The Importance of Fiber Quality and Starch Content for Nutrient Value of Corn Silage

Florida/Georgia Forage Day

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Increasing Forage Intake

(60 to 70%Total DMI)

- Reduce feed costs
- Sustainable on-farm resource
- Quality controlled by the dairy manager
- Healthy rumen environment
- Selection of high yield & high NDF digestible forage hybrids
- Reduce cereal grain use (human and fuel competition)

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

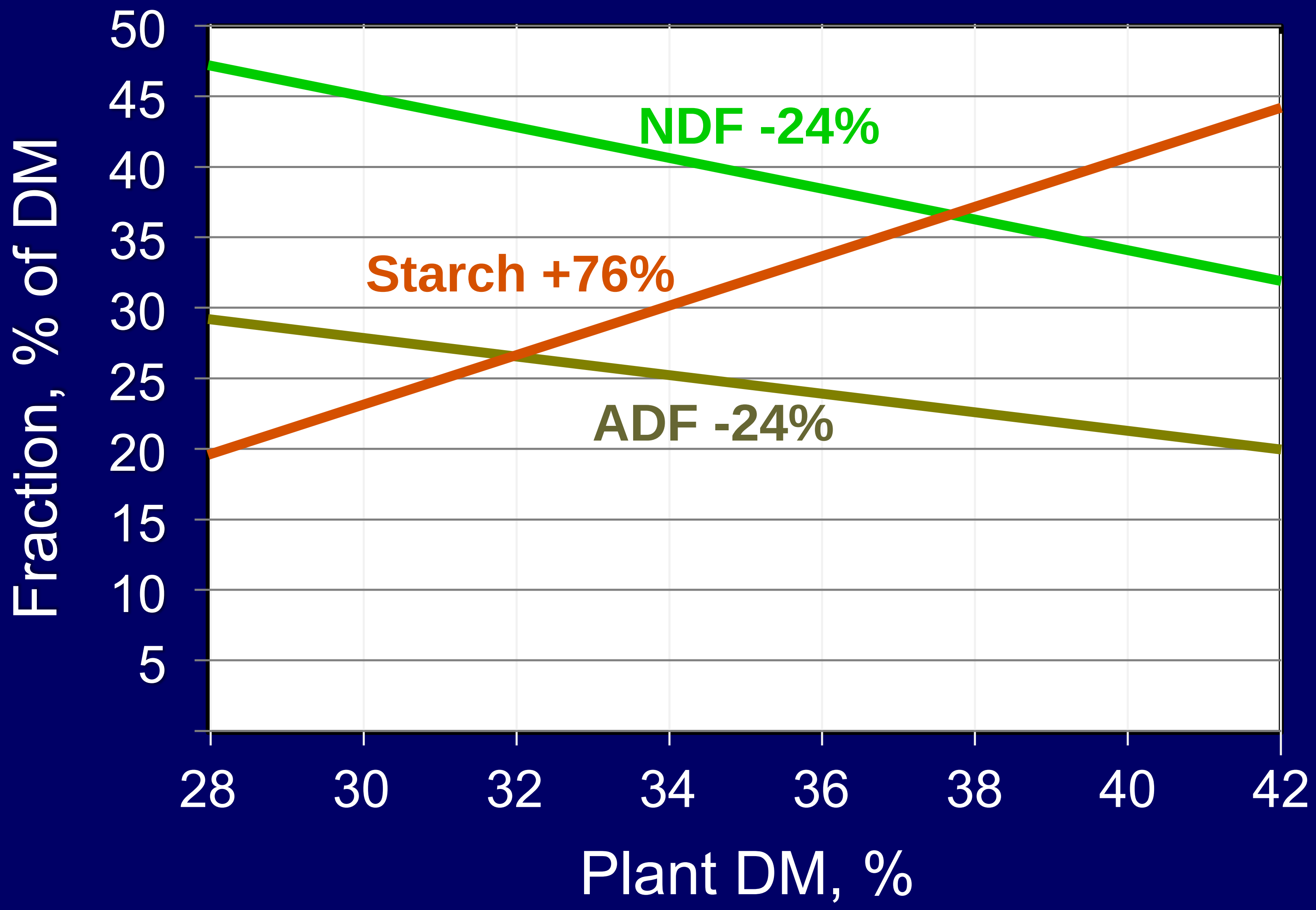
- Lignin/NDF
- Hybrid Type
- Maturity
- Additives

Variable peNDF as per chop length

Adapted from Joe Lauer, UW Madison Agronomy Dept.

Plant Dry Matter vs. Composition

Plant Composition 2008



Pioneer-ISU Collaborative Field Study

Using the Forage NDFD or uNDF

Forage NDF digestibility and cow performance

For every 1 percentage-unit increase in NDF digestibility

- +0.40 lb/d DMI
- +0.55 lb/d 4%FCM

(Oba and Allen, 1999)

