EVALUATING FORAGE QUALITY
1. Review NDF, ADF, RFV
2. RFQ
3. TTNDFd
4. Using reduced lignin alfalfa
*NDF = neutral detergent fiber

= cellulose, hemicellulose, and lignin

Cell wall, partly digestible

Reduces intake
* NDF = neutral detergent fiber
  = cellulose, hemicellulose, and lignin
  Cell wall, partly digestible
  Reduces intake

* ADF = acid detergent fiber
  = cellulose and lignin
  Mostly indigestible
  Lowers energy
Relative Feed Value = (Intake Potential * Digestible DM) Constant
Relative Feed Value = (Intake Potential * Digestible DM) 

Constant

Intake Potential = 120/NDF

Digestible DM = 88.9 - (0.779*ADF)

Constant = 1.29
Relative Feed Value = (Intake Potential * Digestible DM)\[\text{Constant}\]

Intake Potential = \(\frac{120}{\text{NDF}}\)

Digestible DM = 88.9 - (0.779*ADF)

Constant = 1.29

\[\text{RFV} = \frac{120}{\text{NDF}} \times (88.9 - 0.779\times\text{ADF})\]

1.29
Uses of Relative Feed Value

* When to harvest
* Allocation of hay to animals
Forage Quality Needs of Animals

- Dairy, 1st trimester
- Dairy Calf
- Dairy, last 200 days
- Heifer, 3-12 month
- Stocker cattle
- Heifer, 12-18 mo
- Beef cow & calf
- Heifer, 18-24 mo
- Dry cow

Relative Feed Value

100  110  120  130  140  150  160+
Uses of Relative Feed Value

* When to harvest
* Allocation of hay to animals
* Buying/selling hay
Comparison of ADF to *in vitro* digestibility of alfalfa

Anderson and Cuomo, 1993
Comparison of ADF to Fiber Digestibility of World's Forage Superbowl Samples

Neutral Detergent Fiber Digestibility (% of NDF)

Acid Detergent Fiber

\[ y = -0.38x + 61.22 \]

\[ R^2 = 0.09 \]
Solution?
Solution?

Relative Forage Quality (RFQ) = \frac{(\text{Intake Potential} \times \text{TDN})}{\text{Constant}}
Relative Forage Quality (RFQ)

RFV = Intake potential * DDM
     1.29

= 120/NDF * [88.9 - (0.779*ADF)]
     1.29

RFQ = dlIntake potential * dTDN
     1.23

= [NDF + ((dNDF-avg dNDF)*.374)] * [dNFC+dCP+dFA*2.25+dNDF-7]
     1.23
RFQ changes as the following change:

- NDF
- digestible fiber (dNDF)
- Crude protein
- Nonfibrous carbohydrate
- Fatty acids
*Change in RFV and RFQ over time*
*Change in RFV and RFQ over time*

This difference will be even greater with grasses.
Fiber digestion is affected by:

**Feed characteristics**

- The amount of fiber (NDF, or NDF_{om})
- Potentially digestible fiber (pdNDF)
  \[pdNDF = NDF - uNDF_{240}\]
Fiber digestion is affected by:

**Feed characteristics**
- The amount of fiber (NDF, or NDF_{om})
- Potentially digestible fiber (pdNDF)
  \[
  \text{pdNDF} = \text{NDF} - uNDF_{240}
  \]
- Rate of fiber digestion (kd)

**Animal and diet**
- Intake affects rate of fiber passage (kp)
Total Tract NDF Digestion
*Slides by David Combs, dairy nutritionist at the University of Wisconsin, used at World Dairy Expo, 2016*
The Math:

1. \( \text{NDF digestion} = \text{pdNDF} \times \frac{\text{kd}}{(\text{kd} + \text{kp})} \)

- pdNDF = \( (\text{NDF} - u\text{NDF}_{240}) \)
- \( k_d \) = Digestion rate of the fiber \( (kd) \)
- kp pdNDF = Passage rate of the digestible fiber

TTNDFD is a measure of fiber digestion that accounts for pdNDF, kd and kp
## Variation in iNDF and kd of forages harvested in 2015

