How Fiber Digestibility Affects Forage Quality and Milk Production

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What causes performance swings in dairy diets? MOST OF THE TIME ENERGY

- ✓Diet Energy is impacted largely by carbohydrates
  - ✓ Fiber
  - ✓ Starch
- ✓Fiber is always lower energy than starch (grain)
- ✓ 2-3 unit drop in Fiber or Starch digestibility will decrease milk by about one pound

New Technologies and Innovations in Forage Feeding Programs for Livestock
Digestibility!

Corn Silage
- Shredlage (⇧ starch digestibility)
- BMR (⇧ fiber digestibility)

Alfalfa
- Reduced lignin (⇧ NDF digestibility)

Grasses
- Improved grasses for high producing dairy cows (Higher fiber digestibility than alfalfa or corn silage)

Forage testing/analysis
- Indigestible fiber ($uNDF_{240}$)
- Total Tract NDF digestibility (TTNDFD)

Topic #1. 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

Forage Fiber Tests

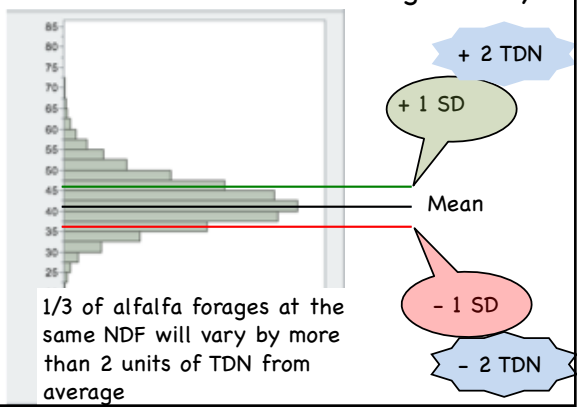
Test	Rumen Fill	TDN Estimation	Diet Formulation	Herd Diagnostics	Quality Index
NDF_{OM}	X	X	X	X	
$NDFD_{(30 \text{ or } 48)}$	X/?	X			X/?
TTNDFD	X	X	X	X	X
$uNDF_{240}$	X				?
NDF kd			X		
RFV/RFQ					X
Milk/ton					X

Fiber digestibility varies in forages

TTNDFD	Range in % of NDF
Alfalfa hay and silage	25-70
Corn silage	25-80
Grass hay and silage	15-80

Two units increase in diet TTNDFD can potentially increase milk yield by 1 lb

How variable is alfalfa fiber digestibility?



1/3 of alfalfa forages at the same NDF will vary by more than 2 units of TDN from average

Why is fiber digestibility important?

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 does fiber digestibility vary? 1: Maturity

	NDF	Lignin	TTNDFD
	% of DM	% of DM	% of NDF
Immature	33	5.4	54
Vegetative	37	6.2	50
Mid-maturity	43	7.3	47
Mature	50	8.4	46

Why does fiber digestibility vary? 2: Growing conditions/environment

- ✓Moisture
- ✓Temperature
- ✓Sun intensity

2/3 or more of variation in fiber digestibility is likely due to growing conditions/environment

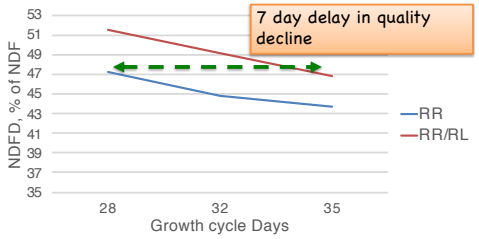
Why does fiber digestibility vary? 3: Genetics: Reduced Lignin Alfalfa

HiGest™ Alforex
HarvXtra™ Forage Genetics International

Why does fiber digestibility vary? 2: Genetics

Variety	Lignin Reduction	Unit reduction (assuming 7% lignin)
HiGest™ (Alforex)	7 to 10%	0.49 to 0.7
HarvXtra™ (FGI)	10 to 15%	0.7 to 1.05

Effect of harvest delay on NDFD, average of 4 cuttings (HarvExtra Alfalfa)



