

Nonfiber Carbohydrates In Forages

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Carbohydrates provide the main energy source to support high production.

However, CHO do not all function the same way in rations, or support similar performance.

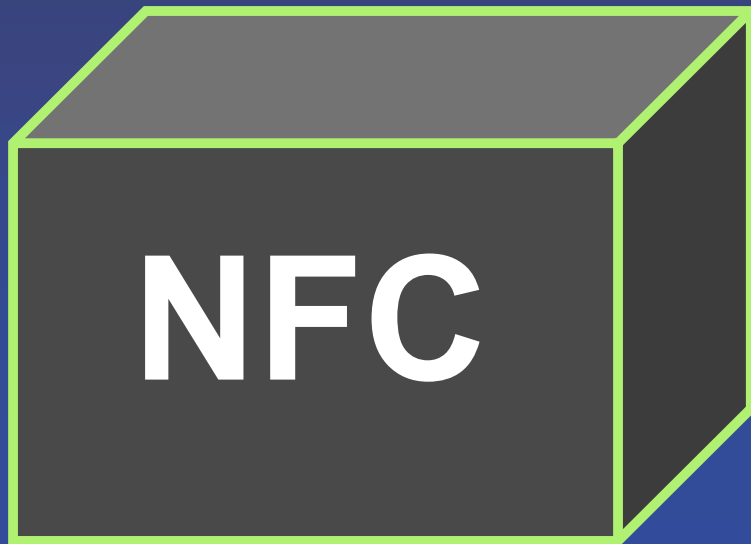


Which can affect profitability.

Non- NDF Carbohydrates (circa 1860)

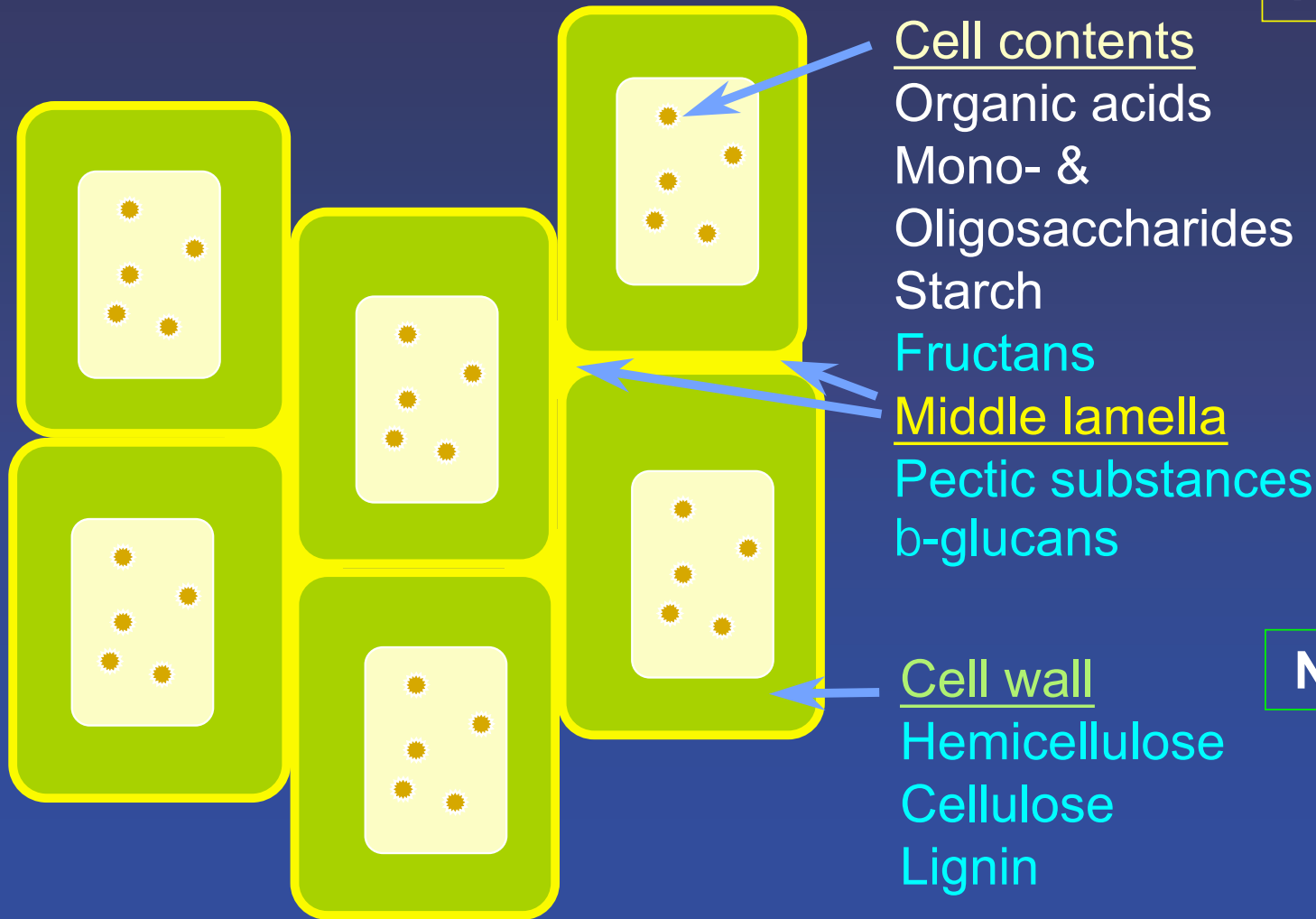
$$\text{NFE} = 100 - \text{CP} - \text{CF} - \text{EE} - \text{Ash}$$

$$\text{NFC} = 100 - \text{CP} - (\text{NDF} - \text{NDFCP}) - \text{EE} - \text{Ash}$$



- ☀ Very digestible (98%?)
- ☀ Error pool
- ☀ Chemically and nutritionally diverse

