Milk fat and milk protein; how to change it in the dairy herd

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Milk fat and protein production in the dairy cow

- Important for pricing
- Important for dairy cow health and production levels
- Nutrition plays an important role

Average fat and protein content of milk produced by different breeds.

Breed	% Fat	% Protein	F:P
Ayrshire	3.86	3.18	1.21
Brown Swiss	4.04	3.38	1.20
Guernsey	4.51	3.37	1.34
Holstein	3.65	3.06	1.19
Jersey	4.60	3.59	1.28

Source: USDA-AIPL summary of herds on DHI test during 2004.

Benchmarks for common herd parameters

- Production
- Holstein
- Milk per cow (milking cows)
- 2x 32 kg (70 lbs)
- Fat % 3.8%
- Protein % 3.1%

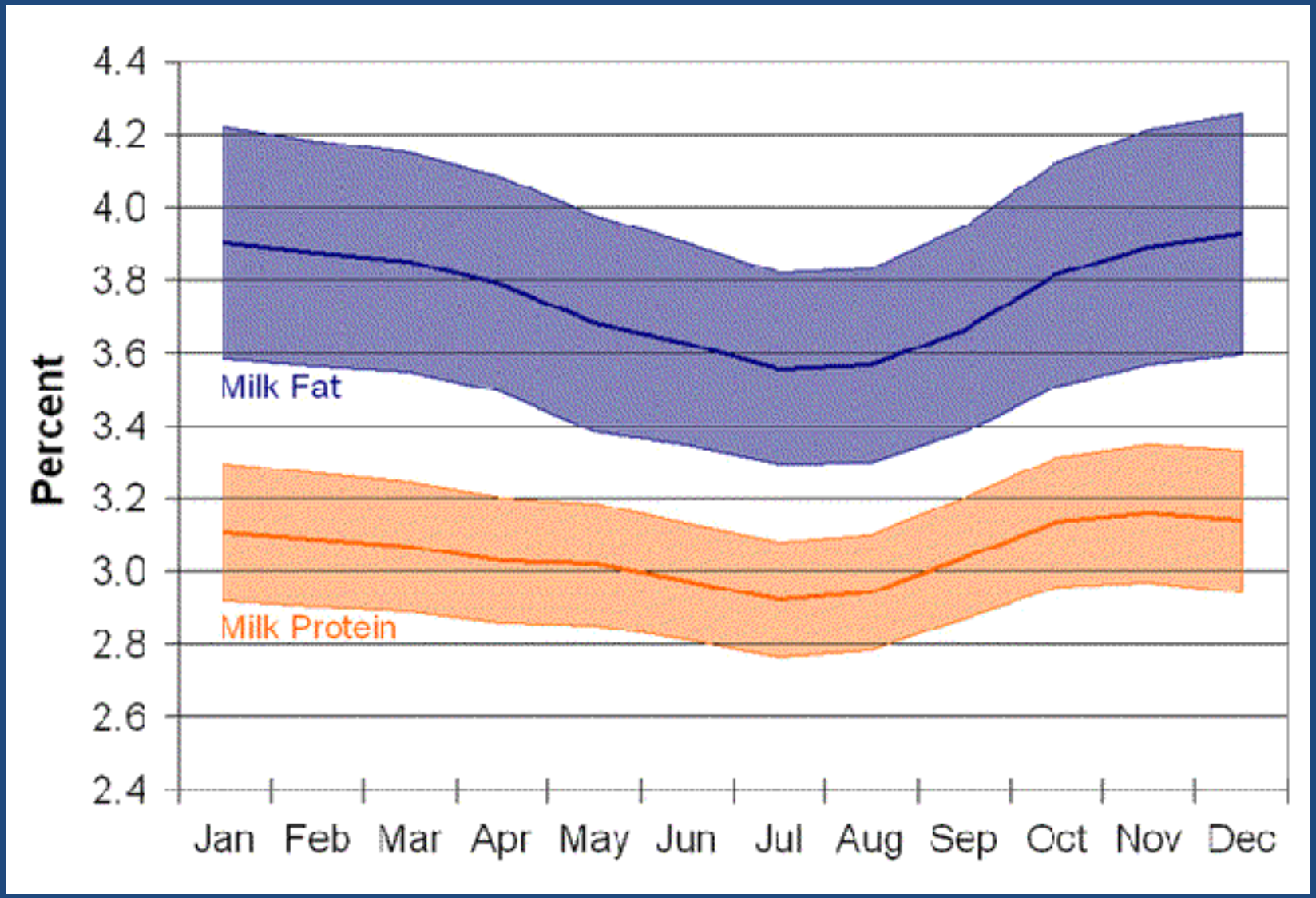
Factors affecting milk fat and protein

- Stage of lactation
  - Highest right after calving
  - Drops to lowest point 30-50 days post calving
  - Then peaks at about 250 days in milk
- Older animals have lower values

Factors affecting milk fat and protein

- Season- hot weather reduces both fat and protein
  - Decreases more with high humidity
  - May be related to changes in feed intake
- Mastitis infections reduce milk protein and fat
  - Total milk protein may be same but is SCC and not casein

Seasonal variation in milk fat and milk protein in Pennsylvania



Factors affecting milk fat and protein

- Depressed milk fat and protein may be from mechanical errors
  - Cooling problems in bulk tank
- Sampling problems
- Over agitation in pipelines or tank

[1]Estimate of genetic standard deviation.
Source: USDA-AIPL yield traits definition (May 2005) and trend estimates for cows born in 2000.

Factors affecting milk protein and fat-genetics

Table 3. Heritability (h2) estimates for milk and its components.

Trait	Holstein h	Holstein SD	Jersey h	Jersey SD
Fat, %	0.58	0.23	0.55	0.28
Protein, %	0.51	0.14	0.55	0.20
Fat, lb	0.30	52	0.35	50
Protein, lb	0.30	37	0.35	36
Milk, lb	0.30	1444	0.35	1204

Nutrition and feeding management that affect milk fat and protein

- Milk fat can be altered in 7-21 days by feeding
- Milk protein can be altered in 3-6 weeks by feeding
- Nutrition or ration formulation is more strongly related to milk fat than protein
  - Milk fat can change by 0.1-1.0 %
  - Milk protein can change by 0.1- 0.4%

Source of milk components- fat

- Fiber digestion produces VFA (acetate and butyrate)
  - Butyrate is converted to B- hydroxybuterate in the rumen
  - These are absorbed in the blood
  - About 50% of milk fat is made from these 2 products in the udder
- Remainder comes from blood fatty acids
  - These can be from body fat, absorbed diet fats, or liver fat
  - Herds with ketosis problems will have high fat levels

Source of milk components- protein

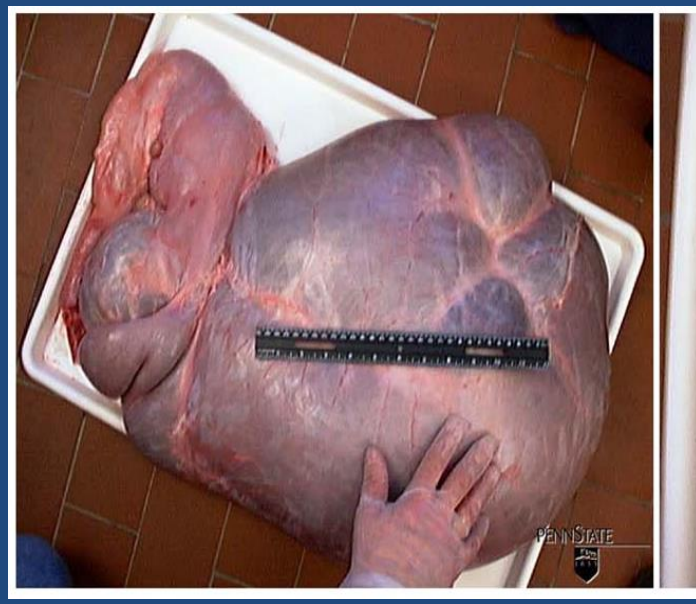
- Rumen microbe convert dietary protein and nitrogen into microbial protein
  - These microbes are made of amino acids and when are digested they are used by the mammary glad to make milk protein
  - This requires energy from propionate (a rumen VFA) for energy which is absorbed from the GI tract

