Cows agree with Total Tract NDFD

A new (and) better tool for assessing forage quality

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Balancing rations for carbohydrates (starch and NDF) are critical for health and production in high producing dairy cows.

Milk production is affected by variations in:

- Fiber digestibility => 6-7 lbs of milk
- Starch digestibility => 3-5 lbs of milk
Assessing fiber digestion is not easy

Poor digestion < 40%
Excellent digestion > 50%

A 2-3 unit change in fiber digestibility corresponds to 1 lb change in milk yield.
Fiber digestibility varies in forages

<table>
<thead>
<tr>
<th>TTNDFD</th>
<th>Range in % 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
# The ‘Alphabet Soup’ Forage Fiber Tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Rumen Fill</th>
<th>TDN Estimation</th>
<th>Diet Formulation</th>
<th>Herd Diagnostics</th>
<th>Quality Index</th>
<th>Agronomy Trials</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDF</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>NDFD&lt;sub&gt;(30 or 48)&lt;/sub&gt;</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>TTNDFD</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>uNDF&lt;sub&gt;240&lt;/sub&gt;</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>NDF kd</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>RFQ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Milk/ton</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
TTNDFD — Total Tract NDF Digestibility

Licensed procedure through the University of WI

>15 years of research, > $500,000 invested in development

A precise laboratory test that accurately predicts how fiber is utilized by high producing dairy cows
TTNDFD → *Total Tract NDF Digestibility*

Feed and cow factors are combined to measure true fiber digestion.

A 2-3 unit change in ration TTNDFD corresponds to 1 pound change in milk yield.
Think of forage quality as how far you can travel on a tank of gas:

You can’t calculate how far you can go unless you know:

- How much fuel is in the tank (pdNDF)
- The miles traveled per gallon (kd)

HOW much milk your forage will make depends on the amount of potentially digestible fiber AND the rate of fiber digestion!
How is TTNDFD determined?

Forage sample

Rate of fiber digestion \( (kd) \)
Potentially digestible NDF \( (pdNDF) \)

Rate of fiber passage, \( (kp) \)

Standardized iv NDFD (24, 30, 48h) and iNDF

Rumen and hindgut digestion

\[ \text{TTNDFD} = \frac{\text{PD NDF} \times kd}{kd + kp} \]

TTNDFD (total tract NDF Digestibility)
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.

Cost of analysis TTNDFD report (NIR) $26 vs $22 for a standard analysis w/o TTNDFD
Feed Analysis Lab Report

<table>
<thead>
<tr>
<th>Description (%DM unless specified)</th>
<th>Dry Matter Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>54.44%</td>
</tr>
<tr>
<td>Dry Matter</td>
<td>45.56%</td>
</tr>
<tr>
<td>TTNDFD</td>
<td>51.4</td>
</tr>
<tr>
<td>Relative Forage Quality</td>
<td></td>
</tr>
<tr>
<td>Dynamic NDF Kd (using 24,30,48,120 hr)</td>
<td>11.53%/hr</td>
</tr>
<tr>
<td>Relative feed value</td>
<td>136</td>
</tr>
<tr>
<td>aNDF</td>
<td>42.6%</td>
</tr>
<tr>
<td>TTNDFD</td>
<td>44.1</td>
</tr>
</tbody>
</table>

Which is the better Alfalfa?

Both forages have similar RFV
Validating the TTNDFD model
What do the ‘real experts’ say?

<table>
<thead>
<tr>
<th>Legume/grass feeding trials</th>
<th>Mean 47.3 % of NDF</th>
<th>Median 47.5 % of NDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>(20 trials, 64 observations</td>
<td>Range 31.1-66.2 % of NDF</td>
<td>St. Dev 8.1</td>
</tr>
<tr>
<td>In vivo NDF diet digestibility)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cows report that TTNDF digestibility of legume/grasses are higher than TTNDF digestibility of corn silage.