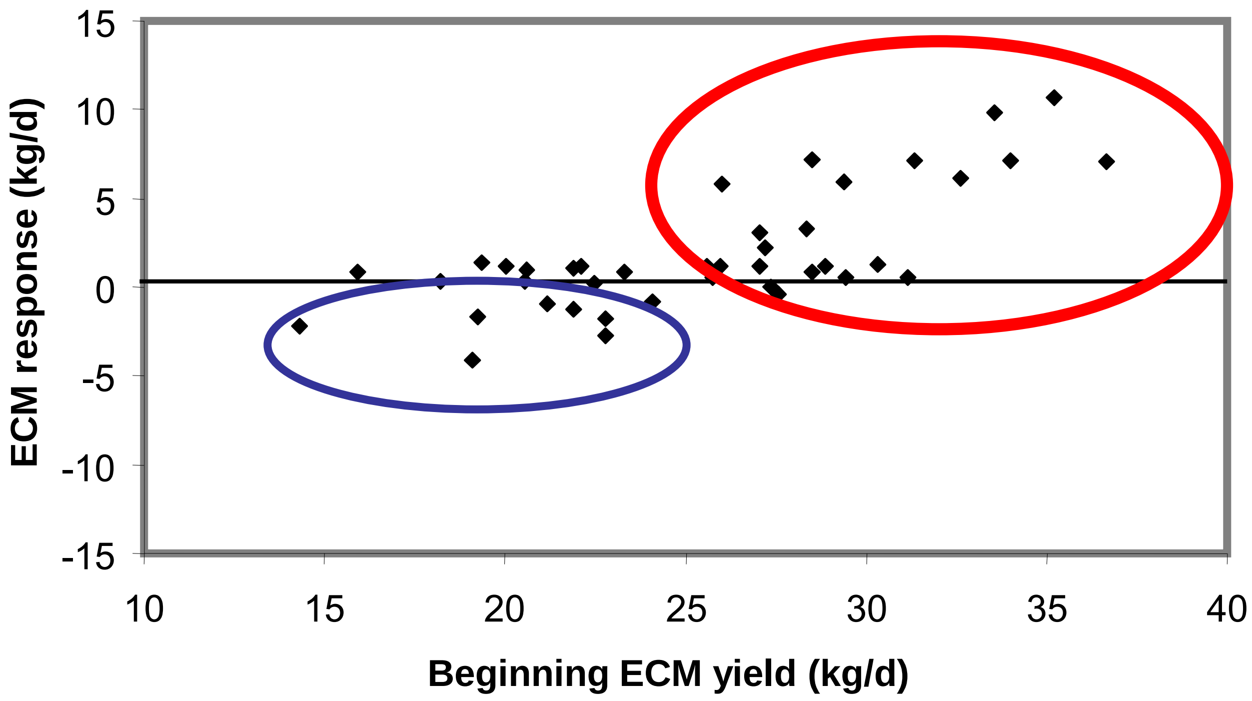
>40% corn silage in diet

- +0.26 lb/d DMI
- +0.31 lb/d 3.5%FCM

(Jung et al., 2010)

Response to high-NDFD corn silage by milk production level (Ivan et al., 2004)

✓ **Overall, DMI increased by 1.4 lb/d and milk by 2.0 lb/d**

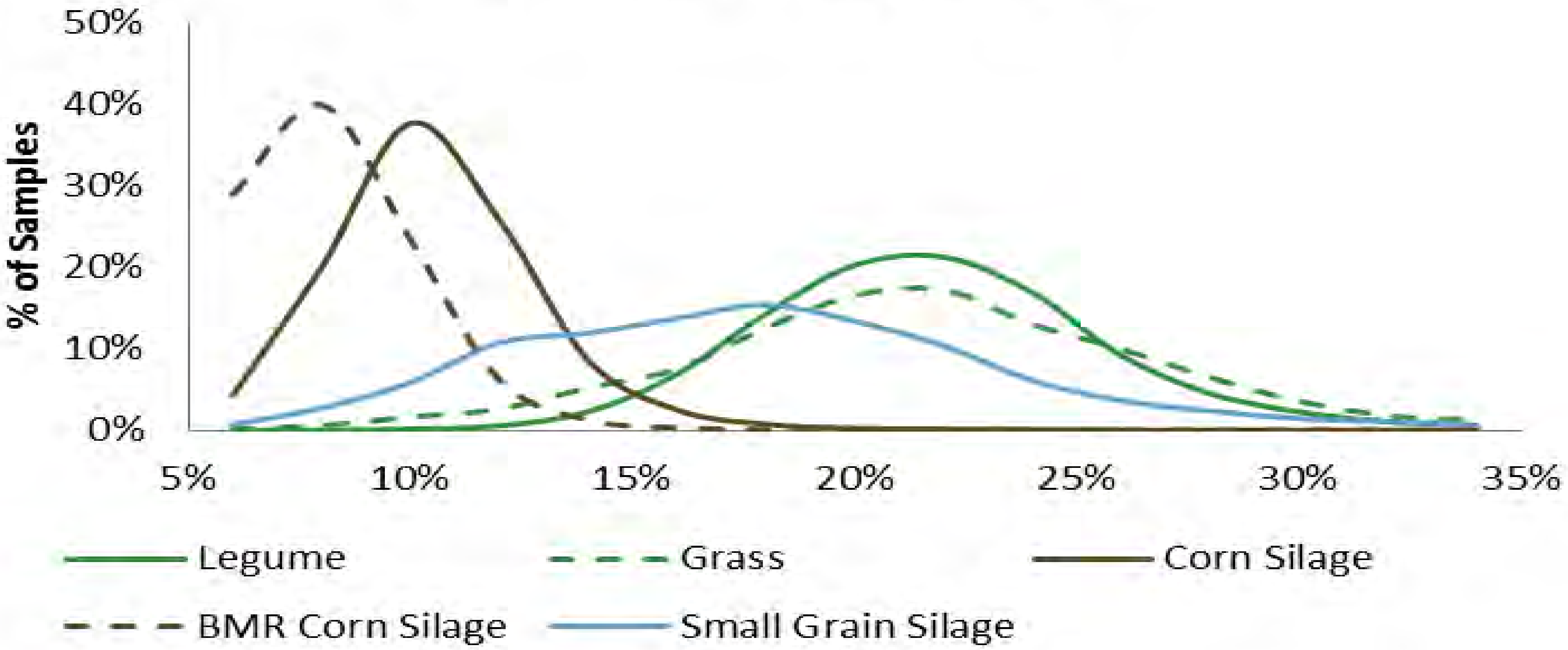


Allocation of forage by production level gets more milk from fiber!

