Feeding Cows For Maximum Efficiency

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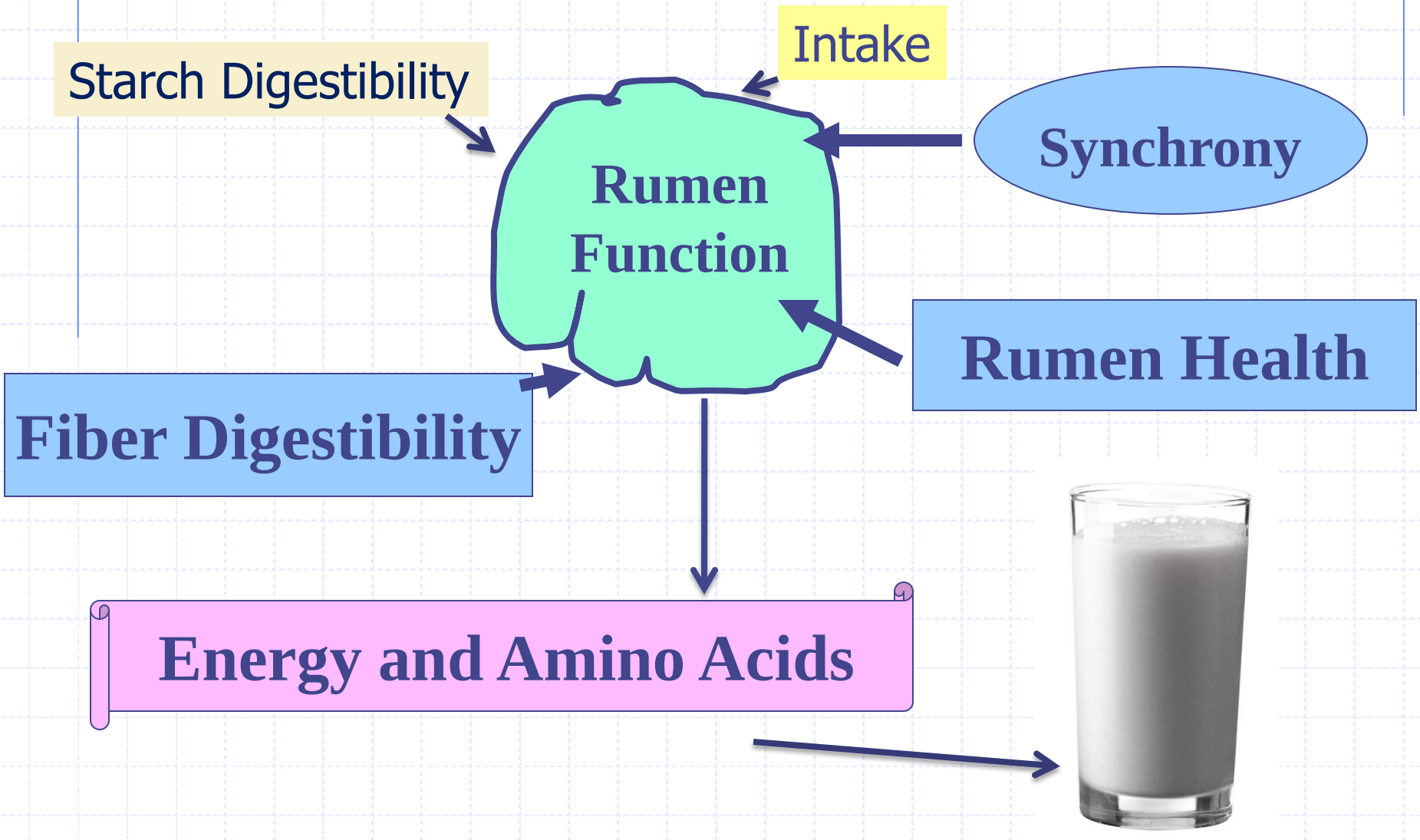
Making the Most of the Rumen…




Loose, Bubbly
Pasty Manure
Stiff Manure
Do You See
Inconsistent
Manure?
It's Probably Sub-Clinical Rumen Acidosis…

Here's A Close-Up.. Check out the Bubbles and Pastiness

Photo courtesy of M.B. Hall

What is "Ideal" Manure According to Eye Inspection

- Stacks up 1 – 1.5 inches
- Dimple in the Middle
- 2 to 4 concentric rings
- Sticks to boot
- No Visible Grain or Fiber
- Shaving Cream Consistency

Sub-Clinical Acidosis Manure

- Varies from firm to diarrhea
- May be foamy with gas bubbles
- Mucin casts may be present
- Contains undigested fiber & feed
- Increased fiber particle size (>0.5 inch)
- Grain in feces (<1/4 inch)

Hall, 2002

Why Does It Look Like That?

- Lack of Fiber, Less Rumination, and Faster Rates of Passage
  - → Fiber and Grain in the Manure
- More Intestinal Fermentation of Feed
  - →Organic acids damage intestinal wall and mucous is secreted for protection
  - → Gases can't be belched out and instead end up in the manure

Sub-clinical Rumen Acidosis

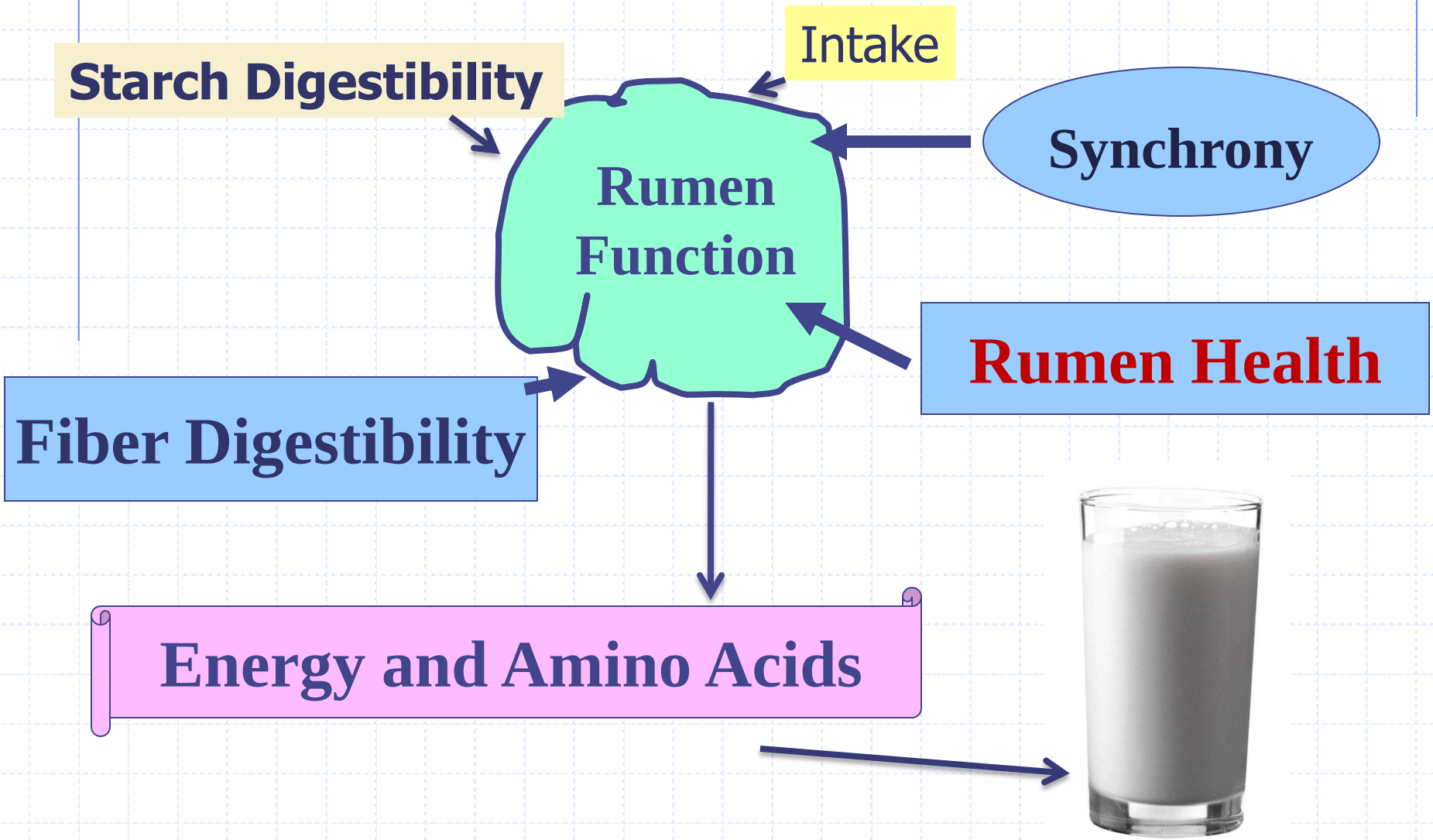
pH < 6.0

- Inhibits the Growth of Rumen Bacteria, especially the Fiber Digesters
- Reduces Rate of Fiber Digestion
- Reduces Rumen Microbial Protein