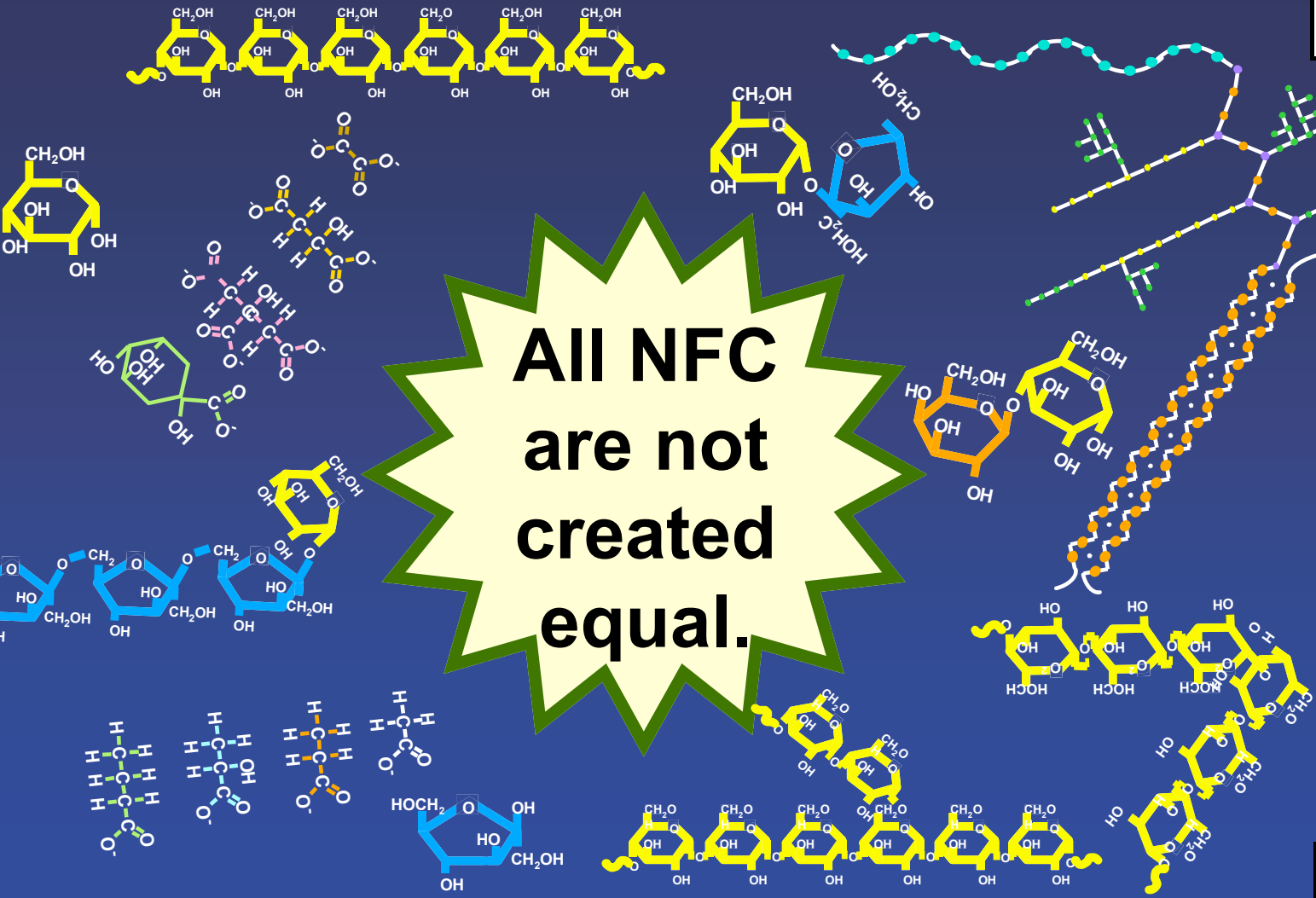
Plant Cell Structure



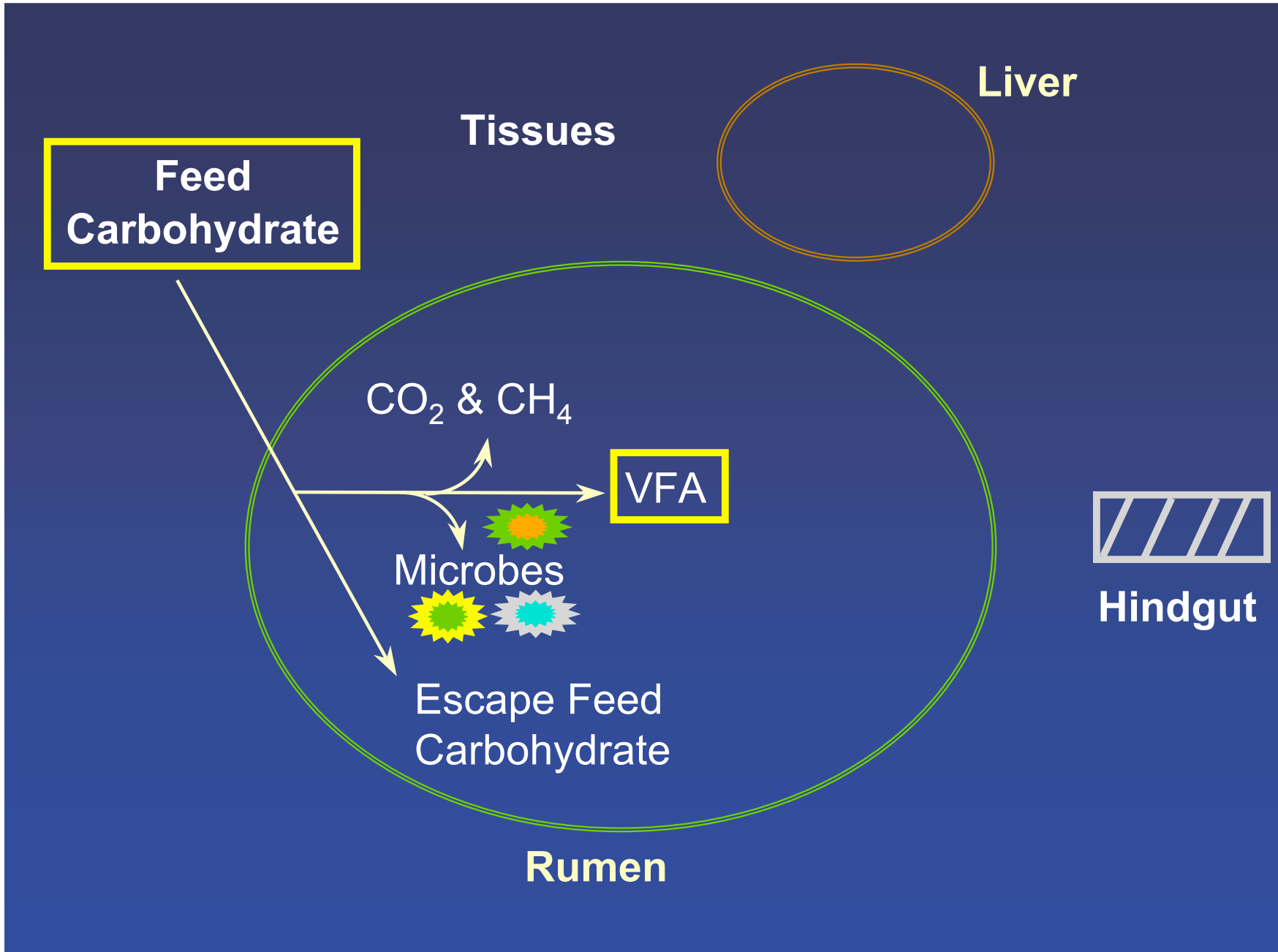
NFC

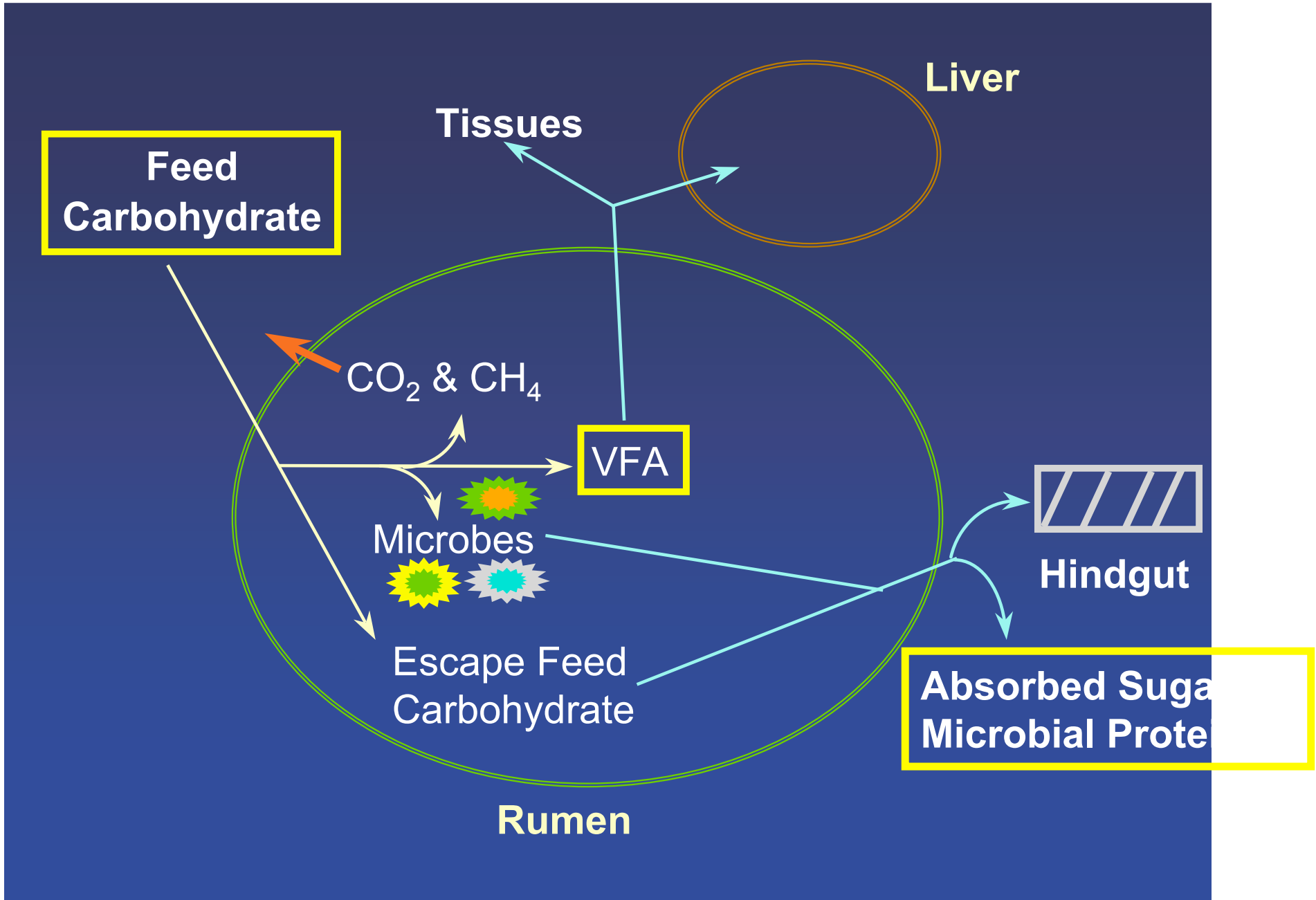
NDF

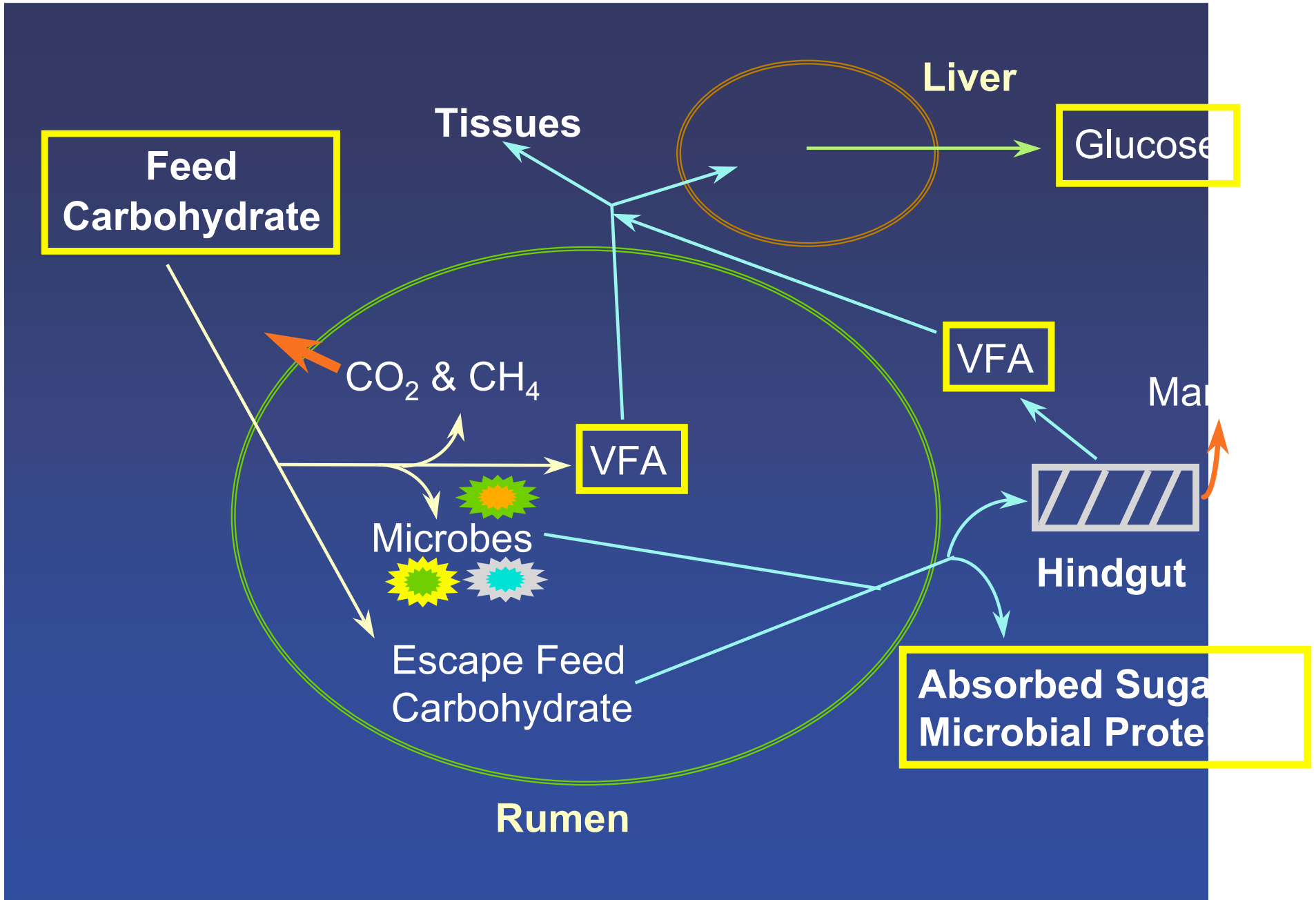
**All NFC
are not
created
equal.**











NFC Digestion Characteristics

Digested by
Mammalian
Enzymes

Support
Microbial
Growth

Organic
Acids

Sugars ?