Corn Silage Fiber Values

		DRY BASIS	AVERAGE	Normal Range
ADF	%DM	24.68	24.66	17.06 - 32.26
aNDF	%DM	38.85	41.00	30.08 - 51.92
aNDFom	%DM	37.90	40.10	29.71 - 50.76
NDFD 30	%NDF	51.93	53.87	43.57 - 64.17
NDFD 120	%NDF	61.58	71.54	62.62 - 80.34
NDFD240	%NDF	65.83	73.90	65.70 - 83.20
uNDFom30	%DM	18.22	18.20	13.30 - 23.30
uNDFom120	%DM	14.56	11.45	7.02 - 15.78
uNDFom240	%DM	12.95	10.50	6.00 - 14.90

uNDFom240 % DM



179,753 Samples – 2014 Crop Year

Measured ranges in uNDF240

(source: Dairy One, May, 2015 newsletter)

- Corn silage
  - 8.7% of DM
  - Range: 2.0 to 25.5%
- Legume silage
  - 17.6% of DM
  - Range: 5.5 to 31.7%
- Grass silage
  - 15.5% of DM
  - Range: 2.3 to 44.8%

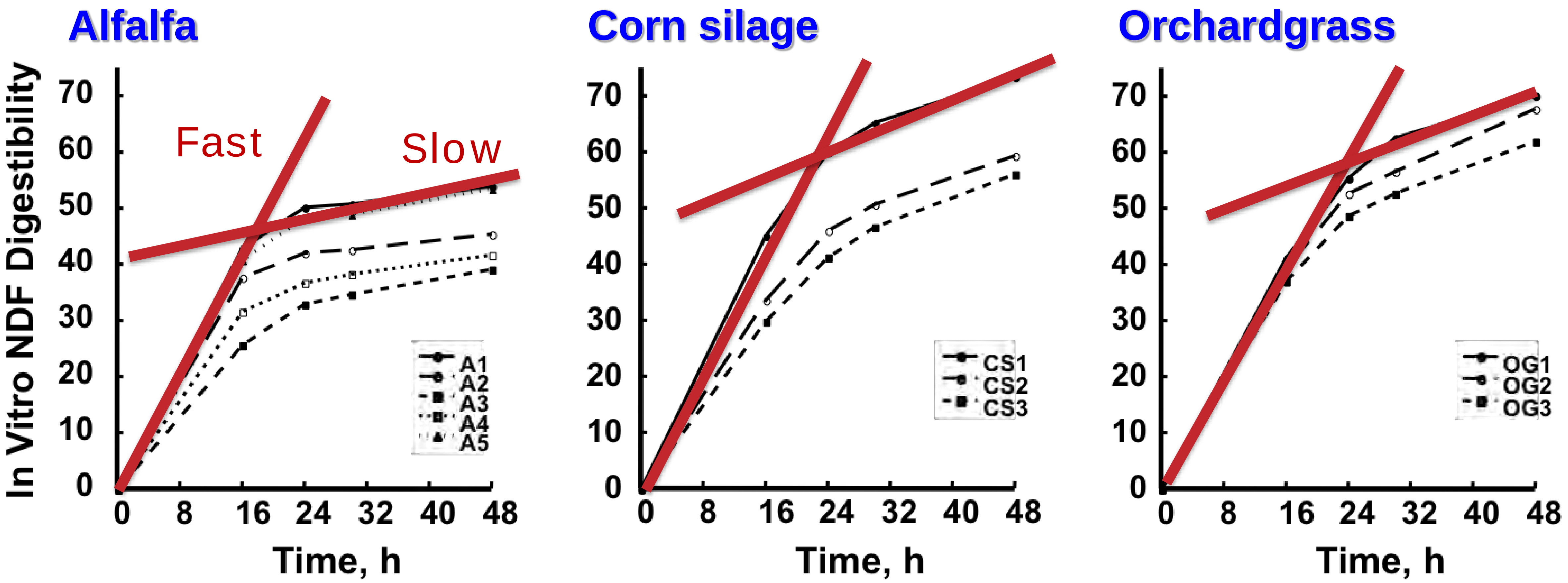
Tremendous variation in uNDF

that we need to capture

when formulating diets

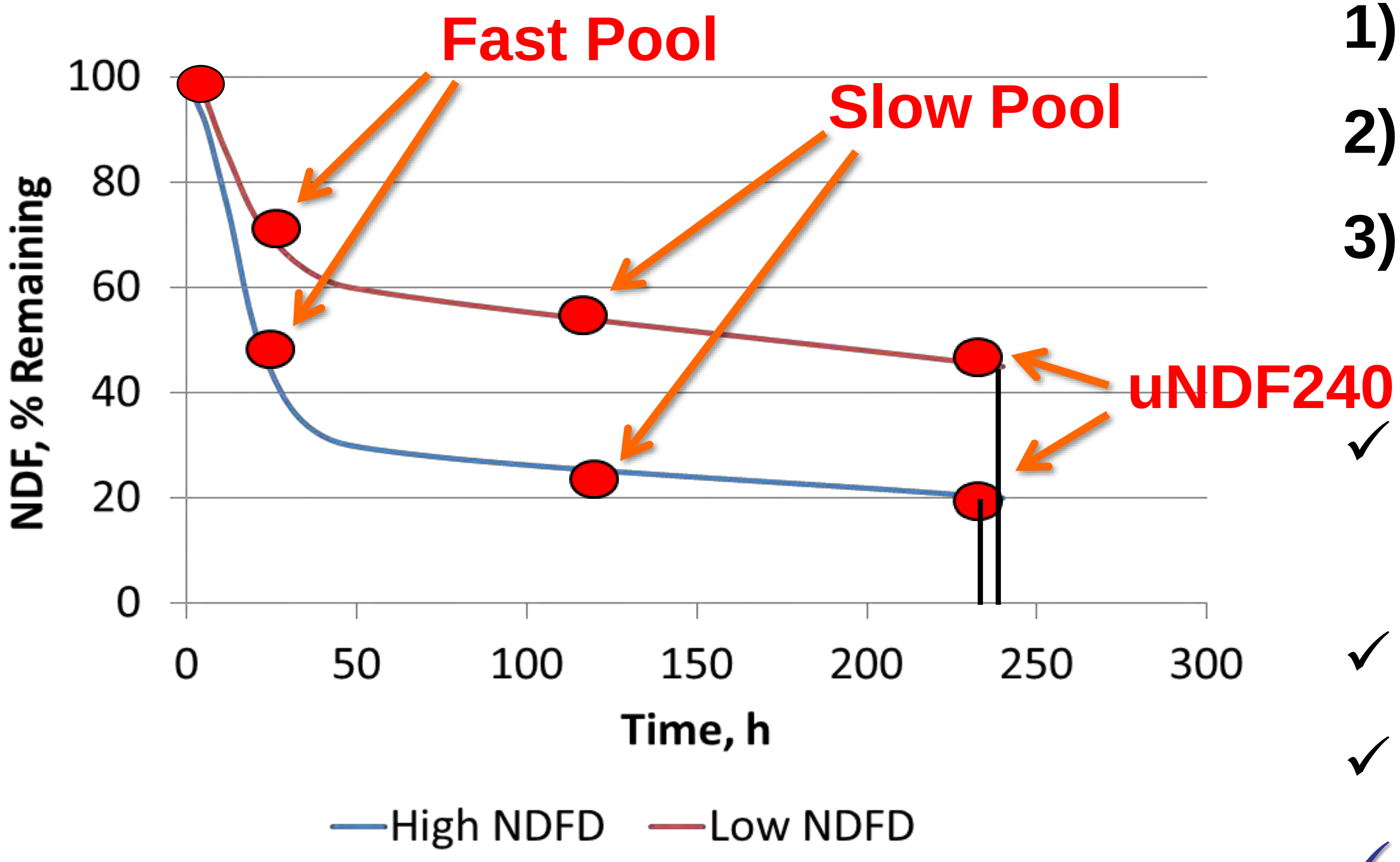
and predicting cow response!

Fast and slow NDF exists in all forage types (Allen, 2005, unpublished)



Slide courtesy of Dr. Mike Alle

3-Pool Model of NDF Digestion: Better Measure of Reality?



1) Indigestible NDF (uNDF240)
2) Fast NDF
3) Slow NDF

- ✓ Focus on 0, 30, 120, 240 hour
- ✓ Labs measure routinely now
- ✓ NIR more accurate than ADL
- ✓ **Better characterize fiber digestion profile!**

Importance of rumen digestion: Corn silage NDF (47-h in situ)

Wheat straw NDF (47-h in situ)

Rumen Fill Dynamics

Range in ration uNDF
(% of BW)

- Is there a max and min uNDF240 for high-performing cows?
- Suggest:
  - 0.25 to 0.45% of BW
  - Below range, inadequate rumen fiber
  - Above range, rumen fill constraint
  - Work in progress...

Use of uNDF

- Determines rumen fill from forage sources
- Guideline is 6.0 to 6.2 pounds of uNDF-30 (Holstein) and 5.0 lb uNDF-30 (Jersey)

Holstein Example:

30% ration NDF X 50 lb DMI X 40% uNDFD = 6.0 lb uNDF

This herd should be able to consume this level of dry matter intake based on uNDF ration levels

