

Is it better for forages to be more digestible or to digest more quickly?

Dave Combs
Professor

Department of Dairy Science
University of Wisconsin – Madison.



College of
Agricultural & Life Sciences
UNIVERSITY OF WISCONSIN-MADISON

What makes a better forage?

- ✓ High digestibility
 - ✓ Grain (+)
 - ✓ Fiber (-)
 - ✓ Fiber digestibility (+)
- ✓ High intake potential
 - ✓ Fiber (-)
 - ✓ Fiber digestibility (+)



BOTH NDF and NDF digestibility are needed to assess forage quality



College of
Agricultural & Life Sciences
UNIVERSITY OF WISCONSIN-MADISON

New Technologies and Innovations in Forage Feeding Programs for Dairy Cattle

Corn Silage

Shredlage (↑ starch digestibility)

Improving fiber digestibility (BMR)

Alfalfa

Low lignin

Grasses

Improved grasses for high producing dairy cows

Forage testing/analysis

Amount of fiber (NDF)

Indigestible fiber (uNDF_{240})

Rate of fiber digestion (kd)



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.

Forages can differ greatly in fiber digestibility

	Range in TTNDFD	
	Avg	% of NDF
Alfalfa hay and silage	42%	25-70
Corn silage	42%	25-80
Grass hay and silage	44%	15-80