Starches

Fructans

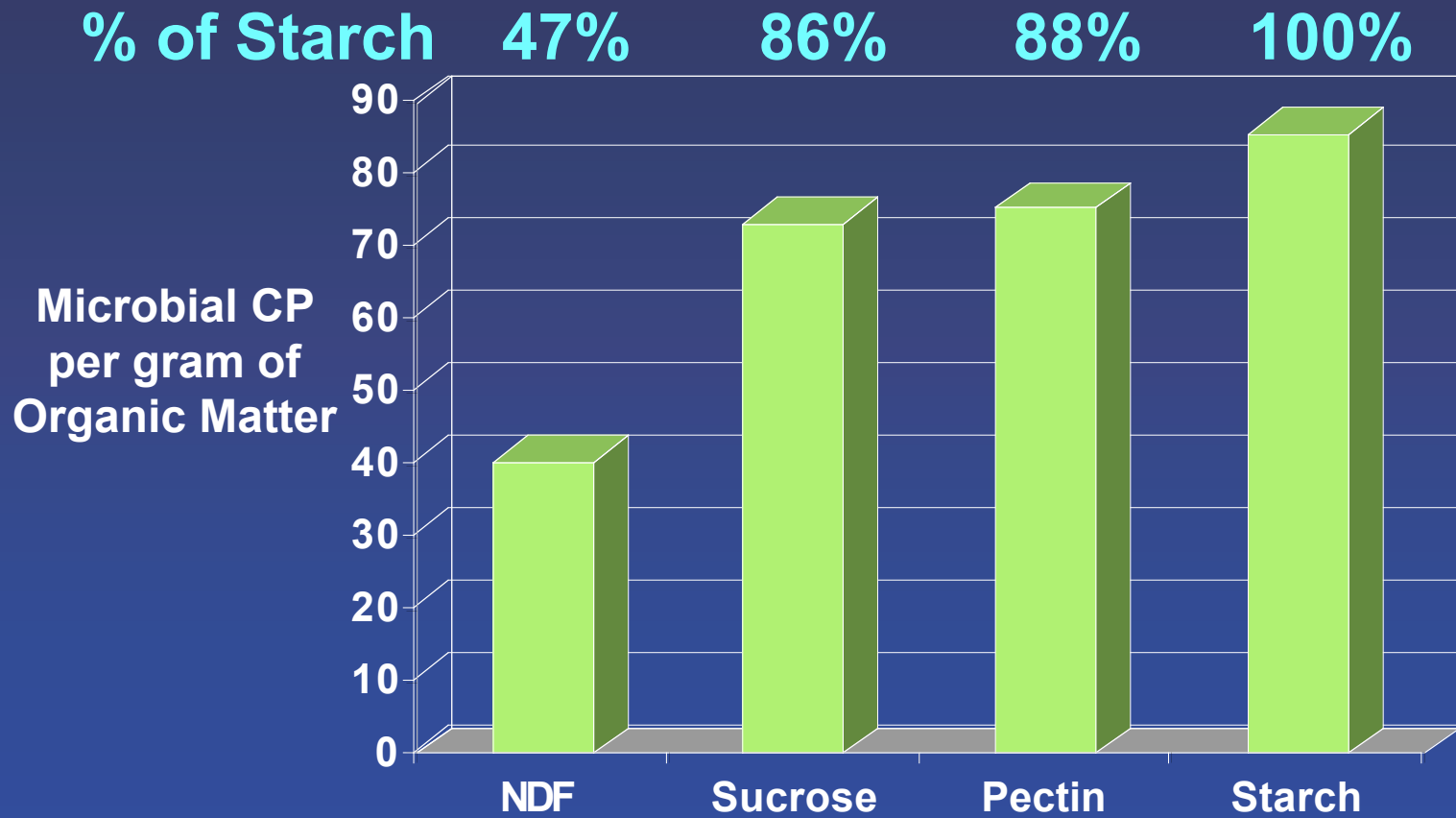
Pectic
Substances

b-Glucans

Potentially
Ferment to
Lactic Acid

Decreased
Fermentation
at Low pH

Maximum Microbial CP Yield



NFC Types & Sources

Organic Acids

Silages

Whey

Steep liquor

Sugars

Molasses

Bakery waste

Fresh forages/hays

Beet & citrus pulps

Almond hulls

Starch

Grain silages

Corn, sorghum

Small grains

Bakery waste

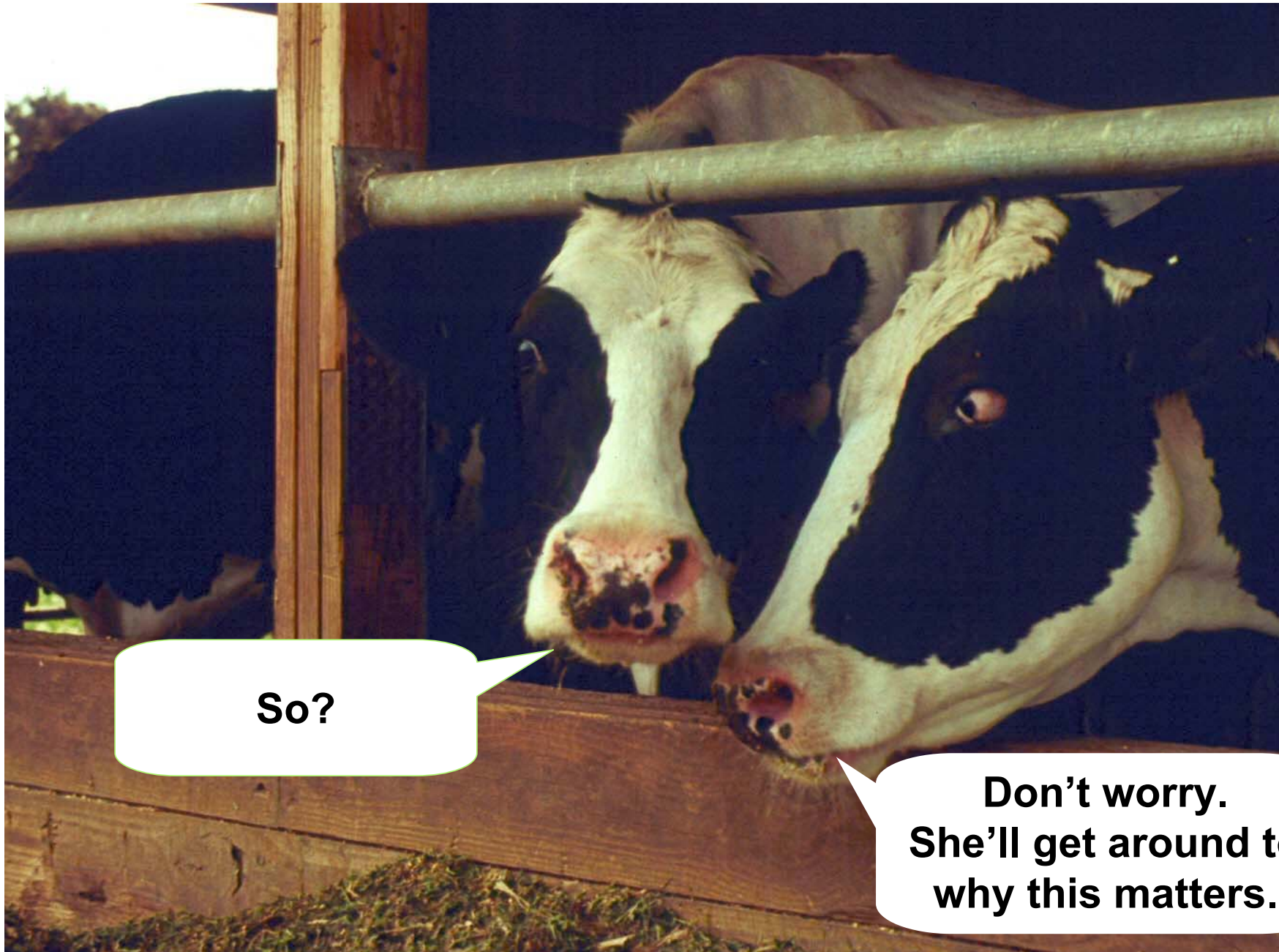
Wheat midds

Soluble Fiber

Legume forages

Beet & citrus pulps

Soybean meal



So?