Dietary energy and protein effects

- Lack of energy may reduce will reduce milk fat and often raise milk protein- 0.1-0.4%
  - May be due to grain quantity or forage quality
- Protein intake can depress milk protein marginally, 0.0-0.2%
  - Will not increase it
  - Has little effect on milk fat

Rumen function is important

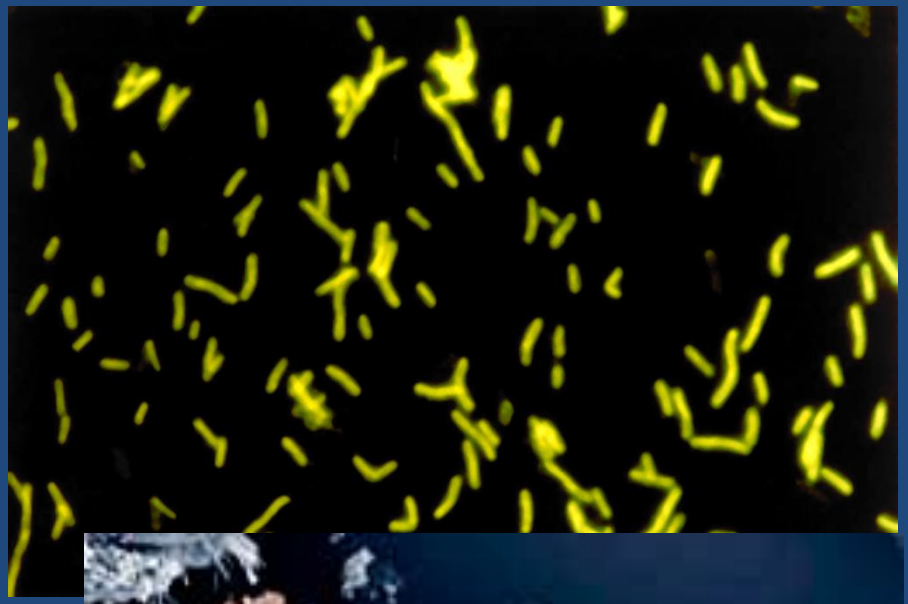
- Good rumen function is vital to obtaining proper milk fat and protein levels

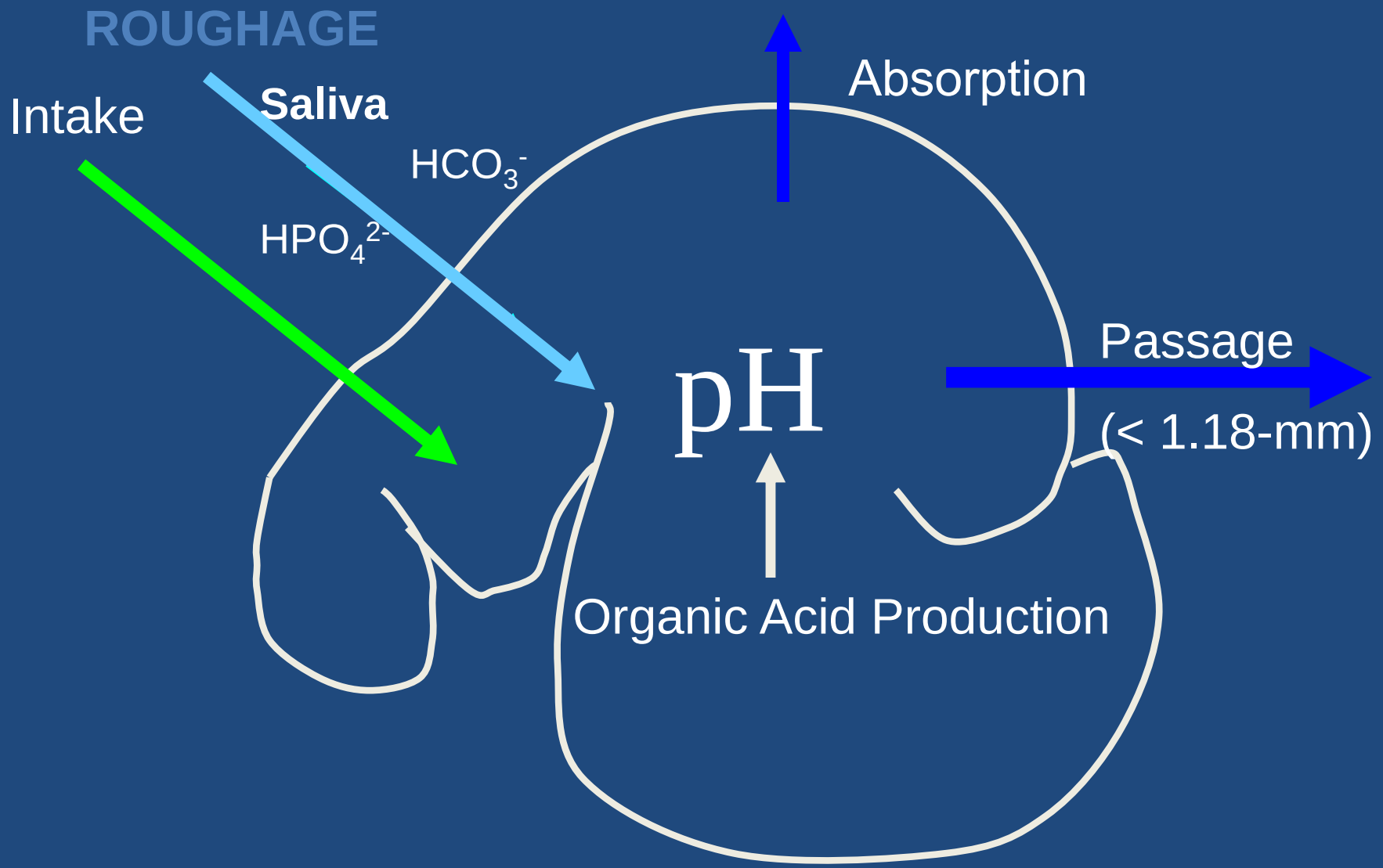


Rumen Microbes

- Bacteria
- Protozoa
- Fungi

- 10^{10} to 10^{11} cells/gm of rumen fluid

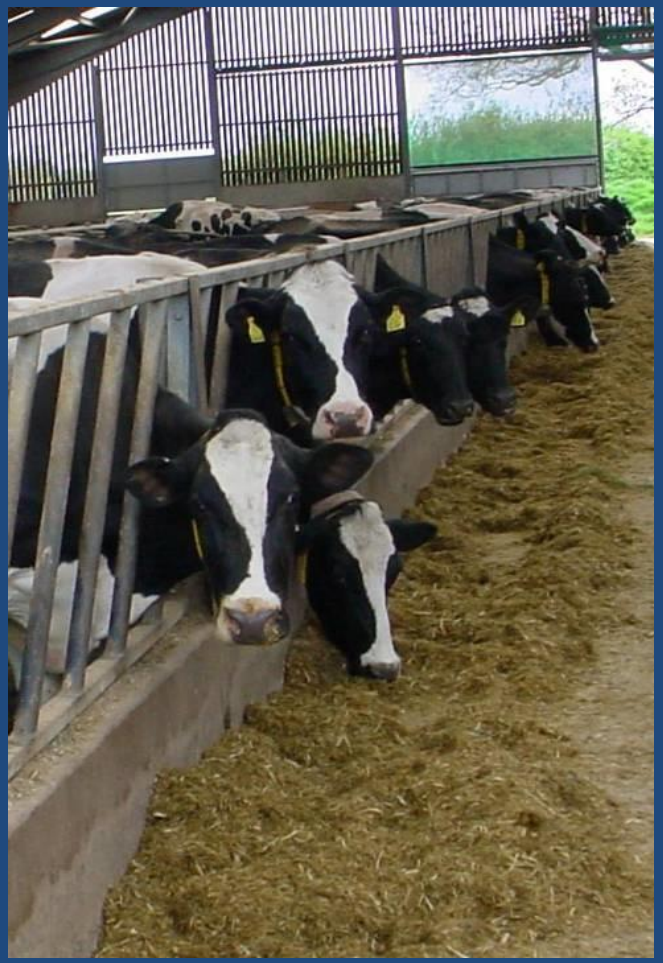




Factors affecting rumen pH

Feeding management

- Any situation that limits feed intake may affect milk fat and protein



Ruminal Acidosis

- Condition of low rumen pH
- Acute ruminal acidosis
  - Rumen pH < 5.0
  - Increased lactate
- Subacute ruminal acidosis (**SARA**)
  - 5.2 > rumen pH < 5.6
  - Accumulation of volatile fatty acids (**VFA**)