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



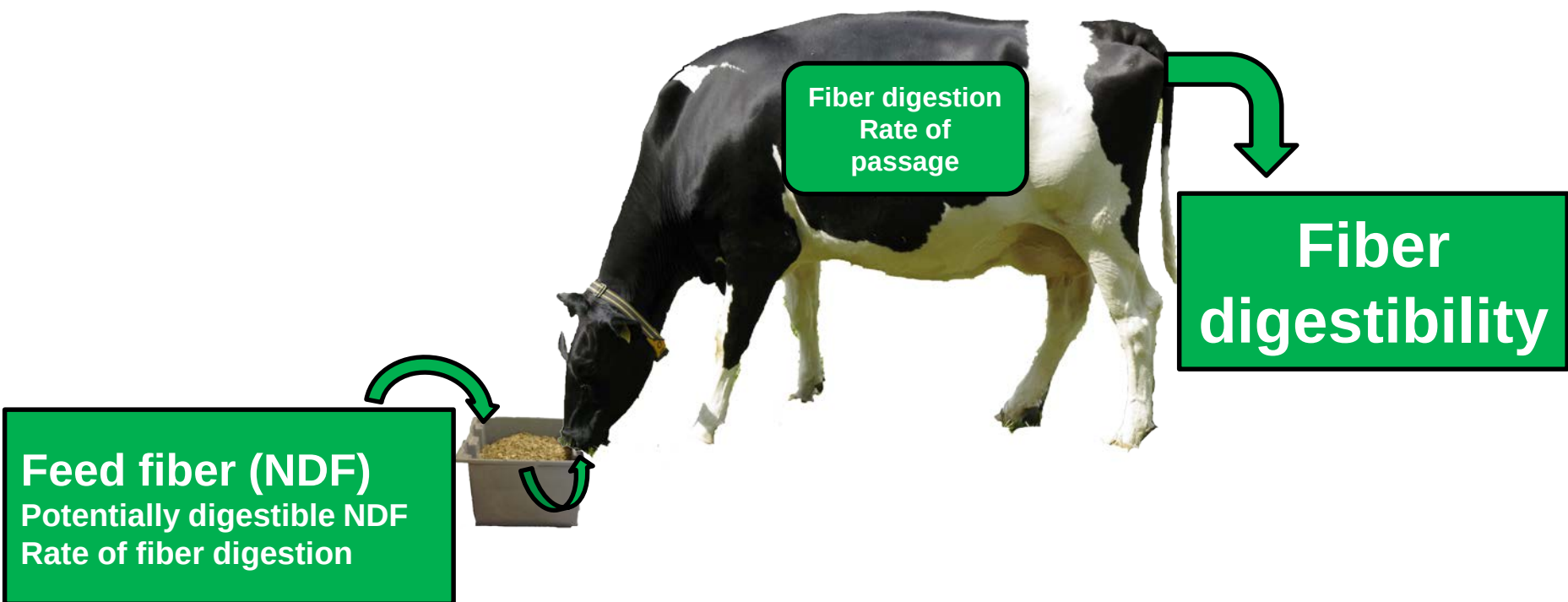
The 'Alphabet Soup' Forage Fiber Tests

Test	Rumen Fill	TDN Estimation	Diet Formulation	Herd Diagnostics	Quality Index	Agronomy Trials
NDF _{OM}	X	X	X	X		
NDFD _(30 or 48)	X	X			X	X
TTNDFD	X	X	X	X	X	X
uNDF ₂₄₀	X		X	X		
NDF kd			X			
RFQ					X	X
Milk/ton					X	X



The Process of Fiber Digestion

Feed and cow factors both affect fiber digestion



Fiber digestion is affected by:

Feed characteristics

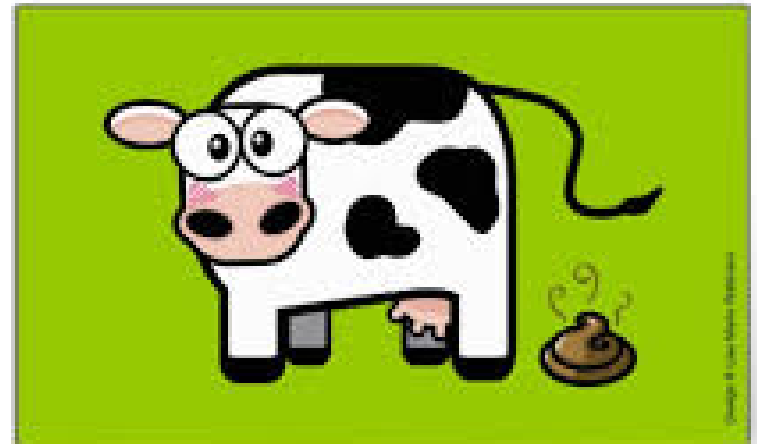
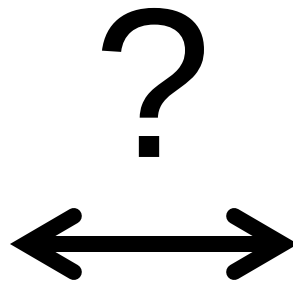
- ✓ The amount of fiber (NDF, or NDF_{om})
- ✓ Potentially digestible fiber (pdNDF)
(pdNDF = NDF - uNDF₂₄₀)
- ✓ Rate of fiber digestion (kd)

Animal and diet

- ✓ Intake affects rate of fiber passage (kp)



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



The Math:

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

- ✓ $\text{pdNDF} = (\text{NDF} - \text{uNDF}_{240})$
- ✓ $\text{Kd} = \text{Digestion rate of the fiber (kd)}$
- ✓ $\text{kp pdNDF} = \text{Passage rate of the digestible fiber}$

TTNDFD is a measure of fiber digestion that accounts for pdNDF, kd and kp



Typical TTNDFD values of forages harvested in 2015

Forage	aNDF	TTNDFD	range in TTNDFD*
Corn silage	41.0	40	30 to 50
Alfalfa silage	41.0	43	30 to 54
Grass silage	52.4	51	31 to 71
Grass hay	61.1	45	24 to 65

