Assessing the Feeding Value of your Corn Silage

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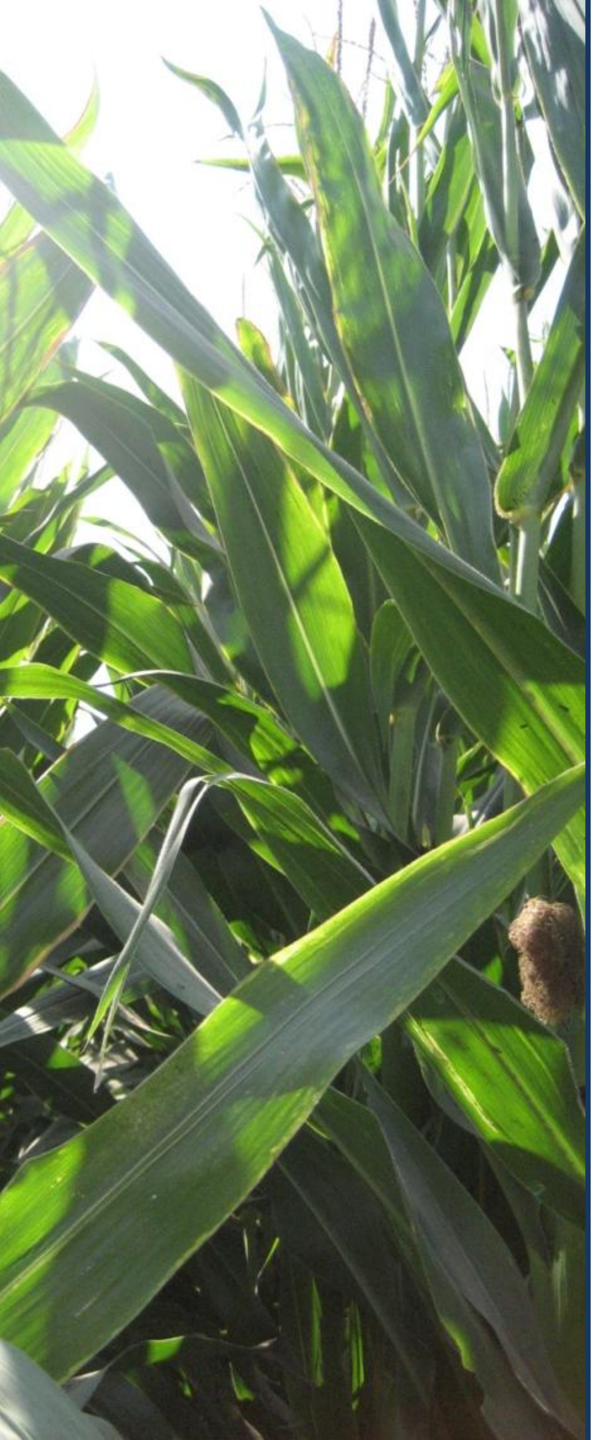
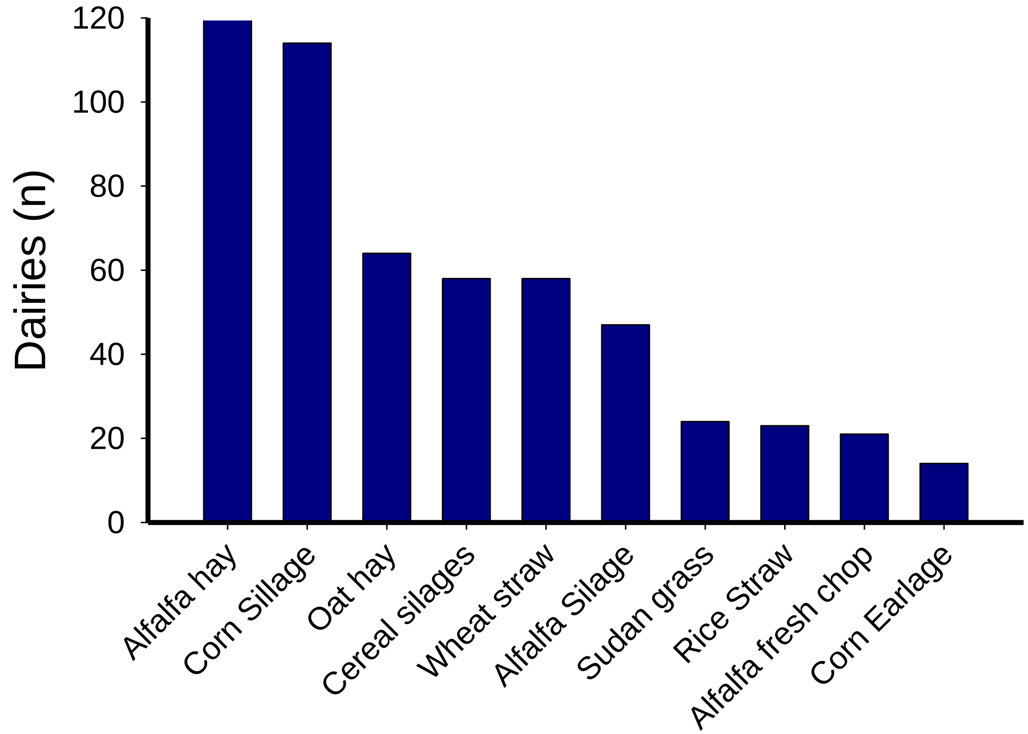


Forages Fed in California Dairies (n=120)



Corn Silage in TMR

2.2 to 10.7 kg/day in lactating cows - *Castillo (2012)*

7.1 to 23.1% of the DM in high producing cows - *UCDavis Peter Robinson (2007)*

Does all corn silage have the same feeding value?

Silage 1

Silage 2

Quality of the Forage Crop

Various factors affect the quality of the forage standing in the field:

Hybrid

Agronomic Practices

Growing Conditions

Quality of the Ensiled Crop

Various factors affect the quality and quantity of the ensiled forage:

Harvest

Storage

Feedout

After ensiling, the quality of the ensiled crop may not correlate with the quality of the forage standing in the field.

How can we assess if corn silage 1 has a superior feeding value than silage 2?

Silage 1

Silage 2


Nutrient Analysis

Microbial Quality

Physical Form

Fermentation

Taking a representative sample

In the field

At the silage pit

Nutrient Analysis

What are the lab assays that you are most interested in?

Question to Nutritionists from California and Pacific South West ARPAS UCCE Dairy Nutritionist Survey - Daniel H. Putnam, 2011

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1. Starch
2. NDFD
3. NDF
4. DM, IVDDM, Ash

*DM was consider very important for quality and yield estimations

DRY MATTER

Dry Matter

Desirable dry matter: 30 to 36%

Low Dry Matter Silages:

1. Low starch
2. High seepage losses
3. Poor fermentation (high production of fermentation acids)
4. Less susceptible to aerobic spoilage

High Dry Matter Silages:

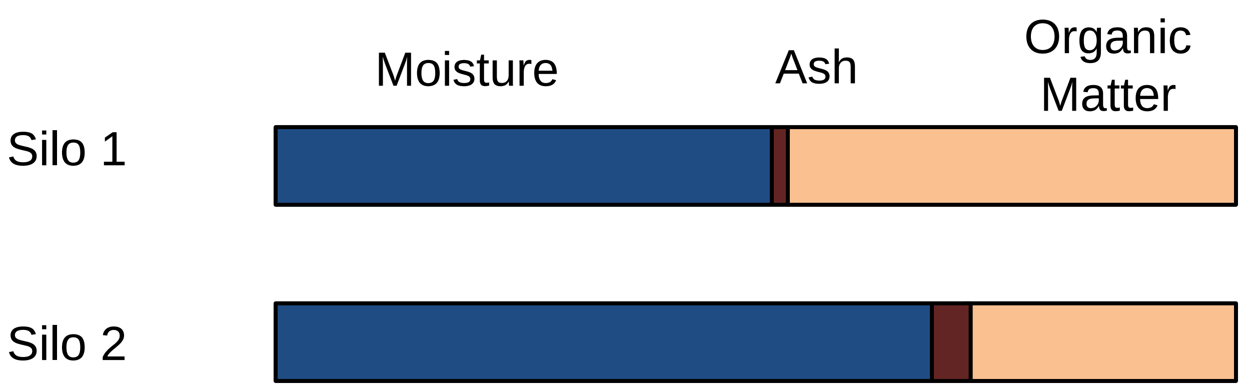
1. High starch
2. Lower NDF and starch digestibility
3. Hard to pack
4. More susceptible to aerobic spoilage

	Silage 1	Silage 2
DM	45.4	26.6

Which silage is less likely to heat up in the feedbunk?