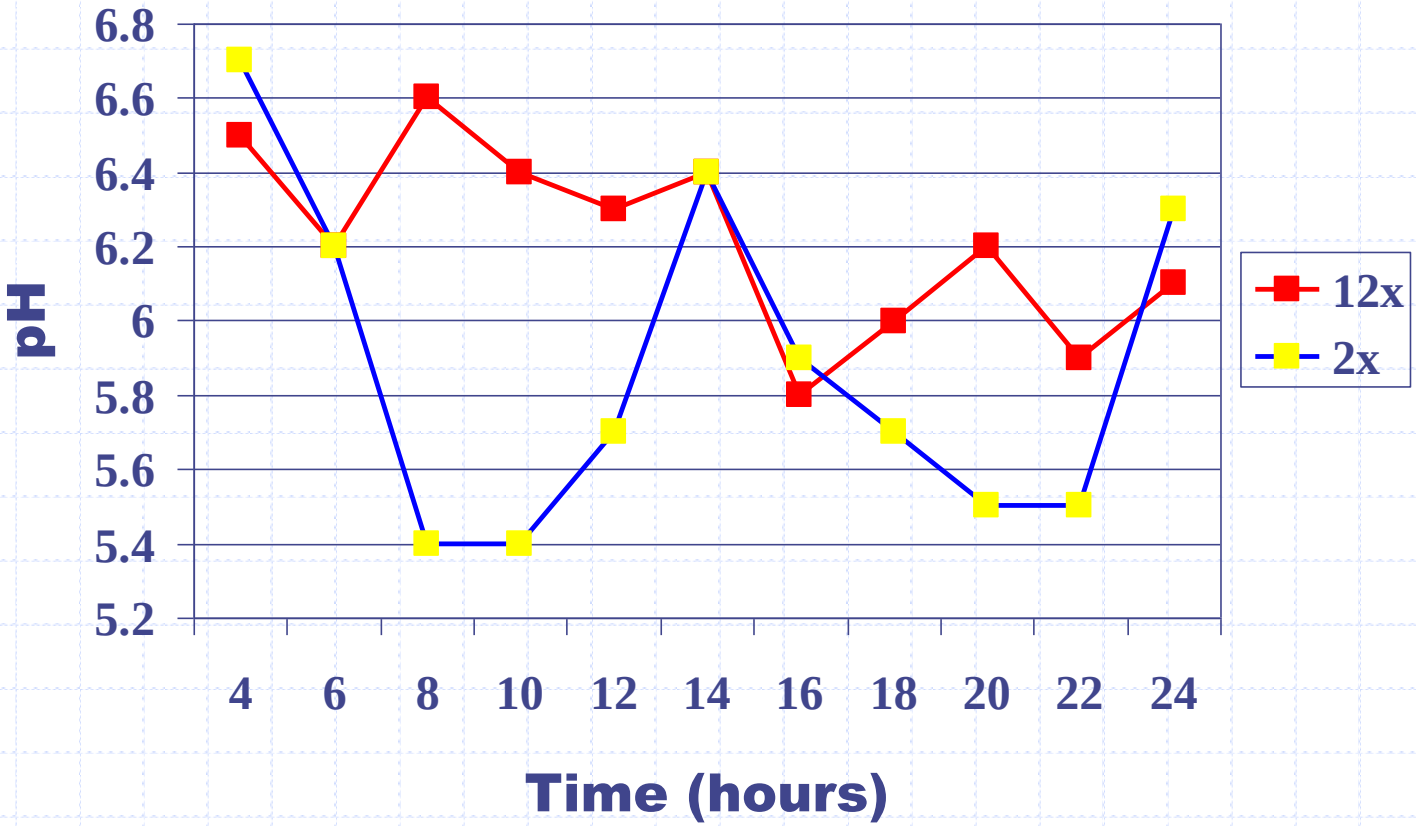
Hourly Fluctuations in Rumen pH

Making the Most of the Rumen…

1. Management Strategies



Hourly Rumen pH of Cows Fed Grain 2x/day or 12x/day



French & Kennelly, 1985

Avoid Slug Feeding

- High Producing Cows Eat 9-14 Meals/Day
- Watch……
  - Number of Feedings & Push-Up's / Day
  - Bunk Space (at least 18 inches/cow)
  - Competition Among Cows
  - Floor Surface / Footing for Cows
- Time For Eating, Drinking & Ruminating

Daily Time Budget (Grant, 2003)

Activity	Time Needed / Day
Eating	3-5 hours
Ruminating	7-10 hours
Drinking	30 minutes
Milking Time in Parlor	2-3 hours
Lying / Resting	10-12 hours

Feeding Behavior

High-Producing Cows Eat
9-14 Meals Per Day

2 X vs. 1 x TMR Feeding:
→10 min. more feeding/day
→ less TMR sorting

39 vs. 20 in. Feedbunk Space:
→57% Fewer Hostile Interactions
→10% More Eating Time/Day

Submissive Cows
Most Affected by Crowding

Resting & Rumination Economics

- 30% versus 0% Overcrowded
  → **25% Less Rumination on the Same TMR**

- Two pounds more milk per day for each extra hour of resting due to better health and blood flow to the udder

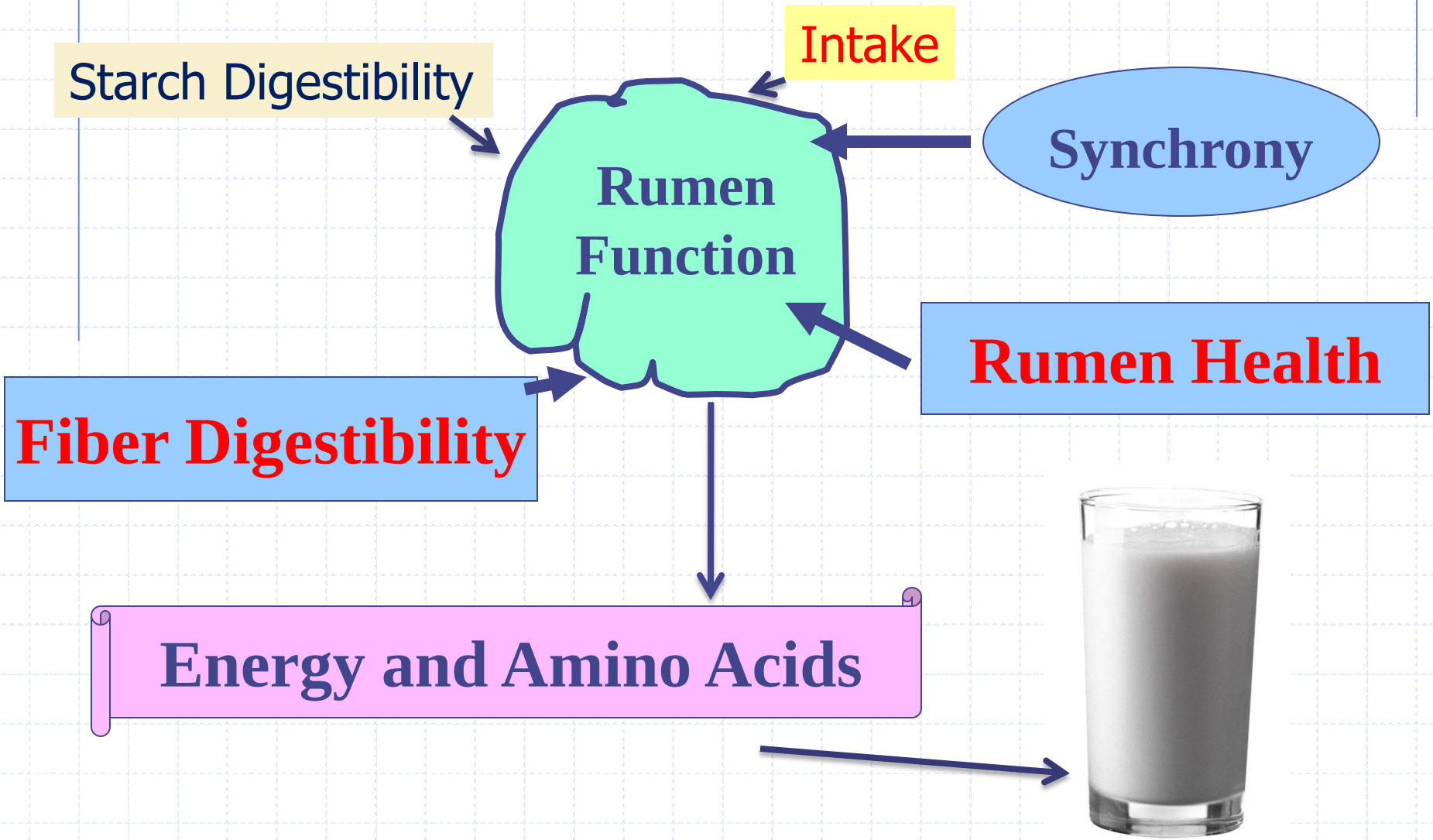
- One Farm:
  - **20% → 13% of day in parlor**
  - **36% → 49% of day resting**
  - **6 – 7 lbs more milk / cow / day**

Grant, 2003

Feeding Behavior Affects Rumen Function

Making the Most of the Rumen…

2. Fiber Length + Digestibility



How Does Fiber Help The Cow?