* mean value $\pm$ 2 standard deviations

Samples submitted to Rock River Laboratories in 2015 and 2016

Variation in iNDF and kd of forages harvested in 2015

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

* mean value $\pm$ 2 standard deviations

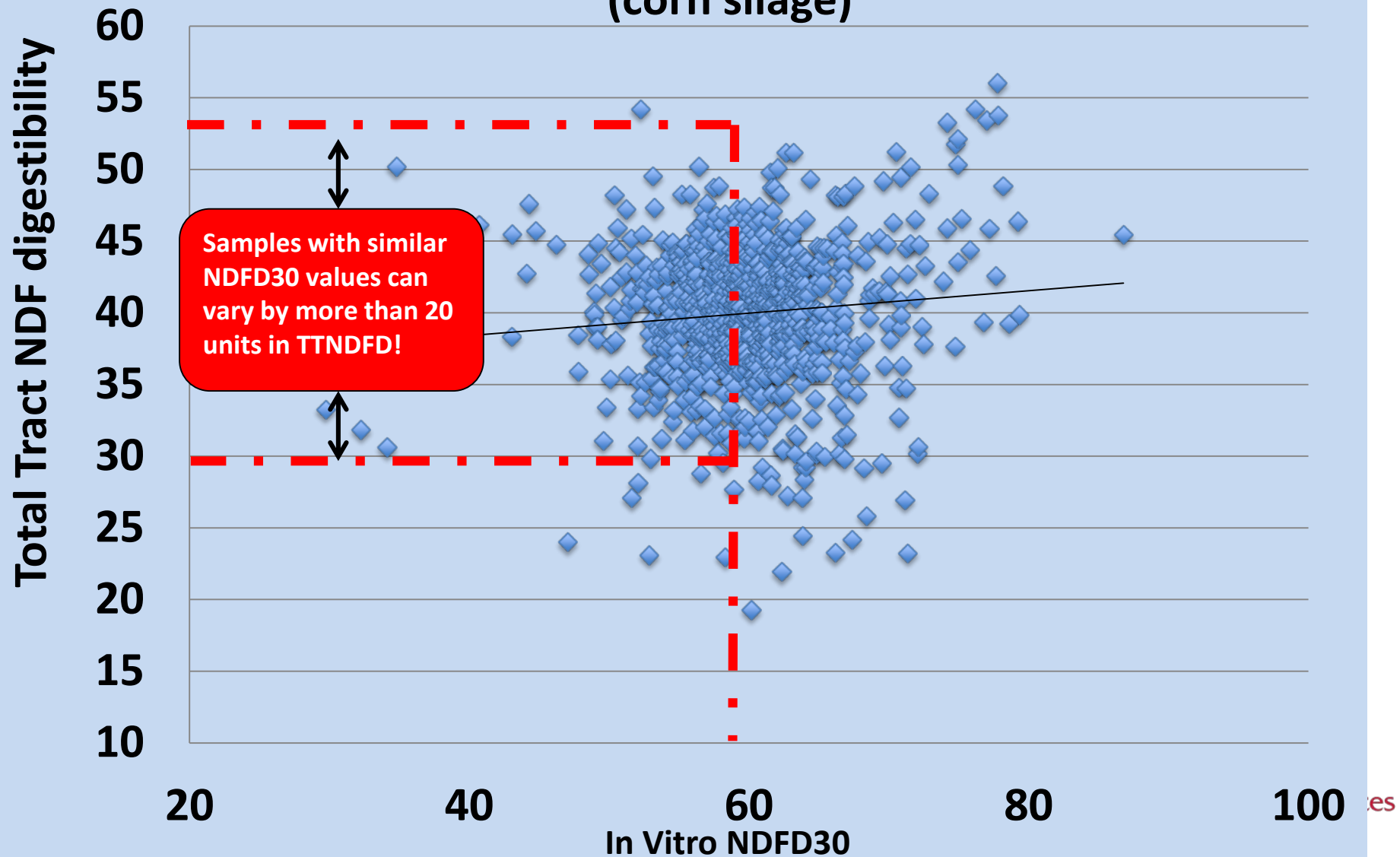
Samples submitted to Rock River Laboratories in 2015 and 2016

