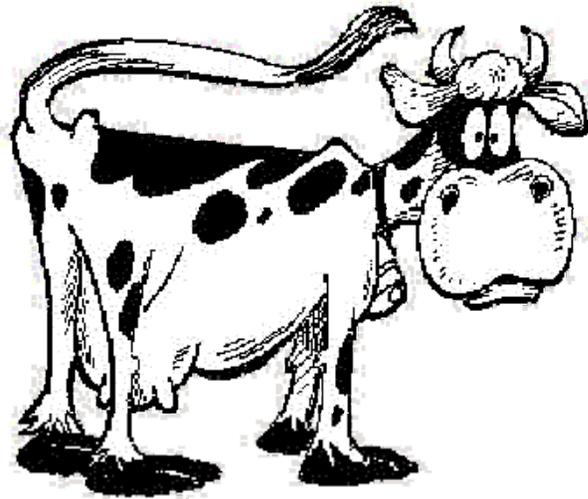


What do the real experts (cows)  
say about corn silage fiber analysis?



Dr. David Combs  
Dept. of Dairy Science  
University of Wisconsin-Madison

# Corn silage as a forage

- Advantages over other forage crops
  - High yield
  - High energy (TDN) forage
  - Manure management options
  - Custom harvesting



# What makes a better corn silage?

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



# Milk 2006

## Ranking CS by yield and quality

- Milk/acre: Yield, digestibility and intake
  - ✓ Lauer (2009): correlation between corn silage yield and Milk<sub>2006</sub>/acre = .97
  - ✓ Average difference between top and bottom performing hybrids in UW trials is 3.7 tons DM/Acre
  - ✓ 11,500 lb milk/acre difference between top and bottom performing hybrids

# Milk 2006

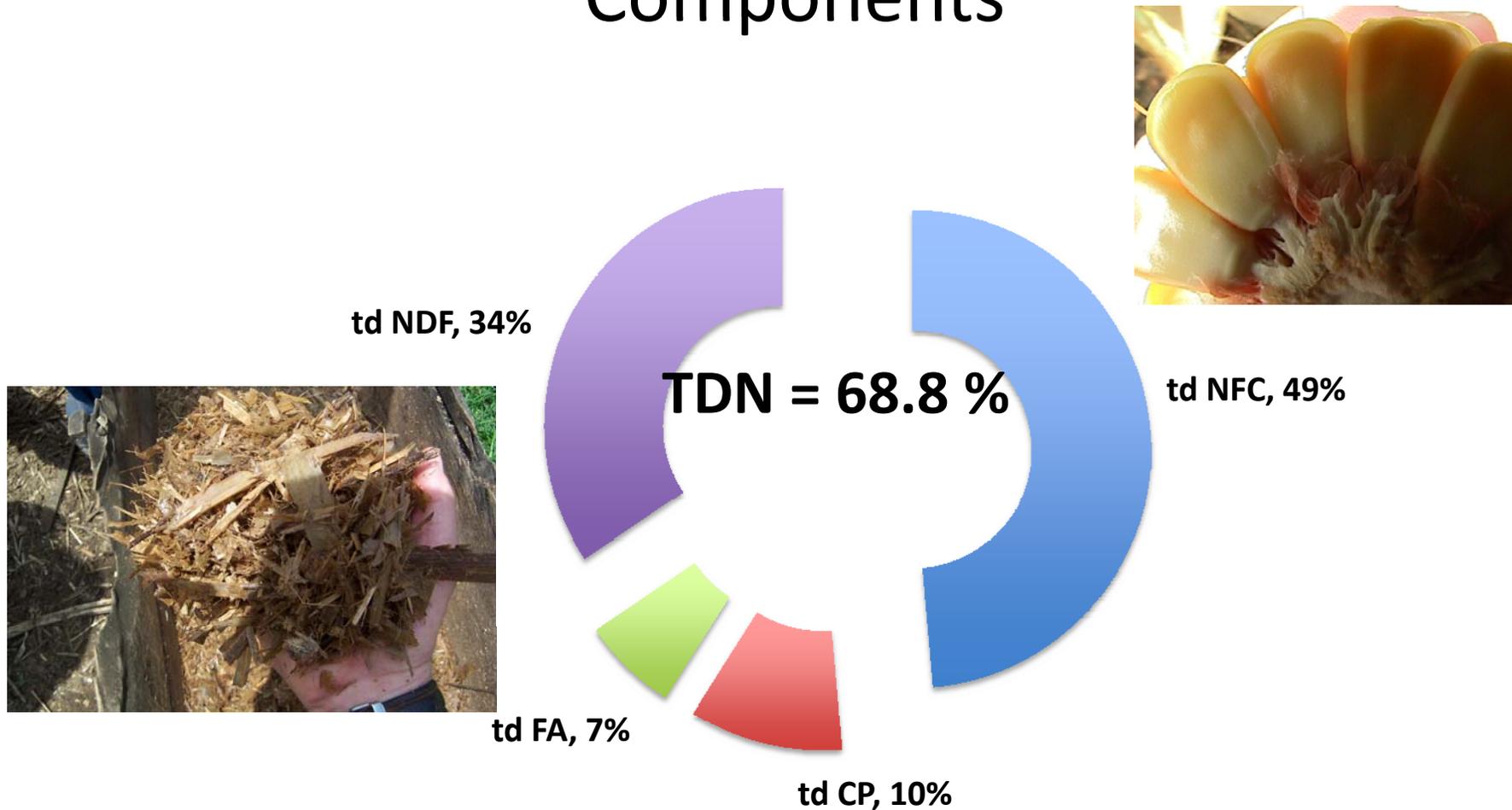
- Milk/ton: Ranks CS by Quality (Digestibility and Intake)