Britton and Stock, 1987; Harmon et al., 1985; Krause and Oetzel, 2006

Subacute Ruminal Acidosis

- Decreases cellulytic bacteria activity
  - Lower fiber digestion
  - Decreased DMI and feed efficiency
  - Decreased milk yield and milk fat content
- Many negative health effects
  - Diarrhea
  - Rumenitis
  - Laminitis
  - Liver abscesses

Britton and Stock, 1987; Nocek, 1997; NRC, 2001

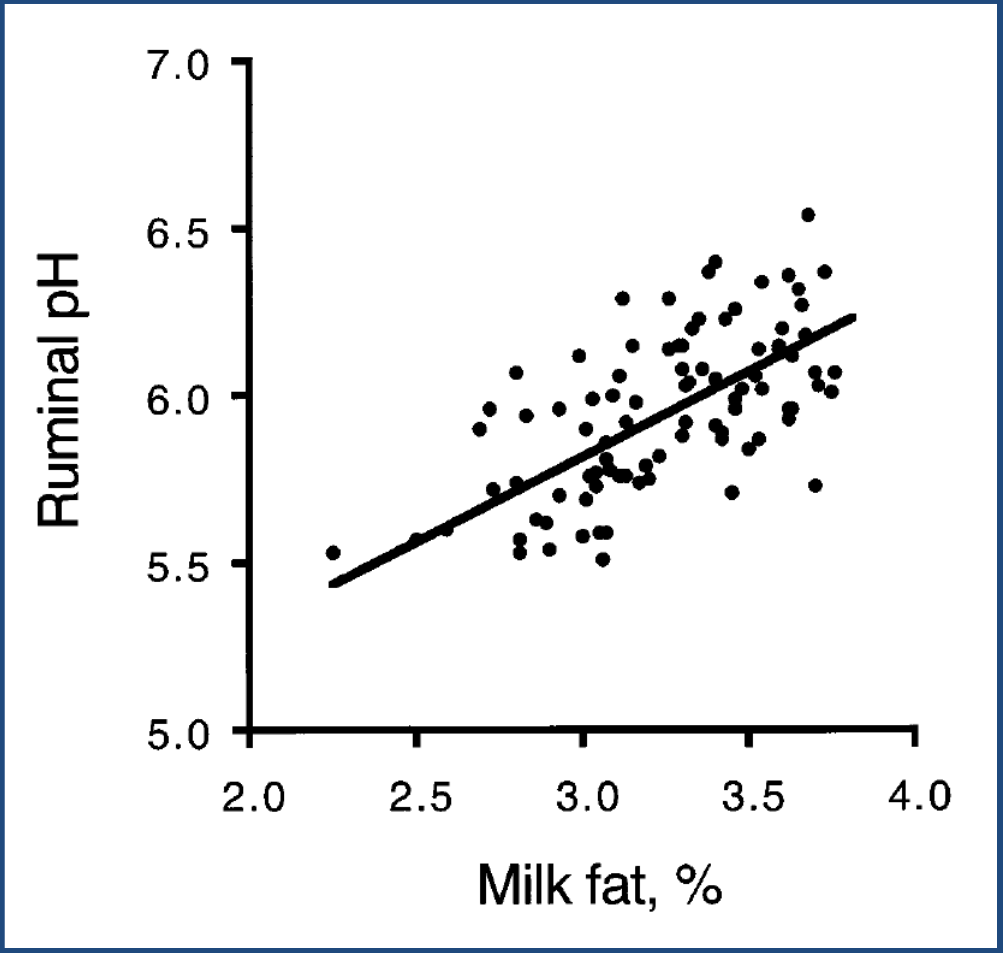
Fiber and Rumen Health

- Need forage to be available for fiber digestion and maintaince of rumen pH prior to grain feeding

Rumen pH

- Dairy rations must be balanced to maintain an optimal rumen pH
- Low pH
  - ↓ Fiber digestion (Terry et al., 1969)
  - ↓ Microbial growth (Hoover, 1986)
  - ↓ Milk yield and fat (Allen, 1997)

Rumen pH vs. Milk fat %



Allen, 1997

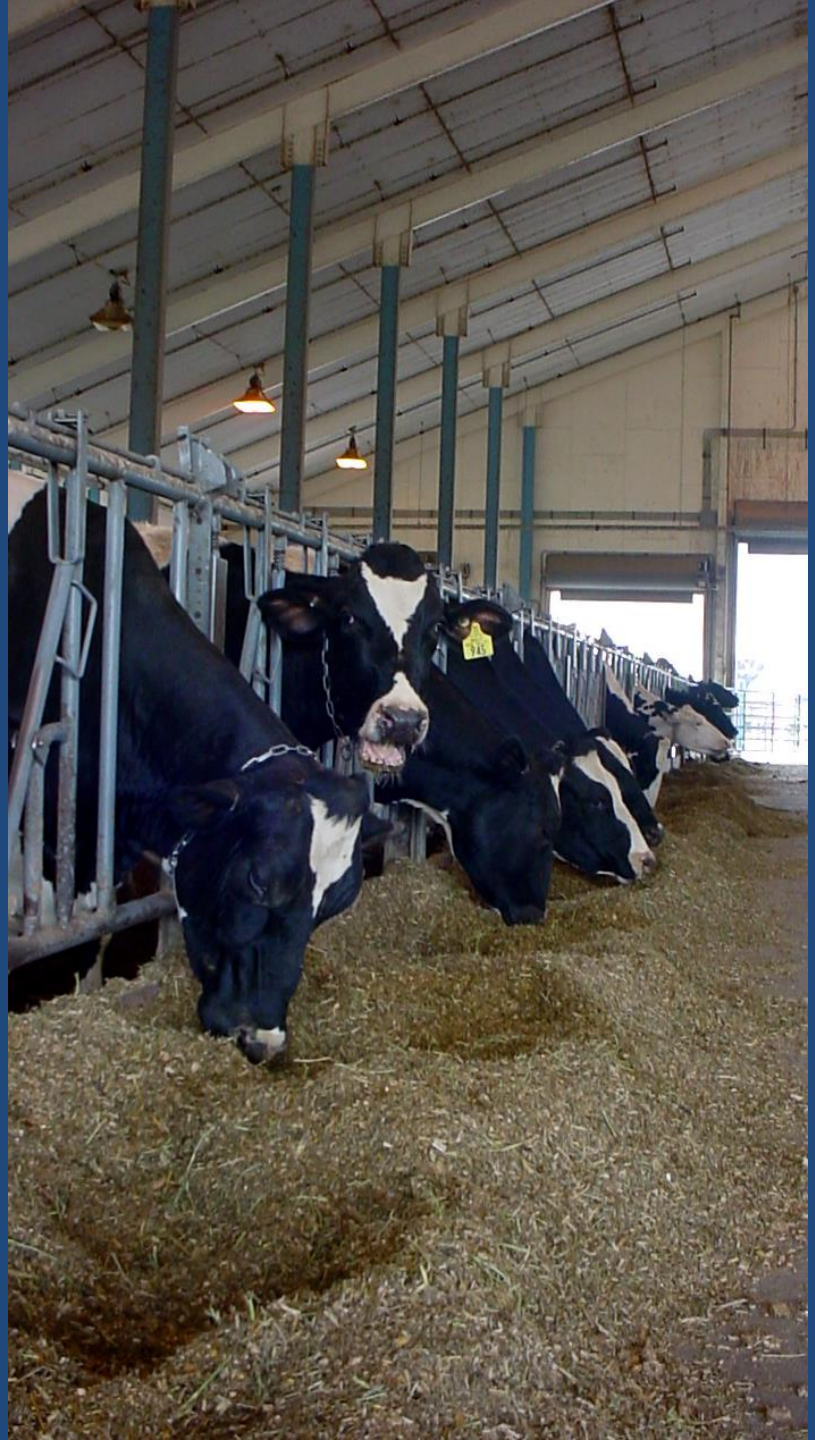
How do we affect rumen pH ?