	Silage 1	Silage 2
DM	45.4	26.6
%DM		
Ash	2.4	5.1
Starch	45.7	21.5
NDF	26.9	47.6
NDFD	41.1	45.4
CP	7.9	8.8
Fat	3.5	2.4

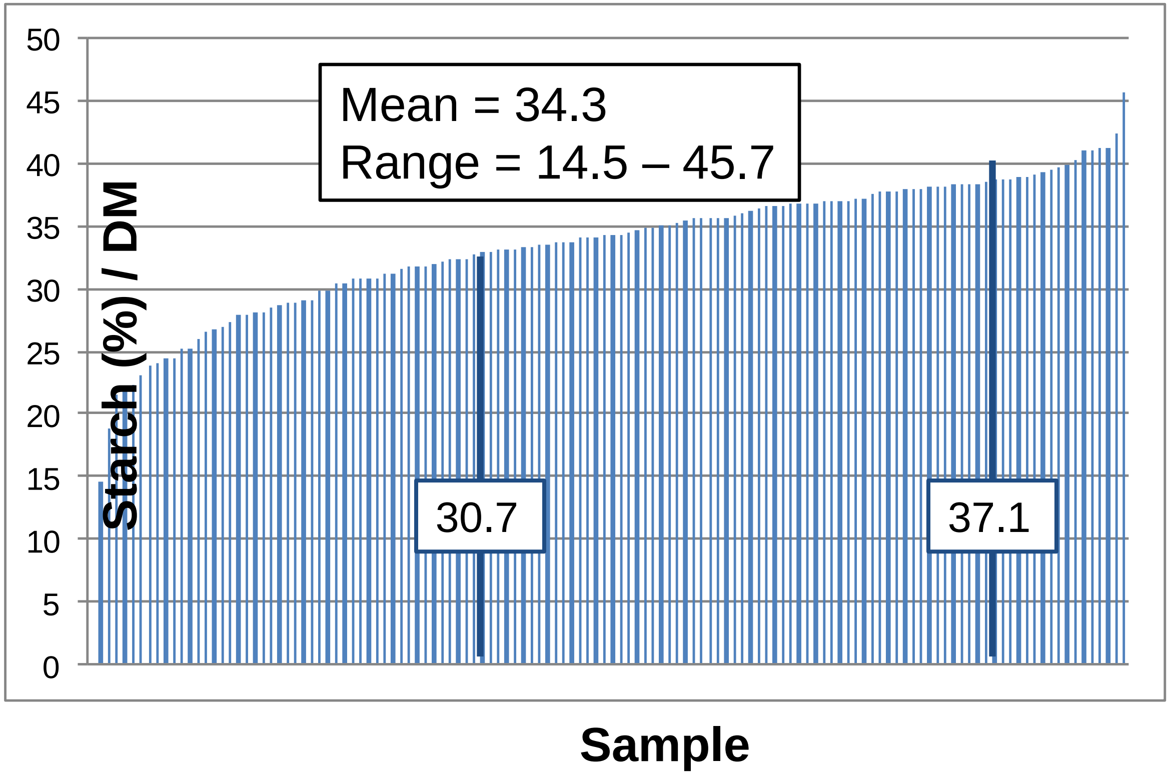
Which silage provides the most nutrients based on wet weight?



STARCH

Starch

Starch (%) in corn silage samples from California dairies (n=126)

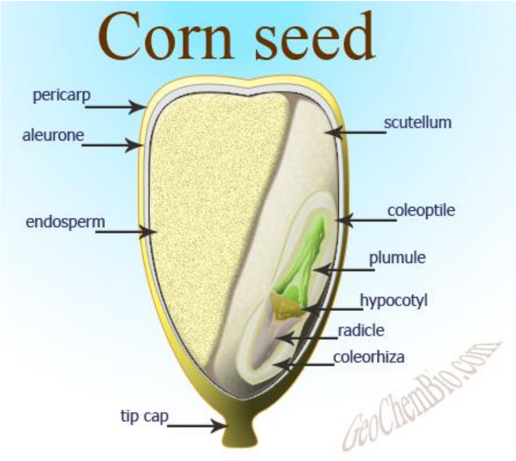


Type of Hybrid
Growing Conditions
Chopping Height
Dry Matter at Harvest

**Starch analysis were done with a modified lab assay

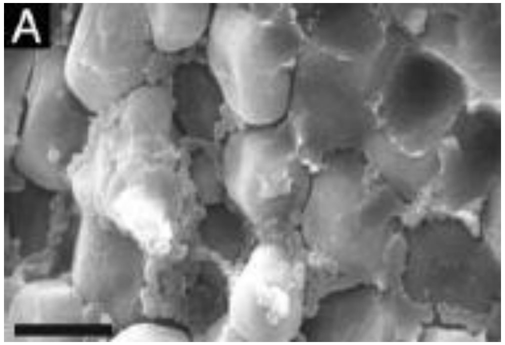
Starch Digestibility

Macro-protective coats of the seeds – *kernel*



Maturity at harvest
Chop length
Kernel processing

Micro-protective coats of starch granules within the seeds – *prolamin type*



Storage length
Type of corn endosperm

Kernel Processing

Kernel processing improves the whole plant value by breaking all the corn kernels and reducing the presence of large cob pieces.

*** In CA, 5-15% of the dairy producers do not kernel process because of harvest costs (Collar and Silva-del-Rio, 2010)*

Processing corn silage increases milk production up to 1.7 to 2.5 lbs/cow/d when corn silage represents 30 to 40% of the ration.

It is normal to find 2 to 3% of the kernel DM consumed in feces. If large amounts of kernels are found in feces, then kernel processing may have been inadequate.

Whole kernels found in feces

Kernel Processing

Kernels separated from fodder with a bucket of water (Courtesy of Dr. Limin Kung)

Guidelines for kernel processing evaluation on-farm *(Mertens, 2005)***:**

- 90 - 95% cracked
- 70% smaller than ¼ of a kernel
- Nicking and crushing is not enough

Kernel Processing

Corn Silage Processing Score

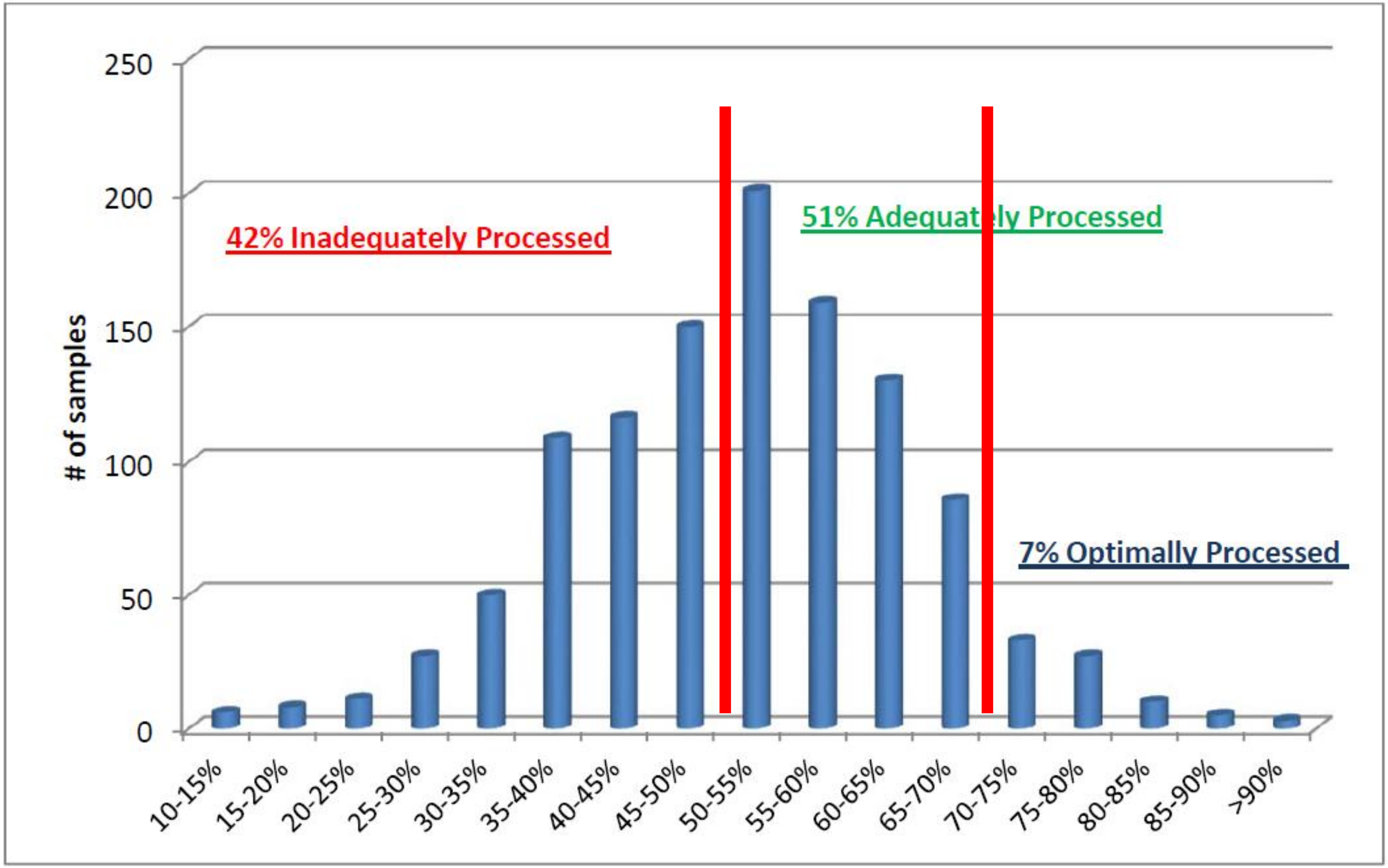
Coarse Fraction > 4.75mm (0.18 in):

Fiber will stimulate chewing activity.