Undersander, 2015

Effect of Low Lignin Trait on Alfalfa ADF and NDF Digestion

Item	Harvest interval	Roundup Ready	Roundup Ready + Low Lignin*	P Value Forage	Harvest interval
ADF	28d	26.6	26.5	NS	NS
	33d	27.2	26.6		
	35d	27.8	26.5		
TTNDFD	28d	52.1	56.3	0.05	0.01
	33d	46.3	51.9		
	35d	46.8	51.1		

+ 8%
+12%
+ 9%

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

Nutrient composition of corn silage stalk hybrids

Item	BMR	CONS	HFD	LFY	SEM	P-value
DM, % as fed	33.7	34.5	35.1	33.2	0.9	0.45
CP, %DM	8.0	7.8	8.1	8.0	0.2	0.20
NDF, %DM	42.3	42.6	45.0	42.3	0.8	0.09
Lignin, %DM	2.0^{b}	2.8^{a}	2.9^{a}	2.6^{a}	0.2	0.001
Starch, %DM	28.7^{ab}	30.1^{a}	26.7^{b}	30.0^{ab}	1.1	0.02

Ferraretto and Shaver, 2013

DMI & Milk Yield greater in BMR/HFD

Item	BMR	CONS	HFD	LFY	SEM	P-value
DMI, kg/d	25.1^{a}	24.0^{b}	24.6^{a}	23.0^{b}	0.5	0.001
Milk, kg/d	38.6^{a}	37.2^{b}	38.1^{a}	37.4^{b}	0.8	0.001
Fat, %	3.55	3.62	3.61	3.64	0.08	0.25
kg milk/kg DMI	1.52	1.54	1.55	1.55	0.03	0.61

Why does fiber digestibility vary? 4: Harvest management

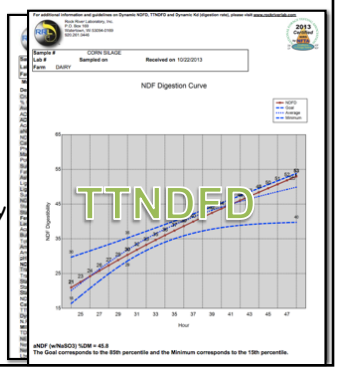
- ✓Moisture (leaf shatter)
- ✓Rain damage
- ✓Respiration losses due to slow dry-down

Fiber in leaves is higher in digestibility than fiber in stems

Using forage analysis to assess quality

Reading Forage Analyses

- ✓Dave's Quick List:
  1. NDF and Starch
  2. Protein
  3. Ash Content
- ✓Evaluate Digestibility
  - ✓ TTNDFD
  - ✓ StarchD



TOPIC # 2: Assessing fiber digestion

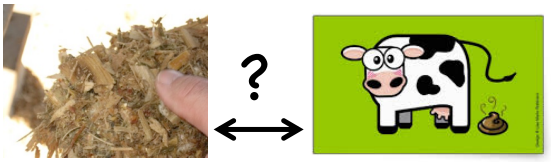
Poor digestion < 40% Excellent digestion > 50%

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

Forage Quality Indicators for High-Producing Dairy Herds

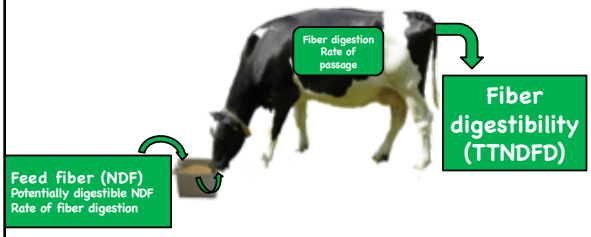
Parameter	Indicates Better Quality	Primary Reason
NDF	↓	↓ Rumen Fill Limitation of DMI Potential for production response or feeding of higher-forage diets
Lignin	↓	
$uNDF_{240}$	↓	
$NDFD_{30}$	↑	
TTNDFD	↑	
NFC	↑	↑ Energy Density Potential for production response or feeding less corn grain
CP	↑	↓ Supplemental Protein
Ash	Minimal Soil Contamination	↑ Energy Density
RFV; RFQ	↑	Quality Index for Ranking