- Forage amount in the ration
  - Ration Balancing
- How the diet is fed
  - TMR
- Physical form

  Particle size

What affects rumen pH?

- Feed type- forage vs grain
- Feed quality
- Feeding patterns



Forage Fiber Mat

Grain has a large effect in producing acid

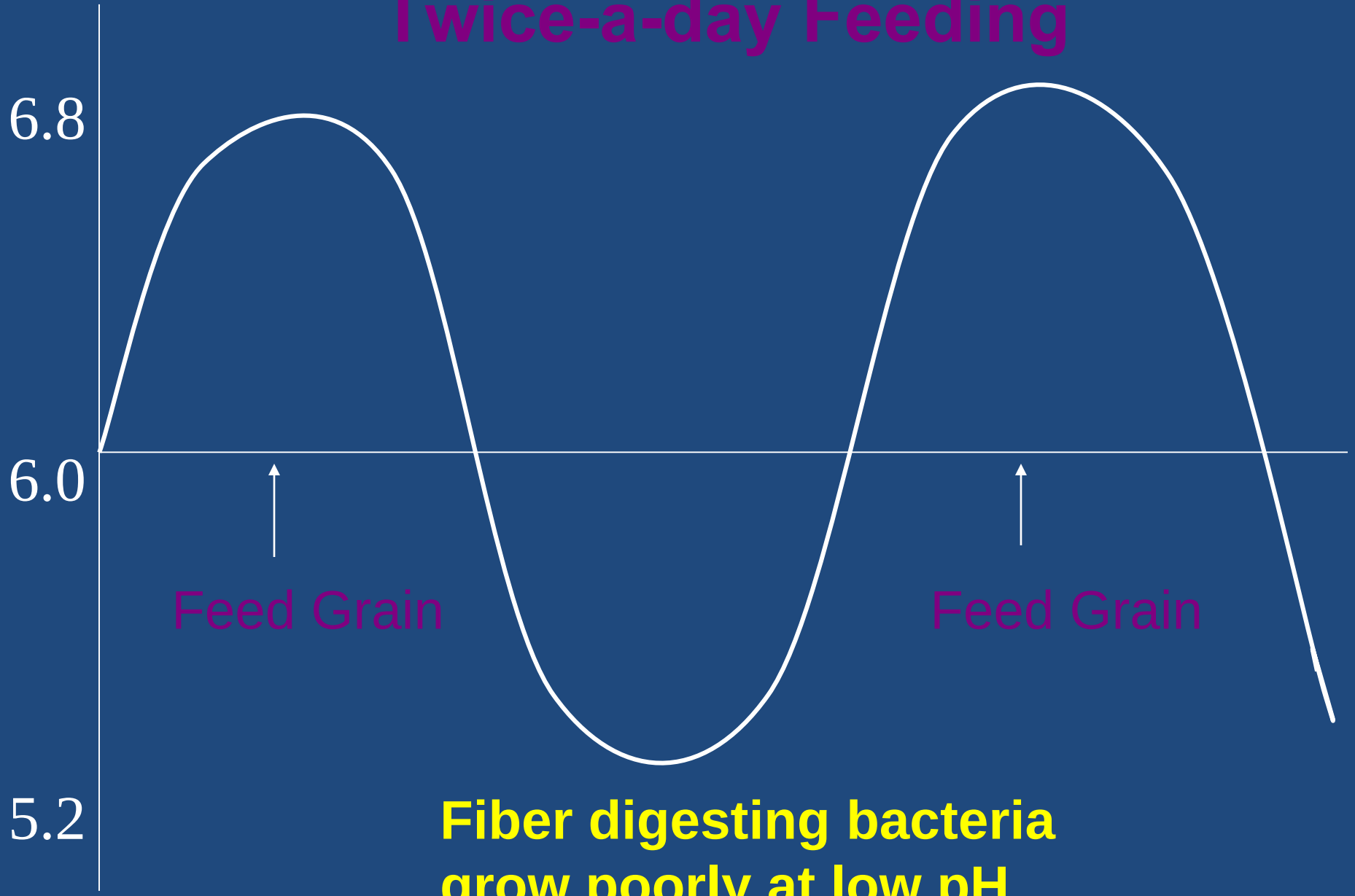
Forage Particle Size

- Longer particle size
  - Maintain rumen mat
  - Stimulate chewing
  - Buffer the rumen
- Excessive particle length
  - Sorting of the ration
  - Limit dry matter intake (DMI)
  - Improper silage fermentation