Starch will be poorly digested.

Starch (%) passing through the coarse screen	Ranking
> 70%	Optimum
50 -70%	Average
< 50%	Inadequate Processing

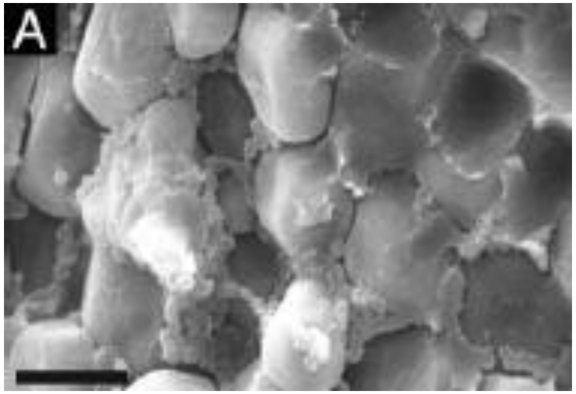
Corn Silage Processing Score



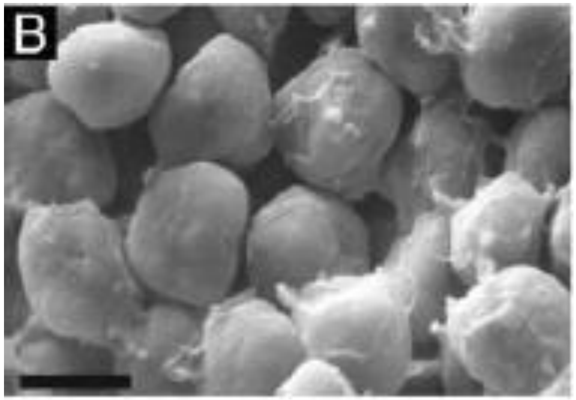
Cumberland Lab, 2009 -2011 (n=1131)

Starch Micro-Coat

Prolamin micro-coats of the starch granules within the endosperm.



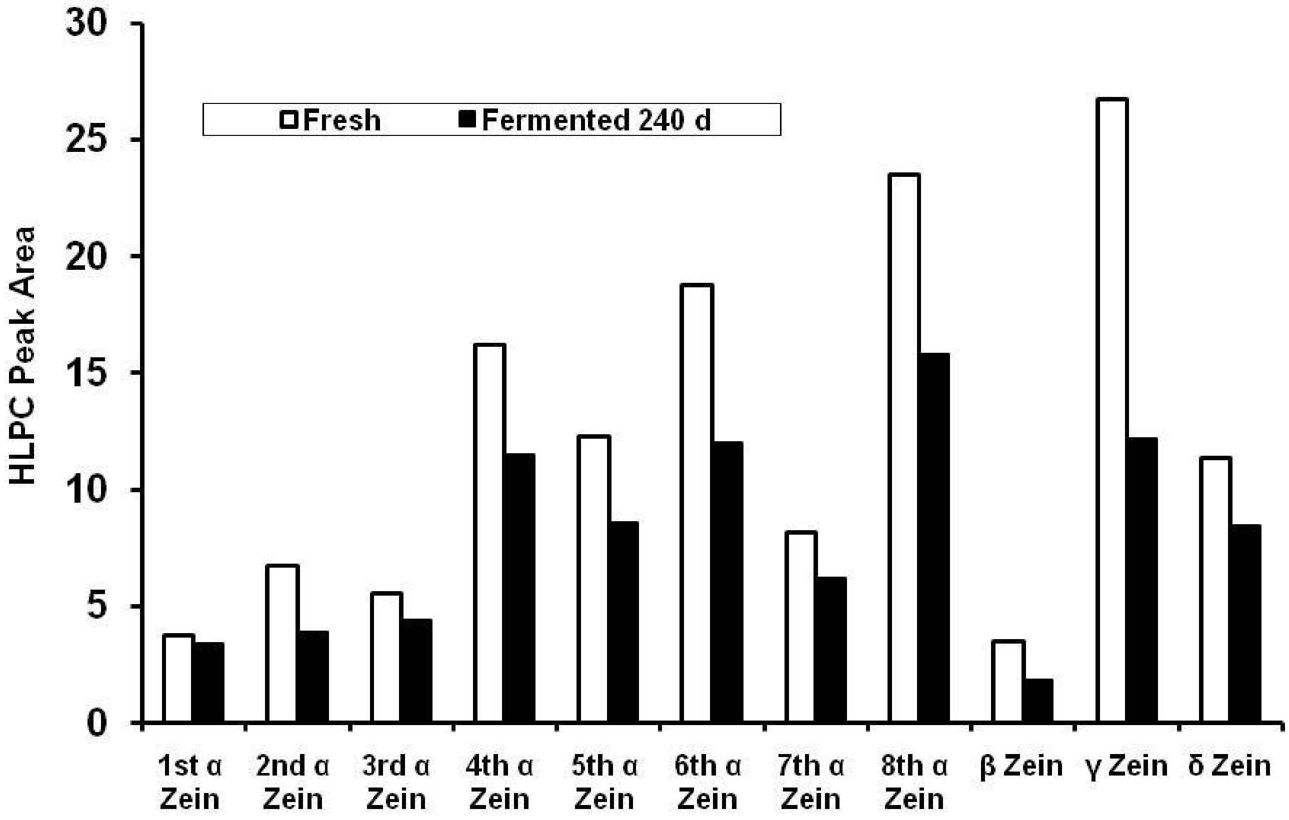
Starch heavily imbedded in prolamin-protein complex



Starch less encapsulated by prolamin-protein complex.

(Gibbon et. al., 2003)

Effect of storage period on prolamin-zein proteins in high moisture corn.



Hoffman et al. (2010)

Why new corn silage doesn't feed as well?

Forage from a single field (n=2)
Samples were vacuum sealed and kept in an environmentally controlled room
Samples were removed every 30 days and kept frozen until analysis

Average changes in digestibility values after ensiling					
Time (mo.)	DMD12	DMD30	NDFD30	STRD12	ttSTRD
0	37.4%	42.5%	29.2%	69.3%	91.6%
1	37.9%	43.2%	30.9%	70.6%	92.5%
3	38.8%	44.3%	34.6%	72.5%	94.1%
5	39.5%	45.1%	36.6%	73.5%	95.3%
7	40.0%	45.6%	37.4%	73.6%	96.1%
9	40.4%	45.9%	38.6%	73.9%	96.4%
11	40.5%	46.4%	39.2%	73.9%	96.9%
Monthly change (0-6 mo.)	0.50%	0.70%	1.20%	0.60%	1.80%

DMD = dry matter digestibility at 12 or 30 hours
NDFD30 = digestibility of NDF fraction at 30 hours
STRD12 = starch digestibility at 12 hours
ttSTRD = total tract starch digestibility

Chris Hallada, Vitta Plus - Hoards Dairyman, Nov 2009

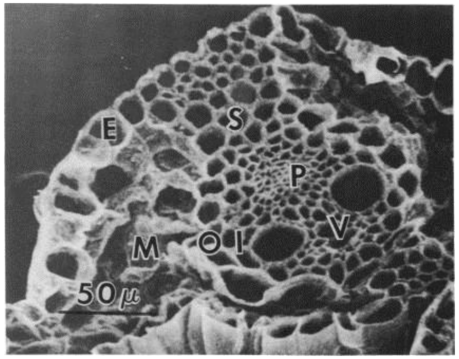
What can you do to maximize the starch available for rumen microbes?

