>TTNDFD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% of DM</td>
<td>% of DM</td>
<td>% of NDF</td>
</tr>
<tr>
<td>Immature</td>
<td>33</td>
<td>5.4</td>
<td>54</td>
</tr>
<tr>
<td>Vegetative</td>
<td>37</td>
<td>6.2</td>
<td>50</td>
</tr>
<tr>
<td>Mid-maturity</td>
<td>43</td>
<td>7.3</td>
<td>47</td>
</tr>
<tr>
<td>Mature</td>
<td>50</td>
<td>8.4</td>
<td>46</td>
</tr>
</tbody>
</table>
Why does fiber digestibility vary?

Genetics

Digestibility of Alforex Hi-Gest® 360 Alfalfa

<table>
<thead>
<tr>
<th>Alfalfa Variety</th>
<th>pdNDF</th>
<th>Dyn Kd</th>
<th>TTNDFD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hi-Gest 360</td>
<td>73.3</td>
<td>7.2</td>
<td>55.1</td>
</tr>
<tr>
<td>Conventional Check</td>
<td>68.2</td>
<td>6.6</td>
<td>48.2</td>
</tr>
<tr>
<td>% Difference:</td>
<td>7%</td>
<td>10%</td>
<td>+ 14%</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Alfalfa Variety</th>
<th>pdNDF</th>
<th>Dyn Kd</th>
<th>TTNDFD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hi-Gest 360</td>
<td>59.1</td>
<td>5.9</td>
<td>39.3</td>
</tr>
<tr>
<td>Conventional Check</td>
<td>54.8</td>
<td>5.4</td>
<td>35.6</td>
</tr>
<tr>
<td>% Difference:</td>
<td>8%</td>
<td>8%</td>
<td>+ 10%</td>
</tr>
</tbody>
</table>
### Effect of Low Lignin Trait on Alfalfa ADF and NDF Digestion

<table>
<thead>
<tr>
<th>Item</th>
<th>Harvest interval</th>
<th>Roundup Ready</th>
<th>Roundup Ready + Low Lignin*</th>
<th>P Value Forage</th>
<th>Harvest interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADF</td>
<td>28d</td>
<td>26.6</td>
<td>26.5</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>33d</td>
<td>27.2</td>
<td>26.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>35d</td>
<td>27.8</td>
<td>26.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TTNDFD</td>
<td>28d</td>
<td>52.1</td>
<td>56.3</td>
<td>0.05</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>33d</td>
<td>46.3</td>
<td>51.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>35d</td>
<td>46.8</td>
<td>51.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* HARVXTRA® Forage Genetics International Li, Li, Undersander and Combs, 2015, ADSA abstract

Why does fiber digestibility vary? Genetics

- + 8%
- +12%
- + 9%
Why does fiber digestibility vary?
Growing conditions/environment

✓ Moisture
✓ Temperature
✓ Sun intensity

2/3 or more of variation in fiber digestibility is likely due to growing conditions/environment
How to get dairy producers and hay producers on the same page?

Dairy producers and nutritionists: A more accurate estimate of forage TDN would help to value alfalfa and predict animal performance.

Agronomists and hay producers: Incentive to manage for high fiber digestibility.
Combs' proposal: Adjusting the Market Value of Hay for Fiber Digestibility

Western hay TDN equation does not factor in fiber digestibility

\[
\text{TDN (100\% DM)} = 82.38 - (0.7515 \times \text{ADF(\% DM)})
\]
How to build in fiber digestibility into existing system

✓ Current system:

TDN = 82.38 - (0.7515 x ADF)

‘average’ NDF digestibility = 46% of NDF

✓ ‘Adjusted’ TDN

TDN = (82.38 - (0.7515 x ADF)) +/- (NDF x deviation in fiber digestibility from 46%)
Example: Adjusting TDN for a reduced lignin alfalfa (28% ADF, 36% NDF, 52% NDF digestibility)

- **Current system** (no fiber digestibility adjustment: all forages assumed to have 46% NDF digestibility)
  
  $\text{TDN} = 82.38 - (0.7515 \times 28\%) = 54.5 \% \text{ TDN}$

  (Good/Premium grade) Value = $150/\text{ton}$

- **Adjusted TDN** (+6 unit higher than average fiber digestibility)
  
  $[82.38 - (0.7515 \times 28\%)] + (36 \% \text{ NDF} \times .06) = 56.7 \% \text{ TDN}$

  (Supreme grade) Value = $173/\text{ton}$
Example: Adjusting TDN for fiber digestibility can also decrease TDN: (28% ADF, 36% NDF, 40% NDF digestibility)

✓ Current system (no fiber digestibility adjustment)
TDN = 82.38 –(0.7515 x 28%) = 54.5 % TDN
(Good/Premium grade) Value = $150/ton

✓ Adjusted TDN (-6 unit lower than average in fiber digestibility)
[82.38 –(0.7515 x 28%)] – (36 % NDF x .06) = 52.3 % TDN
(Good/Fair grade) Value = $130/ton
Fiber digestibility-adjusted TDN vs Western Hay TDN

Data provided by Rock River Labs-Visalia Ca
Which is the better Alfalfa?

Both forages have similar RFV

<table>
<thead>
<tr>
<th>Description (%DM unless specified)</th>
<th>Dry Matter Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>aNDF</td>
<td>42.2%</td>
</tr>
<tr>
<td>TTNDF</td>
<td>44.1%</td>
</tr>
</tbody>
</table>
A proposal for adjusting RFV for fiber digestibility:

\[ y = 8.8977x - 367.28 \]

\[ R'' = 0.99799 \]

Adjusted RFV = RFV + (8.977 \times \text{change in TDN})
Example: Adjusting RFV for a reduced lignin alfalfa

<table>
<thead>
<tr>
<th>Harvest Interval, days</th>
<th>RFV</th>
<th>TDN adjustment for fiber digestibility</th>
<th>Adjusted RFV</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
<td>202</td>
<td>2.4</td>
<td>223</td>
</tr>
<tr>
<td>33</td>
<td>197</td>
<td>1.0</td>
<td>206</td>
</tr>
<tr>
<td>35</td>
<td>193</td>
<td>0.8</td>
<td>200</td>
</tr>
</tbody>
</table>
The Take Home Messages

1. Fiber digestibility has a big impact on forage quality

2. New technologies are increasing emphasis on improving forage quality by improving fiber digestibility

3. Current Western TDN equation does not account for fiber digestibility

4. A relatively simple adjustment could be made to adjust Western Hay TDN values (and RFV) to account for variation in NDF digestibility
The **Wisconsin Idea** is a philosophy embraced by the University of Wisconsin System, which holds that research conducted at the University of Wisconsin System should be applied to solve problems and improve health, quality of life.

*Dairy Starts Here.*

University of Wisconsin
Department of Dairy Science
What makes a better forage?

✔ High digestibility
  ✔ Fiber (-)
  ✔ Fiber digestibility (+)

✔ High intake potential
  ✔ Fiber (-)
  ✔ Fiber digestibility (+)

BOTH NDF and NDF digestibility are needed to assess forage quality