150

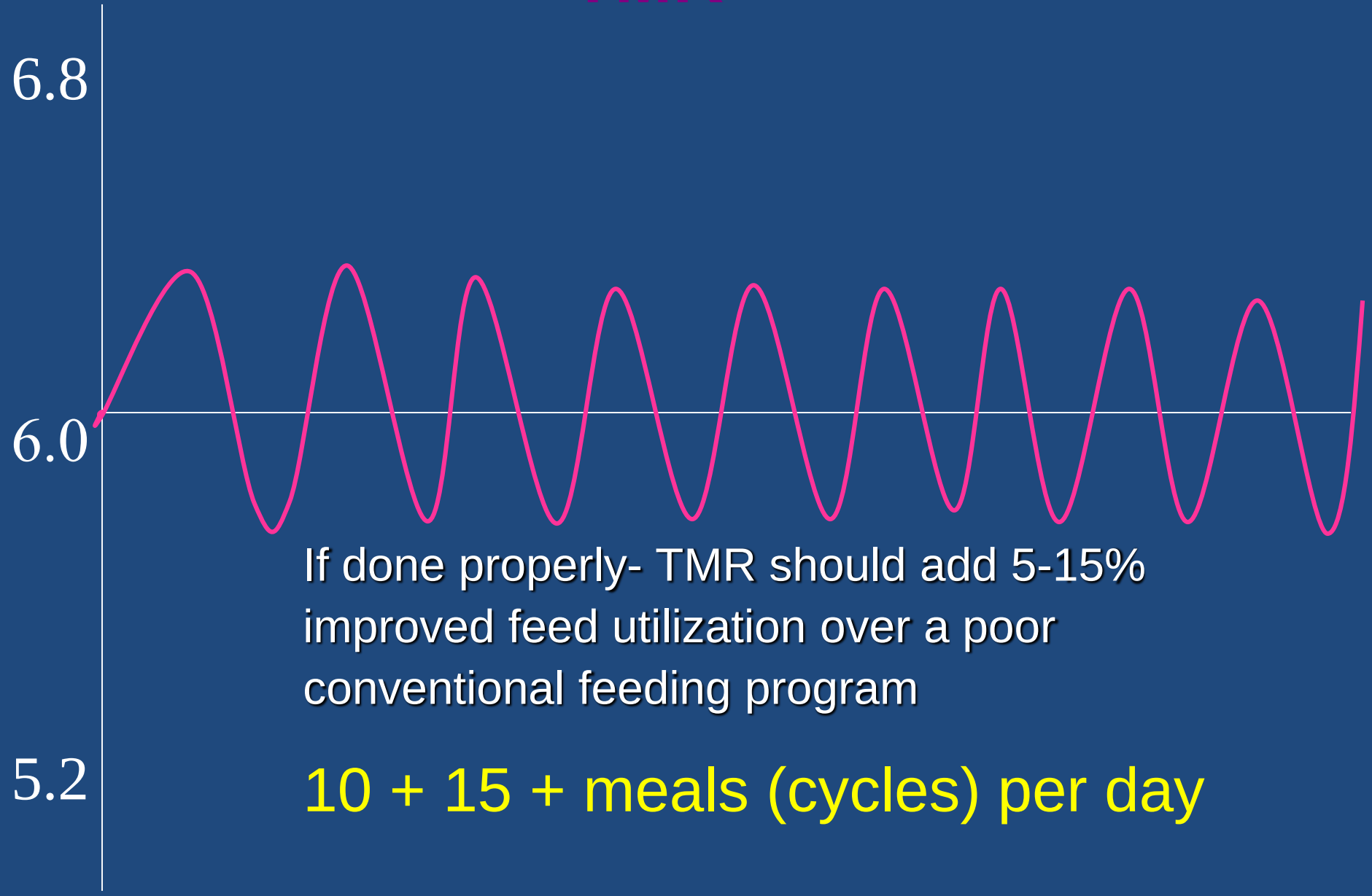
- Effect of feeding frequency

Rumen pH "Conventional" Twice-a-day Feeding



Fiber digesting bacteria grow poorly at low pH

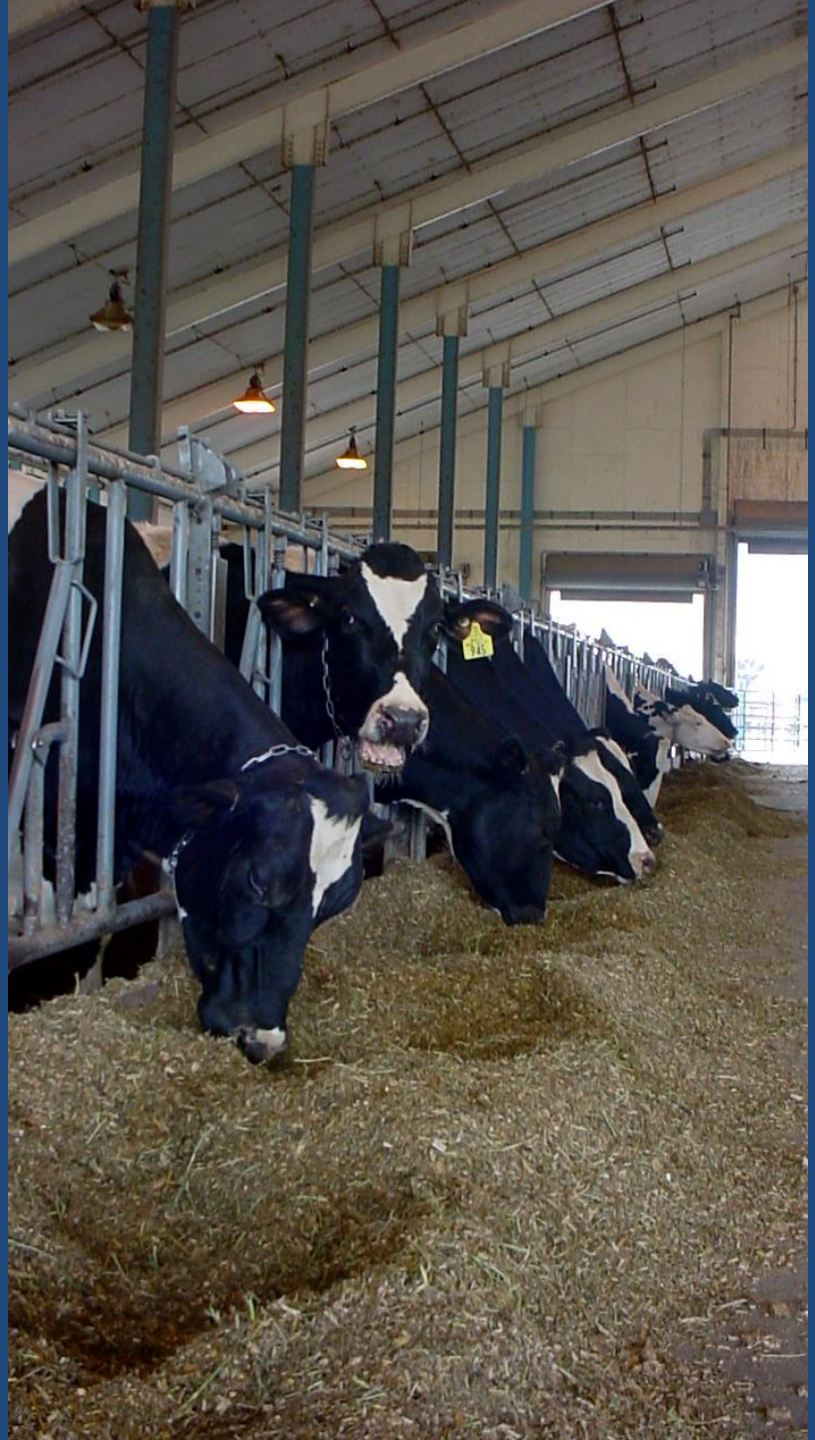
“TMR”



If done properly- TMR should add 5-15% improved feed utilization over a poor conventional feeding program

10 + 15 + meals (cycles) per day

- Cows and eating patterns
- Cows should have many short meals per day
- Number of times fed and push-up of feed bunks is critical



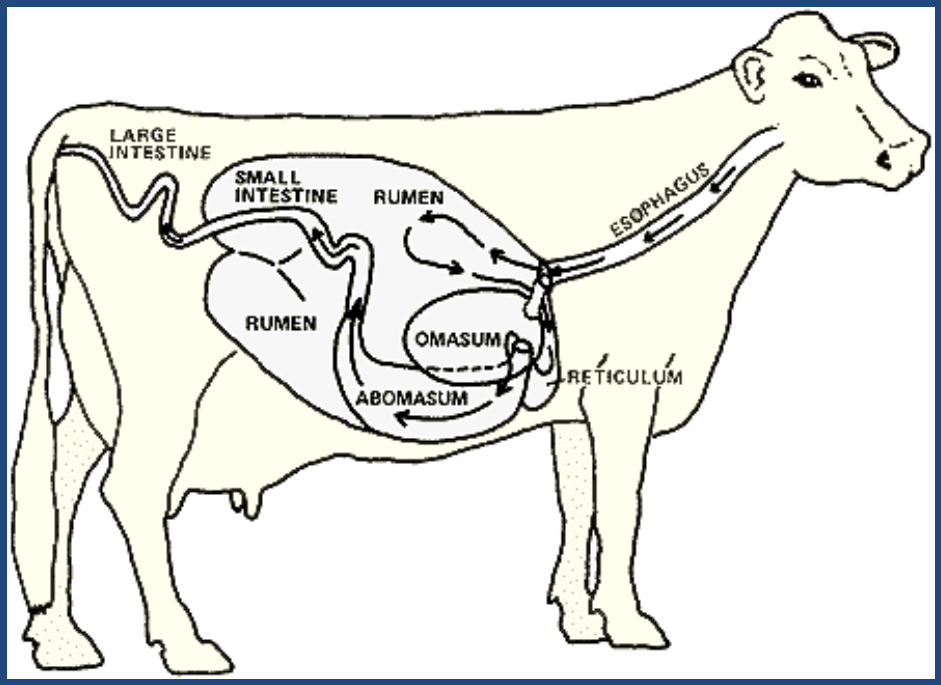
- Measuring sorting as it relates to length of cut

Feeding high quality feeds/forages

That are not contaminated

- Effect of TMR dry matter
- Range of 40-60% DM is often best

As intake increases- retention time in the rumen decreases



Decrease in DMD

- The rate of DMD decrease, increases as intake gets higher
- The rate of decrease is slightly greater on grains than forage diets

Fiber Quality

- Higher quality fiber affects the rumen
- Can feed more forage to improve rumen health
- Up to 55% or even more if high quality
- Can achieve better

Production and components

Poor quality forage

- Reduces rate of passage from the rumen and therefore dry matter intake

ROUGHAGE

Intake

Saliva

HCO_3^-

HPO_4^{2-}

Passage

(< 1.18-mm)

on

Factors that Influence milk components:

- #1 Forages

- The most variable feed ingredient used in terms of digestibility and nutrient composition.
  - Comprise a large portion of the diet of lactating cows.