The proportion of iNDF and rate of fiber digestion (kd) vary in forages



College of
Agricultural & Life Sciences
UNIVERSITY OF WISCONSIN-MADISON

**A single time point in vitro NDFD value is poorly correlated with TTNDFD
(corn silage)**



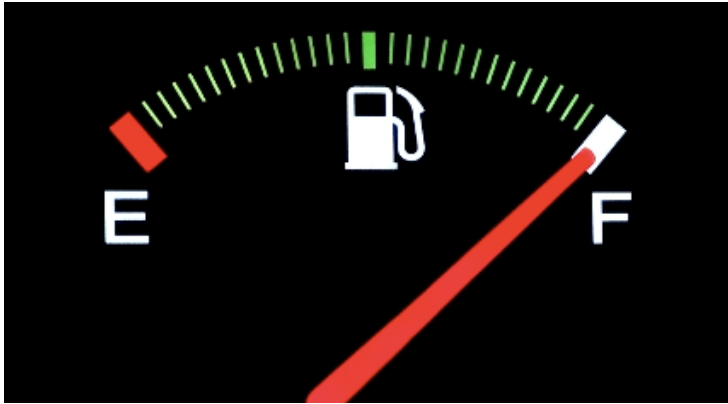
Can the in vitro TTNDFD test detect a difference in fiber digestibility as ratios of corn silage (36% TTNDFD) and alfalfa(42% TTNDFD) change in the ration?

Corn silage:alfalfa ratio	100CS 0AS	67CS 33AS	33CS 67AS	0CS 100AS	
					SE
DMI, lb/d	55 ^{ab}	56 ^a	54 ^b	48 ^c	0.8
4% FCM, l/d	80	78	77	79	0.9
Observed TTNDFD, in vivo	38.3^a	40.9^{ab}	39.4^{ab}	43.8^a	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

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)
AND

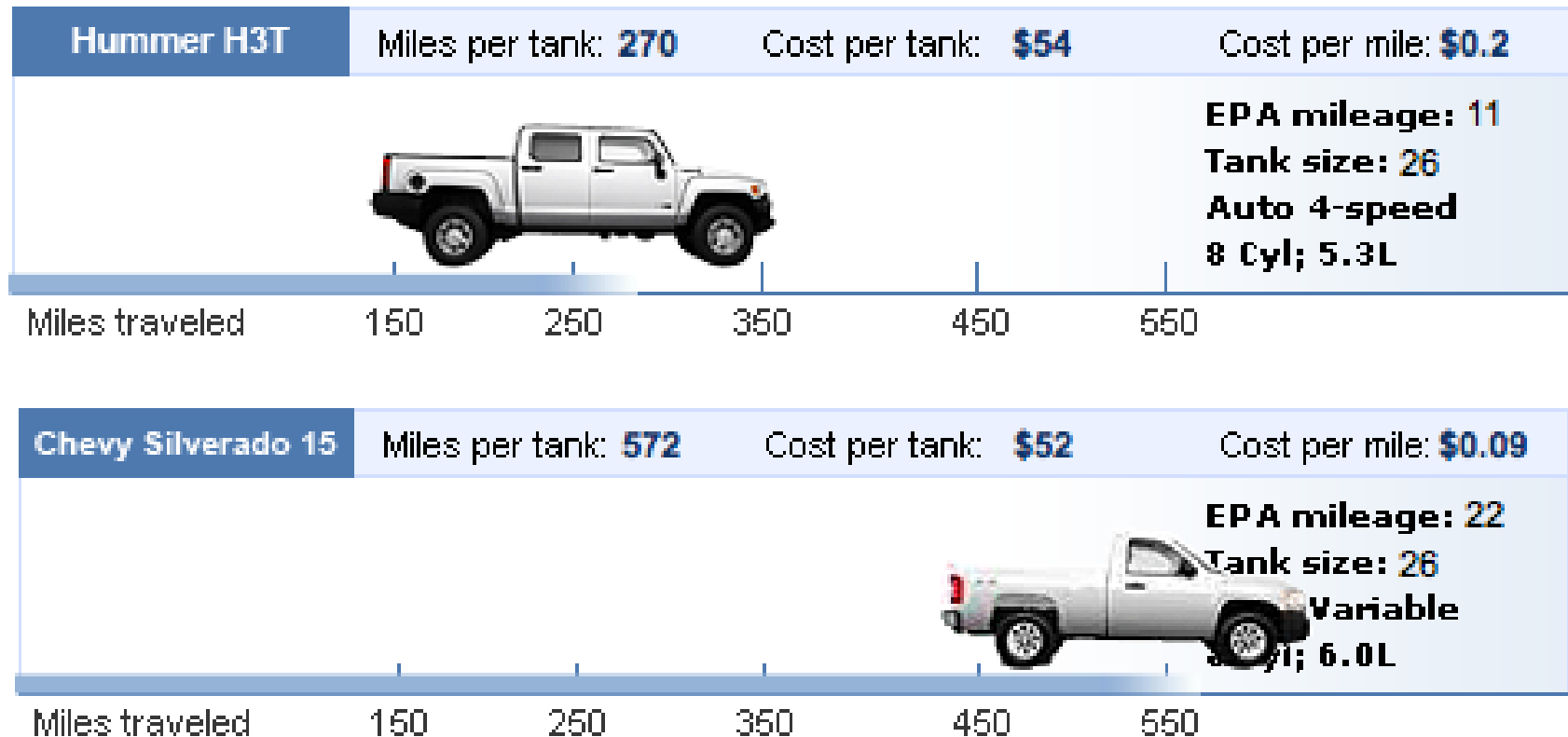
The miles traveled per gallon (kd)