**Don't worry.
She'll get around to
why this matters.**

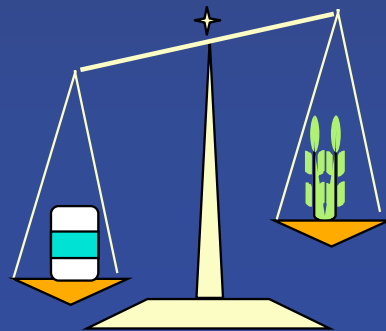
Starch vs. Soluble Fiber + Sugar

	1 Corn vs Beet Pulp	2 Corn vs Citrus Pulp	3 Hominy vs Citrus Pulp
DM Intake, lb	+2.6*	+1.2*	+1.1
Milk, lb	+0.7	+2.0	+3.3
Fat, %	-0.18	-0.05	-0.11
Fat, lb	-0.07	+0.04	+0.02
Protein, %	+0.09*	+0.07*	+0.12*
Protein, lb	+0.11*	+0.08‡	+0.18‡

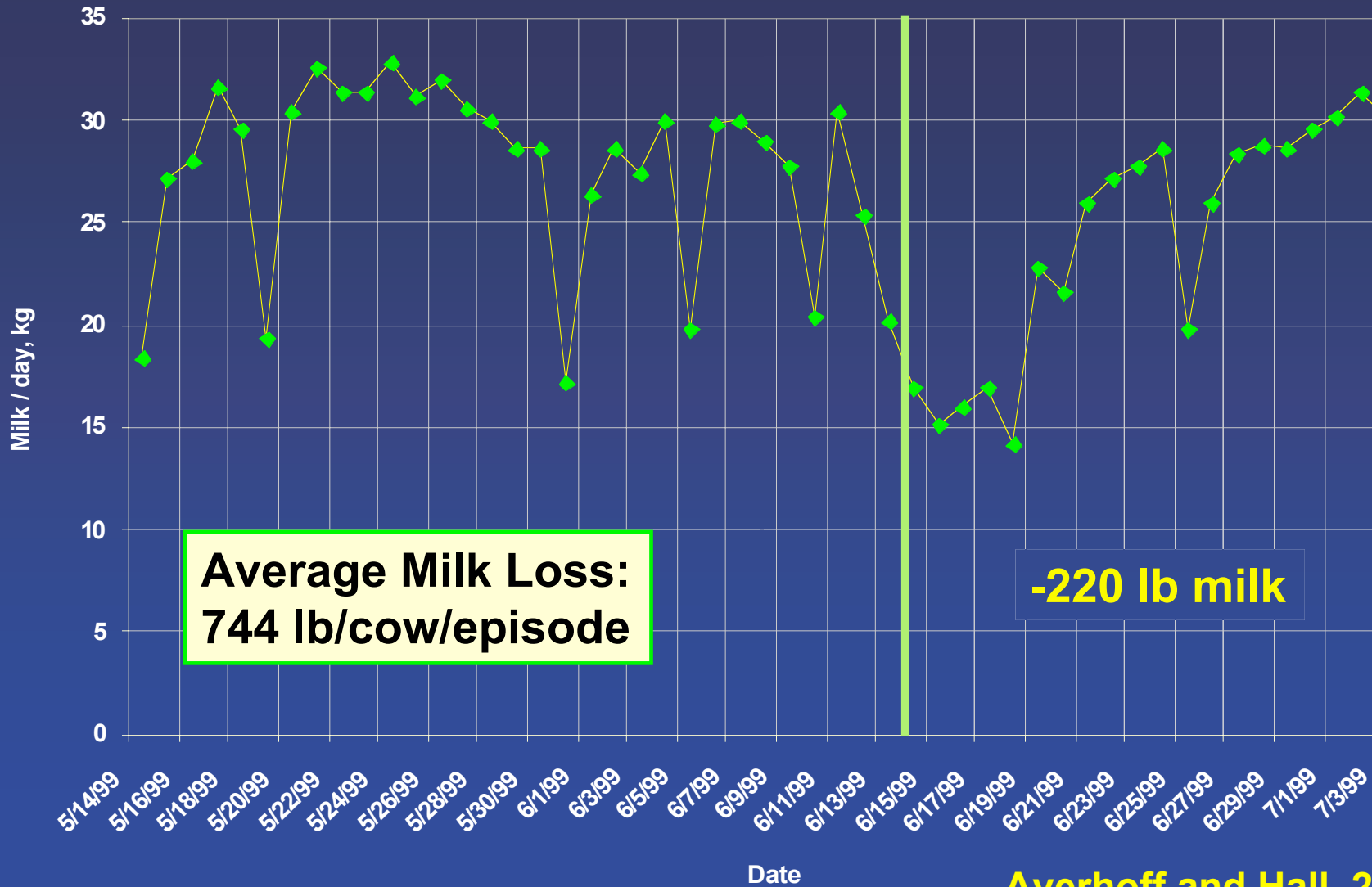
* $P < 0.05$, ‡ $P < 0.15$

Mansfield et al., 1994; Solomon et al., 2000; Leiva et al., 2000

Obviously, we
should feed more
starch.



Moe, 1976



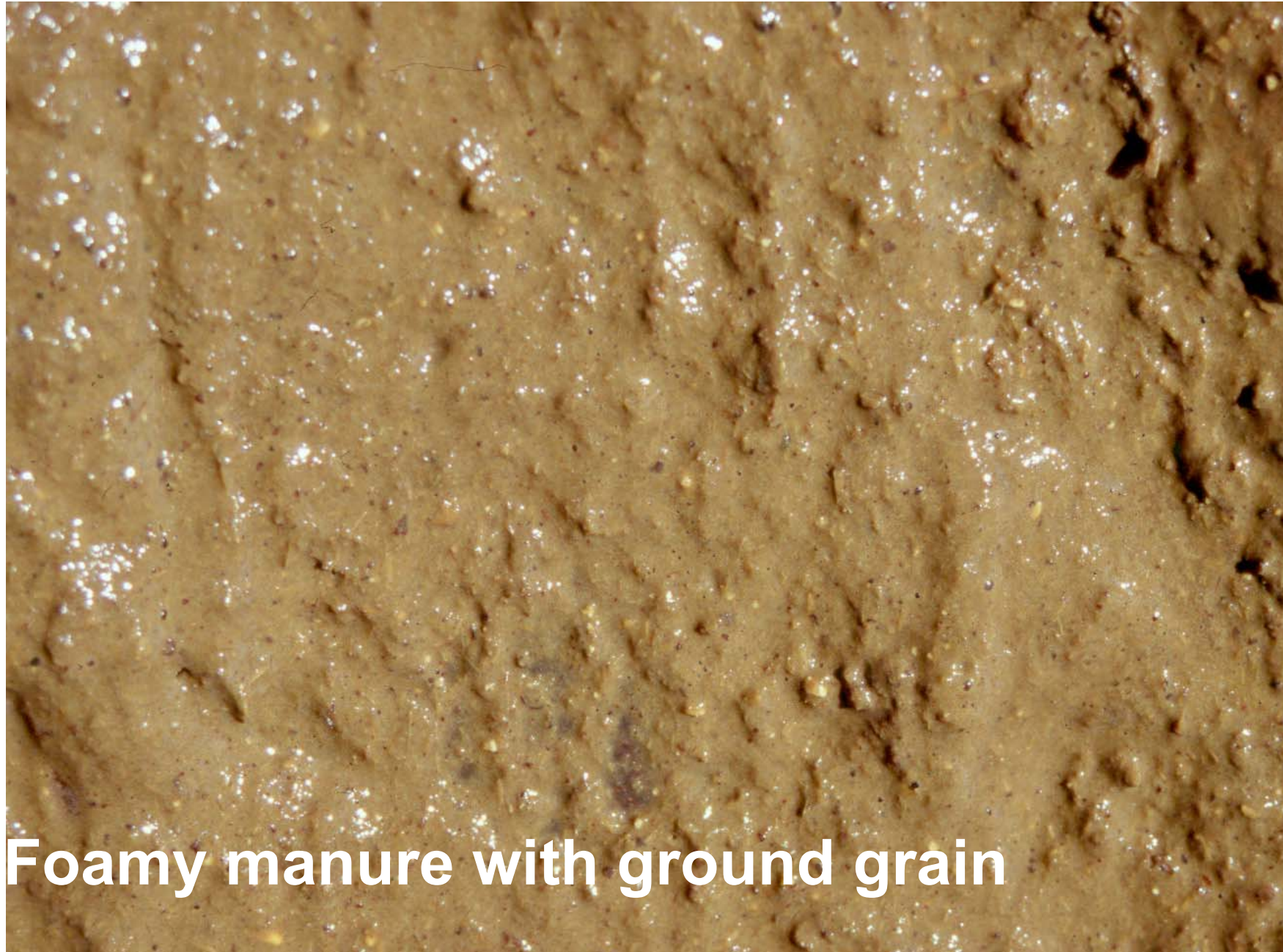
**Average Milk Loss:
744 lb/cow/episode**