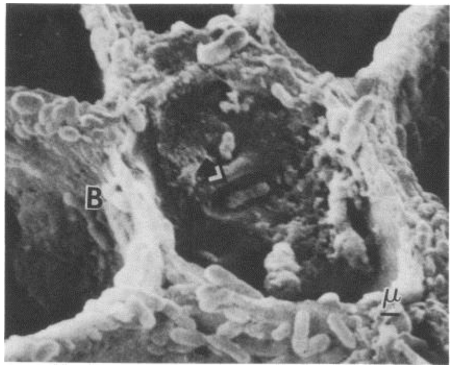
- Harvest at the crop at the correct DM
- Kernel process the crop properly
- Start feeding at least 3 - 6 months after storage

NDF Digestibility

What is NDF?

NDF is the residue obtained after the plant material is washed with a neutral detergent solution (NDF) that leaves the cell wall matrix





NDF

Hemicellulose
Cellulose
Lignin

ADF

Cellulose
Lignin

Lignin

- Polyphenolic acids linked to hemicellulose by ether or ester bonds.
- Limits digestion of the Lignin-Hemicellulose-Cellulose complex

NDF Digestibility

Why NDF Digestibility is important?

- **Fiber is the lowest digesting component in feeds.**
- **Diets containing high digestible fiber allow for more intake and milk.**
- **Increase NDF Digestibility of forages by 1% (Mertens, 2006):**

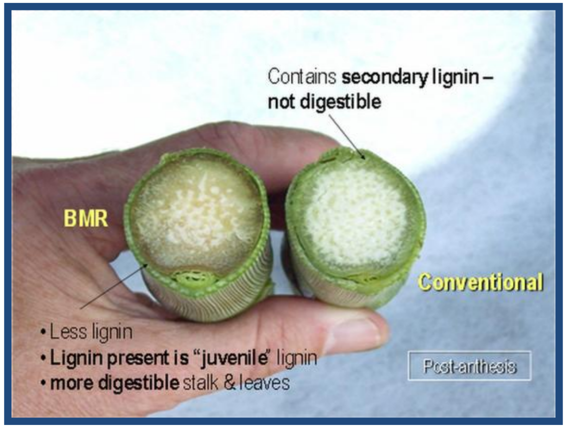
↑ **0.2 lb of DMI**

↑ **0.28 lb of FCM**

Factors affecting NDF Digestibility:

Maturity, Growing Conditions,

Crop Management, Hybrid, Ensiling Time



Conventional (top) vs BMR (bottom) corn

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5	39.5%	45.1%	36.6%	73.5%	95.3%
7	40.0%	45.6%	37.4%	73.6%	96.1%
9	40.4%	45.9%	38.6%	73.9%	96.4%
11	40.5%	46.4%	39.2%	73.9%	96.9%
Monthly change (0-6 mo.)	0.50%	0.70%	1.20%	0.60%	1.80%

DMD = dry matter digestibility at 12 or 30 hours
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Chris Hallada - Hoards Dairyman, Nov 2009

Effective Fiber from Corn Silage

Effective Fiber from Corn Silage

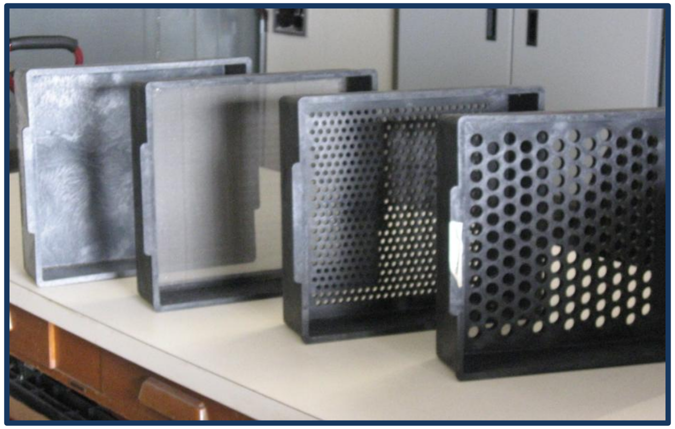
Corn silage particle length should be long enough to supply effective fiber for optimal rumen function and adequately short to favor packing and fermentation.

TLC adjusted based on DM and kernel processing.

DM < 33%: TLC 0.75 – 0.90 in. and the rollers open.
DM 33-38%: TLC 0.75-0.90 in. and rollers with 0.12 in.
DM 38%: TLC 0.5 in. and close rolls.
(http://www.livestocktrail.uiuc.edu/dairynet/paperDisplay.cfm?ContentID=615)

If ensiled corn is the only roughage source at the dairy, it is recommended to chop long to ensure enough effective fiber in the ration.

Evaluate Forage Particle Length



	3/4 TLC Processed	3/8 TLC Unprocessed
Top	5-15	3-8
Second	>50	45-60
Third	<30	30-40
Bottom	<5	<5

Effective Fiber from Corn Silage

Corn Shredlage

Cross-grooved processing rolls

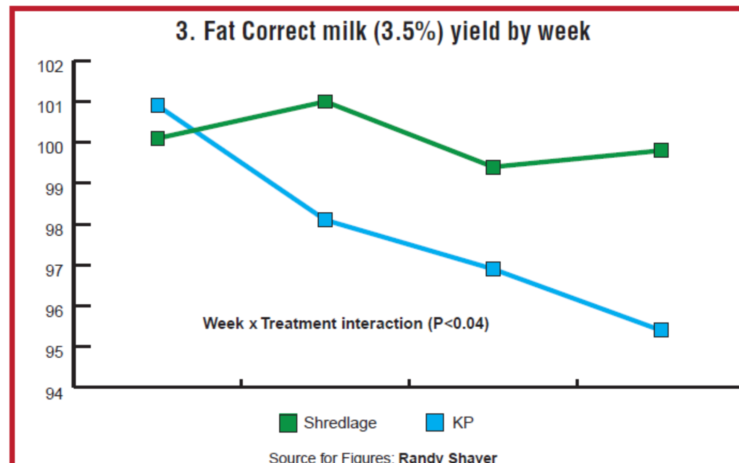
Greater proportion of coarse stover particles

http://www.shredlage.com/

Corn Shredlage Trial

Experimental Design
Corn Silage DM=35%
Conventional: 0.74 inch TLC and 0.12 in roll opening
Shredlage: 1.18 inch TLC and 0.10 in roll opening
Experimental unit: 14 pens (n=8).
50% of the TMR was corn

Results Shredlage vs Conventional:
Dry Matter Intake (1.4 lb/d; P < 0.08)
Fat Corrected Milk (100.1 vs 97.8 lb/d; P < 0.08)
Fat Corrected Milk by time interaction (P <0.03)



Ferraretto and Shaver, 2012
http://www.uwex.edu/ces/crops/uwforage/Shredlage-FOF.pdf

Fermentation Acids

Fermentation Acids

pH   3.7 - 4.2

Lactic acid 4-7%

Acetic acid 1-3%

Ethanol 1-3%

Fermentation Acids

pH 3.7 – 4.2

- Indicates the acid level of silage.
- Needs to be low for silage to reach the stable phase.
- It does not inform about how fast the stable phase was reached.

High pH is undesirable and could be explained by:

- High dry matter silage
- Incomplete fermentation – sampling too early
- Poor packing
- Moldy silages
- Silages containing manure

Fermentation Acids

Lactic acid 4 -7 %
65-70% of total silage acids

- Lactic acid is a strong acid responsible for most of the drop in silage pH.
- A fermentation that produces lactic acid results in the lowest dry matter losses during storage.

Low lactic acid could be explained by:

- High dry matter silage
- Incomplete fermentation – sampling too early
- Poor packing
- Moldy silages
- Silages containing manure
- Aerobic exposure that degrades lactic acid

Fermentation Acids

Acetic acid 1 – 3 %

Acetic acid is a less desirable end-product than lactic acid.

It is a weaker acid and fails to effectively decrease silage pH.

High acetic acid results in silage DM losses and low DM intake (unless by L. Bucheneri).

High acetic acid is undesirable and could be explained by:

- Wet silages
- Prolonged fermentation:
  - Slow filling
  - Poor packing

Fermentation Profile

Ethanol 1 – 3 %

Ethanol indicates excessive metabolism by yeasts.

Dry matter losses are usually greater.

These silages are more prone to aerobic stability problems.

High Ethanol can be explained by :

- Poor packing
- High DM

Microbial Quality

Microbial Quality

Insufficient lactic acid production results in a high silage pH that facilitates the growth of potential pathogenic organisms.