<table>
<thead>
<tr>
<th>Forage</th>
<th>Average iNDF, % of NDF</th>
<th>Range in iNDF</th>
<th>Average kd, %/h</th>
<th>Range in kd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn silage</td>
<td>26.5</td>
<td>12.5 to 40.8</td>
<td>2.73</td>
<td>1.7 to 4.7</td>
</tr>
<tr>
<td>Alfalfa silage</td>
<td>40.5</td>
<td>26.5 to 54.5</td>
<td>5.3</td>
<td>1.56 to 9.04</td>
</tr>
<tr>
<td>Grass silage</td>
<td>25.5</td>
<td>0 to 51.5</td>
<td>4.46</td>
<td>2.08 to 6.84</td>
</tr>
</tbody>
</table>

* mean value ± 2 standard deviations

Samples submitted to Rock River Laboratories in 2015 and 2016

The proportion of iNDF and rate of fiber digestion (kd) vary in forages
Forages can differ greatly in fiber digestibility

<table>
<thead>
<tr>
<th></th>
<th>Range in TTNDFD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avg</td>
</tr>
<tr>
<td>Alfalfa hay and silage</td>
<td>42%</td>
</tr>
<tr>
<td>Corn silage</td>
<td>42%</td>
</tr>
<tr>
<td>Grass hay and silage</td>
<td>44%</td>
</tr>
</tbody>
</table>

Two units increase in diet TTNDFD can potentially increase milk yield by 1 lb
TTNDFD combines *in vitro* rate of NDF digestion with *iNDF* to improve the prediction of *in vivo* fiber digestion.

\[
y = 1.03x \\
R^2 = 0.660
\]
# Feed Analysis Lab Report

**Lab #** | **Sampled on 1/8/2014** | **Received on 1/9/2014**  
--- | --- | ---  
**Farm**  
**Moisture** | 54.44% |  
**Dry Matter** | 45.56% |  
**Description (%DM unless specified)** | **Dry Matter Basis** |  
Crude Protein | 22.55% |  
**Calculations**  
TTNDFD | 51.37 |  
Relatvie Forage Quality | 141 |  
Dynamic NDF Kd (using 24,30,48,120 hr) | 11.53%/hr |  
Relative feed value | 136 |  
**60 Day RRL Average** |  
| |  
21.80% |  
43.09% |  
51.4 |  
TTNDFD | 44.70 |  
**aNDF** | 42.6% |  
**Which is the better Alfalfa?**  
**Both forages have similar RFV**  

**Sample # 1** | Haylage  
**Lab #** | **Sampled on 12/26/2013** | **Received on 12/27/2013**  
--- | --- | ---  
**Farm**  
**Moisture** | 69.47% |  
**Dry Matter** | 30.53% |  
**Description (%DM unless specified)** | **Dry Matter Basis** |  
20.87% |  
**Calculations**  
TTNDFD | 44.14 |  
Relative Forage Quality | 159 |  
Dynamic NDF Kd (using 24,30,48,120 hr) | 7.72%/hr |  
Relative feed value | 138 |  
**60 Day RRL Average** |  
| |  
21.86% |  
43.30% |  
44.1 |  
TTNDFD | 44.26 |  
**aNDF** | 42.2% |  
**aNDF** | 44.1 |  

1. Fiber digestibility has a big impact on milk yield.

2. NDF is good (RFV); NDFd is better; TTNDFd is best.

3. Fiber digestion rate and passage need to be considered to best assess fiber quality.
Feeding Considerations Regarding Reduced Lignin Alfalfa

- People are asking about milk production expectations.
- Is there anything that we need to do to the diet to feed reduced lignin alfalfa?
Slides by David Weakley, director of dairy forage nutrition research at Forage Genetics, used at World Dairy Expo, 2016
Why Lignin?

- Lignin is an indigestible phenolic compound in alfalfa cell walls.
- As alfalfa matures, lignin content increases.
- Lignin cross-links with cellulose which decreases digestibility of fiber (dNDF).
- A 10% increase in fiber digestibility:
  - Increase milk/beef by $350M/yr
  - Decrease manure by 2.8MT/yr
Less lignin

Higher NDFd
Highly Digestible Alfalfa NDF

Q & A

Q: So, alfalfa hay of a higher NDFd will have a greater RFV (Relative Feed Value) or TDN (Total Digestible Nutrients), which commands a premium price?
Highly Digestible Alfalfa NDF Q & A

Q: So, alfalfa hay of a higher NDFd will have a greater RFV (Relative Feed Value) or TDN (Total Digestible Nutrients), which commands a premium price?