HOW much milk your forage will make depends on the amount of potentially digestible fiber AND the rate of fiber digestion!



College of
Agricultural & Life Sciences
UNIVERSITY OF WISCONSIN-MADISON

Measuring fiber quality is like calculating how far you can drive ...



Monitoring only indigestible fiber is like looking at the fuel gauge...



Hummer H3T

Miles per tank: **270**

Cost per tank: **\$54**

Cost per mile: **\$0.2**



EPA mileage: 11

Tank size: 26

Auto 4-speed

8 Cyl; 5.3L

Miles traveled

150

250

350

450

550



Chevy Silverado 15

Miles per tank: **572**

Cost per tank: **\$52**

Cost per mile: **\$0.09**



EPA mileage: 22

Tank size: 26

Variable

8 Cyl; 6.0L

Miles traveled

150

250

350

450

550



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%		60 Day RRL Average
aNDF	42.6%	TTNDFD	21.80%
			43.09%

aNDF

42.6%

TTNDFD

Calculations

TTNDFD	51.37		44.70
Relative Forage Quality	141	51.4	
Dynamic NDF Kd (using 24,30,48,120 hr)	11.53%/hr		
Relative feed value	136		

Relative Forage Quality

141

51.4

Dynamic NDF Kd (using 24,30,48,120 hr)

