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

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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

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)

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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

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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		
$NDFD_{(30 \text{ or } 48)}$	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

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The Process of Fiber Digestion

Feed and cow factors both affect fiber digestion

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Fiber digestion is affected by:

Feed characteristics

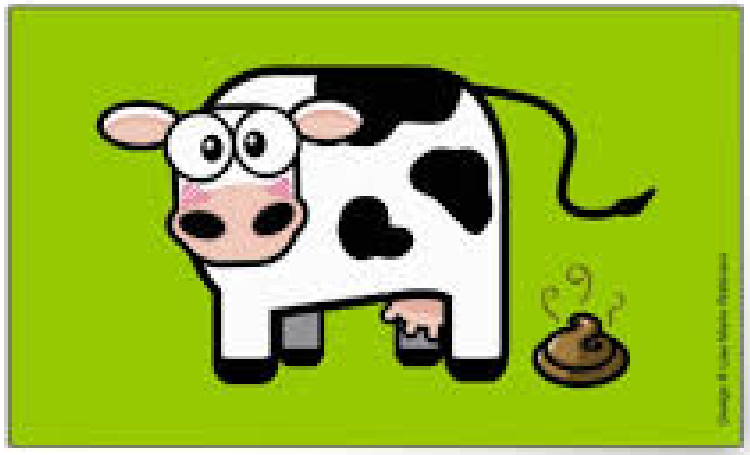
- ✓ The amount of fiber (NDF, or NDF_{om})
- ✓ Potentially digestible fiber (pdNDF)
  (pdNDF = NDF-$uNDF_{240}$)
- ✓ Rate of fiber digestion (kd)

Animal and diet

- ✓ Intake affects rate of fiber passage (kp)

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

?



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The Math:

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

- ✓ pdNDF = (NDF – $uNDF_{240}$)
- ✓ Kd = 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

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 ± 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 ± 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

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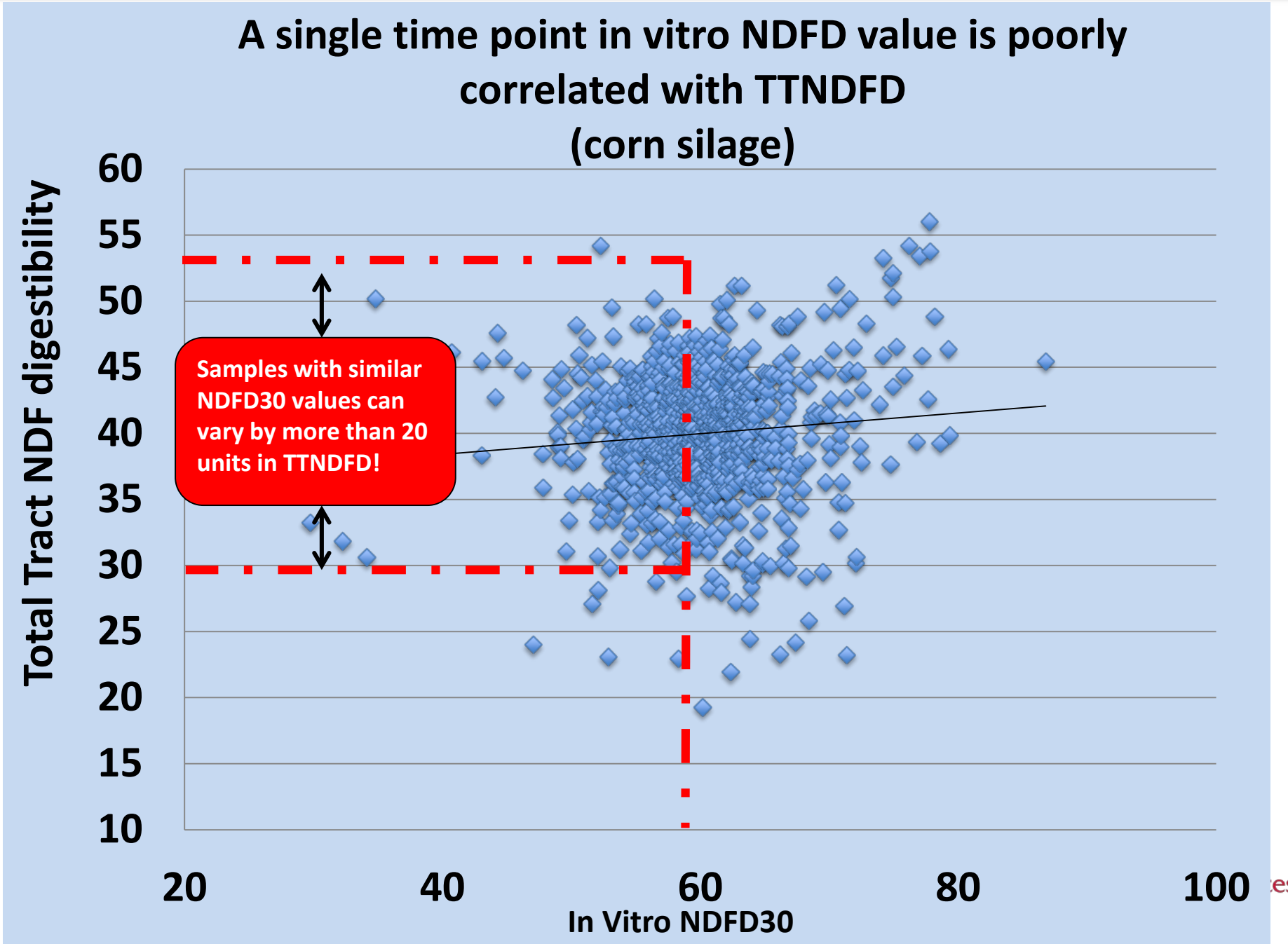
A single time point in vitro NDFD value is poorly correlated with TTNDFD (corn silage)
Total Tract NDF digestibility
60
55
50
45
40
35
30
25
20
15
10
Samples with similar NDFD30 values can vary by more than 20 units in TTNDFD!
20
40
60
80
100
In Vitro NDFD30