<table>
<thead>
<tr>
<th>Corn Silage/Sorghum feeding trials</th>
<th>Mean 40.2 % of NDF</th>
<th>Median 41.1 % of NDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>(25 trials, 81 observations, In Vivo NDF diet digestibility)</td>
<td>Range 20.1-58.8 % of NDF</td>
<td>St. Dev. 8.8</td>
</tr>
</tbody>
</table>
Validating the TTNDFD model

J. Dairy Sci. 92:3833–3841
doi:10.3168/jds.2008-1136

An alternative method to assess 24-h ruminal in vitro neutral detergent fiber digestibility

J. P. Goeser and D. K. Combs
Department of Dairy Science, University of Wisconsin-Madison, Madison 53706
Validating the TTNDFD model

J. Dairy Sci. 92:3842–3848
doi:10.3168/jds.2008-1745

Modification of a rumen fluid priming technique for measuring in vitro neutral detergent fiber digestibility

J. P. Goeser, P. C. Hoffman, and D. K. Combs
Department of Dairy Science, University of Wisconsin, Madison 53706
Method for measuring fiber digestibility
US 20090272889 A1

ABSTRACT
Described is a method of measuring fiber digestion in ruminants and calibrating spectrophotometers using the measured fiber digestion values. The method includes the steps of harvesting rumen fluid from at least one ruminant animal and combining the rumen fluid with a primer composition comprising a carbohydrate. The rumen fluid and carbohydrate are then incubated in a sealed container until a pre-determined pressure is achieved within the sealed container. A plant matter sample is digested with the rumen fluid so treated. The digested sample is the measured for absorbance or reflectance using a spectrophotometer. The digestion values and the absorbance or reflectance values are then correlated to construct a standard curve for predicting fiber digestion values using spectrophotometric analysis, preferably NIRS analysis.
Validating the TTNDFD model

J. Dairy Sci. 98:574–585
http://dx.doi.org/10.3168/jds.2014-8661

Validation of an in vitro model for predicting rumen and total-tract fiber digestibility in dairy cows fed corn silages with different in vitro neutral detergent fiber digestibilities at 2 levels of dry matter intake

F. Lopes, D. E. Cook, and D. K. Combs
Department of Dairy Science, University of Wisconsin, Madison 53706
Validating the TTNDFD model

J. Dairy Sci. 98:2596–2602
http://dx.doi.org/10.3168/jds.2014-8665

Validation of an approach to predict total-tract fiber digestibility using a standardized in vitro technique for different diets fed to high-producing dairy cows

F. Lopes, K. Ruh, and D. K. Combs¹
Department of Dairy Science, University of Wisconsin, Madison 53706
Validating the TTNDFD model

J. Dairy Sci. TBC:1–13
http://dx.doi.org/10.3168/jds.2014-8662
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Effects of varying dietary ratios of corn silage to alfalfa silage on digestion of neutral detergent fiber in lactating dairy cows

F. Lopes, D. E. Cook, and D. K. Combs
Department of Dairy Science, University of Wisconsin–Madison, Madison 53706
In vivo – pool and flux method

- Omasal digesta and rumen fluid collected
- Fecal samples collected
- Rumen contents were evacuated manually at 1300h (4h after feeding) on d 20 and at 0800 h (1 h before feeding) on d 21

Rumen kinetic and pool size

- Rumen pools of iNDF and pdNDF (kg)
- Ruminal passage rates of iNDF and pd NDF (%/h)
- Ruminal digestion rate of pdNDF (%/h)
Can the in vitro TTNDFD test detect a difference in fiber digestibility as ratios of corn silage (36% TTNDFD) and alfalfa (42% TTNDFD) change in the ration?

