Connecting the dots between corn silage digestibility, cow performance and feeding behavior

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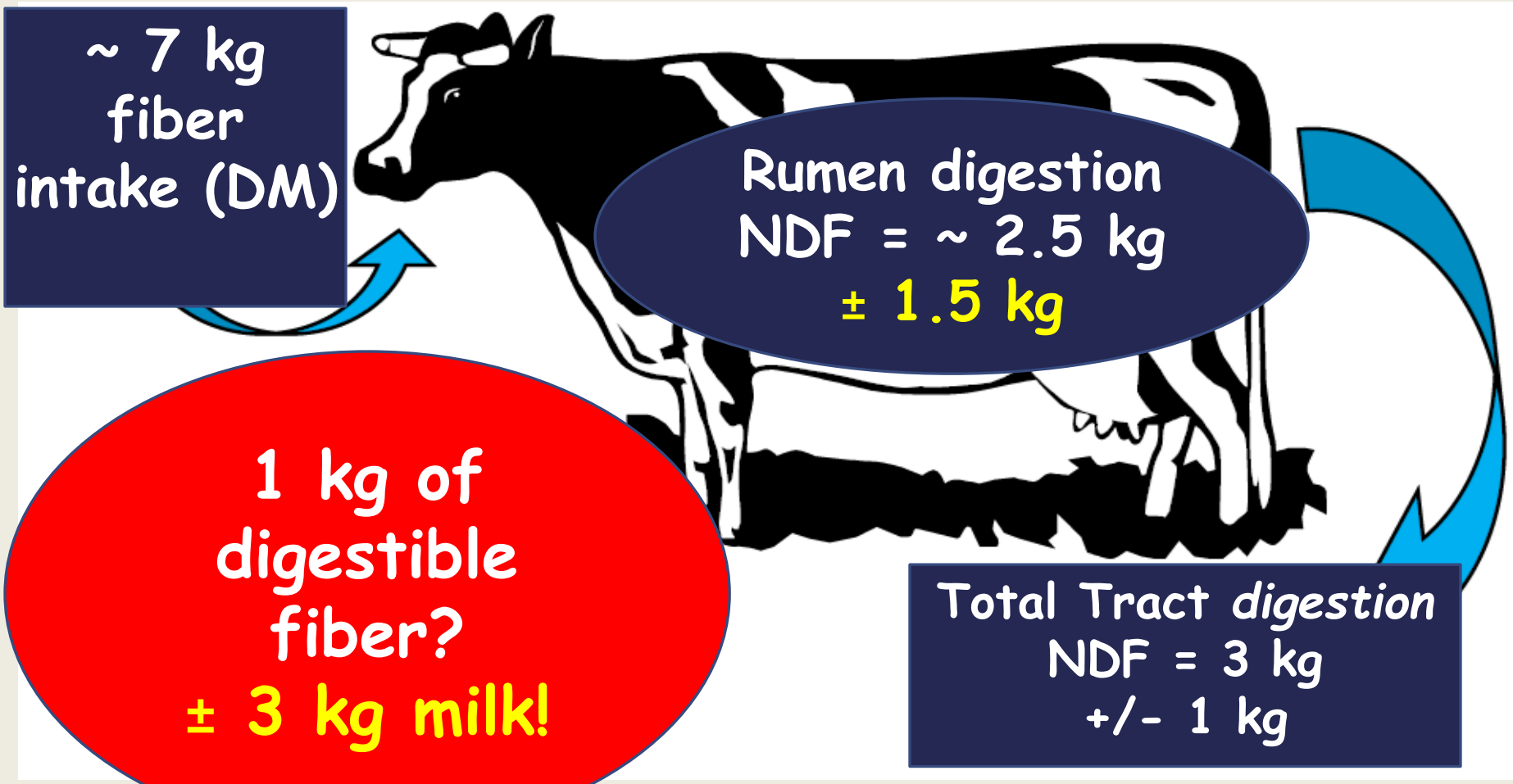
Objectives