Mold and Yeast

Clostridia

Listeria monocytogenes

Clostridium botulinum

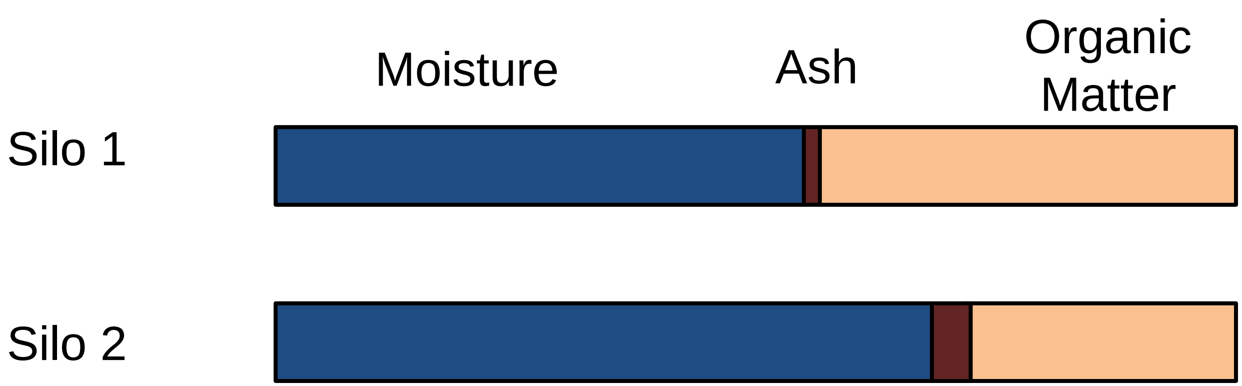
Neospora caninum

Salmonella


T40

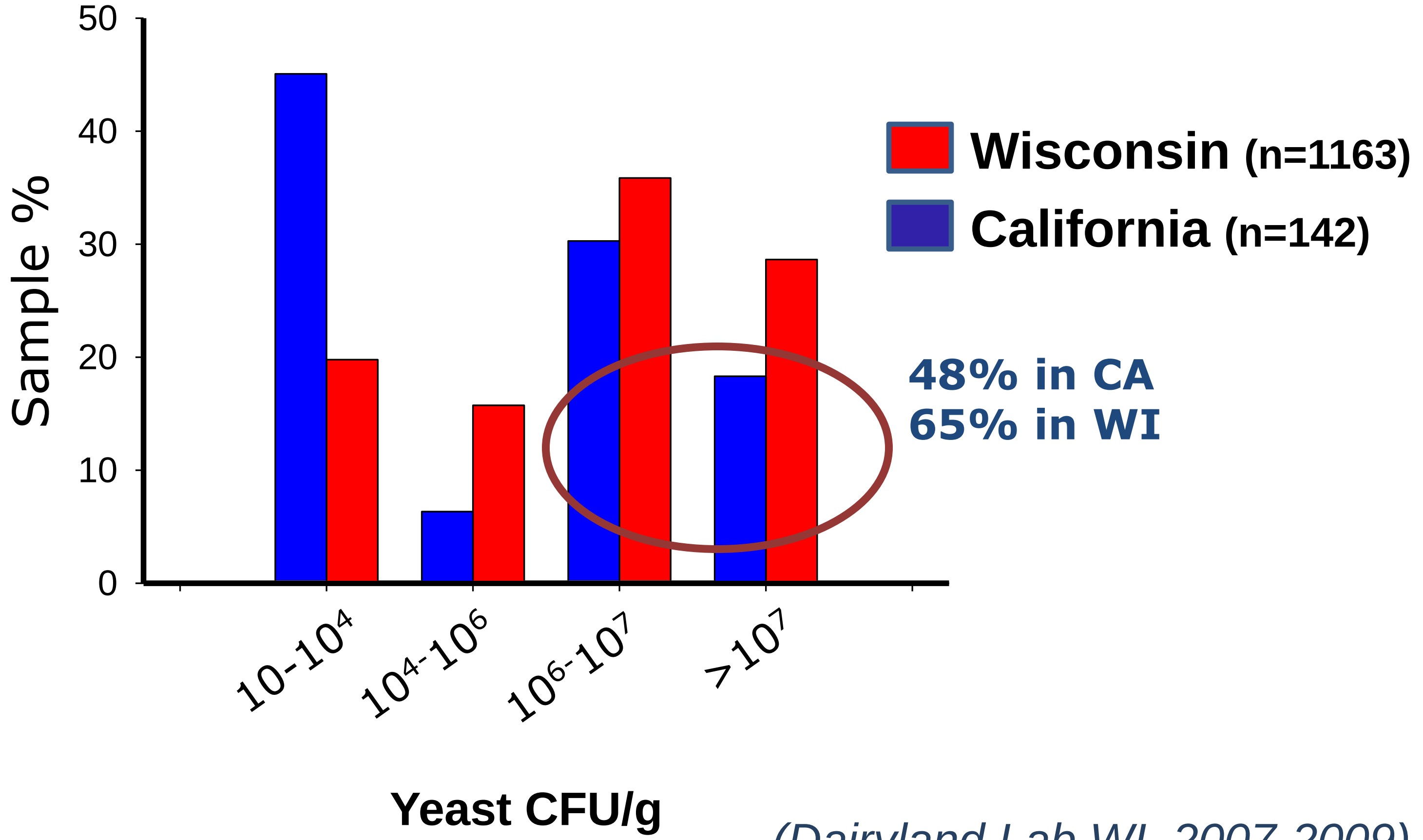
	Silage 1	Silage 2
DM	45.4	26.6
%DM		
Ash	2.4	5.1
Starch	45.7	21.5
NDF	26.9	47.6
NDFD	41.1	45.4
CP	7.9	8.8
Fat	3.5	2.4

Which silage provides the most nutrients based on wet weight?



Microbial Quality - Yeast

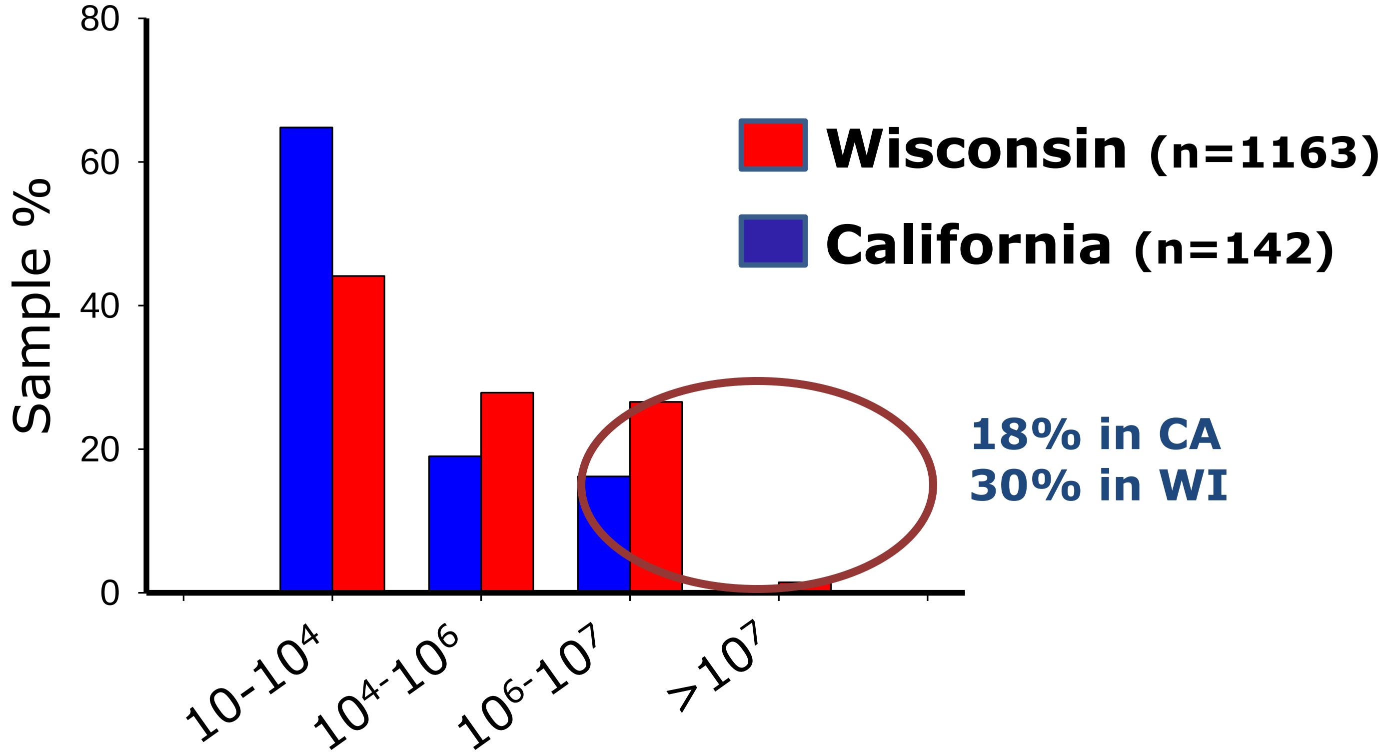
High when > 10^6 CFU of yeast per gr of silage (ethanol, alcohols, CO_2, VFA, lactate)



