Seminar organized by Lallemand Animal Nutrition

THE RUMINANT EXPERT TOUR:
THE UNEXPECTED POWER OF FIBER

19-20 November 2024, Alexandria, Egypt

SPECIFIC FOR YOUR SUCCESS

LALLEMAND ANIMAL NUTRITION

PROGRAM

MONDAY, NOVEMBER 18

04.00 to 08.00 pm Registration (desk at the hotel in the lobby)

08.00 pm Dinner

TUESDAY, NOVEMBER 19

08.15 am Departure from the hotel
08.30 am Registration at Bibliotheca Alexandrina (bring your passport)
08.45 - 09.00 am Welcoming session - *Joe Agnatios, Business Area Manager Africa & Middle-East*

MORNING
Discovering the key role of fiber in dairy rations: from the production to digestion

09.00 - 10.40 am **Overall importance of fiber and key influencer from the field to the silo**

- Introduction to the world of fiber: key definitions *Bill Woodley, Woodley Dairy Direction* + influence of agronomy on final composition; evolution of fiber in plant *Franck Kuechenmeister, International Technical Support Manager Forage additives*
- Good practice of silage manufacturing and citrus techniques *Mohammed Bakr, Assistant Professor of Animal Nutrition, Animal Production Department, Faculty of Agriculture, Cairo University, Egypt*

10.40 - 11.00 am *Break*

11.00 - 12.30 am **Role of fiber and impact on animal performance**

- Role of fiber: physical and digestion
  Bill Woodley, Woodley Dairy Direction
- Management of rumen fermentation
  Aurélien Piron, Global Technical Manager Feed additives

12.30 - 01.00 pm **Q&A**

01.00 - 02.00 pm **Lunch**

AFTERNOON

02.00 - 03.30 pm **Practical Workshops and posters session: from silage to rumen secret**
04:00 pm Visit of the Bibliotheca Alexandrina
08.00 pm Dinner

WEDNESDAY, NOVEMBER 20

MORNING

08.30 - 09.30 am Departure - Transfer to the farm
09.30 - 12.00 am Farm visits: Workshops on silage quality and ruminants (silage, TMR and animal evalutation)

Lunch

AFTERNOON

Discovering the key role of fiber in dairy rations: how farm challenges are affecting feed efficiency

02.00 - 03.30 pm Transition and heat stress impact and nutrition to alleviate

03.30 - 04.00 pm *Break*

04.00 - 05.30 pm **From silage to rumen and gut health: how toxins can affect animal health**
Keeping NDF digestibility high in silo
Rumen fermentation, acidosis and leaky gut

05.30 - 06.00 pm **Q&A - Conclusion** - *Joe Agnatios, Business Area Manager Africa & Middle-East*

08.00 pm Dinner

ACCOMODATION PAGE

HOTEL

TOLIP ALEXANDRIA HOTEL
Moustafa Kamel
Corniche Road
Roshdy, Alexandria
Tolip Alexandria Hotel
Tel: +2 03519330

MORE INFO

ROOMS

Rooms have been already booked by Lallemand Animal Nutrition, considering your needs communicated in the registration form.

CONFERENCE

Conference at
BIBLIOTHECA ALEXANDRINA

Auditorium

Adress: P.O. Box 138,
El Shatby, Alexandria

MORE INFO

SHUTTLES

You can also manage your own transfer by taxi or with applications like inDrive or Uber we recommend to download this application before your arrival in Egypt:

inDrive

4 ways to travel to Alexandria

1 Cairo Airport (CAI), Egypt

Bus	3h 30min	BEST	€1–3
Taxi	2h 18min	FASTEST	€8–10
Train	4h 55min		€17–37
Drive 236.7 km	2h 18min		€12–17

You should have receive your booking confirmation by mail
If no, contact us to know your status

SPEAKERS

BILL WOODLEY

Woodley Dairy Direction

Bill Woodley retired after working for 37 years for a major North American Feed and Nutrition Company. Bill has formed a dairy consulting company, Woodley Dairy Direction, focusing on dairy management and nutrition strategies to improve productivity.

Bill had a variety of roles over the last thirty-seven years but always with a major emphasis on Dairy Nutrition and Management. Bill's role as Ruminant Technical Manager provided a critical liaison between research and the practicalities of the dairy farm. Bill has written several articles for magazines such as the Ontario Dairy Farmer and Progressive Dairyman. Bill's main emphasis through Woodley Dairy Direction is working with dairy operations and dairy specialists to "unlock the potential" on dairy herds. Bill focuses on what he calls "The Legacy Effect" – understanding management and nutrition decisions made on dairy farms today that will affect future production.