- Review indicators of corn silage fiber digestibility
- Discuss strategies to improve digestibility
- Connect forage quality and cow performance and feeding behavior

Speaking "Fiber"



Adapted from slide courtesy of Dr. John Goeser, RRL

US Corn Silage Fiber Quality Summary

Parameter	Indicates Better Quality	n	Normal Range
NDF (% DM)		384,715	36 - 46
Lignin (% DM)	↓	344,134	3 - 4
$uNDF_{240}$ (% DM)	↓	81,418	8 - 13
$NDFD_{30}$ (% NDF)	↑	170,634	48 - 60
TTNDFD (% NDF)	↑	27,954	36 - 46

Summary of combined multi-year, multi-lab (CVAS, DairyOne, RRL, DLL) data, except TTNDFD only from RRL

Adapted from slide courtesy of Dr. Randy Shaver, UW-Madison

Fiber Quality Indicators

Indicator
NDF (% DM)
Lignin (% DM)
$uNDF_{240}$ (% DM)
$NDFD_{30}$ (% NDF)
TTNDFD (% NDF)

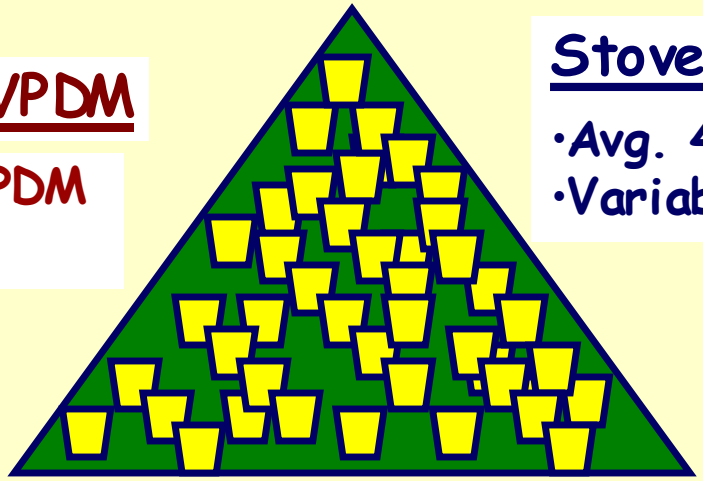
Practical Implication
▪ Intake limitation through rumen fill ▪ Impact milk yield and the establishment of high-forage diets

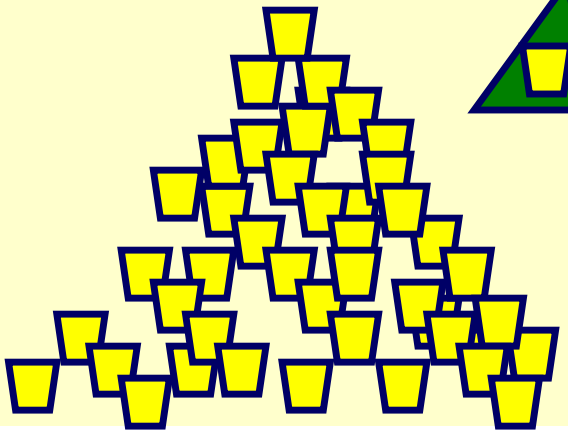
Methods vary across laboratories and may include calculation of pools and rates of digestion.