A: Unfortunately not. Neither of these indexes will reflect the higher NDFd.
Highly Digestible Alfalfa NDF
Q & A

Q: So, if RFV or TDN won’t reflect the higher NDFd, what will?
Highly Digestible Alfalfa NDF Q & A

Q: So, if RFV or TDN won’t reflect the higher NDFd, what will?

A: RFQ (Relative Forage Quality) based on the associated NDFd measurement from a commercial laboratory. An NIR predicted NDFd may underpredict highly digestible alfalfa, but TT NDFd should be accurate.
Highly Digestible Alfalfa NDF

Q & A

Q: Does increasing NDFd increase the energy content of alfalfa?
Highly Digestible Alfalfa NDF
Q & A

Q: Does increasing NDFd increase the energy content of alfalfa?

A: Yes, but relatively little:
- 10 lbs. alfalfa DM x 1.0 mcal ME/lb DM x 42% NDF x10% improvement = 0.42 mcal of ME
- Enough for 0.8 lbs of milk (assuming all the increased ME went for milk production).
Highly Digestible Alfalfa NDF
Q & A

Q: The energy response seems small. So, why feed alfalfa of higher NDFd?
Highly Digestible Alfalfa NDF Q & A

Q: The energy response seems small. So, why feed alfalfa of higher NDFd?

A: To reduce rumen fill and increase DM intake
   - The greater impact of higher alfalfa NDFd on milk production is from increasing DM intake, rather than increasing energy concentration.
* Intake increases when NDF digestibility increases

* One unit increase in NDFd increases intake 0.37 lb/day and 0.55 lb/day milk yield per cow.
* Best response from early lactation, high producing cows in good condition.
Highly Digestible Alfalfa NDF Q & A

Q: If I feed alfalfa of a higher NDFd, will I always see an improvement in DM intake?
Highly Digestible Alfalfa NDF

Q & A

Q: If I feed alfalfa of a higher NDFd, will I always see an improvement in DM intake?

A: No. Only when:
   • Rumen fill is excessive
     • Forage levels are greater than about 55% and/or,
     • Digestibility of forages is below average
Highly Digestible Alfalfa NDF Q & A

• Q: When rumen fill is not excessive, will I see a response in DM intake?
Highly Digestible Alfalfa NDF Q & A

Q: When rumen fill is not excessive, will I see a response in DM intake?

A: No.

- When forage levels in the diet are low (less than about 45%) and/or
- digestibility of forages is above average, rumen fill is not limiting intake.
Highly Digestible Alfalfa NDF Q & A

Q: If I see an improvement in DM intake, will I always get a milk production response?
Highly Digestible Alfalfa NDF Q & A

Q: If I see an improvement in DM intake, will I always get a milk production response?

A: Not always. If cows are in poor body condition or in later lactation, the increased energy intake will be used for tissue growth and not milk production.
Milk response expectations with feeding highly digestible alfalfa will depend on intake improvements, body condition and stage of lactation.

Chances for more milk are better if:
- DM intake increases
- Body condition is good
- Cows are in early lactation (<150 DIM)

One pound increase in DM intake provides enough energy potential for:
- 2.5 pounds of additional milk production
- 0.35 pounds of body weight gain
Highly Digestible Alfalfa NDF

Q & A

Q: If I substitute alfalfa of higher NDFd into the diet and rumen fill is high and body condition is good (> BCS of 3.5) and cows are in early lactation, should I see an improvement in DM intake and milk production?
Highly Digestible Alfalfa NDF Q & A

• Q: If I substitute alfalfa of higher NDFd into the diet and rumen fill is high and body condition is good (> BCS of 3.5) and cows are in early lactation, should I see an improvement in DM intake and milk production?

• A: Very likely. For every 1 lb. increase in DM intake, you should expect a 2.5 lb. increase in fat corrected milk (FCM)
Nutritional Questions Concerning Reduced Lignin Alfalfa

- Is there anything that we need to do to the diet to feed Highly Digestible reduced lignin alfalfa?
  - Not really. Formulation similar to that used with high NDFd alfalfa.
  - If rumen fill amounts are low, there is opportunity to increase forage levels in the diet.
Nutritional Questions Concerning Reduced Lignin Alfalfa

- Should I expect increased milk production?
  - “It depends”. Chances are better if:
    - **Alfalfa is harvested for quality** (normal cutting schedule)
    - DM intake increases
    - Body condition is good
    - Cows are in early lactation (<150 DIM)
    - Can’t always expect a milk production response!
Thank you
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