- Stimulates Chewing & Saliva Production
- Saliva Neutralizes Acids and Increases Rumen pH
- Forms Rumen Mat Which Slows Passage of Grains and Increases Their Digestibility
- Facilitates Movement

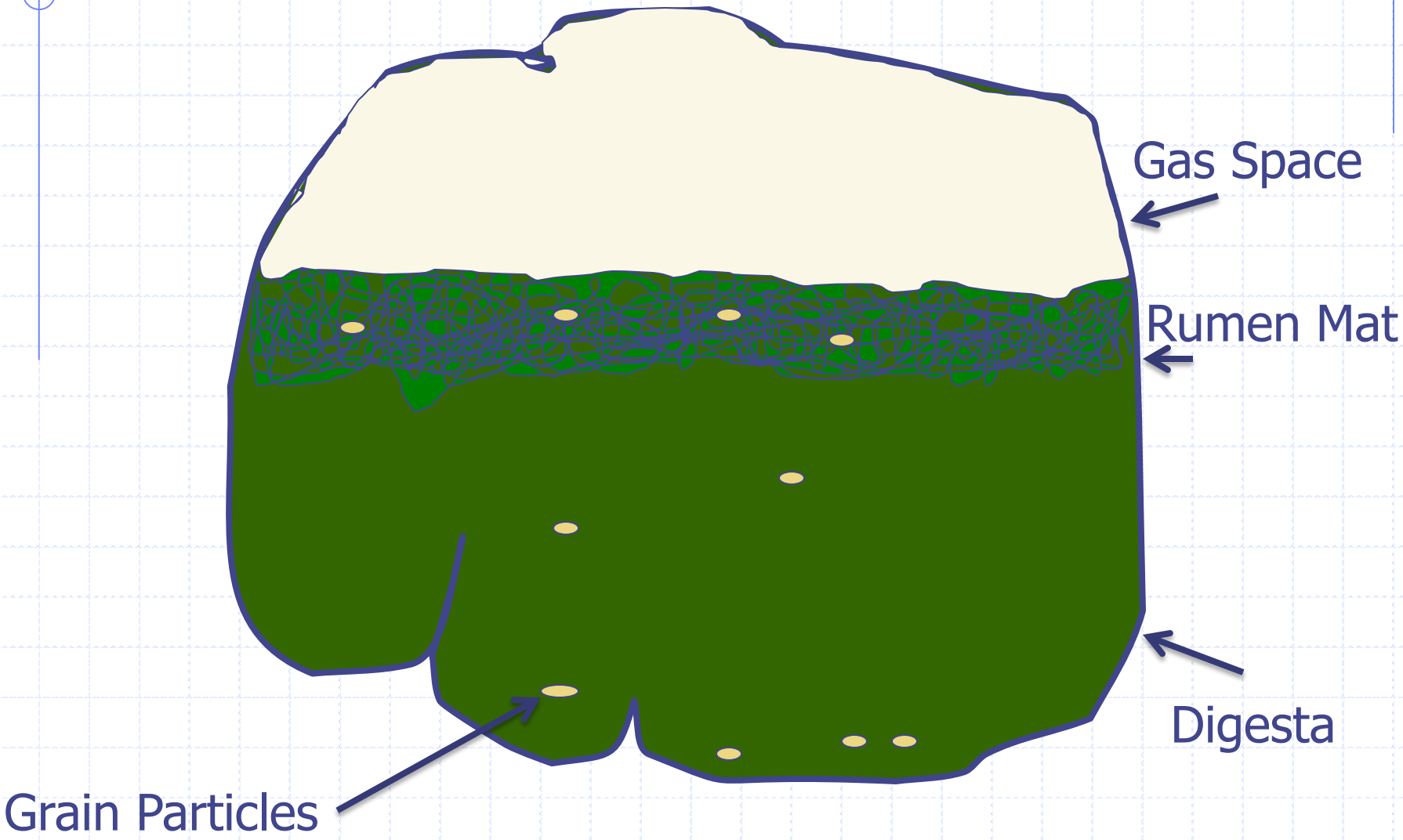
of Rumen Contents

and Absorption of Acids

15% of Ration Particles > 1.5 inches

50-60% of Cows should be Chewing

Slow Down Corn Passage With Good Rumen Mat Formation



How Does NDF Hinder the Cow?

Rumen Fill Limits Intake

High-Producing Cows With a Well-Functioning Rumen Are Limited In Forage Intake By the BULKINESS of the Fiber which Fills up the Rumen.

This Bulkiness is best estimated by the Forage NDF Content & NDF Digestibility

30 Hour NDF Digestibility

(Cumberland Valley Analytical Services, Inc.)

	Mean	SD
Legume Forage	45.91	9.38
Grass Forage	51.64	11.37
Corn Silage	58.65	6.13
BMR Corn Silage	69.84	4.62

Rate of NDF Digestion

- Legumes have less total NDF but due to greater lignification, have lower NDF digestibility.
- Grasses have less lignin and large ranges in maturity contributing to a large range in NDF digestibility.
- As plants mature, fiber content increases and NDF digestibility decreases.
- Warmer weather promotes lignification and reduces NDF digestibility.
- Light (or daylength) promotes photosynthesis and glucose production, having a positive effect on overall plant digestibility.
- Water increases NDF + Lignin and reduces digestibility.

Cows Eat More NDF When It is Highly Digestible…

	Normal Starch	Reduced Starch
NDF, %DM	30.6	36.6
NDF Intake, lbs/d	18	23.5*
NDF Intake, % BW	1.19	1.52*
Soy Hulls, %DM	3.6	12.7
Forage NDF, %DM	20.7	20.7
Starch, %DM	27.1	21.8
3.5% FCM, lbs/d	101.6	108*
DM Intake, lbs/d	58.7	64*

* $P<0.05$

Gencoglu et al., 2010

Effect of NDF Digestibility on Intake and Milk Production (Oba and Allen, 1999)

- Analyzed data from 13 sets of Forage Comparisons in the Literature
- NDF Concentration = Covariate
- One unit increase in NDF digestibility
  - Increase of 0.37 lbs in DMI
  - Increase of 0.55 lbs in 4% FCM

NDF Digestibility Affects Forage Intake & Milk

BMR Corn Silage Study

(Oba and Allen, 1999)

- BMR Corn Sil (44.6%)
  - NDF Dig = 49.1%
- Alfalfa Silage (11.2%)
- NDF = 30.8%
- DMI = 56.3 lbs*
- Milk = 91.7 lbs*
- Fat = 3.44%
- 4% FCM=84 lbs*

- Reg Corn Sil (44.6%)
  - NDF Dig = 39.4%
- Alfalfa Silage (11.2%)
- NDF = 31.6%
- DMI = 51.7 lbs
- Milk = 85.6 lbs
- Fat = 3.46%
- 4% FCM=78.5 lbs

Same Diets Just Switched Corn Silage

NDF Digestibility for the High-Producing Cow

- Affects Ration Energy Content
  - Standard forage tests assume a digestibility value for NDF when NE_l or TDN is calculated
  - Increasing NDF digestibility increases energy
- Dictates Ration Physical Fill
  - Increasing ration NDF digestibility can increase Forage and DM Intake
- Impacts Acidosis
  - Highly Digestible NDF may leave the rumen quicker causing more acidosis if not accounted for
  - If Grain Levels are dropped, Highly Digestible NDF can reduce acidosis & increase milk

NDF Digestibility on the Farm

- **Grow Forages with High NDF Digestibility**
  - Cut Earlier
    - Grass =Boot stage (no heads emerged)
    - "When you see the head, the quality is dead"
    - Alfalfa = Late Bud Stage
  - Change Genetics – e.g. BMR
  - High Chop Corn Silage

- **Measure NDF Digestibility and Use these Values in Ration Balancing**

Using Highly Digestible Forages

- Increase Forage NDF
  - **Typical High Cow Ration ~ 24-26%**
  - **Highly Digestible Forages ~ 27-28% or More?**
- Reduce Grain Levels
- Increase Predicted Dry Matter Intake
- Maintain Good Effective Fiber Levels
  - **Adding Hay or Straw Helps**
- Watch the Manure, Cud-Chewing, Milk Prod.
- Acidosis Signs? .. Reduce Grain More

Allocate Highly Digestible Forages to Early Lactation Cows

BMR vs. Regular Corn Silage (43% of Diet DM)

	Conventional Corn Silage (42% NDFd24h)	BMR Corn Silage (57% NDFd24h)	P-Value
DM Intake, lbs/d	55.4	61.2	0.001
NDF Intake, %BW	1.01	1.17	<0.001
Milk, lbs/d	89.3	92.8	NS
Fat, %	3.62	3.71	NS
Milk/DMI	1.60	1.50	0.03
Eating Min/lb NDF	14	12	<0.001
Ruminating Min/lb NDF	32	26	<0.001

With no other ration adjustments (like extra NDF and straw), there was less chewing and possibly a higher rate of passage (and lower Feed Efficiency) with BMR Corn Silage.