Whole-Plant Corn Silage

Grain ~40-45% of WPDM

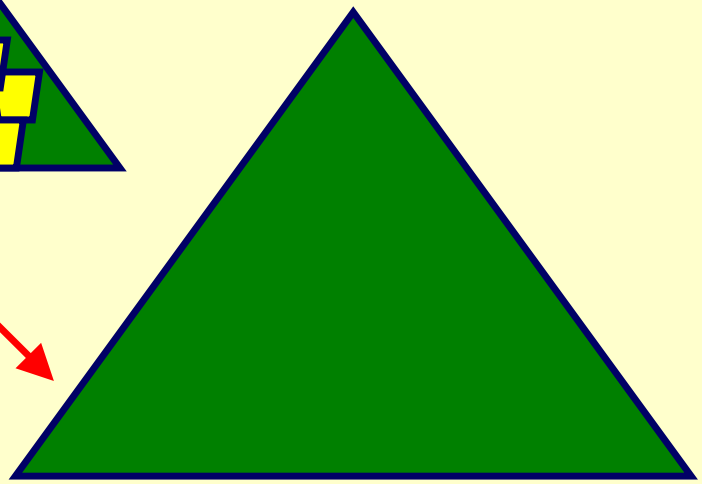
- Avg. 30% starch in WPDM
- Variable grain:stover





Stover= ~55-60% of WPDM

- Avg. 42% NDF
- Variable stover:grain



80 to 98% StarchD

- Kernel particle size
- Duration of silage fermentation
- Kernel maturity
- Endosperm properties
- Additives

40 to 70% IVNDFD

- Lignin/NDF
- Hybrid Type
- Maturity
- Additives

Variable peNDF as per chop length

Adapted from Joe Lauer, UW Madison Agronomy Dept.

Forage NDF digestibility and cow performance

For every 1 percentage-unit increase in NDF digestibility

- +181 g/d DMI
- +250 g/d 4%FCM

(Oba and Allen, 1999)

>40% corn silage in diet

- +118 g/d DMI
- +141 g/d 3.5%FCM

(Jung et al., 2010)

Adapted from slide courtesy of Dr. Rick Grant, Miner Institute

Fiber digestibility and chewing behavior

Study	Intake	Eating time
Grant et al., 1994	88.3	120.7
Aydin et al., 1999 Exp. 1	85.0	117.9
Aydin et al., 1999 Exp. 2	95.6	105.6
Oliver et al., 2004	95.5	114.9

Data presented as percentage of control treatment

Grant and Ferraretto, 2018; JDS

Particle Size

Penn State
Shaker Box

UEM CS Particle Size Trial

- **Treatments:**

  CON – 17% NDF from CS

  <8mm – 17% NDF from CS + 9% NDF from CS <8mm

  8-19mm – 17% NDF from CS + 9% NDF from CS 8-19mm

  >19mm – 17% NDF from CS + 9% NDF from CS >19mm

Piran Filho et al., 2022; ADSA Abstract

Diet nutrient composition

Nutrient, % DM	CON	<8mm	8-19mm	>19mm
DM, % as fed	47.1	45.6	46.5	47.5
CP	15.9	15.9	16.1	16.0
NDF	31.9	37.9	38.3	38.8
Starch	31.5	25.9	25.5	24.9
uNDF	6.43	8.49	8.33	8.12
Forage NDF	17.0	25.3	25.2	25.3
NDF >8mm	12.5	12.2	20.3	20.5
NDF >19mm	1.9	2.1	2.1	8.6

Piran Filho et al., 2022; ADSA Abstract

Performance

Item	CON	<8mm	8-19mm	>19mm	P-value
DMI, lb/d	46.0^{b}	47.7^{ab}	49.5^{a}	46.9^{b}	0.05
Milk, lb/d	57.5^{ab}	58.1^{ab}	59.2^{a}	54.8^{b}	0.05
ECM, lb/d	54.6^{b}	57.0^{ab}	59.4^{a}	54.8^{b}	0.04
Milk fat, %	3.18^{b}	3.43^{ab}	3.62^{a}	3.46^{ab}	0.01
Milk protein, %	3.37	3.27	3.28	3.30	0.30
MUN, mg/dL	10.3	11.2	11.5	12.1	0.07