How Can We Equate Feed Fiber Measurements to Animal Utilization of NDF



The Process of fiber digestion is described with the TTNDFD assay

Feed and cow factors both affect fiber digestion



Fiber digestion is affected by:

Feed characteristics

- ✓ The amount of fiber (NDF)
- ✓ Potentially digestible fiber (pdNDF)
  (pdNDF = NDF-$uNDF_{240}$)
- ✓ Rate of fiber digestion (kd)

Animal and diet

- ✓ Intake affects rate of fiber passage (kp)
- ✓ Approx. 90% of NDF digestion is in rumen

How is TTNDFD determined?

Forage sample

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

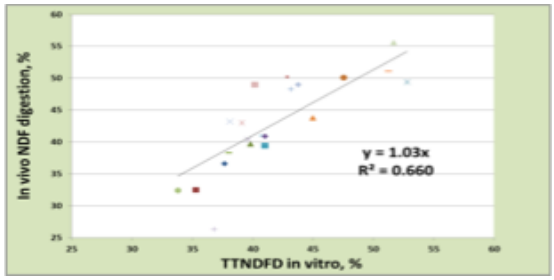
Rate of fiber digestion (kd)
Potentially digestible NDF (pdNDF)

Rumen and hindgut digestion

Rate of fiber passage, (kp)

TTNDFD
(total tract NDF Digestibility)

TTNDFD combines *in vitro* rate of NDF digestion with *iNDF* to improve the prediction of *in vivo* fiber digestion



Lopes et. al. 2015 JDS

Feed Analysis Lab Report
TTNDFD can be quickly and cheaply analyzed by NIRS

TTNDFD is a prediction of NDF digestibility for a feed (or diet) in 650 kg cow consuming 24 kg DM of a 28-30% NDF diet.

TTNDFD	47.98	42.34

Feed Analysis Report

		60 Day RRL Average
aNDF (w/NaSO3)	39.97%	43.78%
Calculations		
TTNDFD	37.10	42.34

Low NDF corn silage (good)

BUT- Lower than average fiber digestibility (bad)

Feed Analysis Report

		60 Day RRL Average
Crude Protein	22.55%	21.80%
aNDF (w/NaSO3)	42.80%	43.09%
Calculations		
TTNDFD	51.37	44.70
Relative Forage Quality	141	
Dynamic NDF Kd (using 24,30,48,120 hr)	11.53%/hr	
Relative feed value	136	

Which is the better Haylage?

		60 Day RRL Average
Crude Protein	20.87%	21.86%
aNDF (w/NaSO3)	42.22%	43.30%
Calculations		
TTNDFD	44.14	44.26
Relative Forage Quality	159	
Dynamic NDF Kd (using 24,30,48,120 hr)	7.72%/hr	
Relative feed value	138	

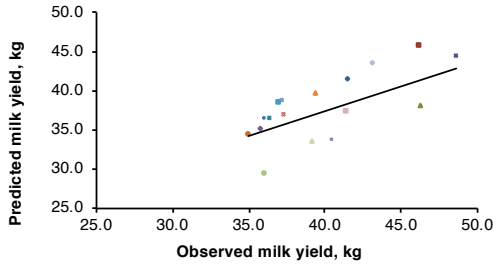
Typical NDF and TTNDFD values

	NDF	Average TTNDFD	High TTNDFD	Low TTNDFD
Alfalfa	< 40%	42%	> 48%	< 36%
Corn Silage	< 40%	42%	> 48%	< 36%
Grasses	< 45%	42%	> 48%	< 36%

Dairy quality alfalfa and corn silages will be < 40% NDF with a TTNDFD value of at least 42%

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

Milk predictions from a model based on NRC equations and TTNDFD as the coefficient for NDF digestibility



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 one 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

Thank You!

Visit our Web sites:
http://dysci.wisc.edu/
http://fyi.uwex.edu/forage/