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!

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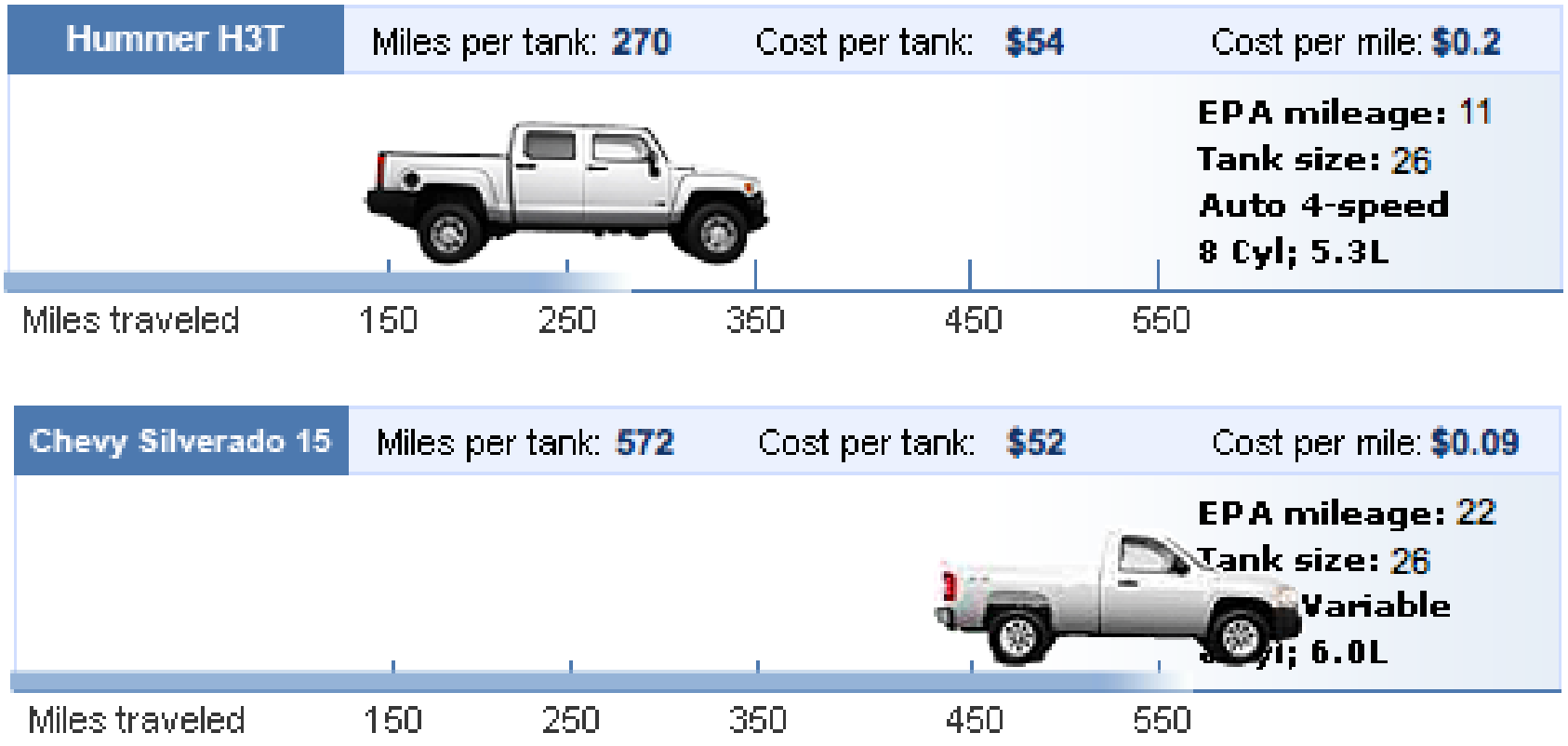
Measuring fiber quality is like calculating how far you can drive …