Piran Filho et al., 2022; ADSA Abstract

Other measurements

Item	CON	<8mm	8-19mm	>19mm	P-value
Eating time, min/d	221	235	256	232	0.13
Rumination time, min/d	383^{b}	424^{ab}	462^{a}	425^{ab}	0.04
Diet NDF sorting, %	98.9^{a}	99.0^{a}	97.8^{a}	95.6^{b}	0.01
Rumen pH	5.85^{b}	6.07^{a}	6.12^{a}	6.12^{a}	0.01
Rumen pH <5.8, h/d	11.1^{a}	3.4^{b}	2.5^{b}	3.0^{b}	0.01
Plasma LPS, EU/ml	0.18^{a}	0.17^{a}	0.03^{b}	0.03^{b}	0.01

Piran Filho et al., 2022; ADSA Abstract

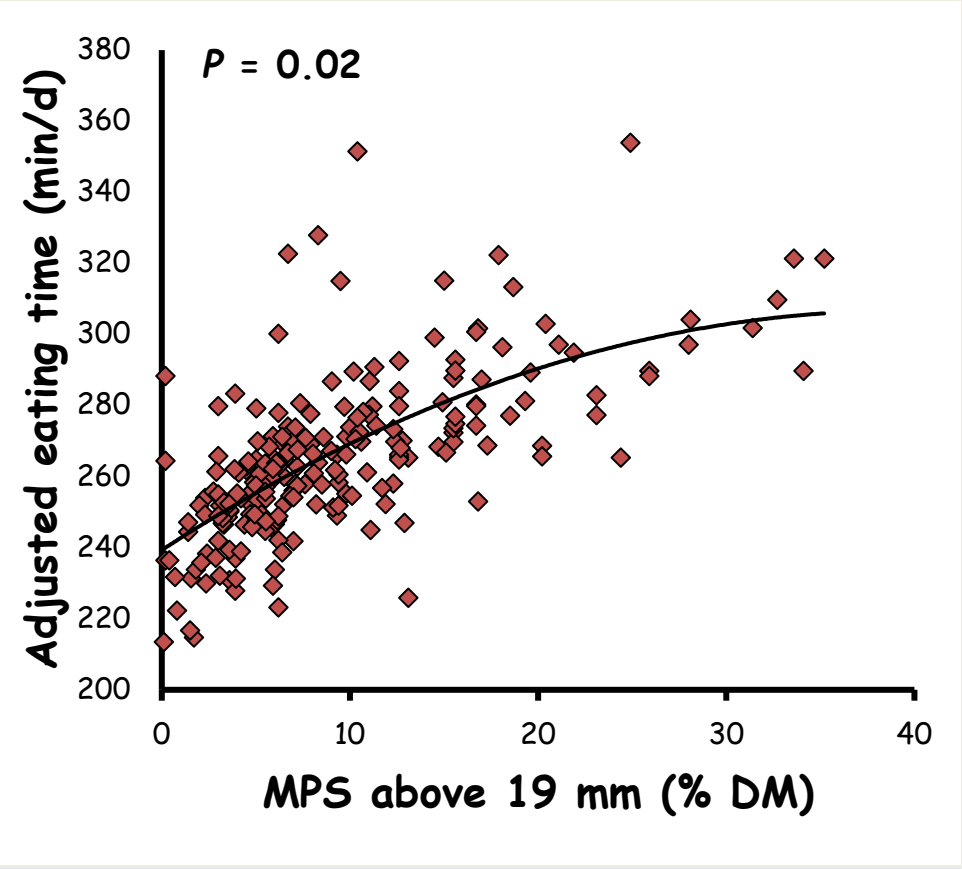
Effect of diet mean particle size above 19 mm on performance

Parameter[1]	Intercept	Slope	n	*P*-value
DMI (kg/d)	29.1	-0.08	219	0.09
Milk (kg/d)	44.6	-0.13	196	0.07
ECM (kg/d)	47.1	-0.17	196	0.06
Milk fat (%)	-	-	196	0.12
Milk protein (%)	-	-	196	0.55