The other key area of focus is on understanding forage quality and particle size. Both quality and particle size interact to have a significant impact on herd productivity.

AURÉLIEN PIRON

Global Technical Manager Feed additives

Aurelien Piron is working for Lallemand Animal Nutrition since 15 years as ruminant technical manager. Aurelien is in charge of technical support for ruminants feed additives range (deployment of on farm services, training for field salesmen, joined RandD program and field experiences with customers) on various areas around the globe. He is also involved in several marketing, technical and RandD projects within Lallemand.

After a master of science in Animal Production performed in University of Angers (France), he worked during 2,5 years in a premix company as technical and applied RandD manager.

SPEAKERS

JOE AGNATIOS ABI-JAOUDÉ

Business Area Manager Africa & Middle-East

Joe Agnatios is currently in charge of 14 countries, promoting pre and probiotics for all animal species. Before joining Lallemand 3 years ago, he worked in several companies as Global R&D Manager, Product Manager, Area Manager, Country Sales & Technical Director all in animal nutrition from milk substitutes to premixes and additives, mostly linked to the Middle East and North African countries.

Graduated from Agro Paris Tech in 2000, PhD in Animal Nutrition, he was investigating the effects of the diet forage/concentrate ratio on the rumen, blood and milk parameters in dairy goats, which led to the publication of several articles.

FRANK KUECHENMEISTER

International Technical Support Manager Forage additives

Frank Kuechenmeister is an international silage tech. support manager at Lallemand Animal Nutrition. His main working areas are Europe and Asia. Checking and improving silage on farm; training of farmers and customers, giving speeches and cooperating internally with marketing and R & D are his main tasks. Frank dealing with silages for ruminants and biogas. Before joining Lallemand, he was also working in the field of silage production and ruminant nutrition mainly in Europe and East Africa.

He graduated from University of Goettingen. During his Master and PhD studies he was investigating the influence of drought stress on forage plant. Parts of his studies were done in Saudi Arabia, Russia and Kyrgyzstan.

Graduated in animal nutrition, he has more than 25 research papers and books in local and international scientific publications. His research focused on the field of innovation and application of non-traditional feed ingredients in dairy and beef farms and as well as the field of functional food, to transform research ideas into applied projects. For 18 years, Mohammed Bakr providing technical advice as a consultant to many private and government sector farms in Egypt (for more than 300 thousand heads of livestock) and in Latin America and Saudi Arabia in order to help breeders achieve higher Possible profitability at the lowest costs without negatively affecting the health of the animal or the quality of the animal product (meat - milk) and also in field of feed manufacturing Technology (animal feed factories).

MOHAMMED BAKR

Assistant Professor of Animal Nutrition, Animal Production Department, Faculty of Agriculture, Cairo University, Egypt

CO SPEAKERS: BILL WOODLEY AND FRANK KUECHENMEISTER

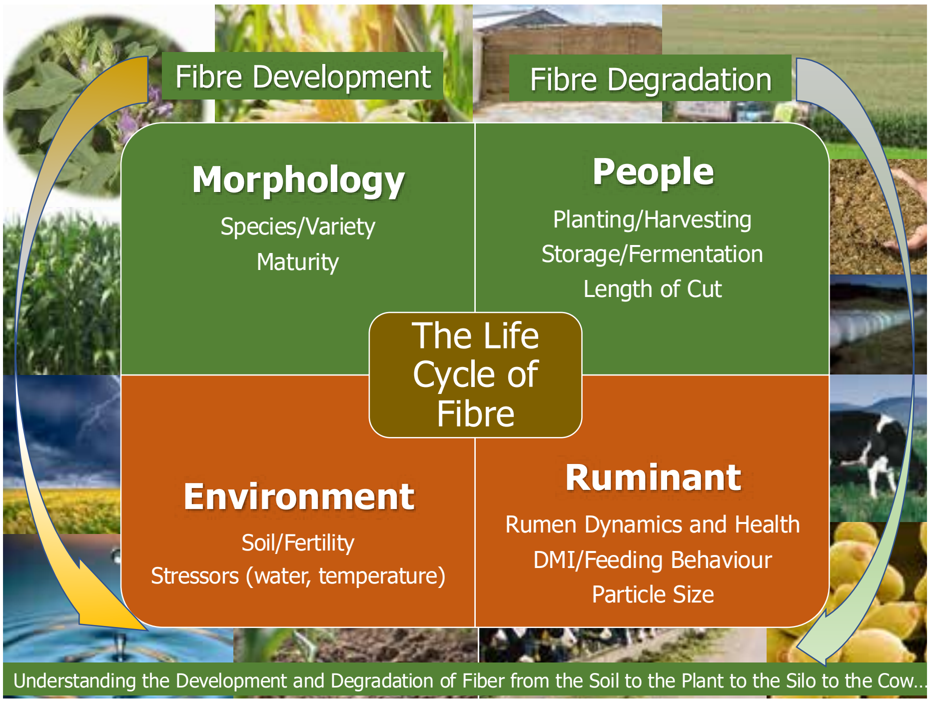
-Role of fiber: Physical and digestion,
- Influence of agronomy on final composition,
- Evolution of fiber in plant