-220 lb milk

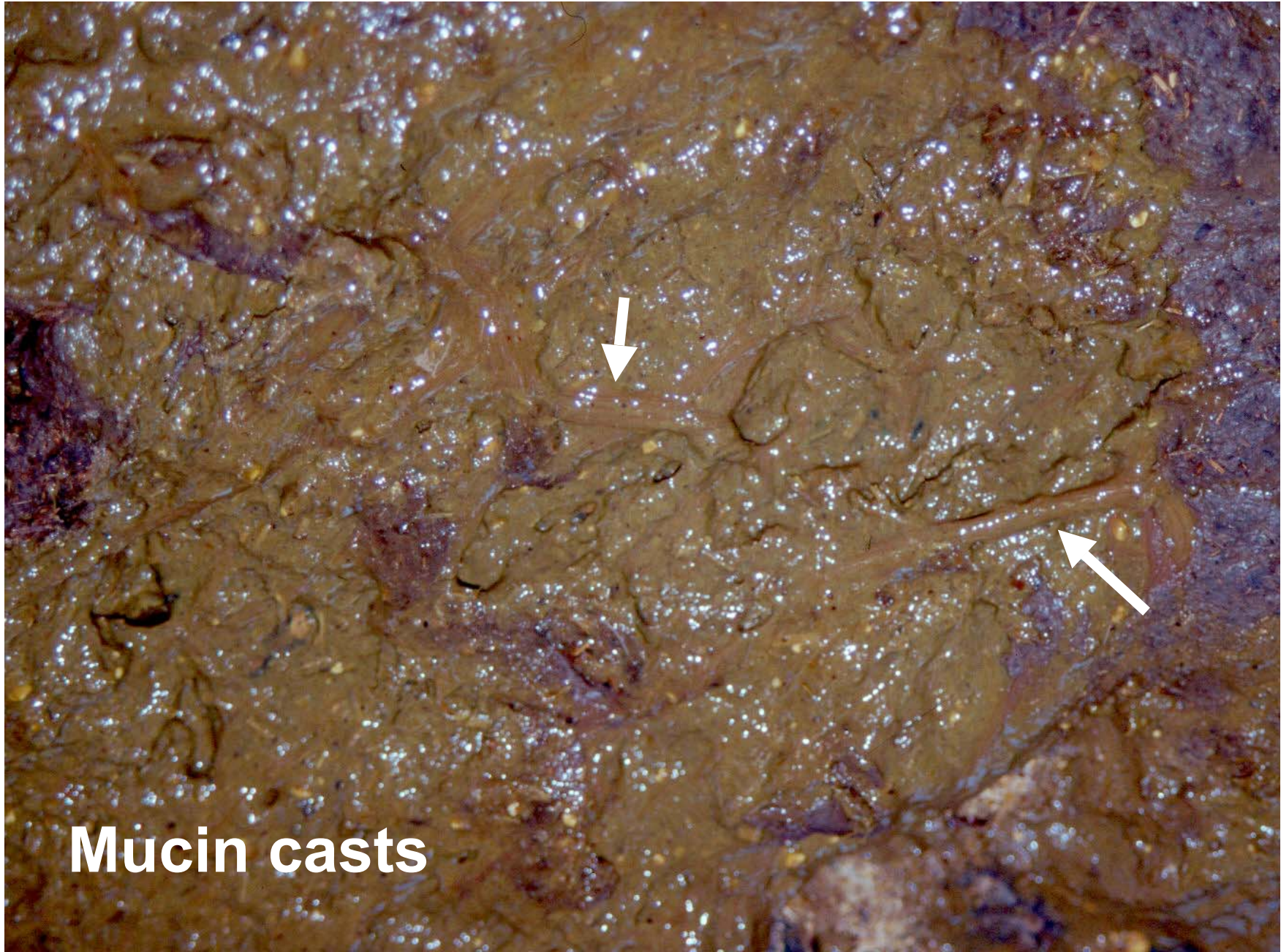
Averhoff and Hall, 2000



Diarrhea



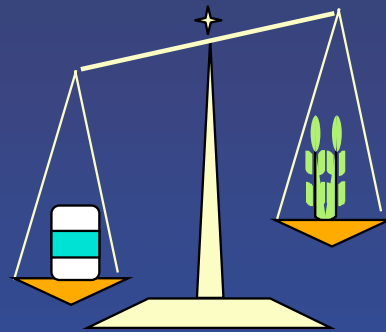
Foamy manure with ground grain



Mucin casts



- ★ **Net Energy and TDN are not fixed values.**
- ★ **They change with changing rations.**



- ★ **They decrease in unbalanced rations & when digestive processes are disturbed.**



Effect of NFC on NDF Digestibility, %

RDP % of BW	Sugars				
	<u>Ctrl</u>	<u>Starch</u>	<u>Glc</u>	<u>Fru</u>	<u>Suc</u>
0.031	60.0	52.5	45.1	52.0	41.9
0.122	59.3	61.2	68.1	71.3	62.3

At the lower level of RDP, no difference among supplements.

At greater RDP, starch differed from sugar ($P=0.05$) and mono- differed from disaccharides ($P=0.03$).

Carbohydrates: Sugar v. Starch

Sugar:Starch (% Diet DM)

	0:7.5	2.5:5.0	5.0:2.5	7.5:0
DM intake ^L	54.0	56.4	57.3	57.3
Milk, lb ^L	85.8	89.1	88.2	86.9
Fat, lb ^L	3.24	3.37	3.64	3.57
Protein, lb	2.73	2.82	2.84	2.82
Rumen pH	6.19	6.16	6.19	6.21
Milk/DM ^L	1.60	1.58	1.54	1.52
FPCM/DM	1.64	1.63	1.66	1.64
MN/IN ^L	0.312	0.291	0.291	0.295

^L $P < 0.05$, ^L $P < 0.10$

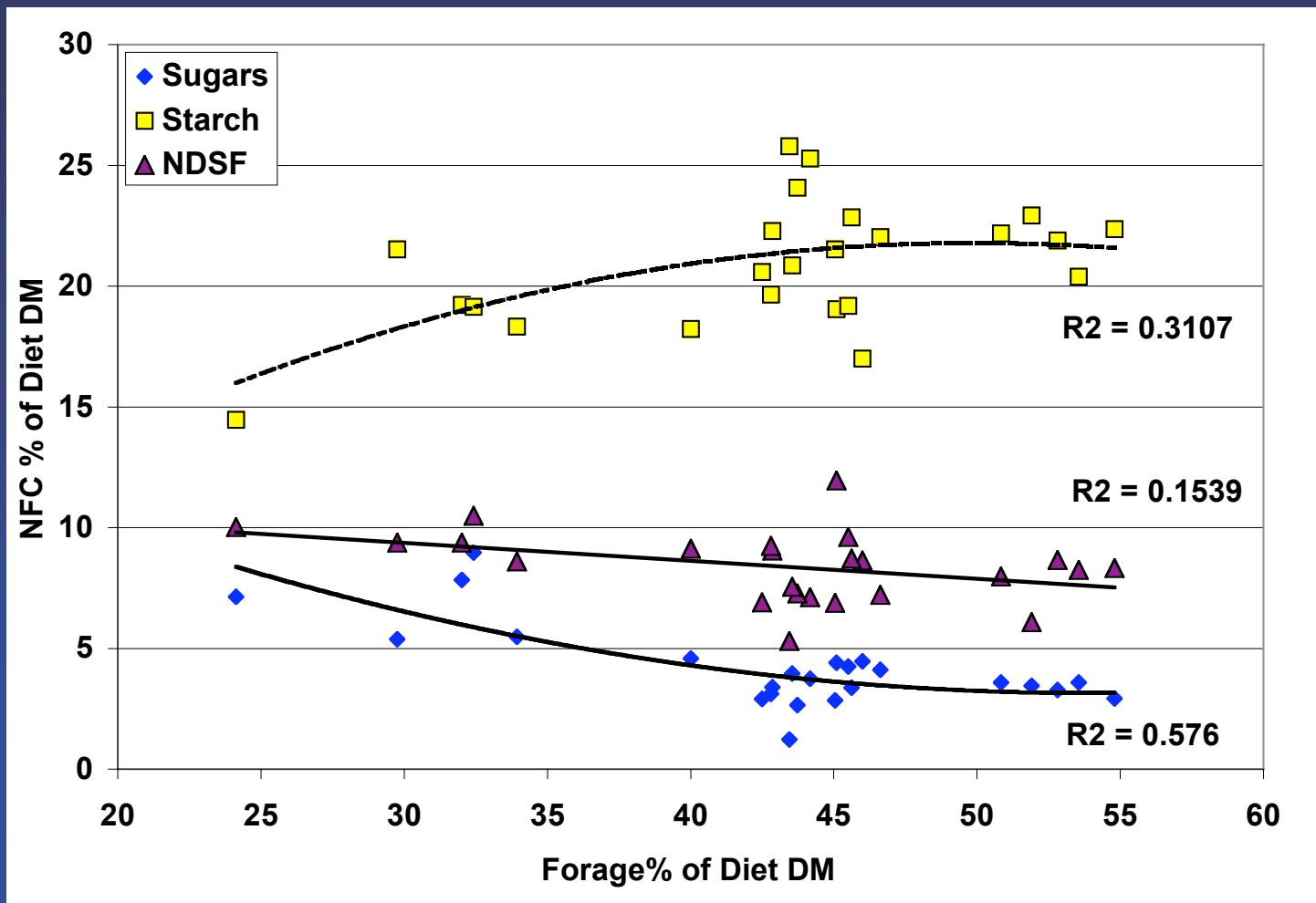
Broderick et al., 2002

Formulating Rations: NFC and Forage

- ★ What balance among NFC and fiber?
- ★ Collected rations
 - Healthy, productive cows
 - Feed analyses
 - Cows ration ~ paper ration
 - Estimated NFC fractions



NFC vs. Forage (% of ration DM)



2001 Dairy NRC NFC Recommendations

Min.
Forage
NDF

19

18

17

16

15

Min.
Dietary
NDF

25

27

29

31

33

Max
Dietary
NFC

44

42

40

38

36

- ☀ Slug feeding
- ☀ Empty bunk
- ☀ Cows sorting
- ☀ Heat stress

Think

“Risk Management”