11.53%/hr

Relative feed value

136

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

Crude Protein	20.87%		60 Day RRL Average
aNDF	42.2%		21.86%
			43.30%

aNDF

42.2%

TTNDF

44.14

44.1

Relative Forage Quality

159

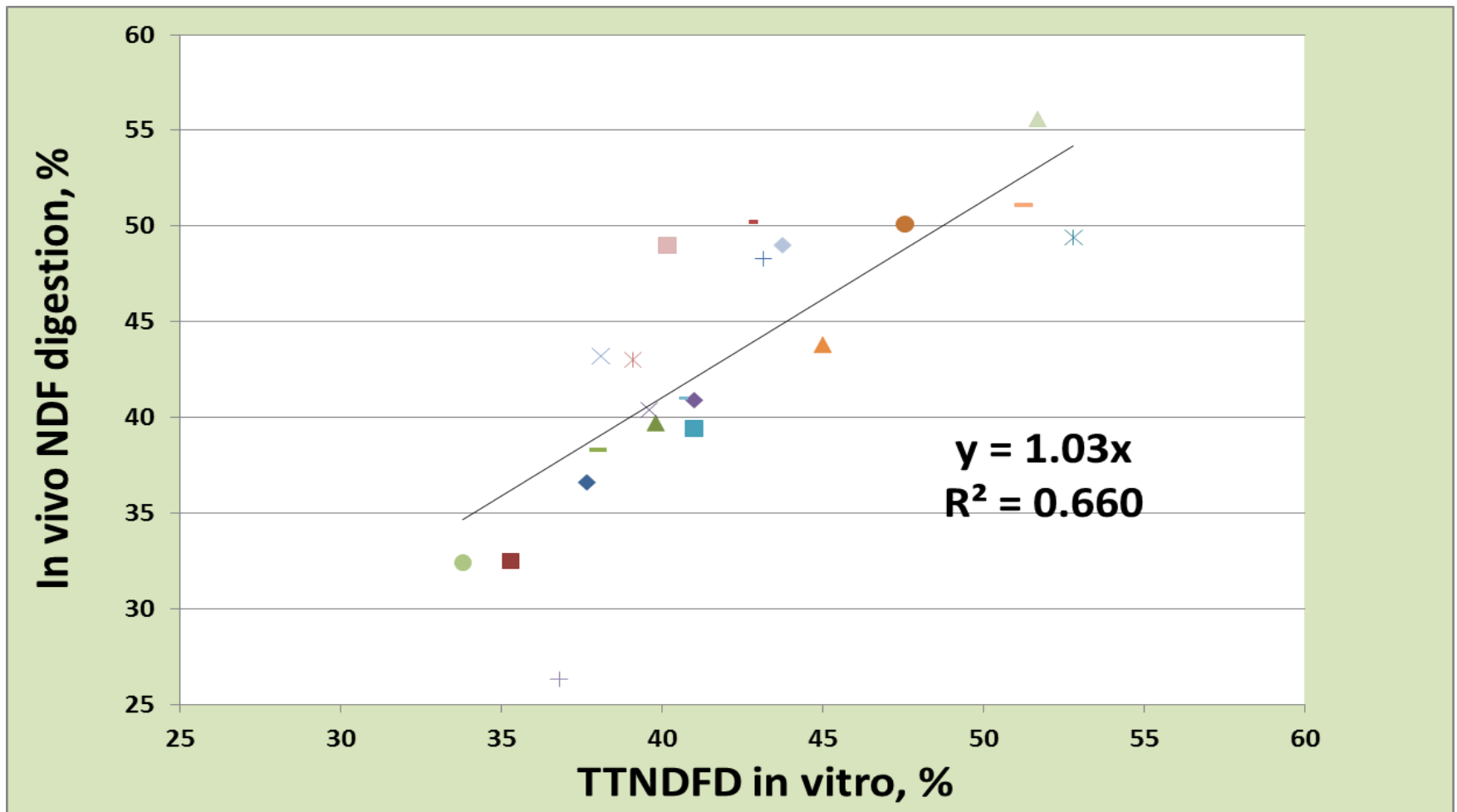
Dynamic NDF Kd (using 24,30,48,120 hr)

7.72%/hr

Relative feed value

138

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



Quiz Time: Is it better for forages to be more digestible or to digest more quickly?

- A. More digestible
- B. More quickly digested
- C. All of the above



Quiz Time: Is it better for forages to be more digestible or to digest more quickly?

- A. More digestible
- B. More quickly digested
- C. All of the above

Answer: C. All of the above

To evaluate forage fiber utilization you need to know pdNDF, kd and kp!

$$\text{Fiber digestibility} = \text{pdNDF} \times \frac{kd}{(kd + kp)}$$



Use TTNDFD to Evaluate Fiber Digestibility

- ✓ Remember **42%** TTNDFD
 - ✓ Corn silage and haylage average!
 - ✓ Grasses have higher TTNDFD values!
- ✓ **Diet Goal = 48+%**



Typical dietary profiles for high producing dairy cows

Item

NDF, % of DM 28-30

TTNDFD, % of NDF > 42%

Starch, % of DM 21-28

Starch Digestibility, % of starch >95%

CP, % of DM 16-18% *

Fat, % of DM 3-7%



Take-home message

1. Fiber digestibility has a big impact on milk yield.
2. NDFD values are poor indexes of fiber quality
3. Fiber digestion is affected by feed characteristics (pdNDF and kd) and the animal (kp, rumen vs hindgut digestion). ALL NEED TO BE CONSIDERED to assess fiber quality.
4. TTNDFD is the only measure that directly predicts fiber digestibility without a ration formulation.





*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.*

Dairy Starts Here.

University of Wisconsin
Department of Dairy Science