Lauer (2009) correlation of silage traits with milk/ton:

- NDF - 0.46
- NDFD + 0.49
- Starch + 0.48
- StarchD + 0.30



# Contributions to TDN by Corn Silage Components



$$\text{TDN}_{1x} = \text{td NFC} + \text{td CP} + (\text{td FA} \times 2.25) + \text{td NDF} - 7$$

- About 1/3 of the energy in corn silage is in the fiber fraction (digestible NDF)
- NFC fraction accounts for about 1/2 of the energy in corn silage



# Energy from corn silage fiber is affected by:

- The amount of fiber (NDF)
  - The digestibility of fiber (NDFD)
- 
- ✓ Both are measurable characteristics of corn silage
  - ✓ Both can be selected for in corn breeding programs
  - ✓ Both are affected by harvest date, growing conditions and environment

# Corn Silage NDF values

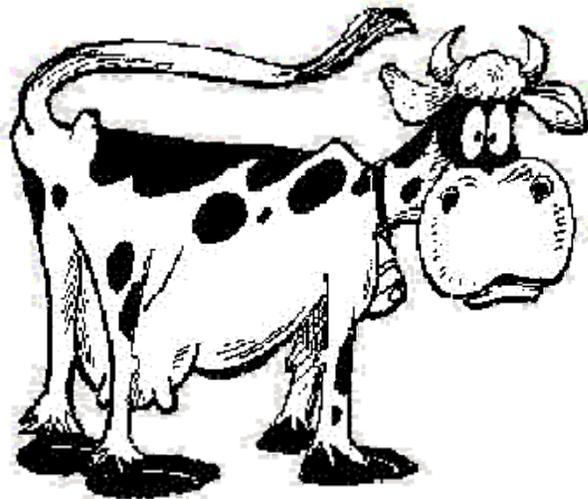
Data base	n	NDF, %	SD	Range
NRC 2001	1033	45	5.3	
Lab 1, 2009	> 15,000	43	5.6	37-48
Lab 2, 2009	> 20,000	42	4.8	32-52
Lab 3, 2009	> 10,000	43	4.6	19-65
UW Corn silage Hybrid evaluation 1995-2008	2665	47	5.4	