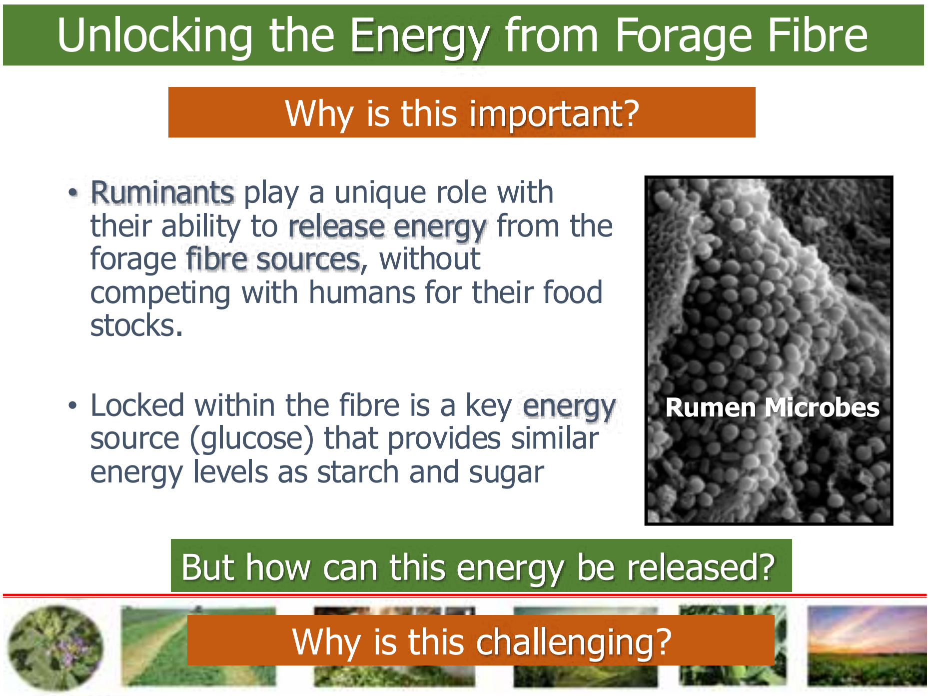
Introduction to the Life Cycle of Fibre

Bill Woodley
Woodley Dairy Direction
woodleydairy@gmail.com

The Life Cycle of Fibre Concept

Understanding the development and degradation of fibre from the soil to the plant to the silo to the cow… and then back to the soil.


Fibre Development
Fibre Degradation
Morphology
Species/Variety
Maturity
People
Planting/Harvesting
Storage/Fermentation
Length of Cut
The Life Cycle of Fibre
Environment
Soil/Fertility
Stressors (water, temperature)
Ruminant
Rumen Dynamics and Health
DMI/Feeding Behaviour
Particle Size
Understanding the Development and Degradation of Fiber from the Soil to the Plant to the Silo to the Cow…


Unlocking the Energy from Forage Fibre
Why is this important?
• Ruminants play a unique role with their ability to release energy from the forage fibre sources, without competing with humans for their food stocks.
• Locked within the fibre is a key energy source (glucose) that provides similar energy levels as starch and sugar
Rumen Microbes
But how can this energy be released?
Why is this challenging?