Fiber and Rumen Health

- Balancing needs of high-producing cows
  - High energy diet (concentrates)
  - Adequate fiber (provided by forages)

Fiber and Rumen Health

- Need forage to be available for fiber digestion and maintaince of rumen pH prior to grain feeding

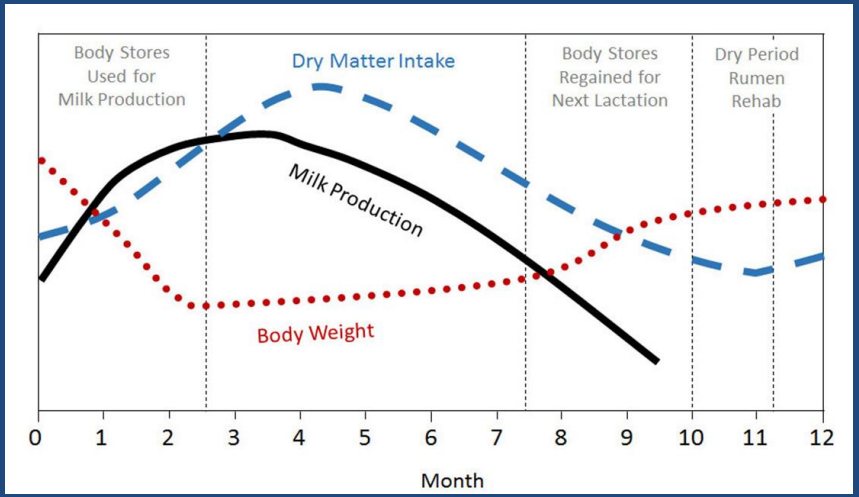
Need to balance CHO and Protein fractions

Factors that Influence Feed Intake:

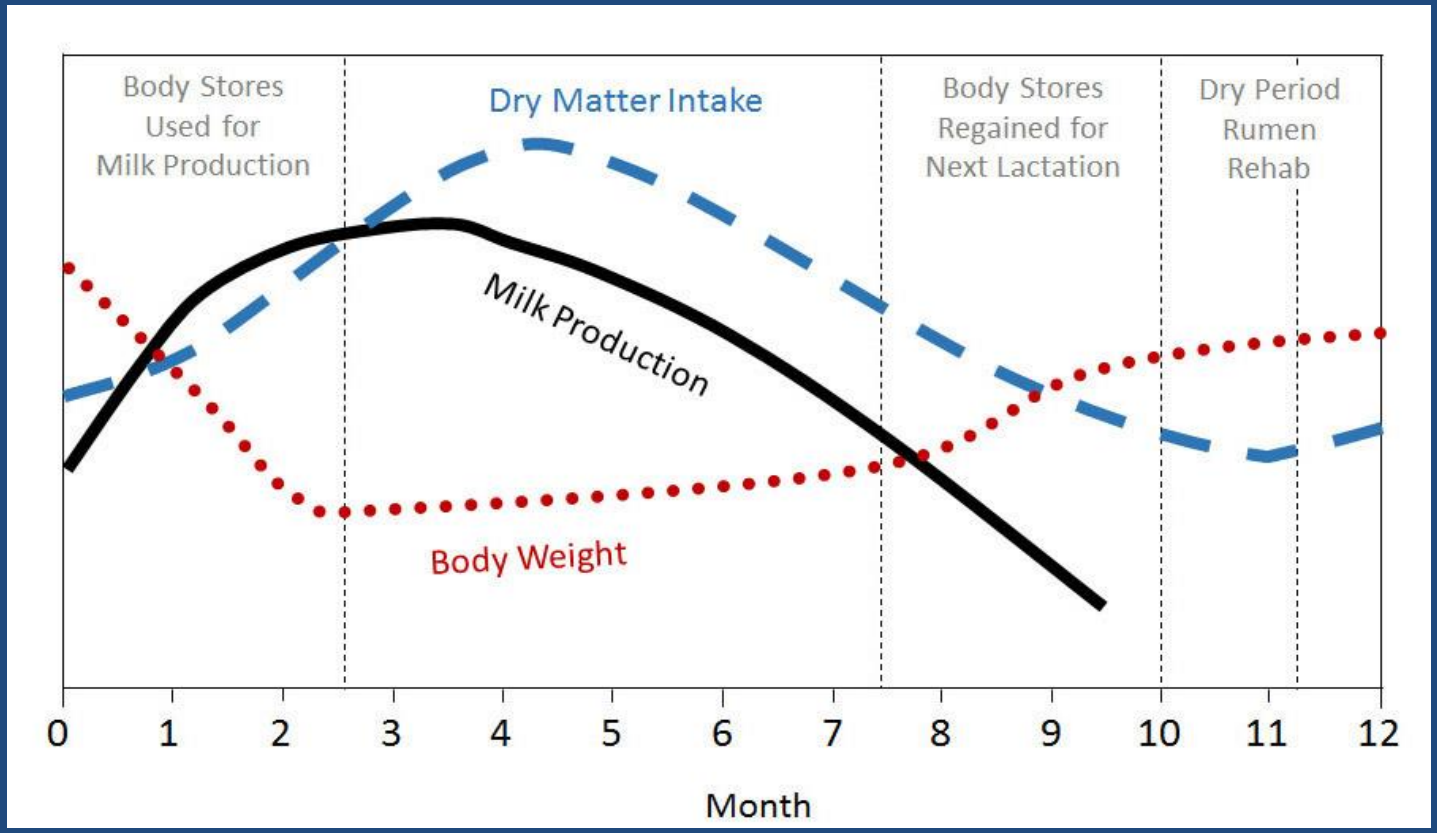
- Cow comfort- stress level

Body condition

- Normal BC will support higher levels of components
- Weight loss in early lactataion will support inc. milk fat
- Thin and fat cows will have low milk fat in late lactation
- Protein can be depressed if cows are too fat or thin



Changes in body weight, dry matter intake, and milk production over a lactation



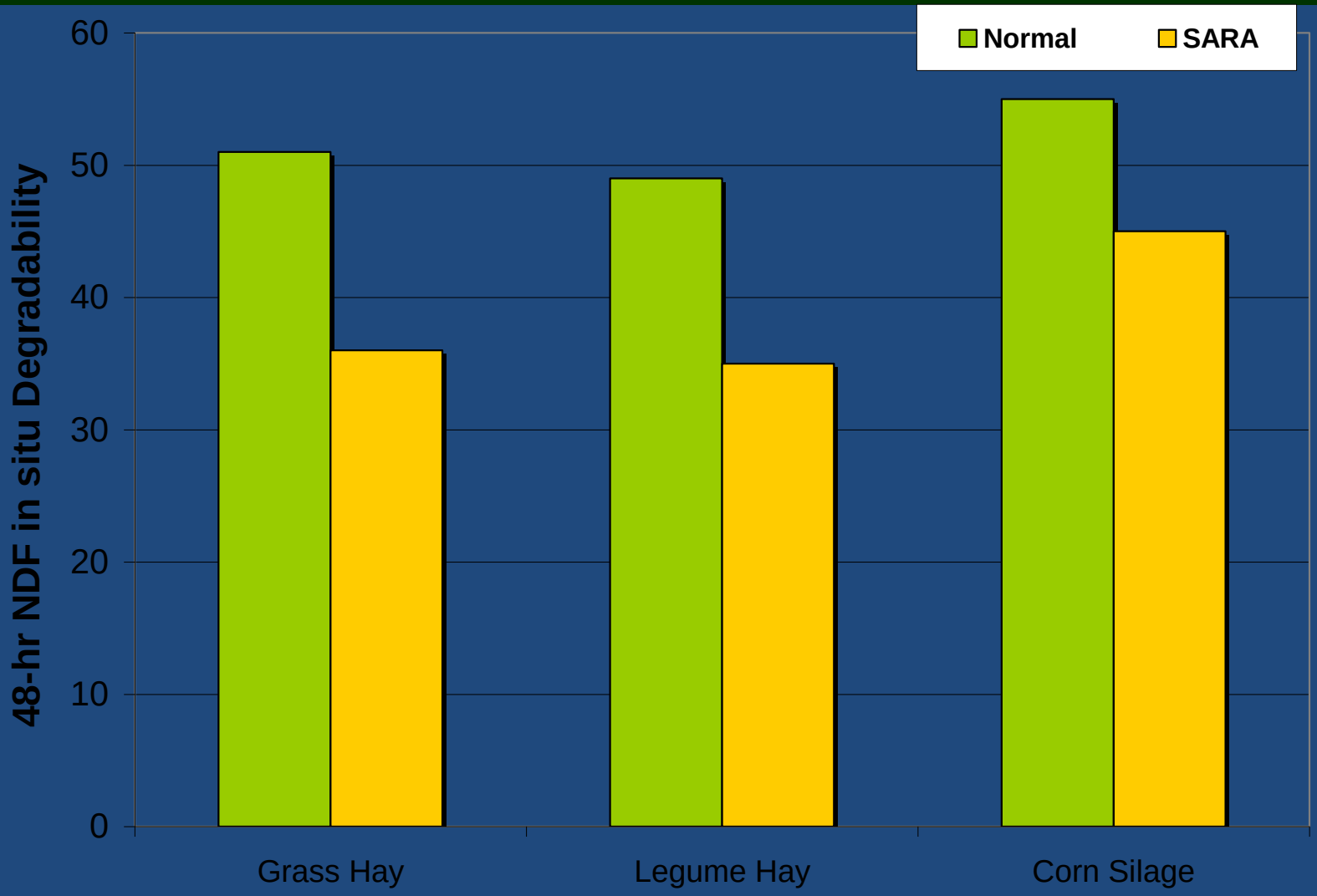
A further factor affecting milk omponents: Udder Health