Miner Institute Farm Report, Nov 2010

HAY or Straw added to TMR's

- 2-3 lbs of Long, Dry Hay or 0.5-1 lb of Straw goes a long way in decreasing sub-clinical acidosis. It is especially important in early lactation.
- Provides a consistent fiber source when silage particles, moisture and quality may vary and different people are mixing the TMR each day.

Dries Out Ration

Forage NDF Level

21%

28%

Less Acidosis Worry; Can Have More Grain In Diet

← Long Forage Particles

←No Overcrowding

←TMR, No Sorting

Slug Feeding →

Fast Degradable Starch →

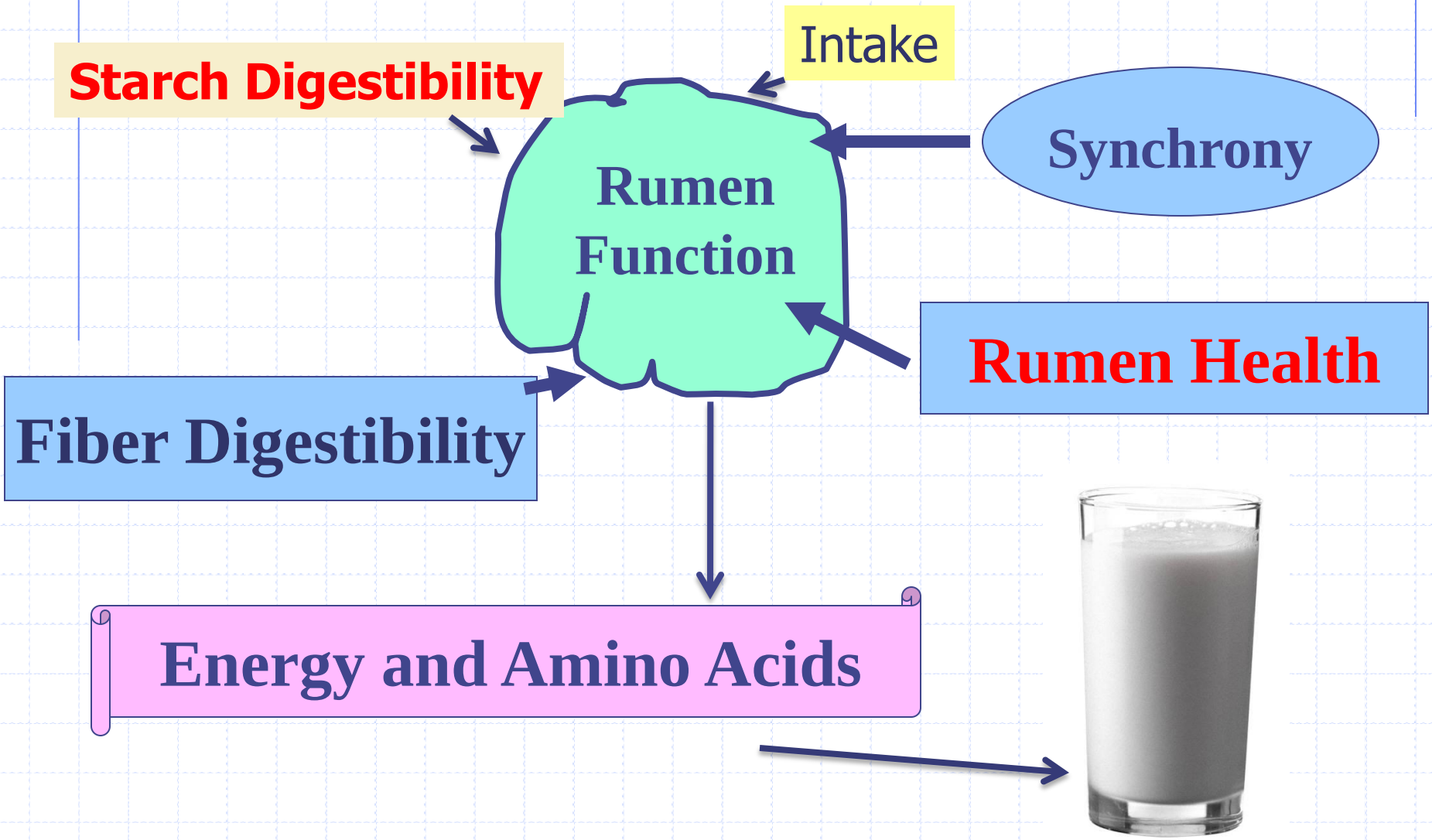
Variation in Forage DM & NDF →

More Acidosis Concern, Must Have More Fiber, Less Diet Energy For Milk

High Fiber Digestibility → Less Grain, More Energy & Milk

Making the Most of the Rumen…

3. Starch Types + Digestibility



Grain Particle Size

- 67% of Cornmeal Should Pass Through a Kitchen Flour Sifter (~ 1.18 mm)
- This Equates to an average Particle Size of 1100 Microns

- **High-Moisture Corn**
  - **28-32% Moisture - Roll Before Feeding**
  - **>32% Moisture - Roll Less**
  - **<25% Moisture - Grind With a Hammermill Before Feeding**

Get All The Starch You Can Out Of Your Corn Silage

30-33% DM

No Cobs > 1/8th Ring

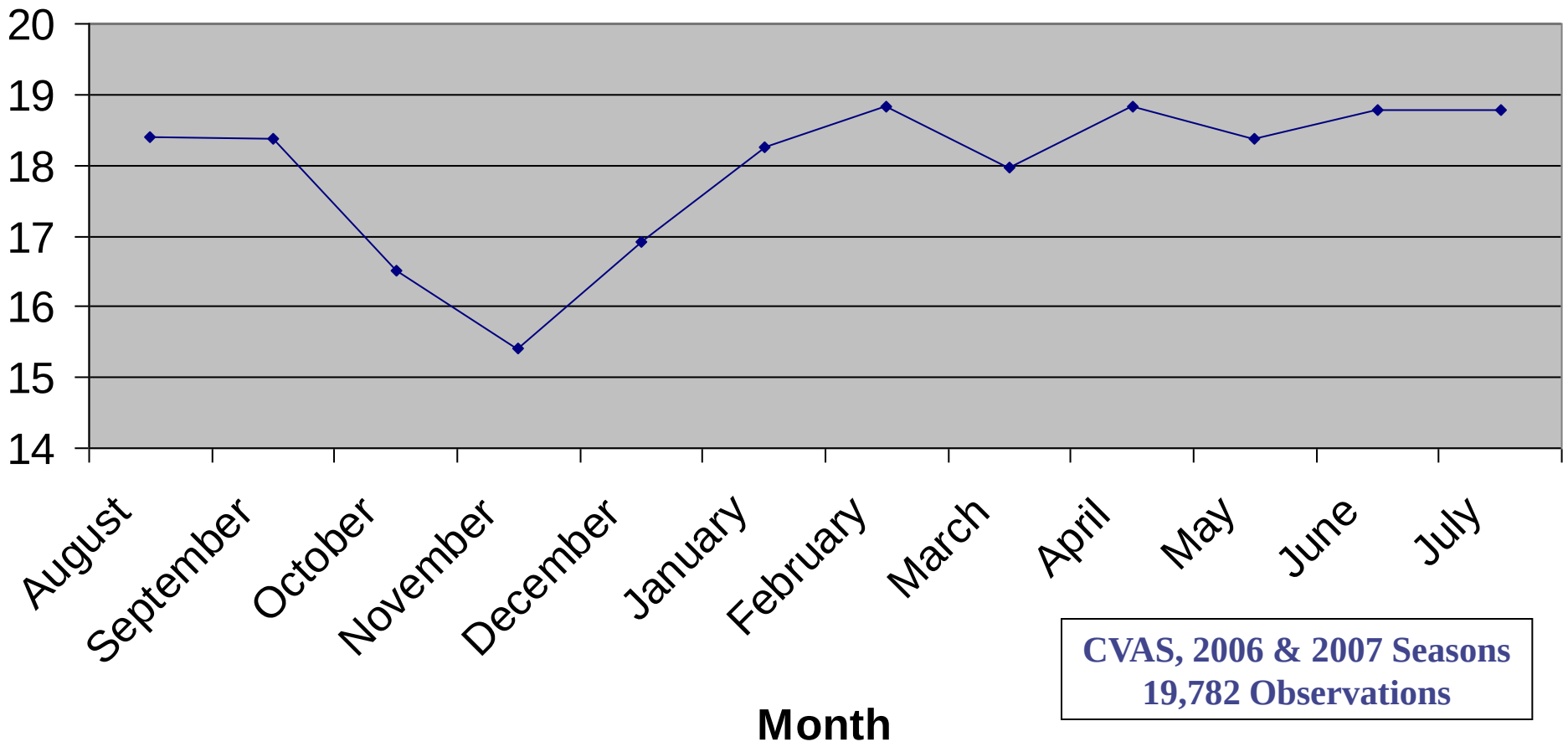
95% Kernel Breakage

Not too coarse so get good fermentation (10-15% Top, >50% Middle, <35% Bottom)