Forage Particle Measurements

Visualizing the Rumen Mat

Penn State Separator Guidelines

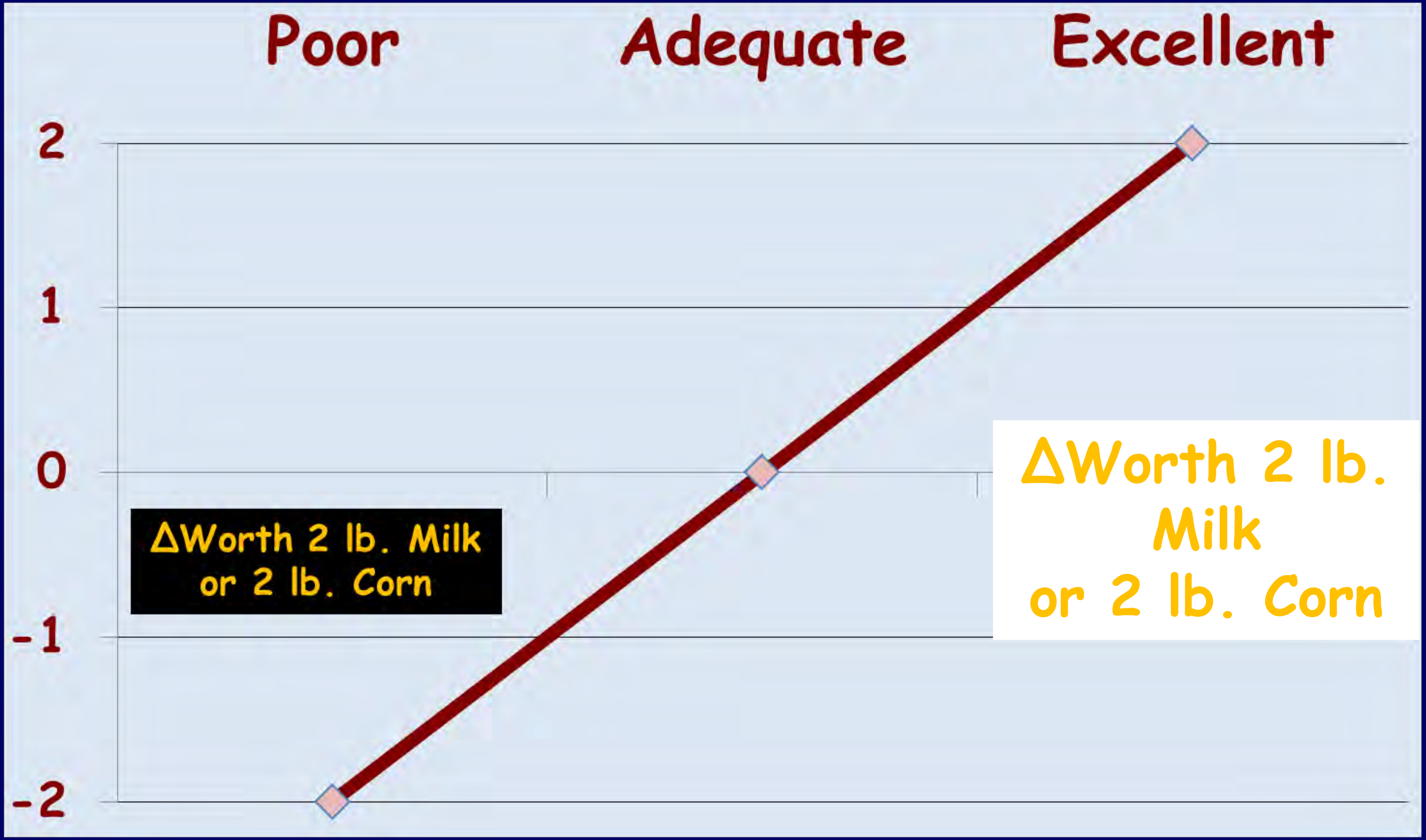
	Top	2nd	3rd	Bottom
	---------------	% (as fed)		---------------
TMR	10-15	> 40	< 30	< 20
Haylage	> 40	> 40	< 20	< 5
Corn silage (3/4 TLC-Process)	5-15	> 50	< 30	< 5

Corn Silage Processing

Poor job of processing

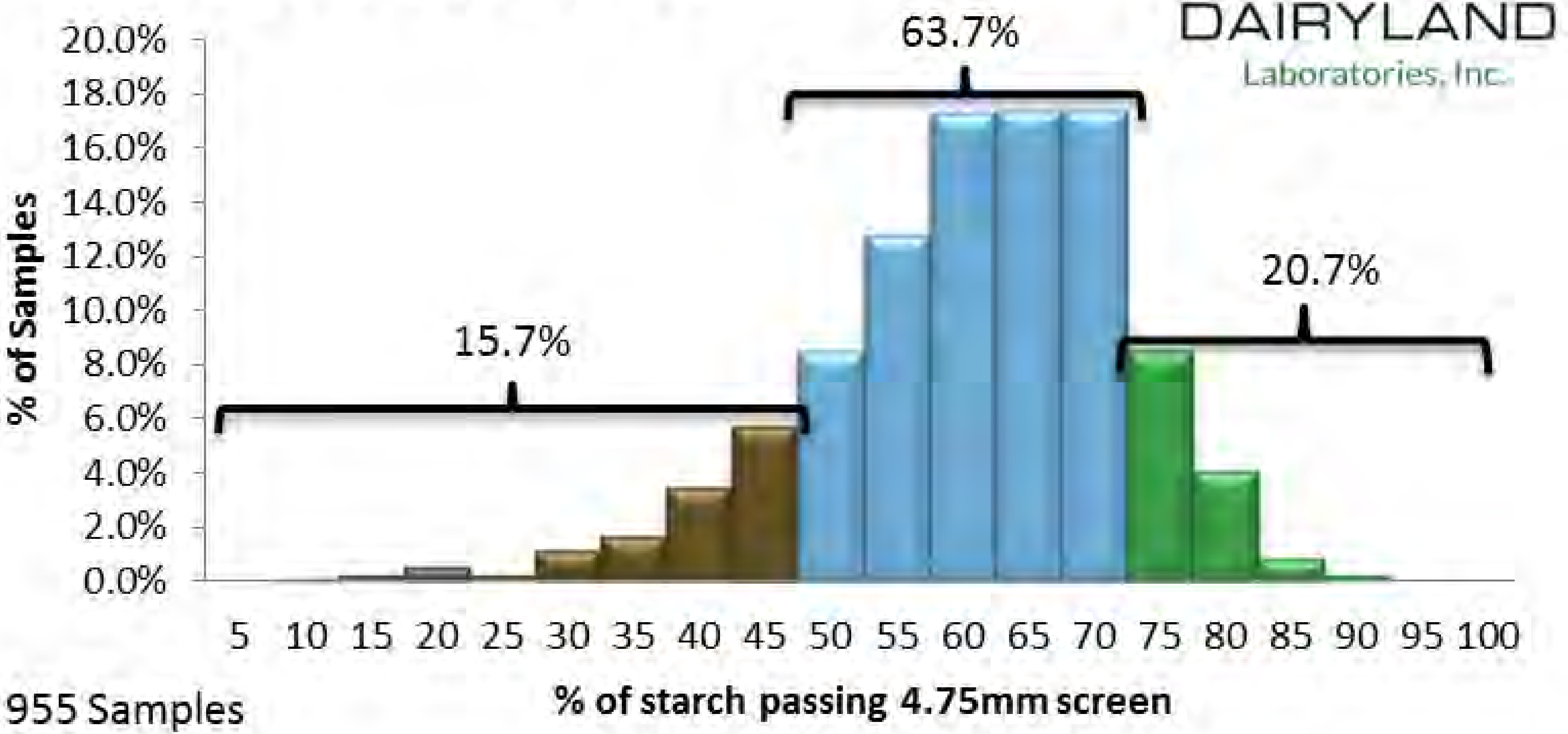
Rotap shaker showing 4.75mm screen and corn retained on the sieve