- Bulk Tank SCC and/or weighted average SCC <150,000
- *Weighted average SCC is a reasonable approximation of bulk tank SCC, but tends to be slightly higher
-
- Average SCS <2.0 – 2.5
- % clinical <3%

Need to improve microbial growth

- Bacteria digest fiber, so more bacteria yields more fiber digestion
- A balance of rumen available nitrogen sources will allow rumen bacteria to grow at optimal rates
- Balance total protein and rumen available protein

Sub-Acute Rumen Acidosis (SARA) Reduces NDF Degradability



Krajcaski et al., 2002

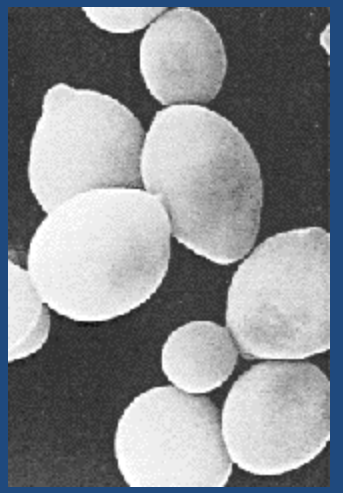
Maintaining a healthy rumen

- Maintianing a healthy population of microbes in the rumen

- To digest forages

Yeast Culture

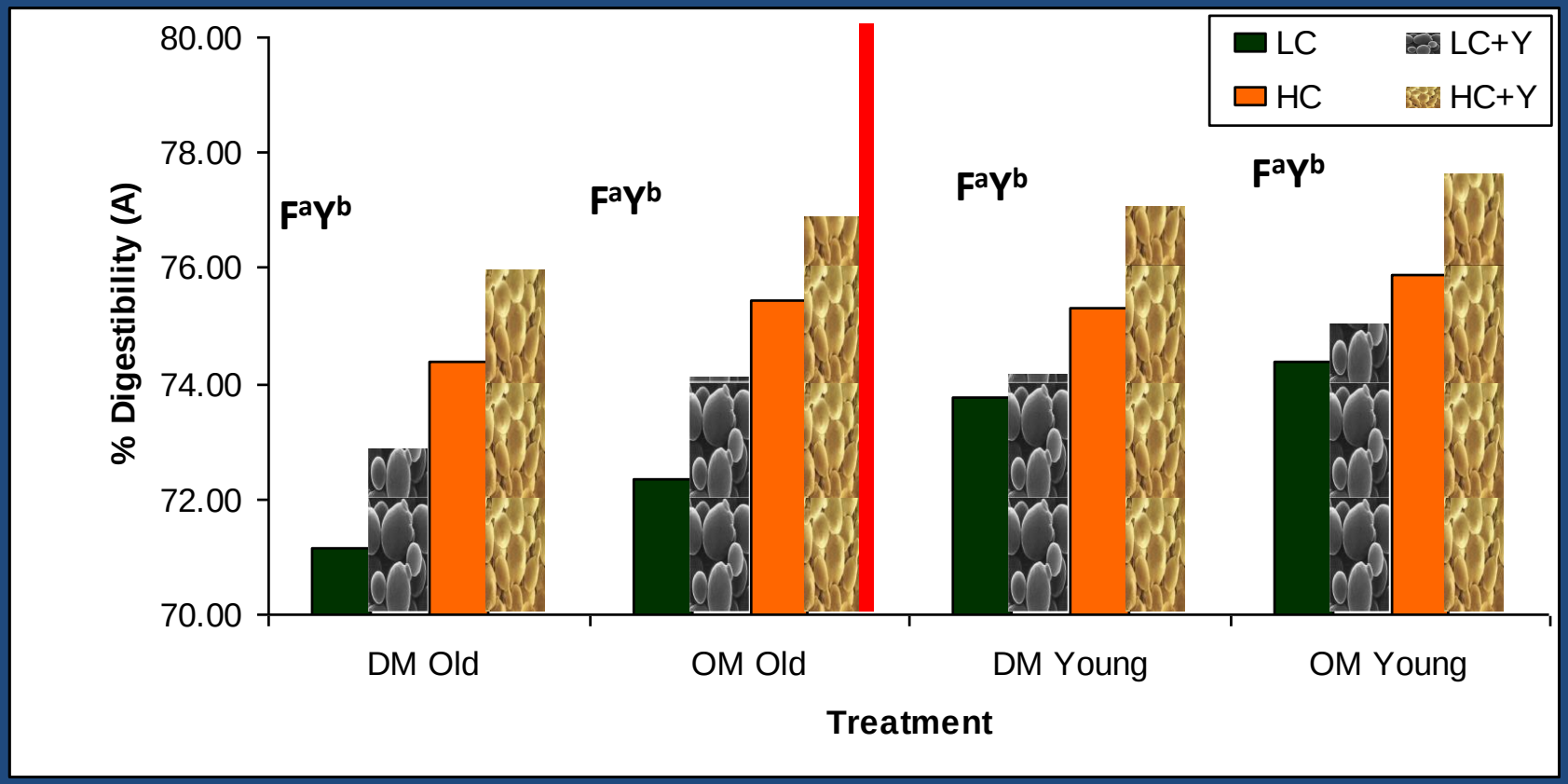
- Live yeast
  - Sacchromyces cerevisiae
- Yeast stabilizes rumen environment
  - Increase microbial protein synthesis
  - Decrease lactic acid
  - Increase rumen pH
  - Cellulolytic and anaerobic bacteria
- Improves fiber digestion
- Prepartum, early, and mid-lactation cows best response



PENNSTATE

Penn State Study

DM and OM Digestibility



F = Forage
Y = Yeast

[a] = $P < 0.01$
[b] = $P < 0.05$

* = Age Effect ($P < 0.01$)