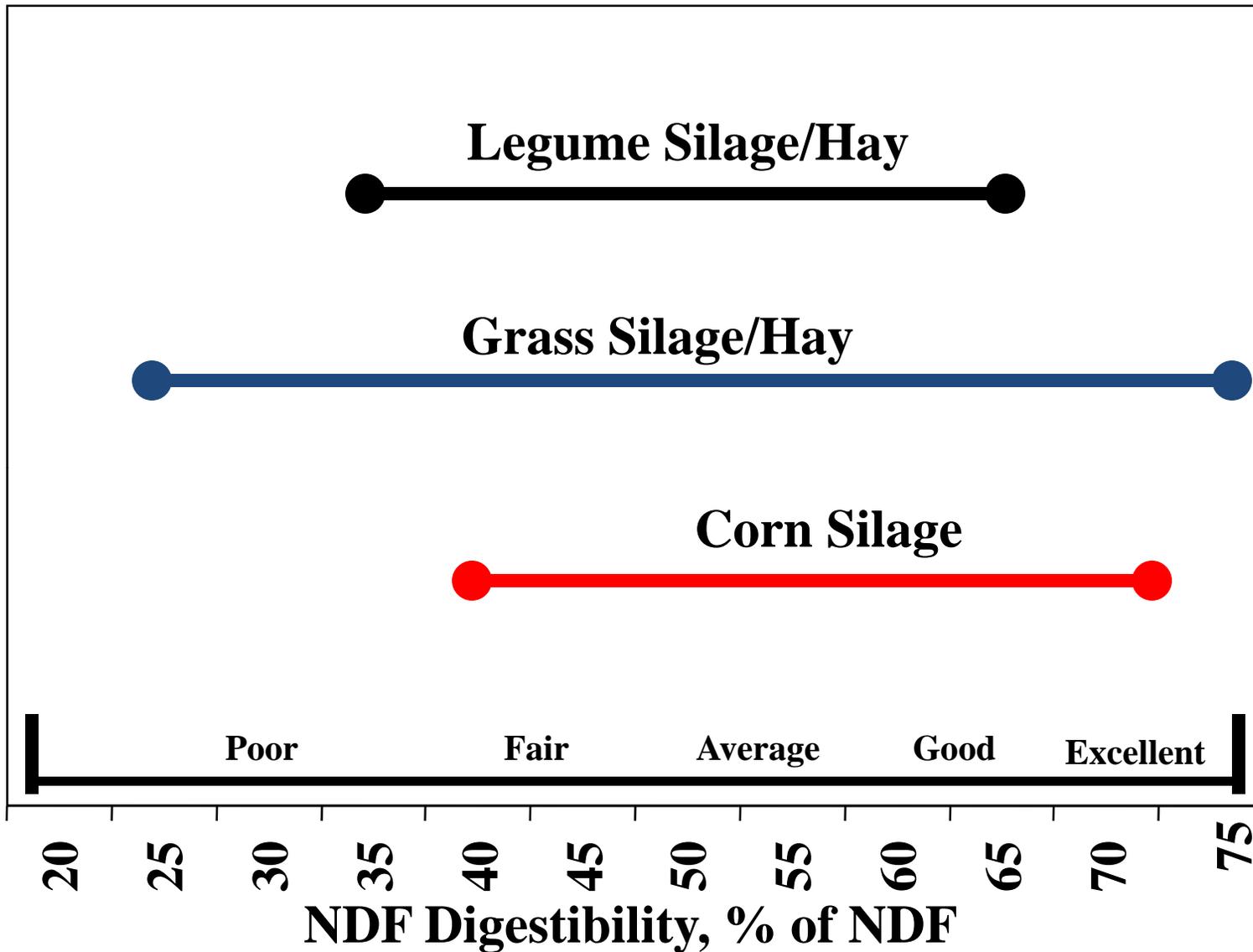
- ✓ Corn silages analyzed by commercial labs vary greatly in NDF content
- ✓ Variations in NDF content in the field are largely due to environment and management

# NDFD and Dairy Performance

*The real experts (cows) report:*

- ✓ Increased IVNDFD correlated with higher milk production
- ✓ Milk response to IVNDFD through DMI, not improved total tract digestibility
- ✓ DMI and Milk responses appear to be greater in higher producing cows





**Figure 1.** Ranges of NDF digestibility for common forages. The NDF digestibility ranges and guidelines are based on a 48 h in vitro true dry matter digestibility assay. (Marshfield Soil and Forage Analysis Laboratory, University of Wisconsin-Madison: 2001 Nutrient Requirements of Dairy Cattle).

## NDFD affects Dairy Cow Performance

Reference	Diets	NDF (% DM)	DMI (lb/d)	Milk (lb/d)
Oba and Allen, 1999	iso-CS	31.6		
	<i>bm3</i> -CS	30.8	+4.6	+6.2
Oba and Allen, 2000	iso-CS	29.1		
	<i>bm3</i> -CS	28.7	+4.0	+6.8
	iso-CS	38.4		
	<i>bm3</i> -CS	37.5	+3.1	+7.3
Tine et al. 2001	iso-CS	32.0		
	<i>bm3</i> -CS	31.3	+5.2	+6.8

# Response to corn silage NDF and NDFD

(Ivan et al. 2005 JDS 88:244-254)

Item	Low NDF	High NDF
CS NDF, %	49	53
CS NDFD <sub>48</sub>	58	67
Diet NDF, %	31	33

DMI, lb/d	53 <sup>a</sup>	56 <sup>b</sup>
3.5% FCM, lb/d	70 <sup>a</sup>	75 <sup>b</sup>

<sup>a,b</sup> DMI and Milk yield were higher for cows fed High NDFD CS, P<0.05

## The *real* experts (cows) agree:

A 1% increase in forage NDFD is associated with a 0.4 lb increase in intake and a 0.8 lb increase in 4% FCM yield.