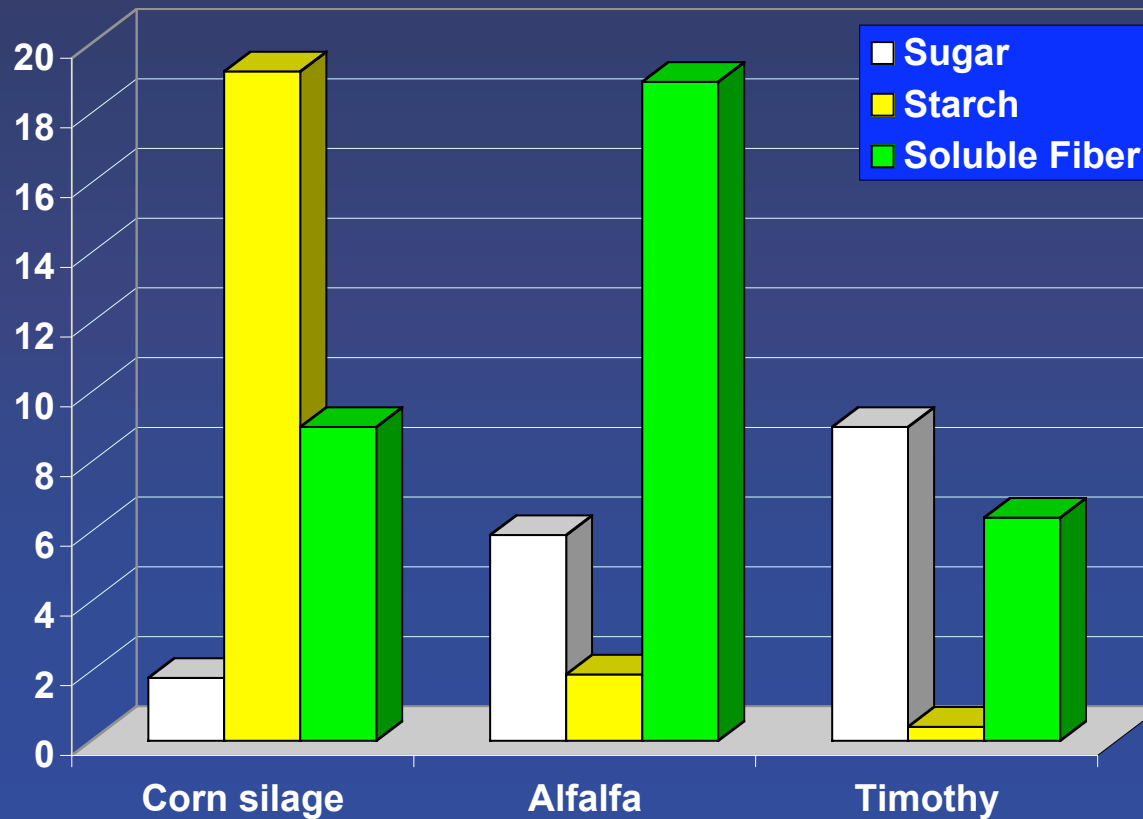
Where do my forages fit?