0.75 inch Theoretical Length of Cut, 2-3 mm roller clearance

Don’t start feed out until January

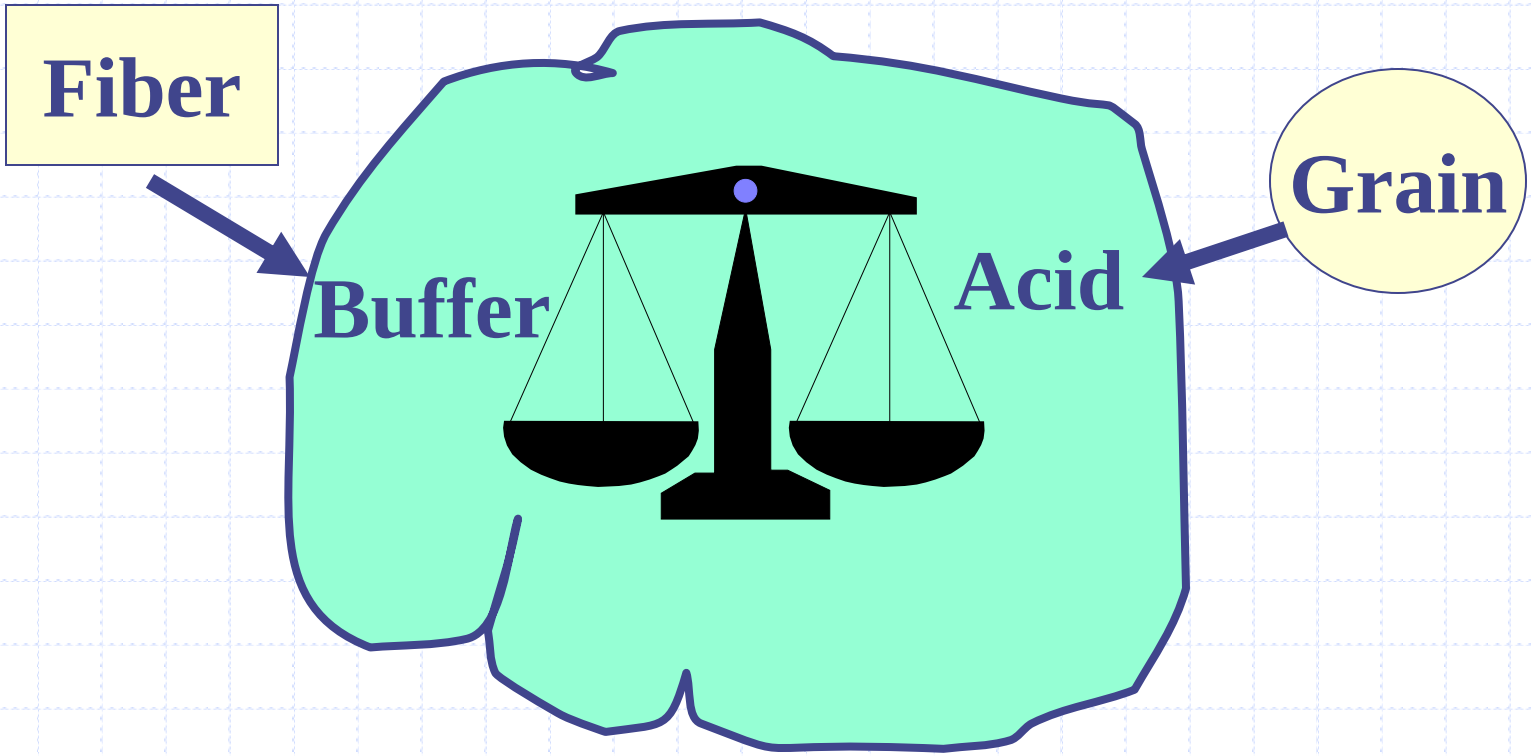
Available Starch in Corn Silage (%Total Starch)



CVAS, 2006 & 2007 Seasons
19,782 Observations

Corn Silage sent to CVAS in October, November, and December had significantly less ($P<0.05$) available starch than samples sent during March through September.

What's Going On in the Rumen?



A Rumen Balancing Act Goes On Each Minute of the Day

Too Much Fast Fermenting Starch Yields Rumen Acidosis

Source:

Wheat
Barley
Oats
Corn
Sorghum

Fast

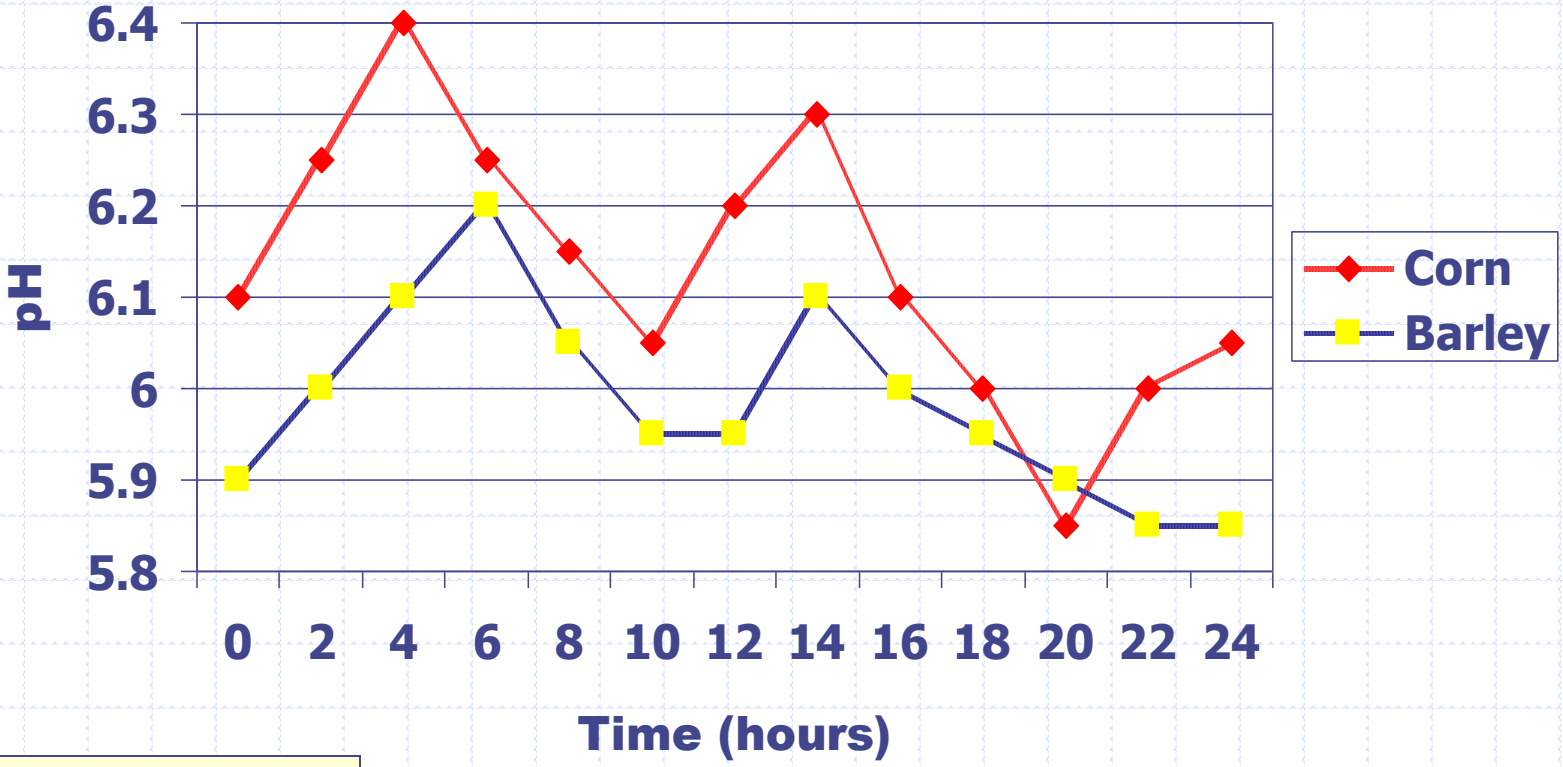
Slow

Form:

Steam-Flaked
High Moisture
Dry Ground
Dry Rolled
Dry Whole

Allen, 1991

Rumen pH of Cows Fed Corn vs. Barley in a TMR

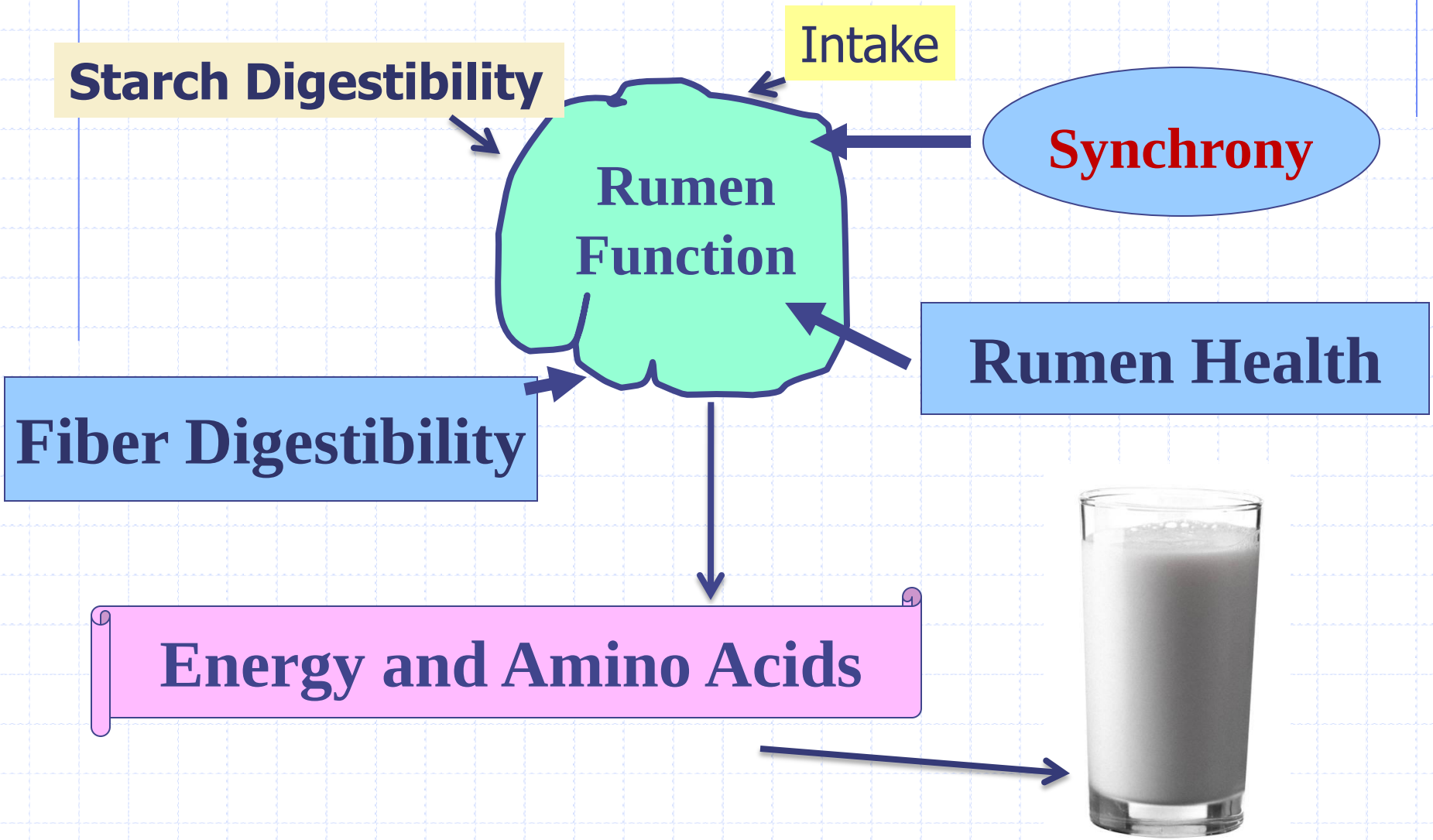


How Many Hours Is pH below 6.0?