Kernel Processing Score



RD Shaver UW-Madison

CSPS 2014 Crop Year



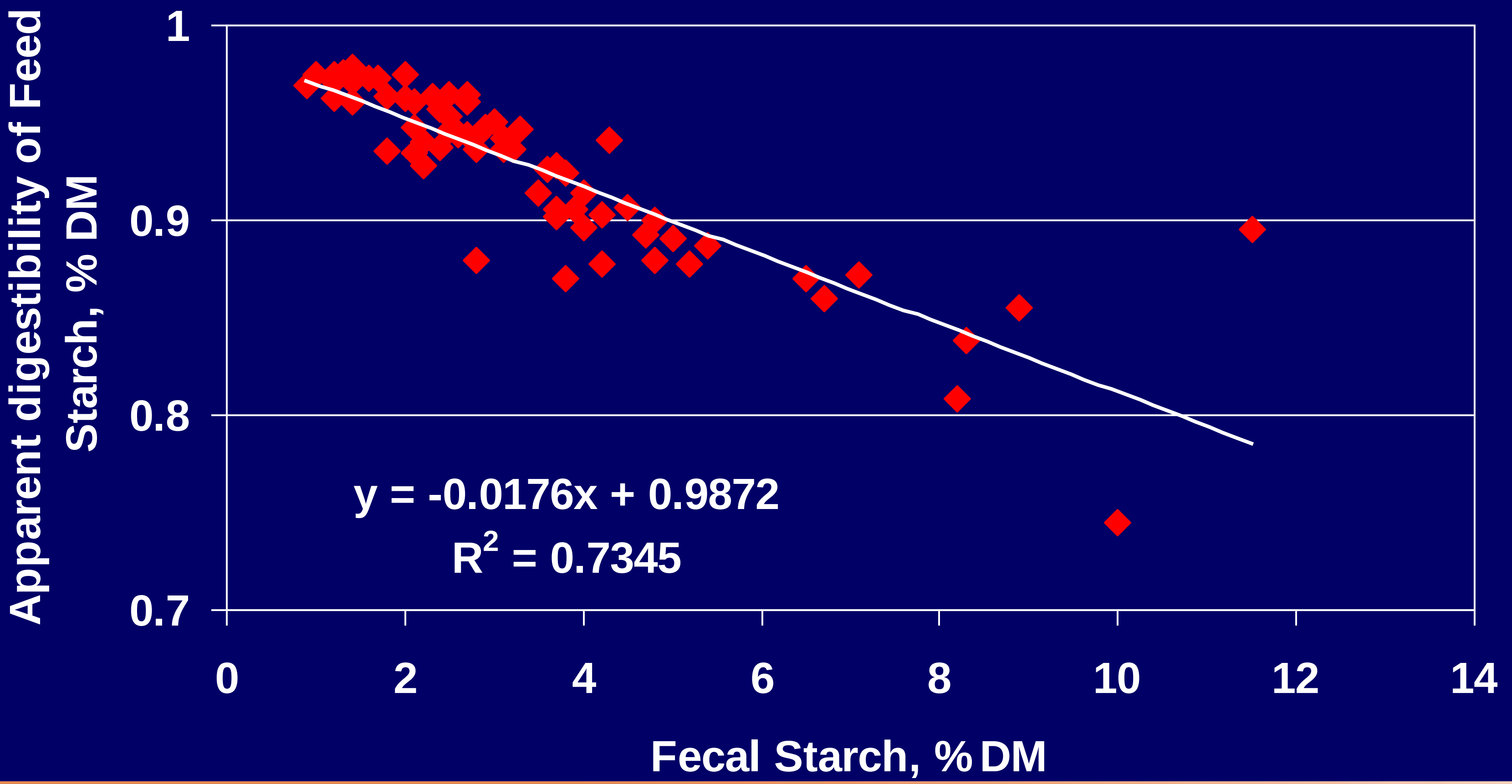
955 Samples

Shredlage vs. Conventional Processing

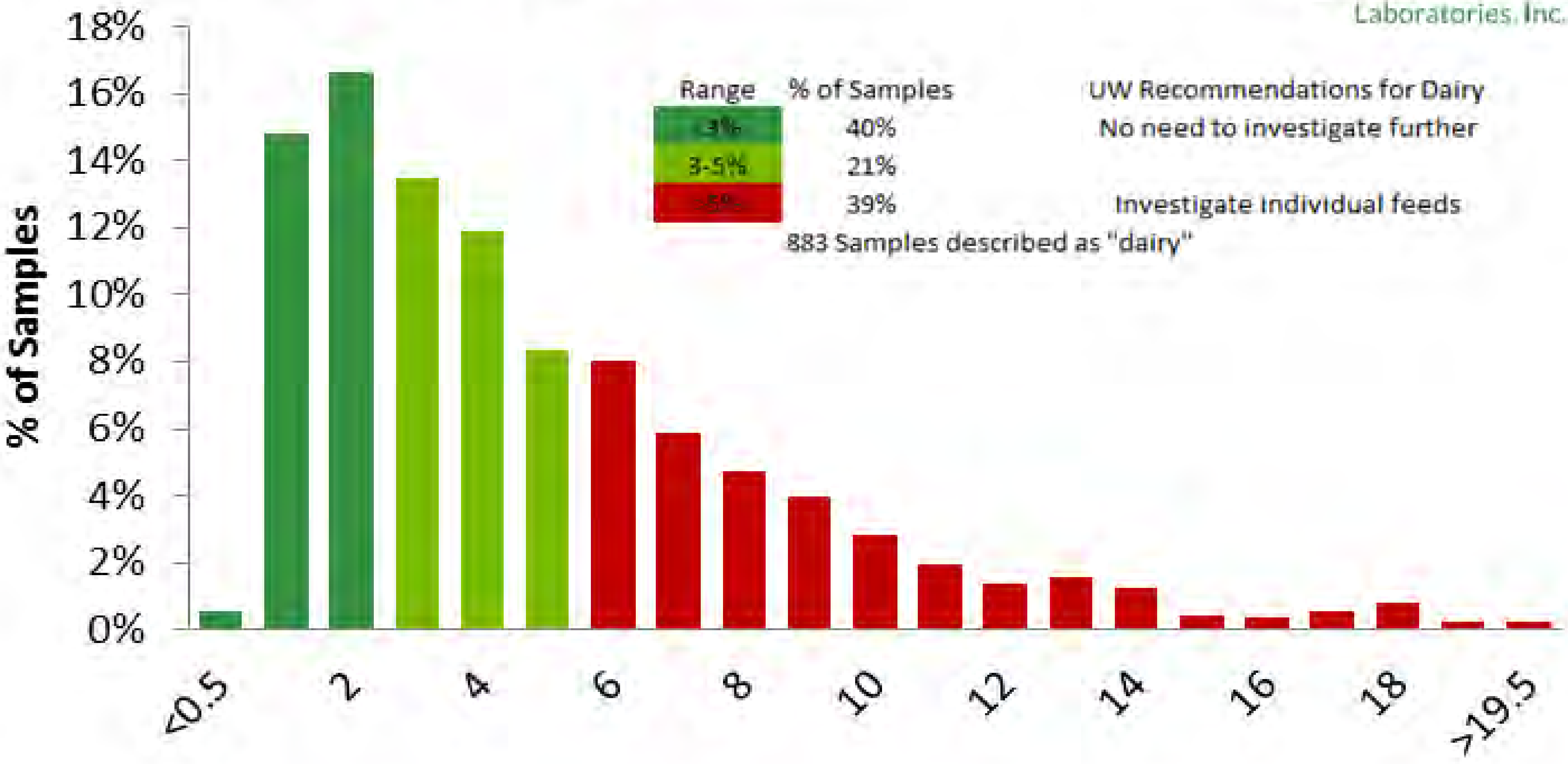
- My goal is to process the corn kernel properly
- Particle size is determined by TLC (3/4 inch to one inch seem optimal)
- Processing rolls wear out
- Shredlage guarentees kernel processing
- Cost: $35,000 unit vs. $10,000/+$2 per ton

Fecal Starch

Apparent digestibility of feed starch and fecal starch (%DM)