<table>
<thead>
<tr>
<th>Corn silage:alfalfa ratio</th>
<th>100CS 0AS</th>
<th>67CS 33AS</th>
<th>33CS 67AS</th>
<th>0CS 100AS</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMI, lb/d</td>
<td>55&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>56&lt;sup&gt;a&lt;/sup&gt;</td>
<td>54&lt;sup&gt;b&lt;/sup&gt;</td>
<td>48&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.8</td>
</tr>
<tr>
<td>4% FCM, l/d</td>
<td>80</td>
<td>78</td>
<td>77</td>
<td>79</td>
<td>0.9</td>
</tr>
</tbody>
</table>

| Observed TTNDFD, in vivo | 38.3<sup>a</sup> | 40.9<sup>ab</sup> | 39.4<sup>ab</sup> | 43.8<sup>a</sup> | 1.9 |
| Predicted TTNDFD, in vitro* | 38        | 41        | 41        | 45        | 2.1 |

*In vitro TTNDFD analysis of feeds matched the observed (in vivo) NDF digestibility values

Lopes et al, 2015
Fiber digestibility TTNDFD vs. in vivo

<table>
<thead>
<tr>
<th>Method</th>
<th>TTNDFD</th>
<th>In vivo</th>
<th>SEM</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDF digested in rumen, lb</td>
<td>5.3</td>
<td>5.7</td>
<td>0.4</td>
<td>0.6</td>
</tr>
<tr>
<td>NDF digested in hindgut, lb</td>
<td>0.4</td>
<td>0.7</td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td>NDF digested in total tract, lb</td>
<td>5.9</td>
<td>6.4</td>
<td>0.2</td>
<td>0.7</td>
</tr>
<tr>
<td>Total tract NDF digestibility, % of total NDF</td>
<td>40.6</td>
<td>41.8</td>
<td>1.86</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Lopes et al, 2015
TTNDFD validation: Comparing lab prediction to results from feeding studies

- Total tract NDF digestibility in vivo studies
  - Seven studies (total of 21 diets) conducted at UW-Madison
- Total tract NDF digestibility in vitro evaluation of diets
  - 21 diets
  - TTNDFD predicted from TMR samples
TTNDFD combines *in vitro* rate of NDF digestion with \( iNDF \) to improve the prediction of *in vivo* fiber digestion.
Stand-alone *in vitro* NDFD30 or iNDF values are poor predictors of in vivo fiber digestion

![Graph](image)

**In vivo NDF digestion vs In vitro NDFD30h**

\[ y = 0.043x + 42.8 \]

\[ R^2 = 0.005 \]

**In vivo NDF digestion vs indigestible NDF (240h in vitro or 288h in situ)**

\[ y = -0.864x + 68.3 \]

\[ R^2 = 0.364 \]


How to use TTNDFD
Troubleshooting with TTNDFD

Switched from 2009 to 2010
Corn Silage  WHAT HAPPENED?

<table>
<thead>
<tr>
<th>Item</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDF</td>
<td>43%</td>
<td>37%</td>
</tr>
<tr>
<td>NDFD30</td>
<td>62%</td>
<td>61%</td>
</tr>
<tr>
<td>TTNDFD</td>
<td>48%</td>
<td>32%</td>
</tr>
</tbody>
</table>
Ration Balancing With TTNDFD

- TTNDFD values are consistent across feed types
- Target rations for >42% TTNDFD
- ‘Dynamic kd’ and iNDF are compatible with AMTS and CNPCS ration software
- Co-product feed tables available
Alforex Introduces Hi-Gest 360
Alfalfa with Improved TTNDFD

28 Day Cut System (5 cuts)*

<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>

35 day Cut System (3 cuts)*

<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>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>

Low lignin: higher fiber digestibility
TTNDFD: Tells you how fiber digestibility was improved
TTNDFD: The Take Home Message

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

   A 2-3 unit change in ration TTNDFD corresponds to a 1 pound change in milk yield.

2. The TTNDFD test was developed to predict fiber digestibility in high producing dairy cattle.

   *Can be used across forage types and byproduct feeds*

   *Can be used in ration balancing and evaluation*

   *Is a more accurate measure of forage quality than RFV or RFQ*
TTNDFD Guidelines

• Remember **42%** TTNDFD
  – Corn silage and haylage average!

• **Goal = 48+%**
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, the environment and agriculture for all citizens of the state.