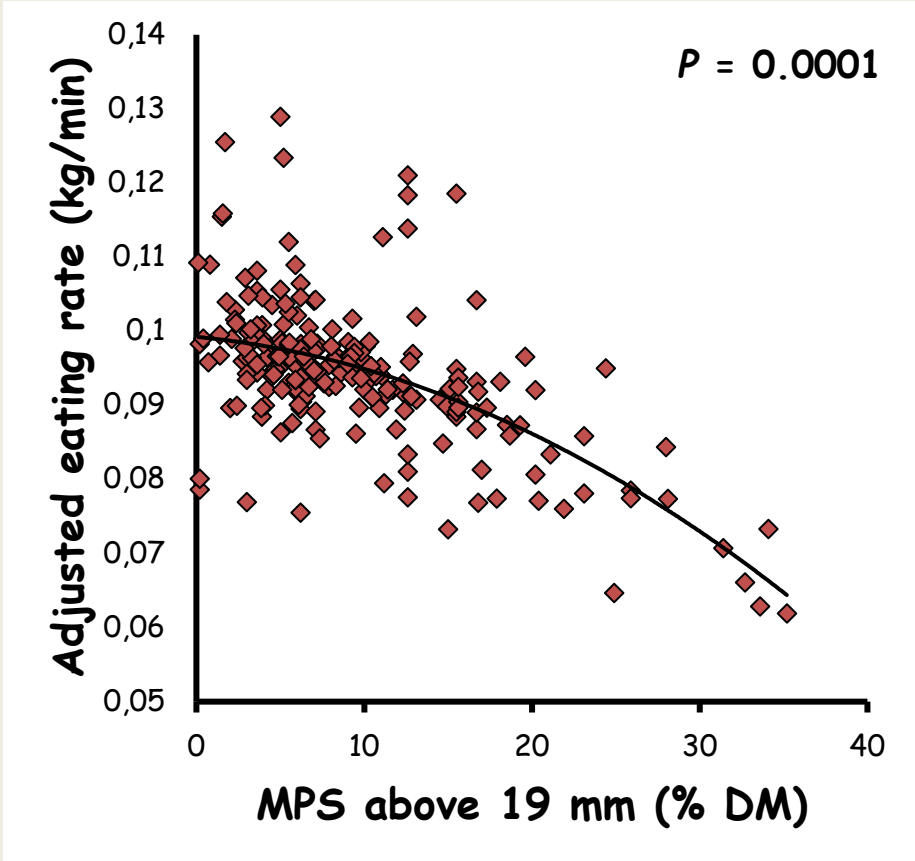
[1]DMI: Dry matter intake (kg/d); ECM = energy-corrected milk

Pupo et al.; unpublished

Diet mean particle size above 19 mm (% DM) and feeding behavior



$y = 236.09 + 3.87x - 0.06x^2$; n = 219



$y = 0.10 + 0.001x - 0.0001x^2$; n= 219

Pupo et al.; unpublished

Particle Size

Sieve	PSPS 2013, % DM	Miner Institute 2017, % as fed	Why does it matter?
19 mm	2 -8	2 -5	Sortable particles, may affect eating time and rate
8 mm	30 – 50	> 50	Physically effective fiber
4 mm	10 – 20	10 – 20	May provide physical effective fiber
Pan	30 - 40	25 - 30	If feeding 40-50% concentrate, this value will likely be 25-30%

Adapted of Grant and Cotanch, 2023; AAS


9.0%
21.4%
27.3%
5.61mm
1.65mm
Pan
8.98mm
18mm
26.9mm
28.1%
13.3%
1.0%


8h after morning feeding / 2-3h after bins were topped off
9.0%
5.61mm
20.0%
1.65mm
22.5%
Pan
8.98mm
31.9%
18mm
14.7%
26.9mm
1.9%

Proper processing and maturity at harvest are key for particle size and nutritive value

Conclusions

- Forage particle size and digestibility drive performance and modulate feeding behavior patterns
- More digestible corn silage increase intake and allow for the establishment of high-forage diets
- Replacing corn silage fiber with a non-forage fiber source increased intake, but not ECM, and reduced IOFC

Questions

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Ferraretto Lab™