Dairy Fecal Starch %



Milk response

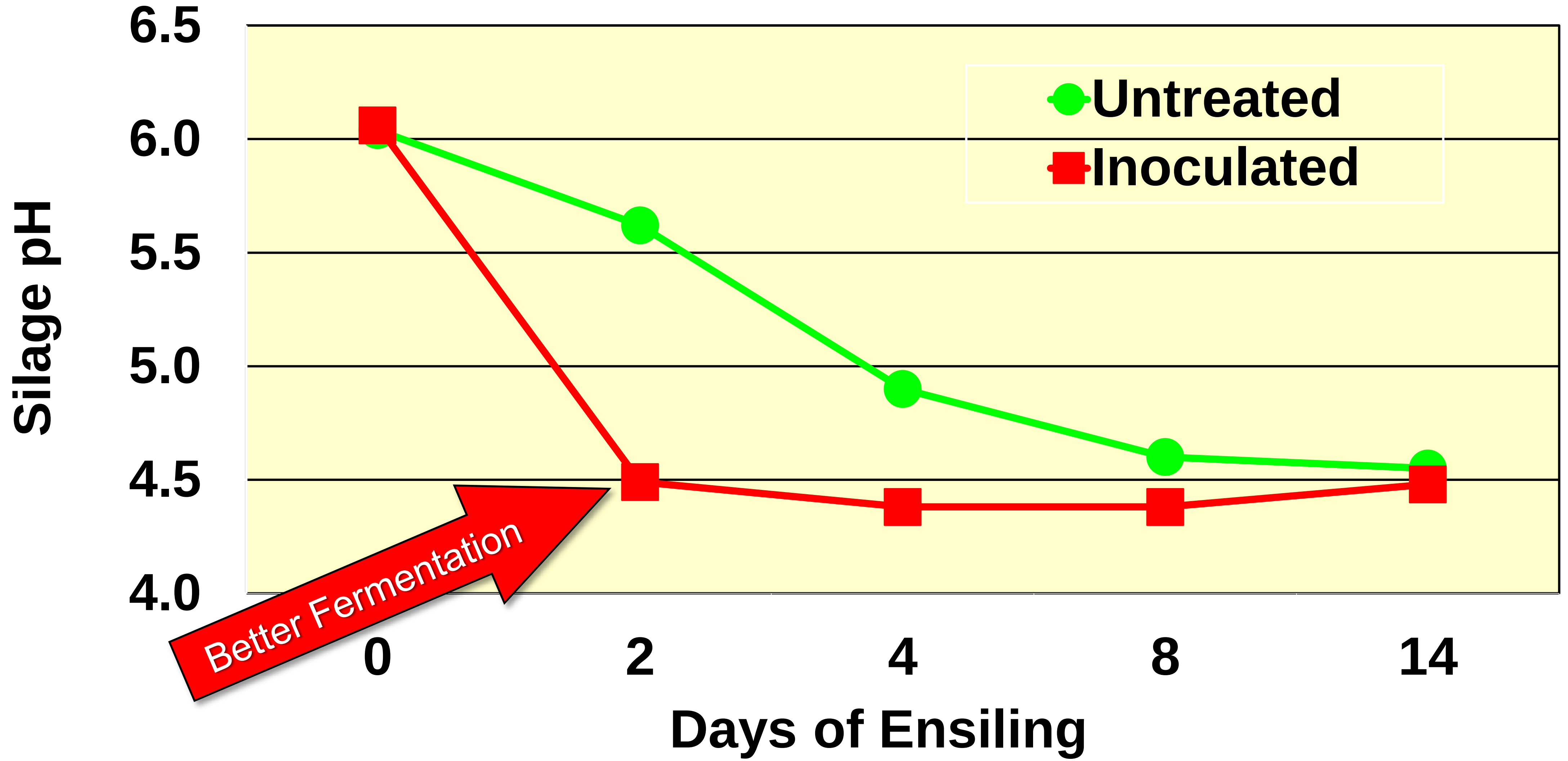
- Fecal starch should be less than 4.5% represents total tract apparent digestibility of 90+ percent.
- If fecal starch can be reduced 1 unit (absolute decrease from 10% to 9%), milk production could increase 0.67 pound (dry matter intake remains constant).

Silage Fermentation Profile

Recommended Fermentation Profile for Ensiled Feeds

Measurement	Legume/grass	Corn Silage	H.M. Corn
Dry matter (%)	35 to 50	30 to 35	70 to 75
pH	4.3 to 4.7	3.8 to 4.2	4.0 to 4.5
Lactic acid (%)	4.0 to 6.0	5.0 to 10.0	1.0 to 2.0
Acetic acid (%)	0.5 to 2.5	1.0 to 3.0	<0.5
Propionic acid (%)	<0.25	<0.10	<0.10
Butyric acid (%)	<0.25	<0.10	<0.10
Ethanol (%DM)	<1.0	<3.0	<2.0
Ammonia (%CP)	<12.0	<8.0	<10.0
Lactic/Acetate	>2.5	>3.0	>3.0
Lactic (% total)	>70	>70	>70

Inoculation Speeds Up Fermentation



Inoculants in Corn Silage

18 peer reviewed studies

	Control	Inoculants
pH	3.9	3.85
Lactic acid (%)	5.11	5.22
Acetic acid (%)	1.59	1.50
DM recovery (%)	86.4[a]	89.9[b]
DM digest (%)	67.5[a]	69.3[b]
Milk (lb)	70.4	71.7

Economics of Silage Inoculants

3% improvement in dry matter recovery

2% increase in digestibility

Benefit to cost ratio ($1 per ton)

- 3 : 1 on nutrient preserved
- 8 : 1 when fed to high producing cows

Corn Silage Hybrids

- **Conventional:** higher tonnage; higher milk/acre; higher starch
- **Brown Mid-Rib (BMR):** lower lignin, higher digestibility, lower tonnage
- **Leafy:** increase digestibility; no significant milk response
- **High Oil:** fed as silage does not reflect advantage

Selecting Corn Silage Varieties

Using Wisconsin Milk2006 equation

- Inputs:
  - Non-Fiber Carbohydrates (NFC)
  - Starch levels and digestibility
  - NDF digestibility and level
  - Dry matter intake
  - NEl (Mcal/lb DM)
  - Moisture content and processing effects
- Outputs:
  - Pounds of milk per ton (quality emphasis)
  - Pounds of milk per acre (quantity and quality emphasis)

What is an Average Corn Silage Hybrid?

Trait(s)	GxE	Forage yield	NDF	NDFD	Starch	Milk2006	
	N	T DM/A	%	%	%	Lbs/T	Lbs/A
Normal →	3398	7.8	47	59	30	3100	25000
Bmr	126	6.4	48	67	26	3300	21000
Leafy	240	8.1	48	59	27	3100	25000
CB	736	8.1	46	59	31	3100	26000
RR	339	7.8	47	58	30	3100	24000
CB,LL	331	8.2	47	59	30	3100	26000
CB,RR	395	8.0	46	59	32	3100	25000
CB,RW,RR	891	7.9	46	58	32	3100	25000
LSD(0.05)		0.6	2	1	4	100	2000
Average	7403	8.0	47	58	30	3100	25000

UW Extension
University of Wisconsin-Extension

Lauer © 1994-2014
http://corn.agronomy.wisc.edu

Lauer, 1990-2010; UW ST trials= 266; n= 21,420

Take Home Messages

- Corn silage requires digestible fiber and high levels of fermentable starch
- Evaluate NDFD and uNDF values
- Testing for fecal starch, kernel processing score, and fermentation profile
- Agronomic considerations should be evaluated (hybrid selection, stacked genetics, and fungicide treatment)