University of Florida

Forage NFC Composition

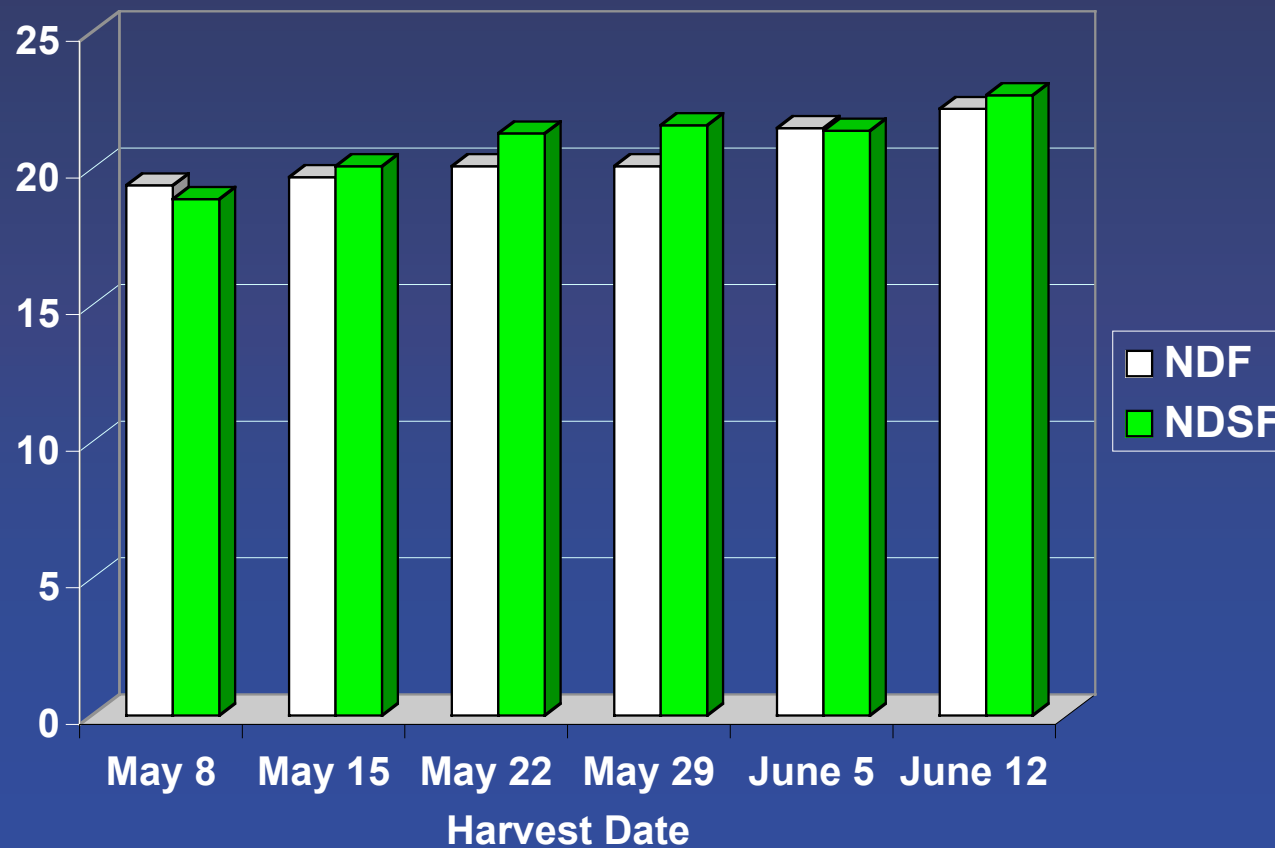
% of Dry Matter



Hall, 2000

Alfalfa Leaves: NDF & Soluble Fiber

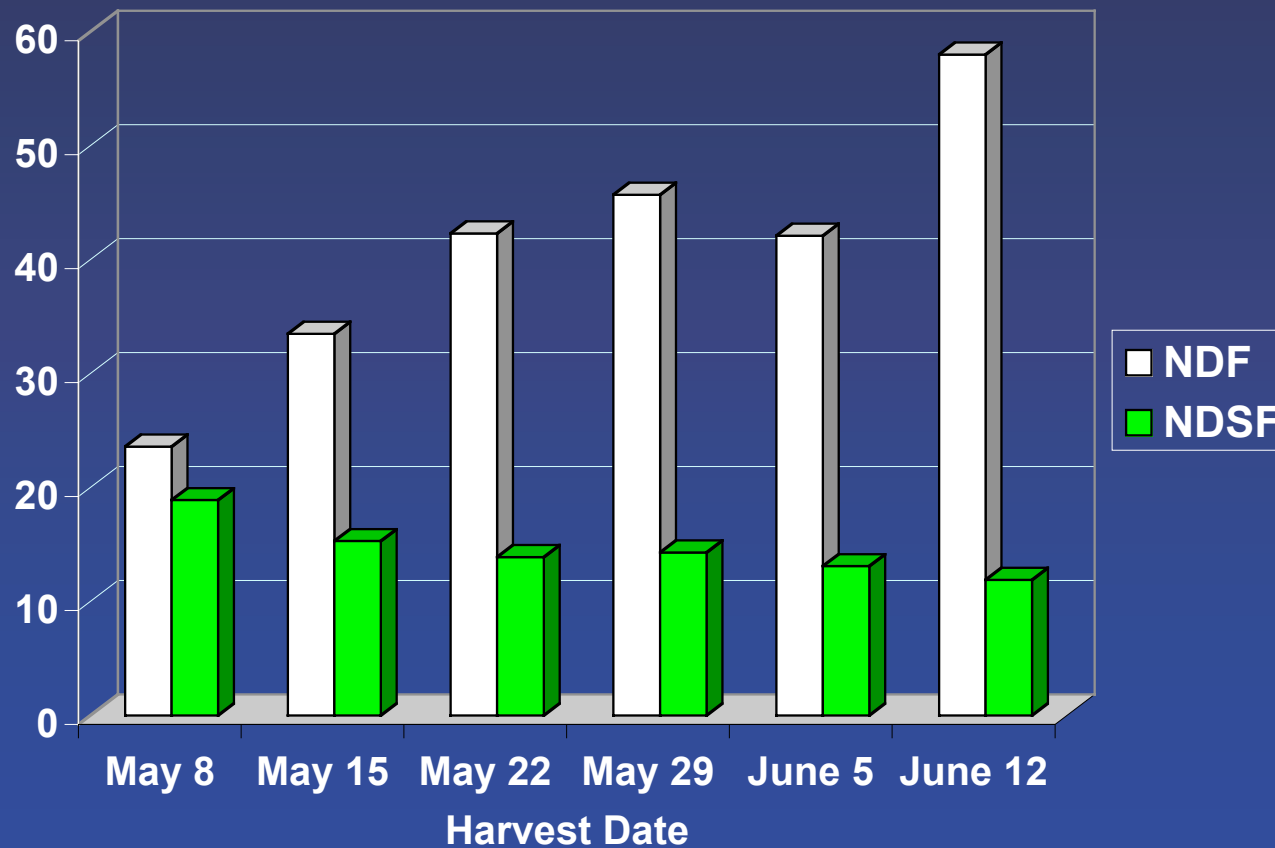
% of Dry Matter



Hall et al., 1997

Alfalfa Stems: NDF & Soluble Fiber

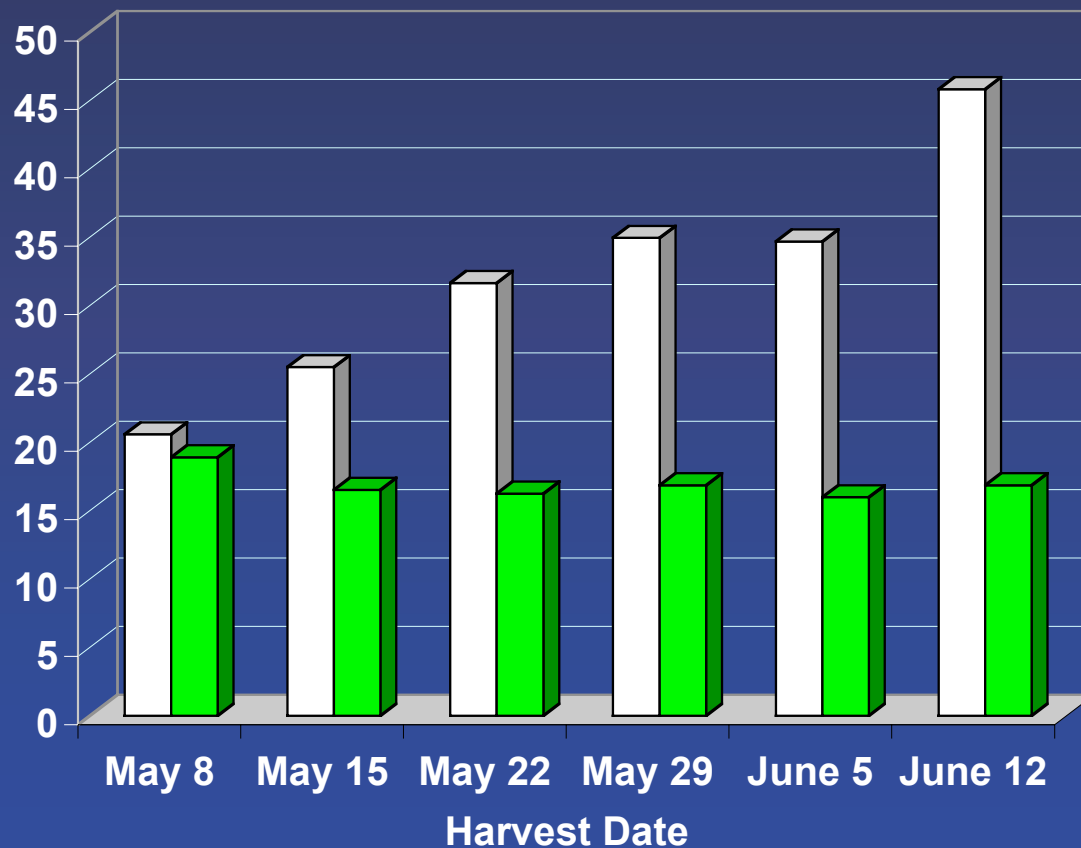
% of Dry Matter



Hall et al., 1997

Alfalfa Plant: NDF & Soluble Fiber

% of Dry Matter



☀ Leaf loss

☀ Maturity

■ NDF
■ NDSF

☀ Sugars?

% Leaf

72

58

48

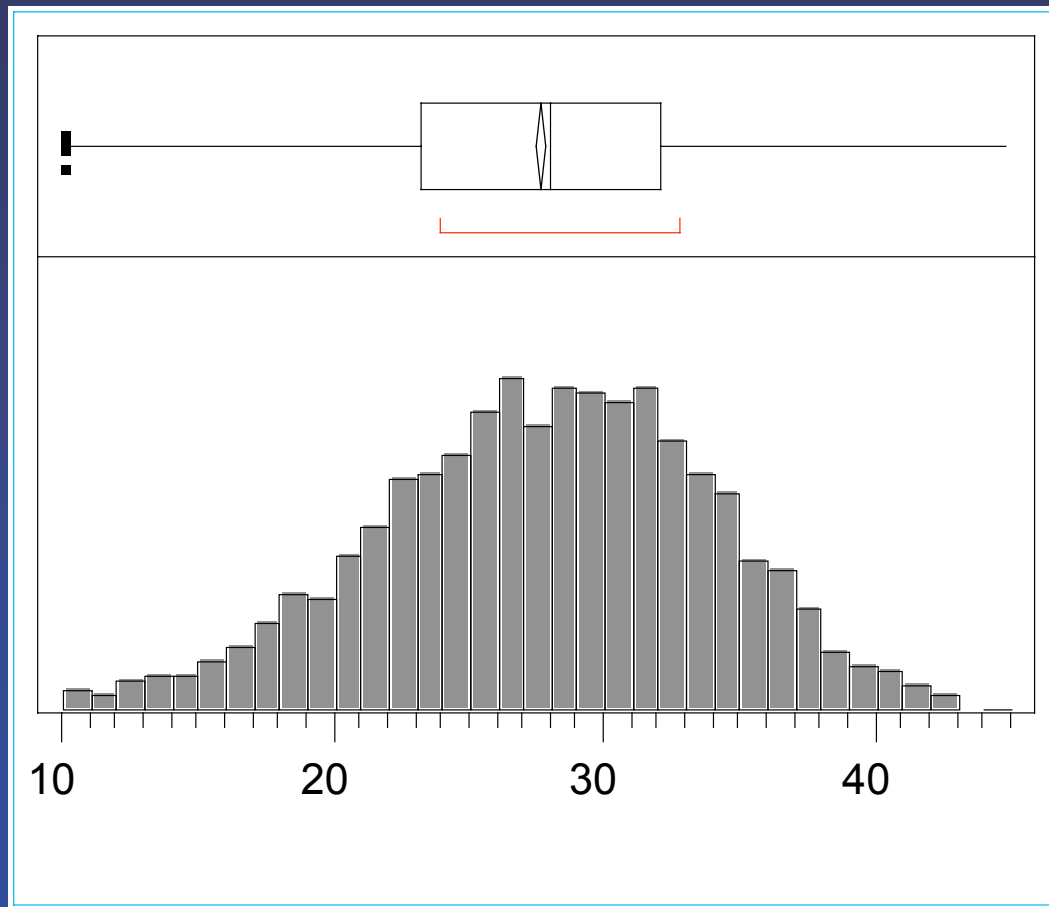
42

36

34

Hall et al., 1997

Corn Silage: Starch Content (% of DM)