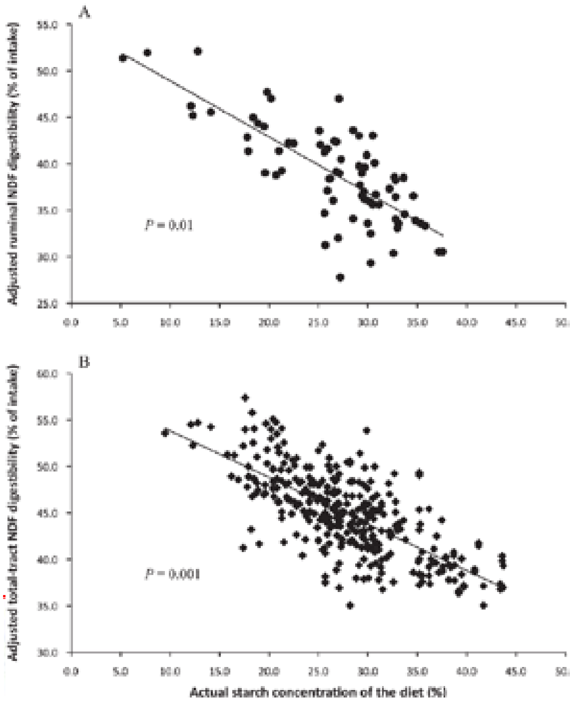
Highly digestible forage fibre reduces feed costs and improves production:

1. Higher fibre digestibility
   - Less reliance on starch (grain) and fat for energy.
   - Potentially higher DMI to improve milk production
2. For every 1%-unit increase in NDF digestibility
   - + 0.20 kgs DMI
   - + 0.25 kgs 4% FCM

   (Oba and Allen, 1999)

Key Thoughts on Feeding Higher Levels of Forage

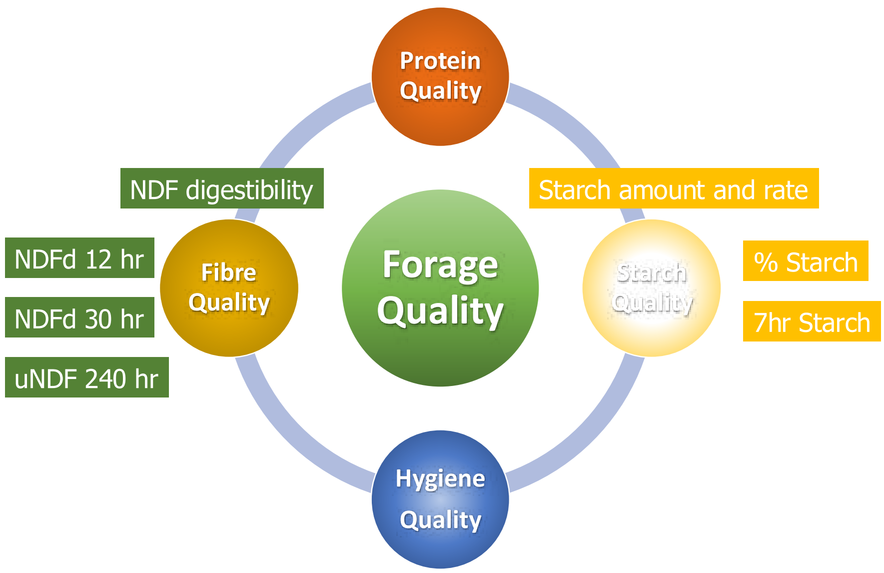
- With increasing forage fibre content, cows will typically:
  - spend more time eating
  - have longer meal length
  - practice greater sorting behavior (Beauchemin, 1991).
  - As NDF digestibility increases, chewing time per unit of NDF often decreases (Beauchemin, 1991).
- Example: when cows were fed hybrids of greater NDF digestibility (reviewed by Ferraretto and Shaver (2015))
  - Higher intake: 0.9 kg DMI
  - Higher milk: 1.2 kg/d milk



Conundrum:

As NDF digestibility deceases:

1. Need to feed more energy (starch)to maintain milk production.
2. High starch can lead to decrease in total tract NDF digestibility



What is forage quality?
How do we measure quality?

What does fibre look like?