(Oba and Allen, 1999)

# The Challenge: NDFD values vary by lab

- **No standard method:** Scientists can't agree on the most appropriate method
- **The Result:**
  - Should not compare NDFD values between labs
  - NDFD is limited to ranking corn silages
  - Can't compare fiber digestibility of corn silage to alfalfa or grasses

# Challenges with NDFD assays

Many different methods/modifications

*lignin*: calculated fiber digestibility

*in situ methods*

*in vitro methods: Procedures differ by lab*

Variation in in vitro lab methods

Rumen fluid is not a reagent

Incubation times

Grind size and type



**Don't compare forages with NDFD results from different labs!**

## Corn Silage NDFD values vary by method and lab (2009 forage data base summaries)

	NDF	NDFD24	NDFD30	NDFD48
	% of DM	-----% of NDF-----		
Lab 1	42	53	57	61
Lab 2	43	NR	58	64
Lab 3	43	16	24	42
Lab 4	43	42	53	62

- Labs use different methods to measure NDFD
- Labs report in vitro NDFD values at different times
- Use in vitro values to index forage within a lab



NDF digestibility values are useful for ‘indexing’ forages:

- Compare corn silages only
- Don't compare values of different labs

# *In vitro* estimates of fiber digestibility are not the same as *in vivo* measurements

*In vitro/ in situ* systems

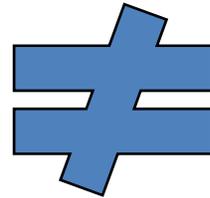
Ruminal  
Batch  
Forage characteristic

Quick, relatively inexpensive

*In vivo* measurements

Total tract  
Continuous fermentation  
Combination of forage, diet and animal

Slow, expensive, impractical for routine analysis



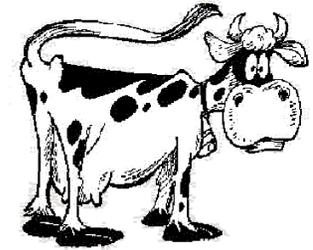
# Comparing corn silage and legume silage NDFD values

(2009 lab data base averages)

	NDFD 30		NDFD 48	
	CS	AS	CS	AS
	<b>-----NDFD, % of NDF-----</b>			
Lab 1	57	48	61	60
Lab 2	54	43	59	46
Lab 3	52	52	62	55

In vitro lab tests suggest that corn silage fiber is more rapidly digested than legume silage fiber

# What do the 'real experts' say?



**Legume/grass feeding trials**  
(20 trials, 64 observations  
In vivo NDF diet digestibility)

**Mean 47.3 % of NDF**

**Range 31.1-66.2 % of NDF**  
**St. Dev 8.1**

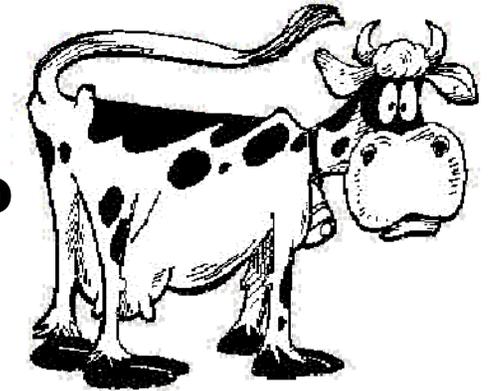
Cows report that NDF digestibility of legume/grasses are higher than fiber digestibility of corn silage.

**Corn Silage/Sorghum feeding trials**  
(25 trials, 81 observations,  
In Vivo NDF diet digestibility)

**Mean 40.2 % of NDF**

**Range 20.1-58.8 % of NDF**  
**St. Dev. 8.8**

# Why don't cows and labs agree?



In vitro  $\neq$  in vivo

In vitro tests might overestimate rate of fiber degradation?

Rate of NDF digestion	NDFD30	NDFD48	Estimated Digestibility in vivo
	-----% of NDF-----		
3 % per hour	42	56	38
6 % per hour	61	71	56

## Research Opportunity!

# The bottom line

**About 1/3 of the energy value of corn silage is associated with NDF**

**Corn silage hybrids vary in NDF and NDFD content**

- NDF and NDFD are tools to compare corn silage hybrids
- Milk 2006 uses NDF and NDFD to compare hybrids

**Limits of NDFD: Not all NDFD tests are the same**

- NDFD values vary by lab (lignin, in situ tests, in vitro)
- Use NDF and NDFD (ie Milk 2006) to compare corn silages
- In vitro NDFD values for corn silage appear to overestimate fiber energy values
- Alfalfa and corn silage in vitro NDFD values are 'apples to oranges' comparisons

# Web Resources

- UW Extension Forage Resources  
[www.uwex.edu/ces/crops/uwforage/uwforage.htm](http://www.uwex.edu/ces/crops/uwforage/uwforage.htm)
- UW Extension Corn Agronomy
- <http://corn.agronomy.wisc.edu/Extension.htm>
- UW Department of Dairy Science
- <http://www.wisc.edu/dysci/>