(Dairyland Lab WI, 2007-2009)

Microbial Quality - Molds

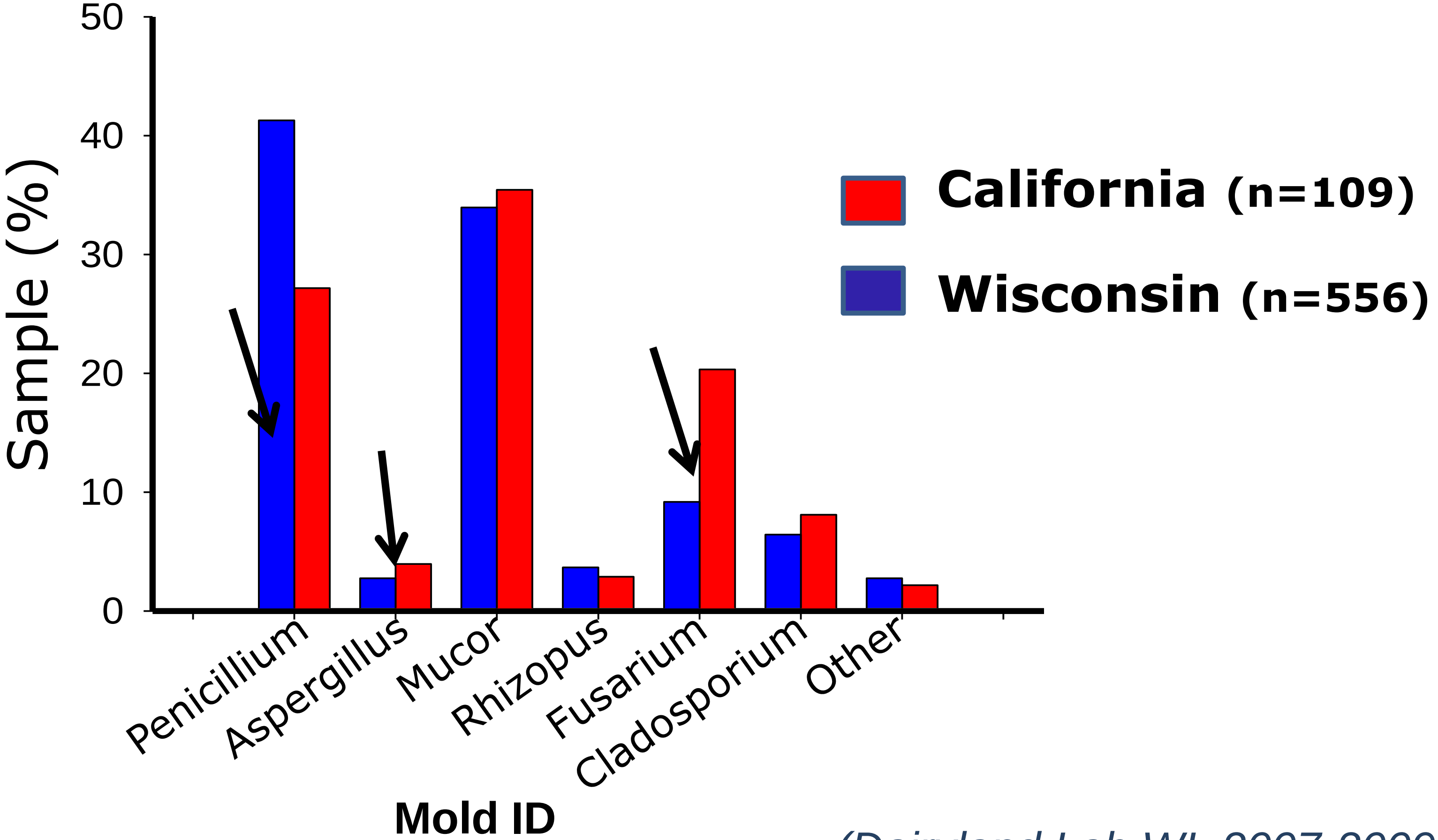
High when > 10^6 CFU of mold per gr of silage (decreases palatability, poor dry matter recovery)



(Dairyland Lab WI, 2007-2009)

Microbial Quality – Mold ID

Penicillium, Fusarium and Aspergillus are mycotoxin producers.



(Dairyland Lab WI, 2007-2009)

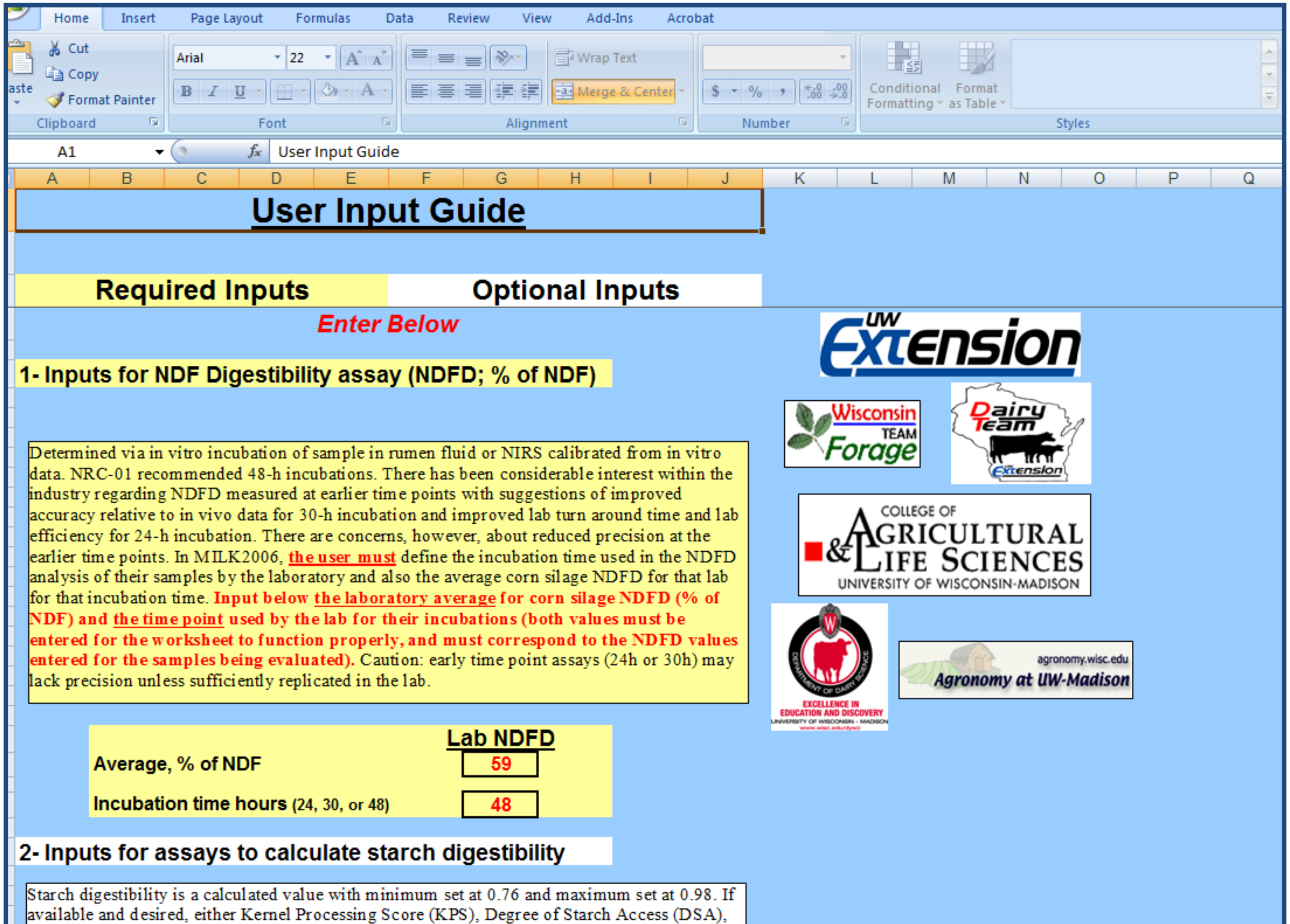
How can we integrate all this information?