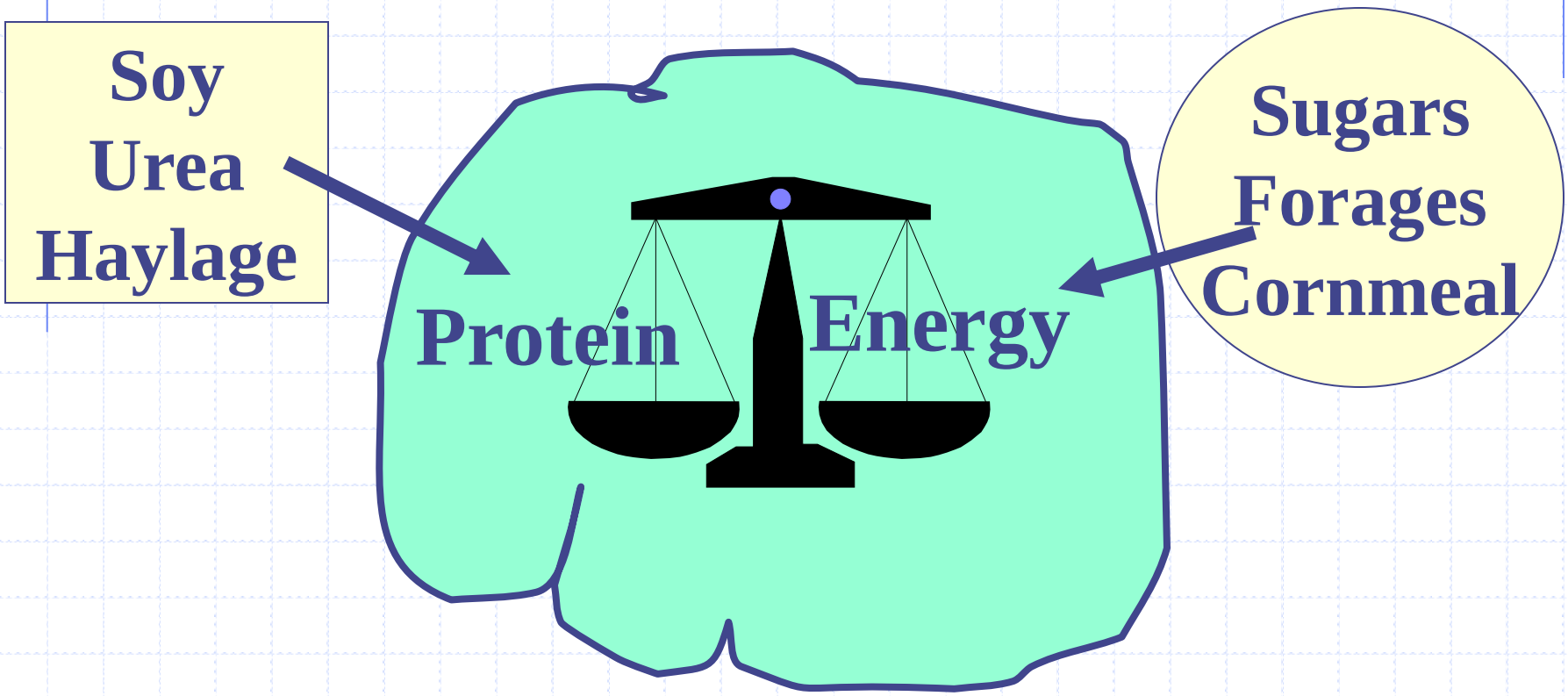
Yang et al., 1997

Making the Most of the Rumen…

4. Microbial Growth



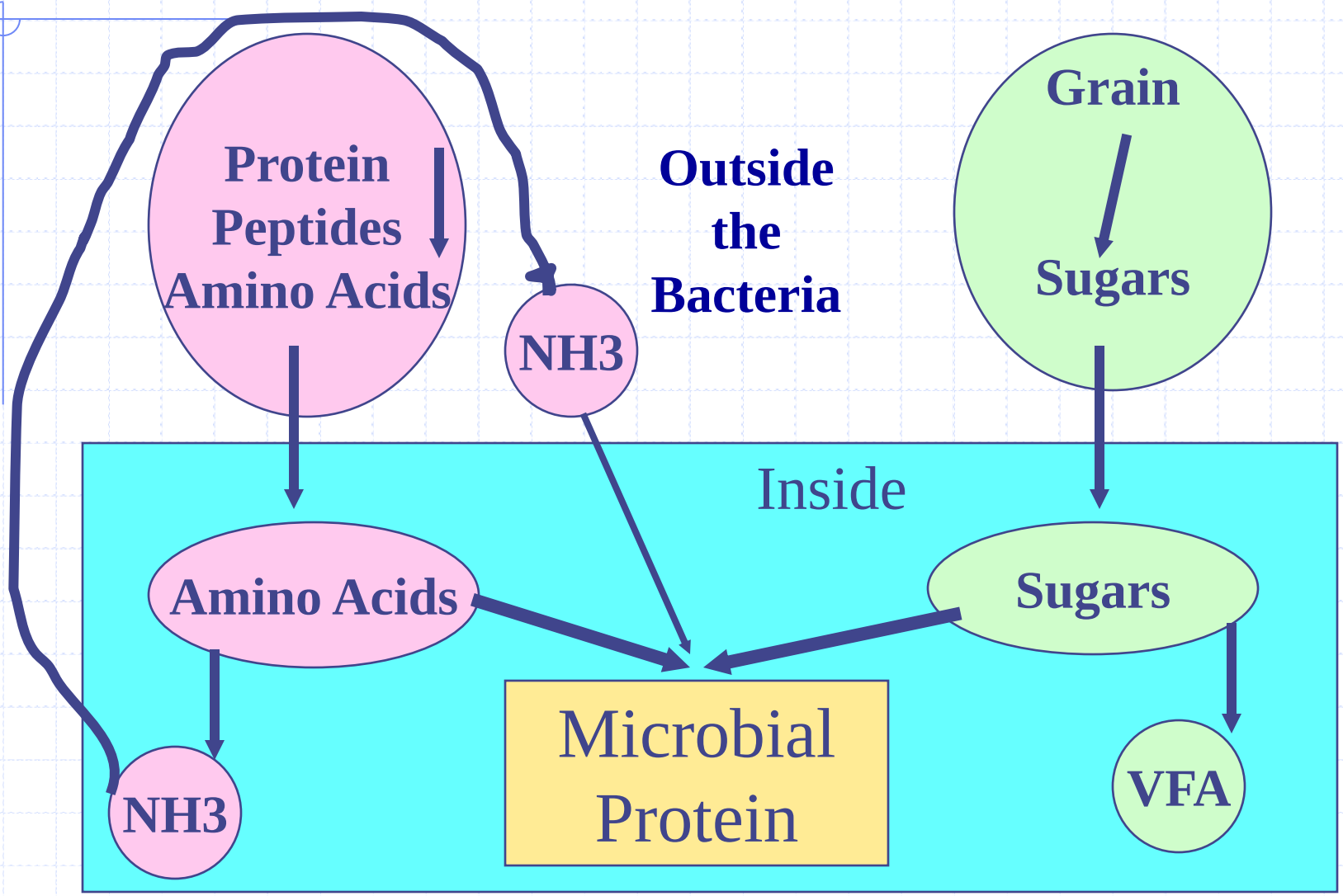
Blending Sugars and Starches Synchronizes Nutrient Supply



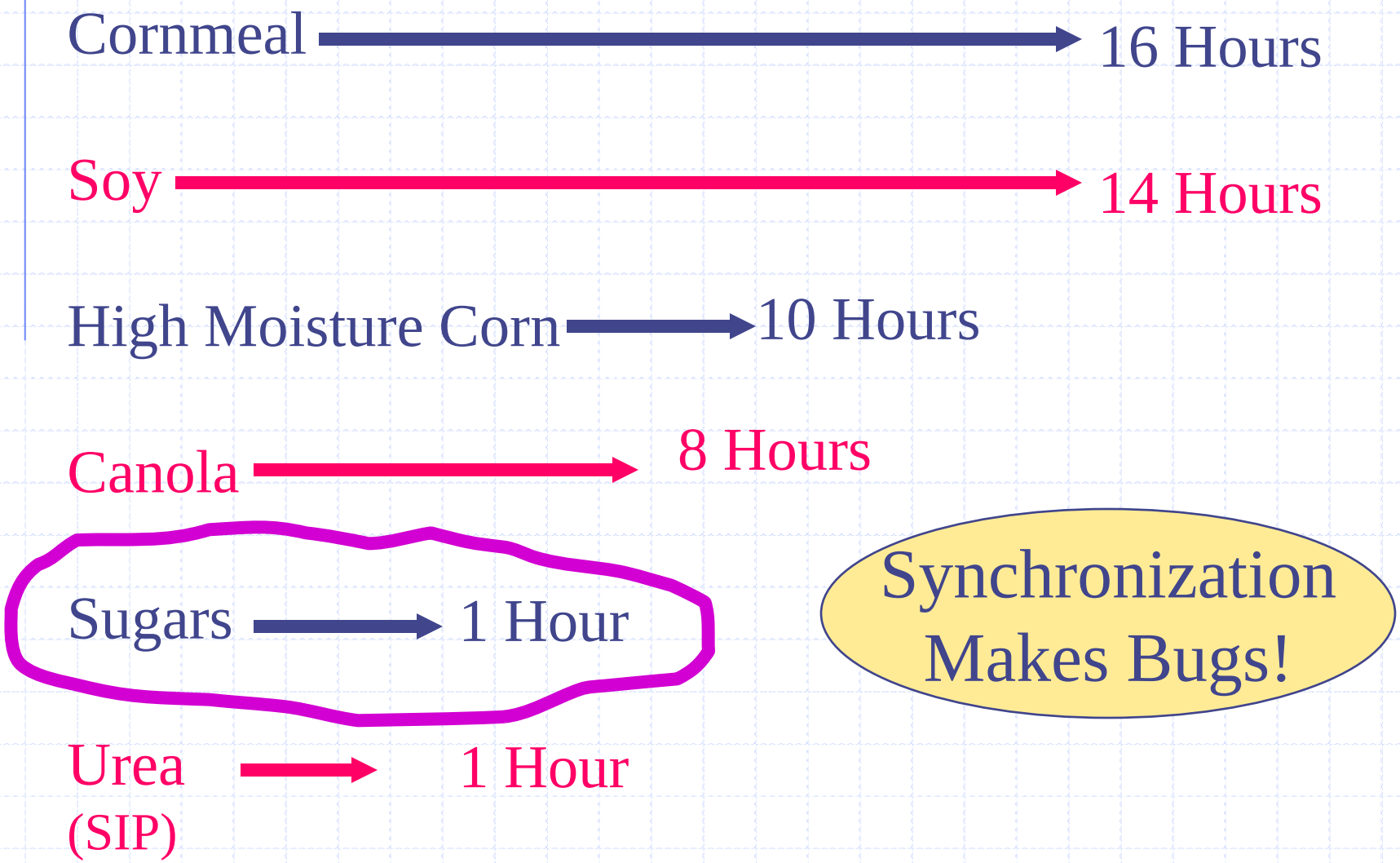
A Rumen Balancing Act Goes On Each Minute of the Day
The Rumen Microbes Want An Ideal Ratio Every Minute

Use of Protein and Carbohydrate by the Rumen Bacteria

Russell, 1988



Protein and Carbohydrate Fermentation in the Rumen



Simple Sugars

General Recommendation = 4-6% of the DM

- Help Provide Needed Energy At the Right Time In Relation to Starch & Fiber In the Ration
- Increase Microbial Protein Production
- Reduce Nitrogen Wastage
- Decrease Undigested Corn in the Manure
- More Milk Response When the Ration Contains Fewer Fast Digestible Starches

Fine-Tuning Ration Synchrony

- Balance for Sugars, Fast Digestible Starches, and Slowly Digestible Starches
- General Recommendations:
  - 4-8% DM Fast Digestible Starch Source
  - 4-6% DM Sugar

Advanced Methods and Models Need to Be Developed To More Accurately Predict Starch Fractions and Microbial Needs for Different Starches

Watching Milk Urea Nitrogen

- MUN's tell us how much nitrogen the cow is wasting
- Excess ammonia from the rumen is converted to urea by the kidney and liver. Urea is excreted in the urine. When levels of blood urea go up, milk urea levels also rise.

Watching Milk Urea Nitrogen

- MUN > 12 mg/dl
  - Good Production + Milk Protein → Consider gradually reducing RDP, especially soluble protein, in order to save on feed costs
  - Poor Production + Milk Protein

    →May need to increase diet sugar and/or rapidly fermentable starch

Best-Value Ration Balancing

What Changes with High Corn Prices?

- Higher usage of fast degradable starch
- Always using finely ground corn (no passage in manure acceptable)
- Higher usage of soluble fiber especially pectin (8-10% DM)
- More dietary sugars (5-6% DM)
- Less overall starch (21-23% DM)
- More fermentable NDF (11-12% DM) and More forage NDF (25-27%)

What to Watch when Lowering Starch & Increasing Fiber:

- Manure – can be stiffer with insufficient digestible starch in the diet
- MUN's – may increase if not enough rumen digestible starch
- Milk protein – may decrease if microbial yield is reduced
- Milk production

Always Lower Dietary Starch Gradually

Who Cares About Quality Control?

Cows Should Be Bored With Their Ration!