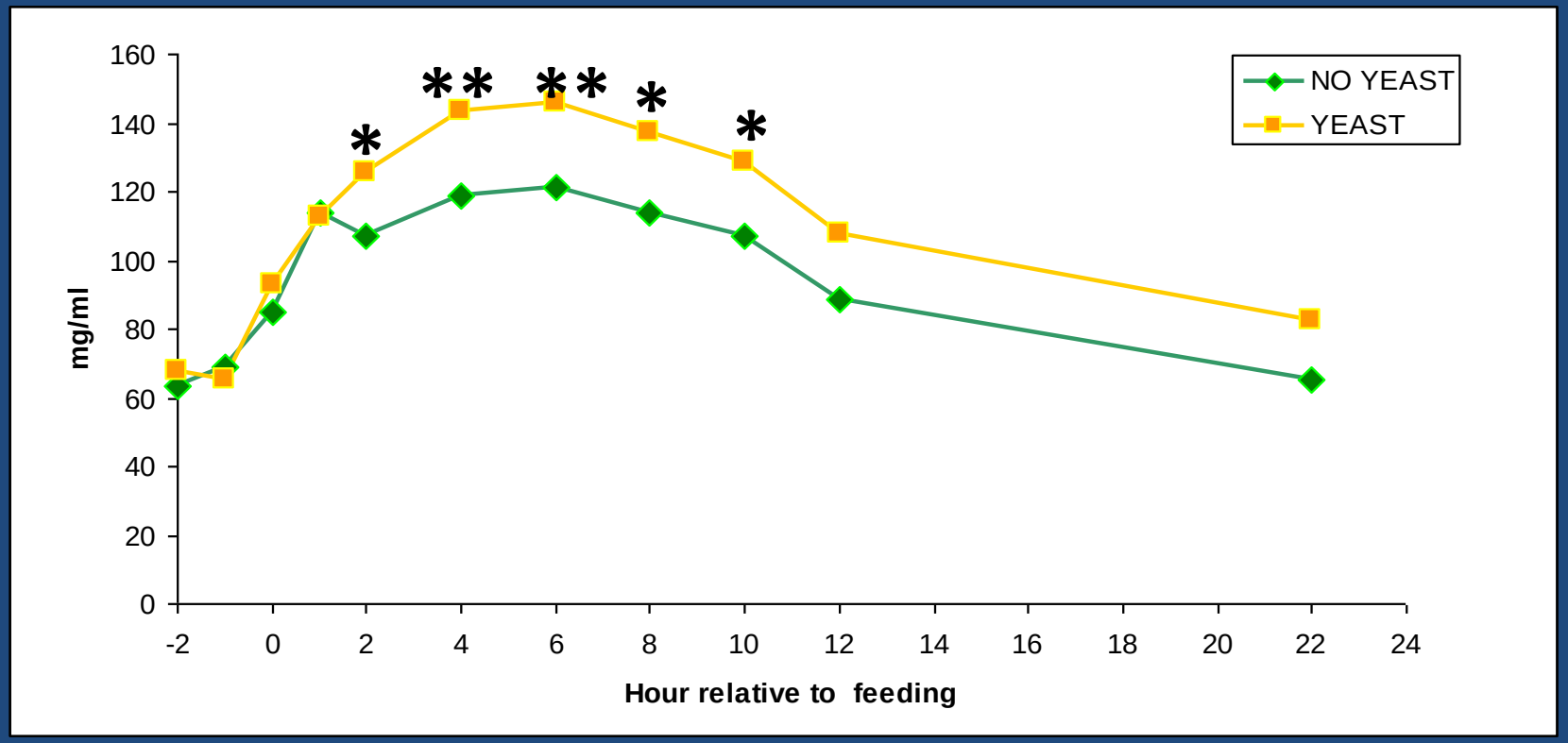
Yea Sacc fed 10gm/hd/d

PENNSTATE

1855

Penn State Study- 1 time /day feeding

VFA Pattern



* * = $P < 0.01$

* = $P < 0.1$

Added fats or oils

- Can affect milk components
  - Fat is toxic to rumen microbes and may reduce fiber digestibility
- Natural fat sources must be <5.0%
- Inert fats can be added to 6 or 7% of total fat
- Milk protein may be reduced in high fat rations
  - Due to reduced blood glucose levels

Summary: Factors that Influence milk components:

- The influence of forages on rumen health and influence feed efficiency
  - Acidosis decreases forage digestibility
- Adequate physically effective fiber is needed
  - Chewing, ruminating, saliva production
  - Proper forage particle length for proper rumen environment and rumen motility

Remember: Healthy Rumens Make for Healthy Cows

Proper forages- quality and quantity

Proper feeding management

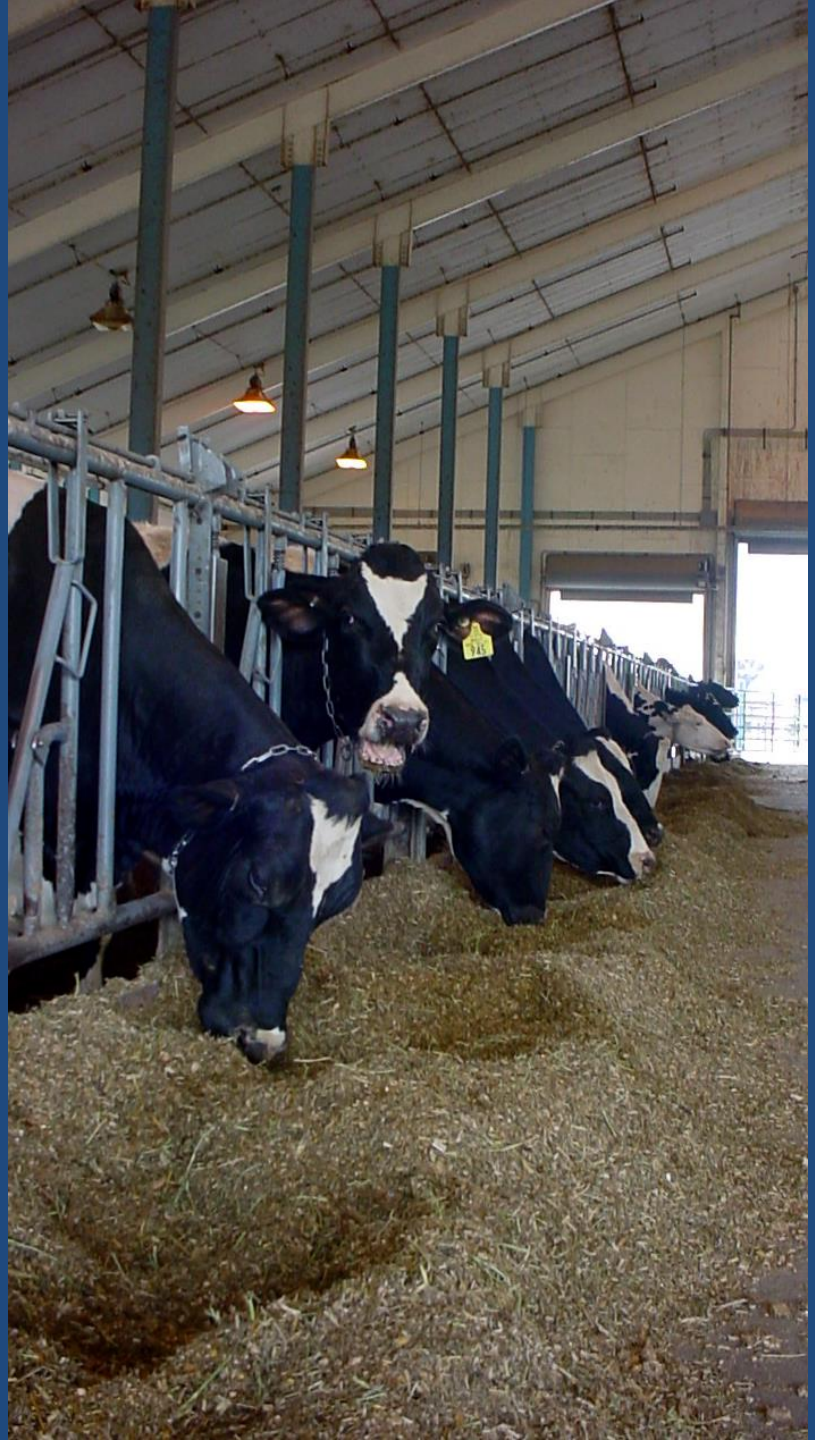
Proper cow environment

Proper diet levels of ingredients- and test for them

Not too much added fat in the diet

How do you read your own situation?

- Observe cows
- Are rations properly balanced?
- Are bunks overcrowded?
- Are all cows eating at once?
- Do you have a lot of variation between your paper ration and actual?
- How many hours are cows away from the feed bunk?



Thank you

QUESTIONS