MILK2006, University of Wisconsin
Index method to estimate milk production from corn silage based on crop yield and nutrient availability

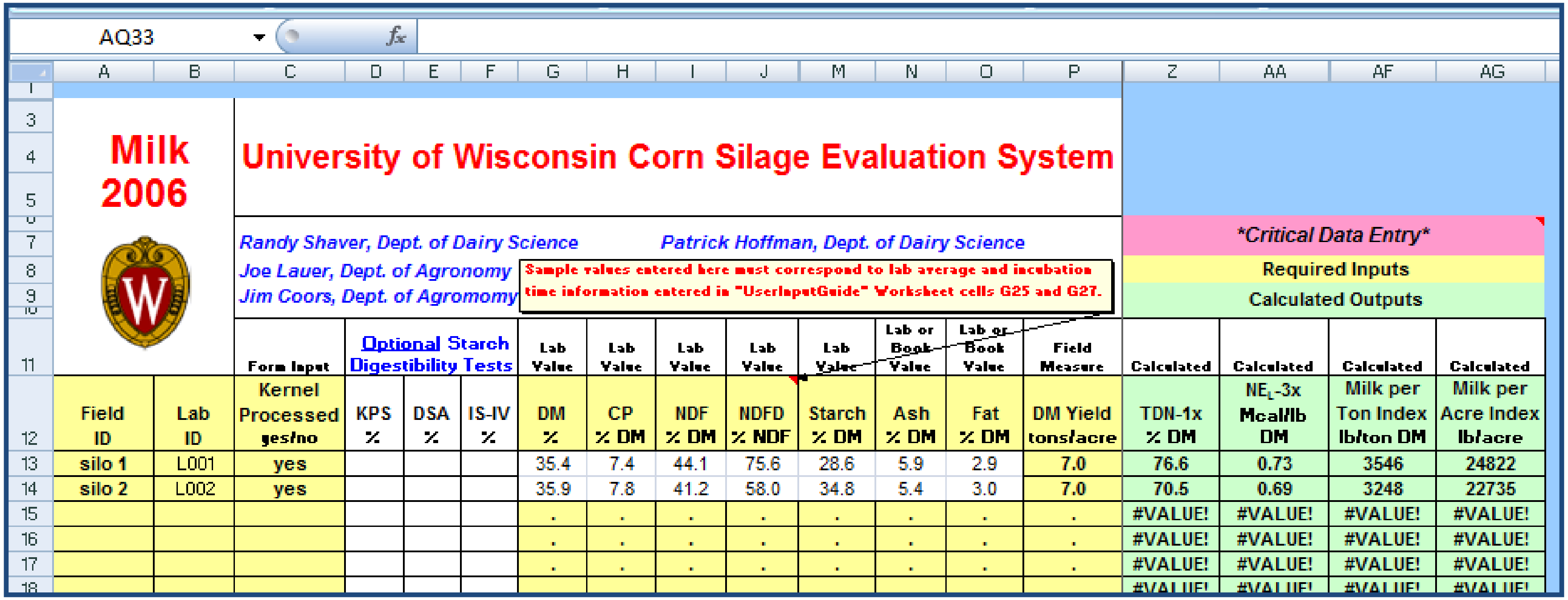
Pricing corn silage, University of Minnesota
Corn silage price adjusted by starch and NDFD

Pricing corn silage, University of Wisconsin
Spreadsheet to calculate corn silage price

MILK2006


Home Insert Page Layout Formulas Data Review View Add-Ins Acrobat
A1
User Input Guide
User Input Guide
Required Inputs
Optional Inputs
Enter Below
1- Inputs for NDF Digestibility assay (NDFD; % of NDF)
Determined via in vitro incubation of sample in rumen fluid or NIRS calibrated from in vitro data. NRC-01 recommended 48-h incubations. There has been considerable interest within the industry regarding NDFD measured at earlier time points with suggestions of improved accuracy relative to in vivo data for 30-h incubation and improved lab turn around time and lab efficiency for 24-h incubation. There are concerns, however, about reduced precision at the earlier time points. In MILK2006, the user must define the incubation time used in the NDFD analysis of their samples by the laboratory and also the average corn silage NDFD for that lab for that incubation time. Input below the laboratory average for corn silage NDFD (% of NDF) and the time point used by the lab for their incubations (both values must be entered for the worksheet to function properly, and must correspond to the NDFD values entered for the samples being evaluated). Caution: early time point assays (24h or 30h) may lack precision unless sufficiently replicated in the lab.
Lab NDFD
Average, % of NDF 59
Incubation time hours (24, 30, or 48) 48
2- Inputs for assays to calculate starch digestibility
Starch digestibility is a calculated value with minimum set at 0.76 and maximum set at 0.98. If available and desired, either Kernel Processing Score (KPS), Degree of Starch Access (DSA),
UW Extension
Wisconsin Forage TEAM
Dairy Team Extension
COLLEGE OF AGRICULTURAL & LIFE SCIENCES
UNIVERSITY OF WISCONSIN-MADISON
EXCELLENCE IN EDUCATION AND DISCOVERY
agronomy.wisc.edu
Agronomy at UW-Madison

MILK2006



Milk 2006

University of Wisconsin Corn Silage Evaluation System

Randy Shaver, Dept. of Dairy Science *Patrick Hoffman, Dept. of Dairy Science*
Joe Lauer, Dept. of Agronomy
Jim Coors, Dept. of Agromomy

Sample values entered here must correspond to lab average and incubation time information entered in "UserInputGuide" Worksheet cells G25 and G27.

Critical Data Entry
Required Inputs
Calculated Outputs

		Form Input	Optional Starch Digestibility Tests			Lab Value	Lab Value	Lab Value	Lab Value	Lab Value	Lab or Book Value	Lab or Book Value	Field Measure	Calculated	Calculated	Calculated	Calculated
Field ID	Lab ID	Kernel Processed yes/no	KPS %	DSA %	IS-IV %	DM %	CP % DM	NDF % DM	NDFD % NDF	Starch % DM	Ash % DM	Fat % DM	DM Yield tons/acre	TDN-1x % DM	NE_L-3x Mcal/lb DM	Milk per Ton Index lb/ton DM	Milk per Acre Index lb/acre
silo 1	L001	yes				35.4	7.4	44.1	75.6	28.6	5.9	2.9	7.0	76.6	0.73	3546	24822
silo 2	L002	yes				35.9	7.8	41.2	58.0	34.8	5.4	3.0	7.0	70.5	0.69	3248	22735
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Kernel processed

MILK2006

AQ33

Milk 2006

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Starch Digestibility

MILK2006

AQ33 f_x

Milk 2006

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DM

MILK2006

AQ33 | f_x

	A	B	C	D	E	F	G	H	I	J	M	N	O	P	Z	AA	AF	AG

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12	Field ID	Lab ID	Kernel Processed yes/no	KPS %	DSA %	IS-IV %	DM %	CP % DM	NDF % DM	NDFD % NDF	Starch % DM	Ash % DM	Fat % DM	DM Yield tons/acre	TDN-1x % DM	NE_L-3x Mcal/lb DM	Milk per Ton Index lb/ton DM	Milk per Acre Index lb/acre
13	silo 1	L001	yes				35.4	7.4	44.1	75.6	28.6	5.9	2.9	7.0	76.6	0.73	3546	24822
14	silo 2	L002	yes				35.9	7.8	41.2	58.0	34.8	5.4	3.0	7.0	70.5	0.69	3248	22735
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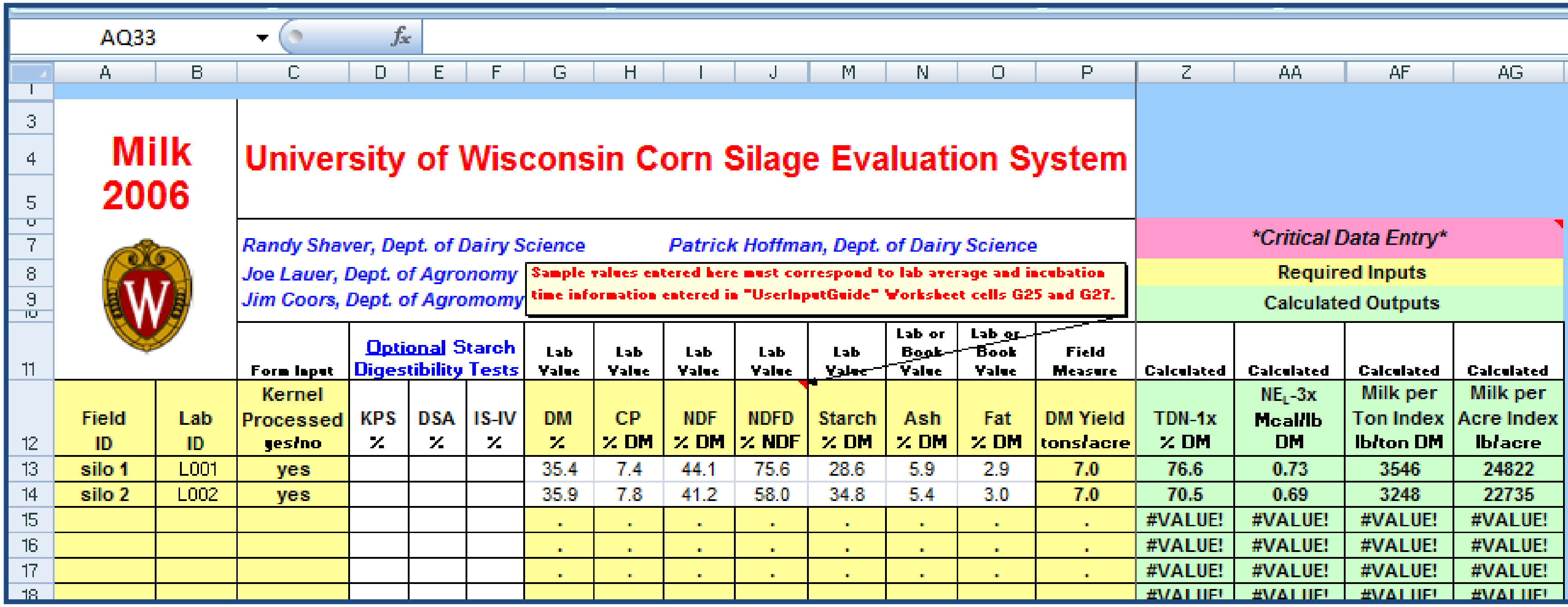
CP