Mean = 27.698 N = 5702

Ward, 2003

☀ Grain yield

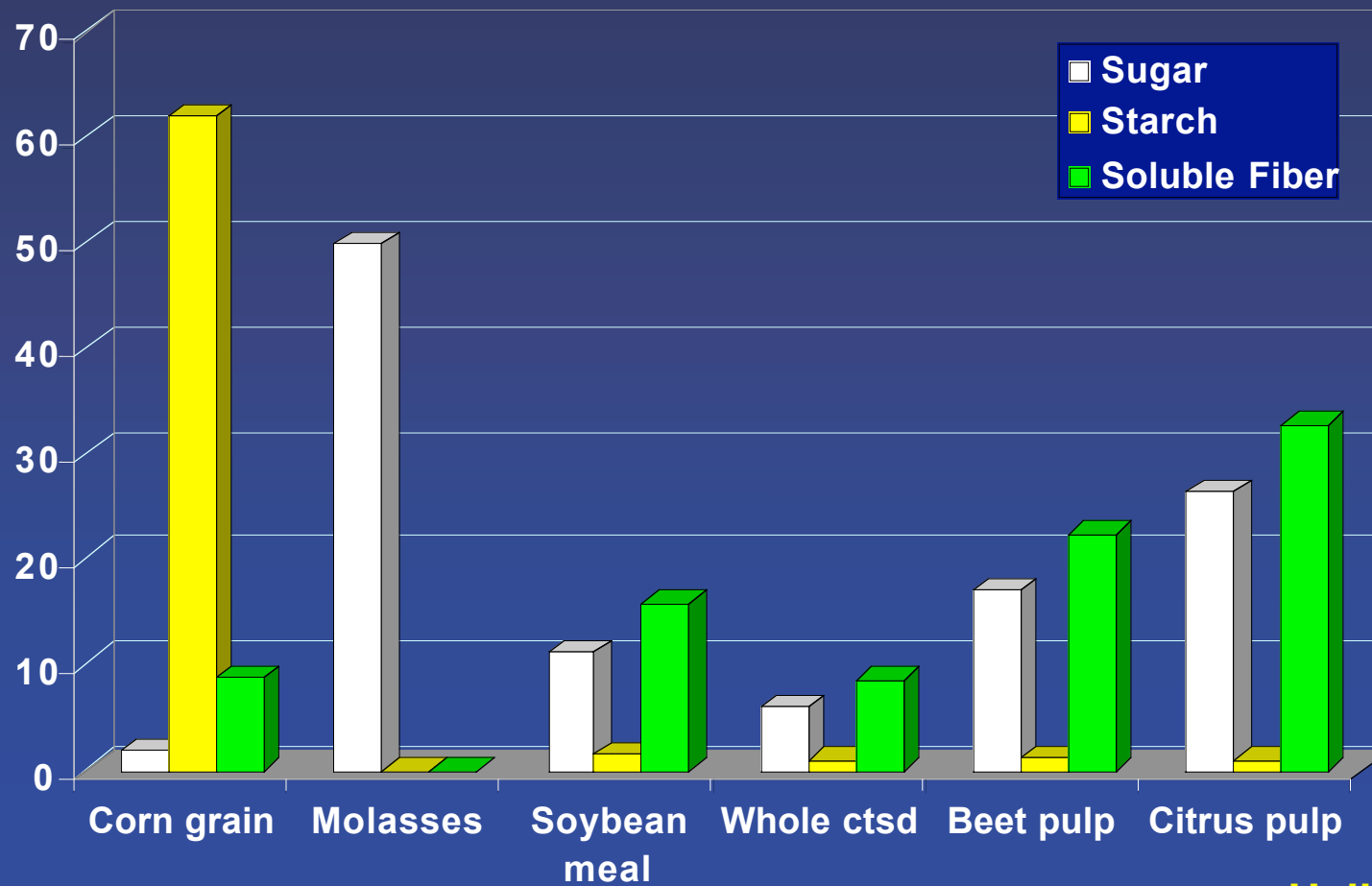
☀ Cut height

➤ + energy

➤ - effective

Supplement Composition

% of Dry Matter



Hall, 2000

Eaten Does Not Mean Digested



Poorly
chopped/processed
corn silage

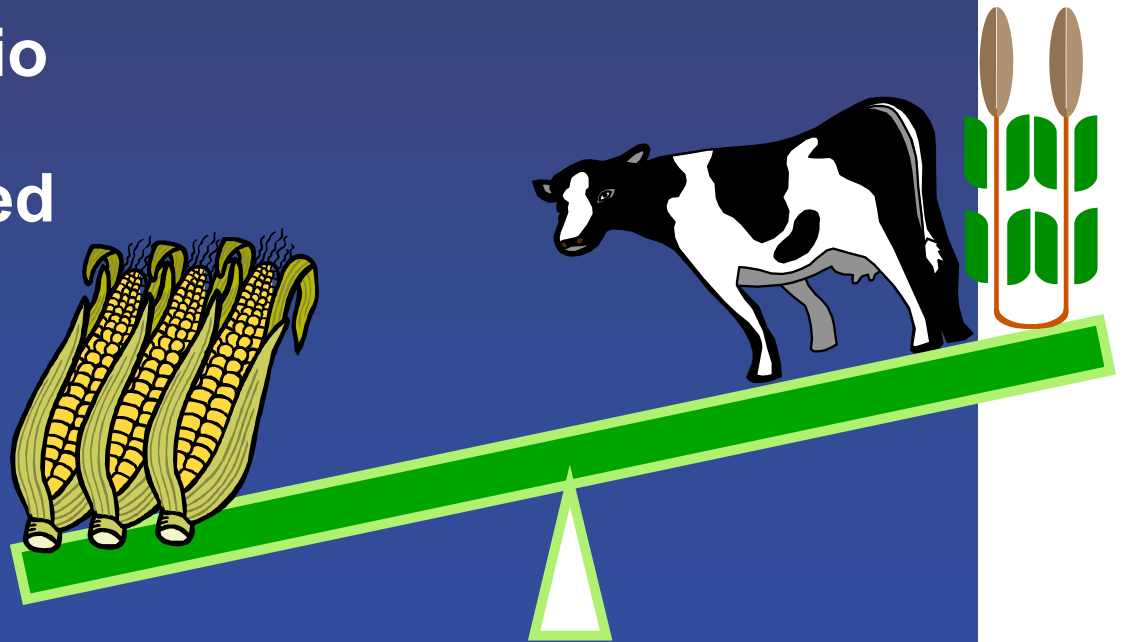
Coarse corn meal



Henry, 1911

Carbohydrates and Problems

- NFC: Too much / wrong kind
- Feeding grain in large meals
- Forage:grain ratio
- Cows sorting feed



Things To Consider

- ☀ NFC & effective NDF need to be looked at together.
- ☀ Forages will vary in NFC & effective NDF.
- ☀ Supplements must complement the forage.
- ☀ Feed for healthy, productive cows.
- ☀ We have more to learn.

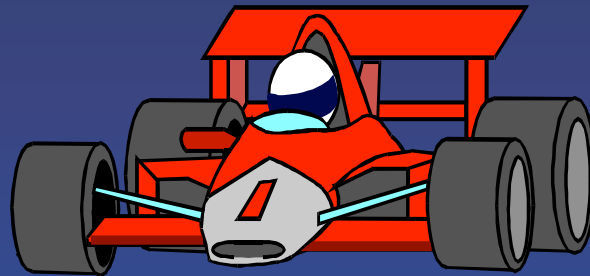


www.animal.ufl.edu/hall/





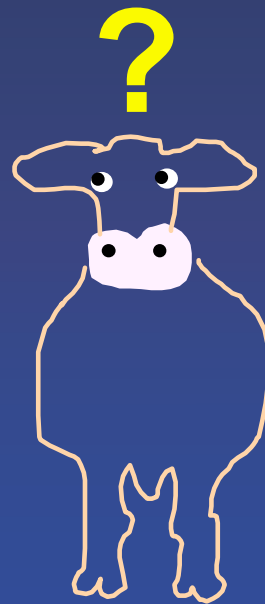
**In the same way that cars need both fuel
and oil to run well....**



...cows need both NFC and fiber.



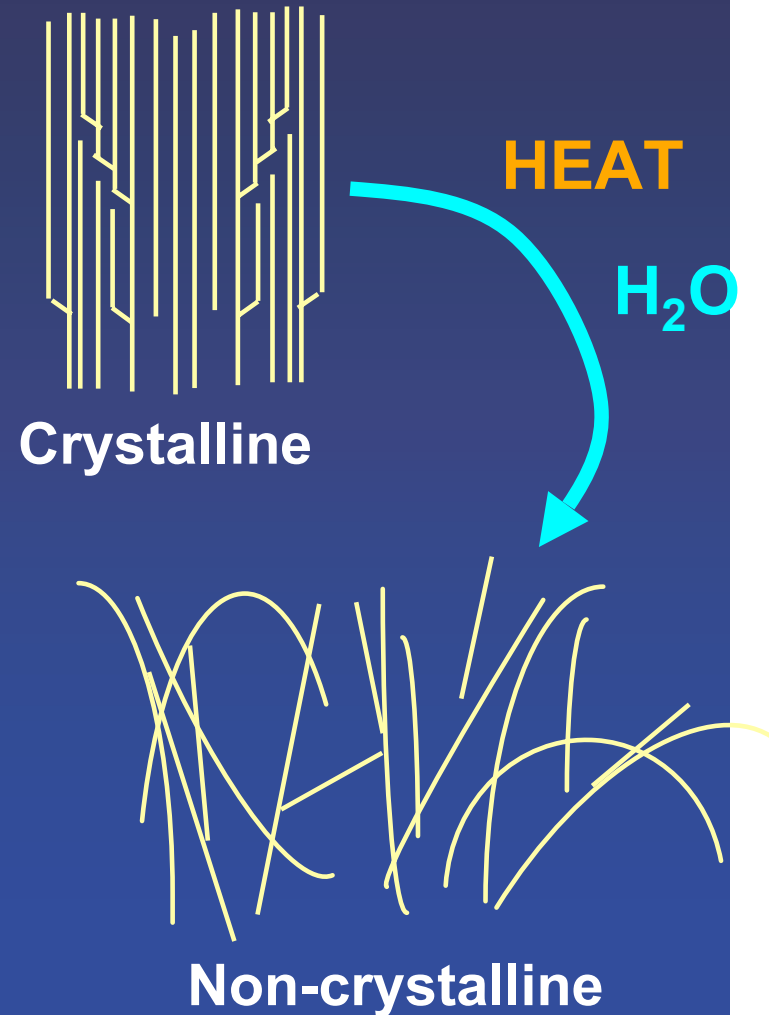
Effective Fiber

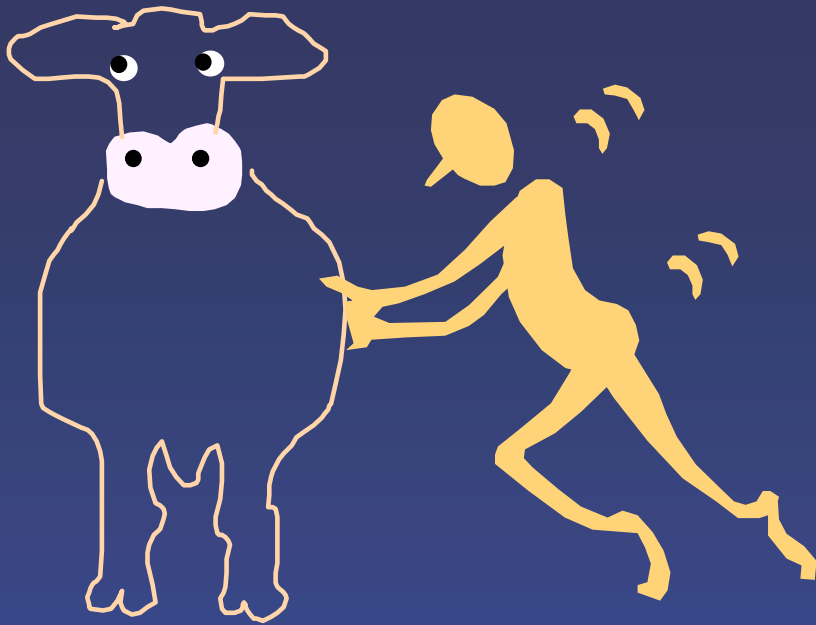


Starch

Rate of digestion affected by:

- Particle size
- Plant source
- Moisture content
- Ensiling
- Steam & heat treatment





You can't push a cow to produce.....

....But you can get the obstacles out of her way so she can.



Carbohydrates: Sugar v. Starch

48 cows (12 blocks of 4 cows) + 4 cannulated cows

Alfalfa Silage	40.0%	CP	16.8%
Corn Silage	20.0%	NDF	29.6%
HMSC	20.5%	NFC	42.8%
SBM	9.0%	Fat	4.0%
Roasted soy	3.0%	Starch	28.2 - 21.5%
Fat	2.0%	Sugar	2.7 - 10.0%
Minerals	1.0%		
Sugar	0 - 7.5%		
Starch	7.5 - 0%		

Broderick et al., 2002

Digestive Upset Results – Average

	Avg.	Range
Treatment Cost:	\$5.60	0 – 74.22
Lost Milk Revenue:	\$115.37	6.23 – 499.92
Cull Value Loss:	\$39.56	0 – 672.39
Early Cull / Dry Off:	\$48.28	0 – 1900.97

Total Cost: \$208.81 6.21 –
2144.45

164 cows. Avg. milk loss: 744 lb

Averhoff and Hall, 2000

Non-NDF Carbohydrates

<u>Ferm. Rates</u>	<u>VFA</u>		<u>NDSC Analysis</u>
30+%/h	Propionic Butyric	Organic Acids Mono- & Oligosacc.	Organic Acids Sugars
4 - 30%/h	Propionic	Starches	Starch
		Fructans	
20 - 40%/h*	Acetic	Pectic Substances	ND-Soluble Fiber
		β -Glucans	