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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
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	60 Day RRL Average
Crude Protein	22.55%	21.80%
aNDF	42.6%	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	

aNDF

TTNDFD

51.4

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

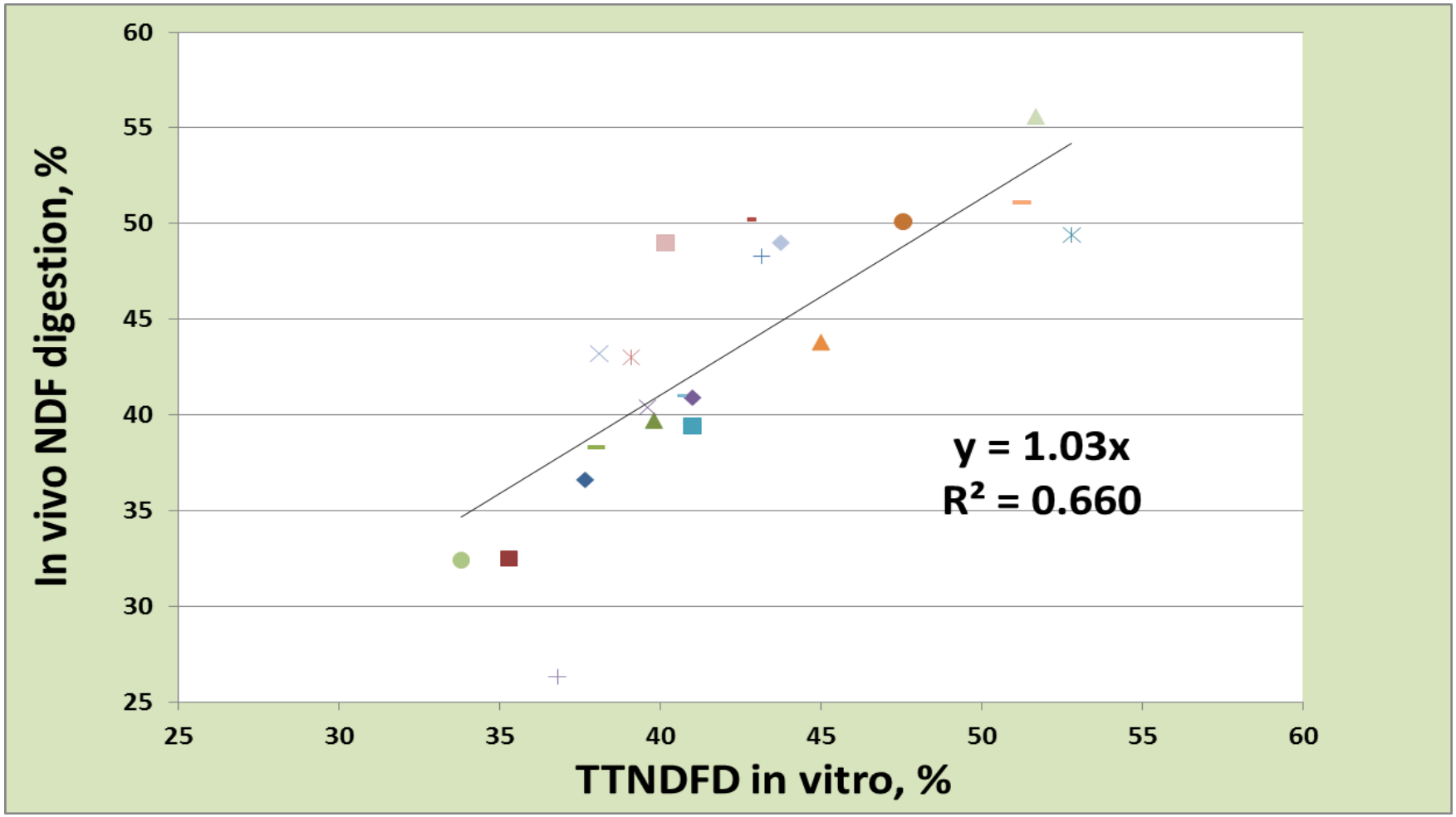
Moisture 69.47% **Dry Matter** 30.53%

Description (%DM unless specified)	Dry Matter Basis	60 Day RRL Average
Crude Protein	20.87%	21.86%
aNDF	42.2%	43.30%
TTNDF	44.14	44.26
Relative Forage Quality	159	
Dynamic NDF Kd (using 24,30,48,120 hr)	7.72%/hr	
Relative feed value	138	

44.1

D

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

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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+%**

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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%

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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.

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