MILK2006



AQ33

	A	B	C	D	E	F	G	H	I	J	M	N	O	P	Z	AA	AF	AG
3–5	Milk 2006		University of Wisconsin Corn Silage Evaluation System															
7			Randy Shaver, Dept. of Dairy Science						Patrick Hoffman, Dept. of Dairy Science						*Critical Data Entry*			
8			Joe Lauer, Dept. of Agronomy			Sample values entered here must correspond to lab average and incubation time information entered in "UserInputGuide" Worksheet cells G25 and G27.									Required Inputs			
9			Jim Coors, Dept. of Agromomy												Calculated Outputs			
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NDF

MILK2006

AQ33

Milk 2006

University of Wisconsin Corn Silage Evaluation System

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NDFD

MILK2006

AQ33

Milk 2006

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Starch

MILK2006

AQ33

Milk 2006

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Calculated
Milk per Acre Index lb/acre
24822
22735
#VALUE!
#VALUE!
#VALUE!
#VALUE!

Ash

MILK2006

AQ33

Milk 2006

University of Wisconsin Corn Silage Evaluation System

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Fat

MILK2006

AQ33 f_x

Milk 2006

University of Wisconsin Corn Silage Evaluation System

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18															#VALUE!	#VALUE!	#VALUE!	#VALUE!

Tons/acre

MILK2006

AQ33

Milk 2006

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TDN
NEl
Milk per Ton
Milk per Acre

MILK2006

- It is very useful to compare hybrids because it combines silage yield and nutrient composition of the crop.

- The information on the energy value of the crop is only as good as the input that is entered into the spread sheet calculation.

Pricing Corn Silage, UMN

Traditionally, corn silage price was calculated as:

7-10 x bushel price of corn = price of a ton of corn silage at 35% DM

New Approach: gives value to **starch** and **fiber** content (Linn, 2002).

Base Price + Starch Adjustment + NDFd Adjustment

Starch adjustment
(% starch - 29%) x (0.5 bu/starch) x (corn price $/bu)

NDFD adjustment
(% NDFd) x (0.6 lb milk/NDFd) x (milk price $/lb)

Starch Adjustment = ((% starch (DM basis) – 29%) x .5 bushels) x corn $/bushel

Example - 26% starch and corn price of $2.40/bushel

Adjustment = ((26 – 29) x 0.5) x $2.40 = -$3.60/ton silage DM

NDF digestibility Adjustment

Example 59% NDF digestibility (48 hour in vitro) and milk at $13.50/cwt

Adjustment = 59% x .6 x .1350 = $4.78/ton silage DM

Base price - established based on planting, seed, agronomic and harvest costs

Example - $20/ton at 33% DM = $60.60/ton DM

$/ton of corn silage DM = Base + Starch Adjustment + NDF dig Adjustment.

= $60.60 + (-$3.60) + $4.78

= $61.78/ton DM or $20.39/ ton at 33% DM

Hedonic Price,
The Ohio State University

Animals do no require feeds but the nutrients within that fed. The value of a feed should be calculated based on the nutrients that it contains.

Hedonic price

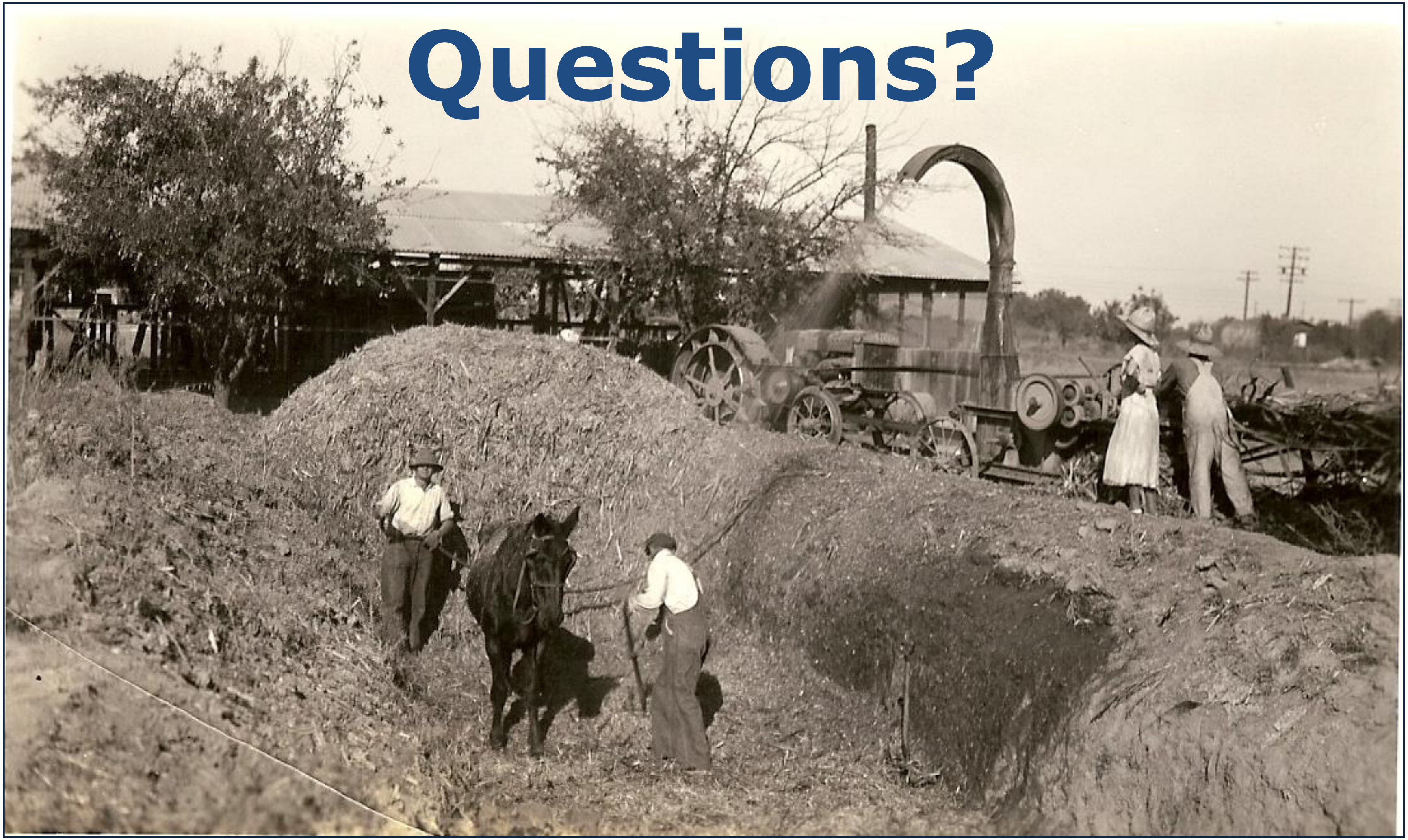
The unit price of nutrients within a feedstuff is calculated based on the commodity prices in a given market

Normam St-Pierrem Progressive Dairyman

Summary

The feeding value of the forage standing in the field may not correlate with the ensiled forage.

Animal acceptability and production performance is related to multiple factors: nutrient content, nutrient digestibility, physical form, quality of fermentation and microbial quality.



Silage pit in the Central Valley (late 1930's)

Photo Courtesy of Alan George, retired UCCE Farm Advisor in Tulare County