- **Consistent Rations Result In:**
  - Consistent Intake & Digestive Health
  - Consistently Upward Milk Production
- **Maintain a Consistent Ration Nutrient Profile**
  - Limit and Account for Ingredient Variation
- **Watch out for Molds and Mycotoxins**

Track Daily Intakes & Daily Milk

Incoming Feed Ingredient Quality

- Feed ingredients must be:
  - **Palatable**
  - **Not Damaged by Weather**
  - **Free of Molds, Bacteria, and Trash**

- Know Your Suppliers
- Measure Bushel Weights
- Inspect all Incoming Loads
- Test Samples at a Laboratory

Know the Nutrient Variation of Ingredients

	CP	NDF	Starch
Corn	9.5 +/- 1.6	9.8 +/- 3.2	70.6 +/- 5.1
CGF	23.5 +/- 7.0	36.1 +/- 6.8	16.3 +/- 7.7
Distillers	30.3 +/- 3.6	33.4 +/- 4.9	5.9 +/- 3.4
Hominy	10.5 +/- 1.9	17.9 +/- 5.7	53.4 +/- 10.5

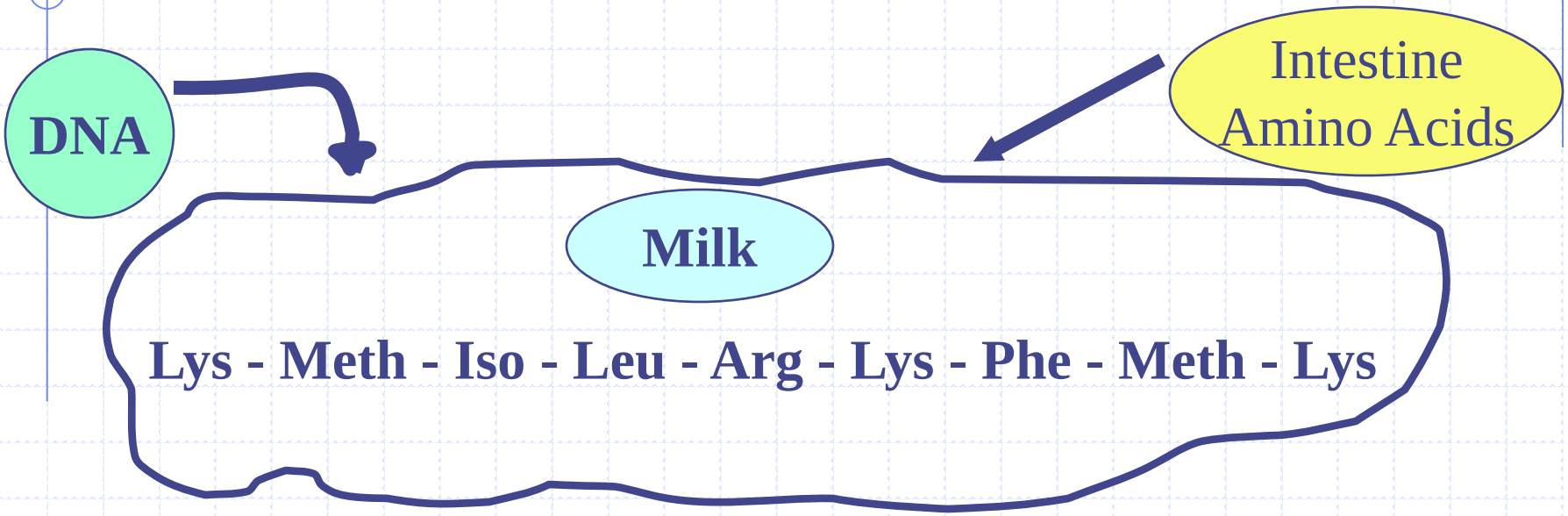
Dairy One, Ithaca, NY

DDGS Have Become Known as a Variable Product

	NRC, 2001	Mean of 8 Plants	Range of 8 Plants
CP (%DM)	26-33	30.1	26-36
Crude Fat (%DM)	7-13	10.5	4-19
NDF (%DM)	31-47	48.8	39-62
Soluble CP (%CP)	---	9.7	1-22
ADF-CP (%CP)	9-29	8.0	1-19
RUP (%CP)	42-51	53.4	41-68
RUP Dig. (%RUP)	80	82.2	72-94

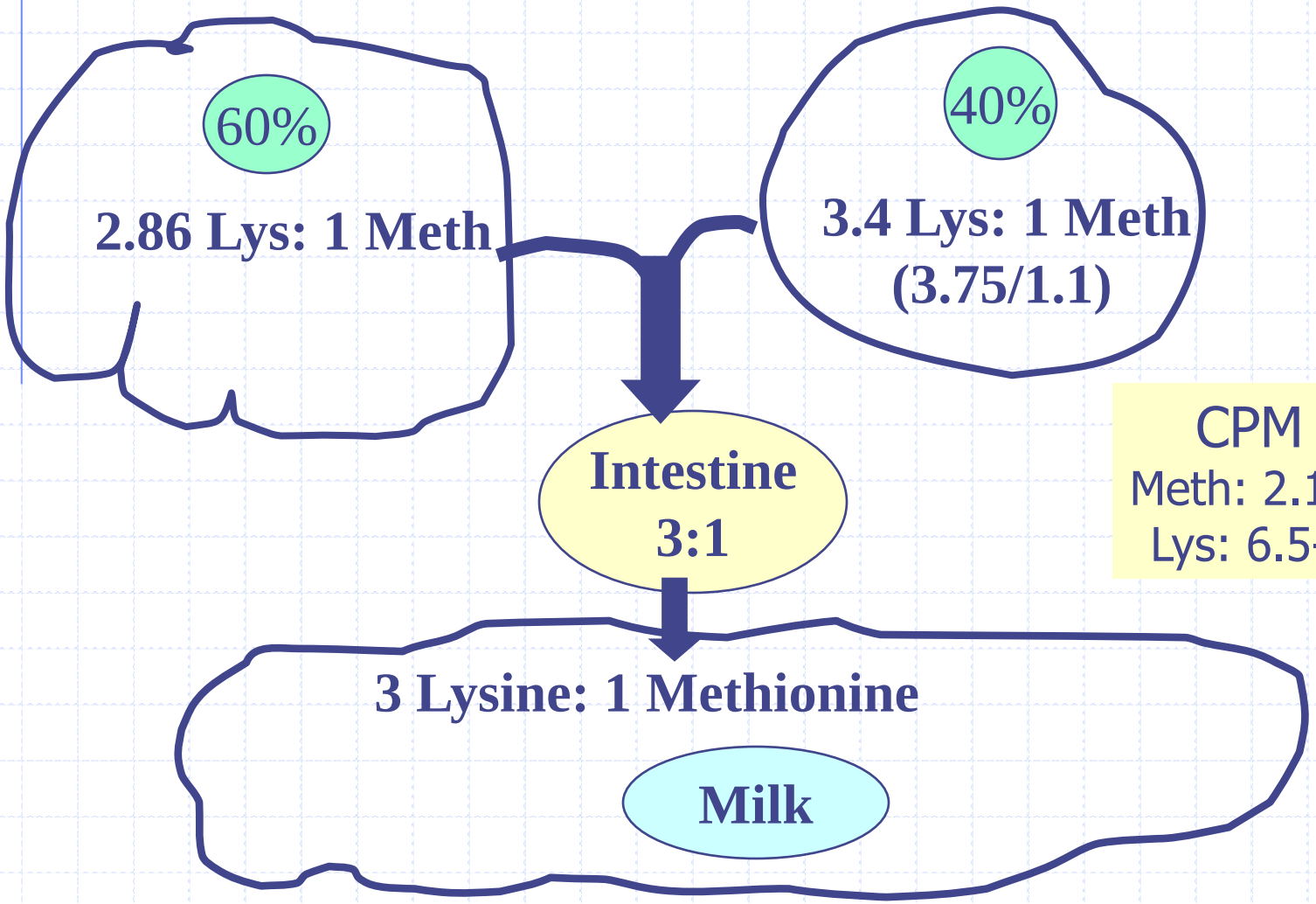
Harty et al., 1998

Cows Require Specific Amounts of Each Amino Acid to Make Milk



Milk production is limited by the amino acid that is in shortest supply in relation to the cow's requirement for forming the amino acid chains. That amino acid is called the "first-limiting" amino acid in the diet. Often, it is lysine or methionine.

Maximize Microbial AA's & Complement with RUP AA's



CPM Dairy:
Meth: 2.1-2.5% mp
Lys: 6.5-7.2% mp

Amino Acid Profile (% of AA) After 12 Hours of *In Situ* Rumen Incubation

	SBM	Fishmeal	DDGS	Milk (for comparison)
Methionine	**1.8**	**3.8**	**2.4**	**2.6**
Lysine	**5.4**	**8.5**	**1.2**	**7.6**
Isoleucine	**5.2**	**5.3**	**4.0**	**5.1**
Leucine	**8.6**	**8.9**	**13.8**	**8.9**
Arginine	**6.2**	**6.2**	**2.6**	**3.5**

O'Mara et al., 1997; Degussa, 1991

Making the Most of the Rumen…