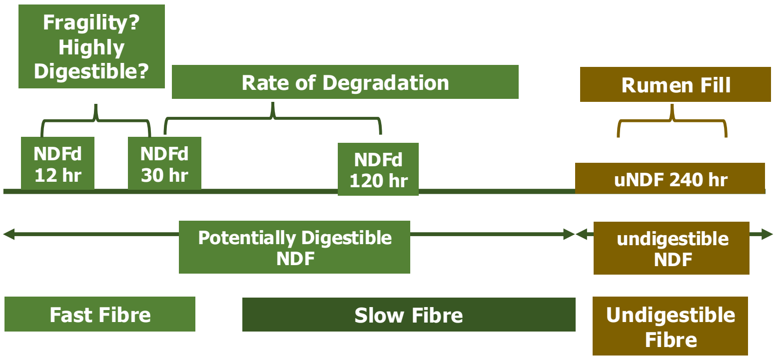
- Cell wall
  - ✓Pectin
    - ✓Viscous material between cells – fast fermentation
  - ✓Hemicellulose
    - ✓More fragile structure
    - ✓Moderate to fast fermentation
  - ✓Cellulose
    - ✓Bundle structure (glucose)
    - ✓Difficult to ferment
  - ✓Lignin
    - ✓Structural support

NFC

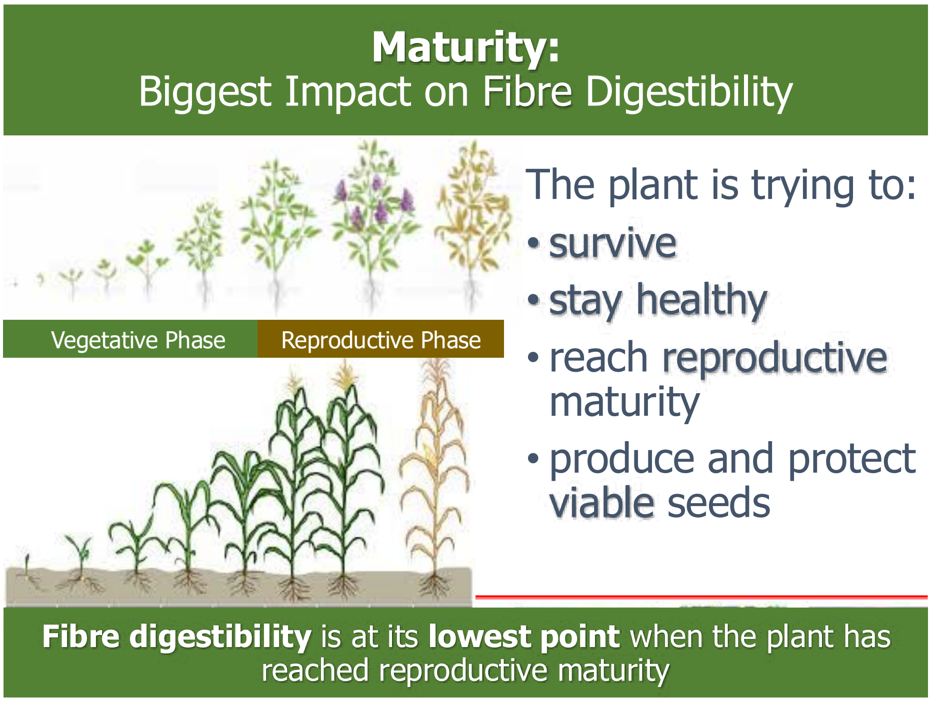
NDF

ADF

What does NDF Digestibility Look Like?




Quality Goals for NDFd30
• Alfalfa >45%
• Maturity, environment
• Corn Silage >55%
• Cutting height, environment (pre-tassel)
• BMR Corn Silage >65%
• environment
• Grass >60%
• maturity
• Winter Cereals >65%
• maturity


Maturity:
Biggest Impact on Fibre Digestibility
Vegetative Phase
Reproductive Phase
The plant is trying to:
• survive
• stay healthy
• reach reproductive maturity
• produce and protect viable seeds
Fibre digestibility is at its lowest point when the plant has reached reproductive maturity

The presence of **starch** in the forage analysis indicates that the plant has reach reproductive maturity.

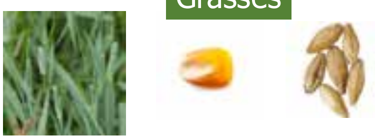
But …. fibre digestibility is at it **lowest** value

What is good for the plant is not necessarily good for the cow!

The Goal of the Plant

- Reach **reproductive maturity**

Grasses

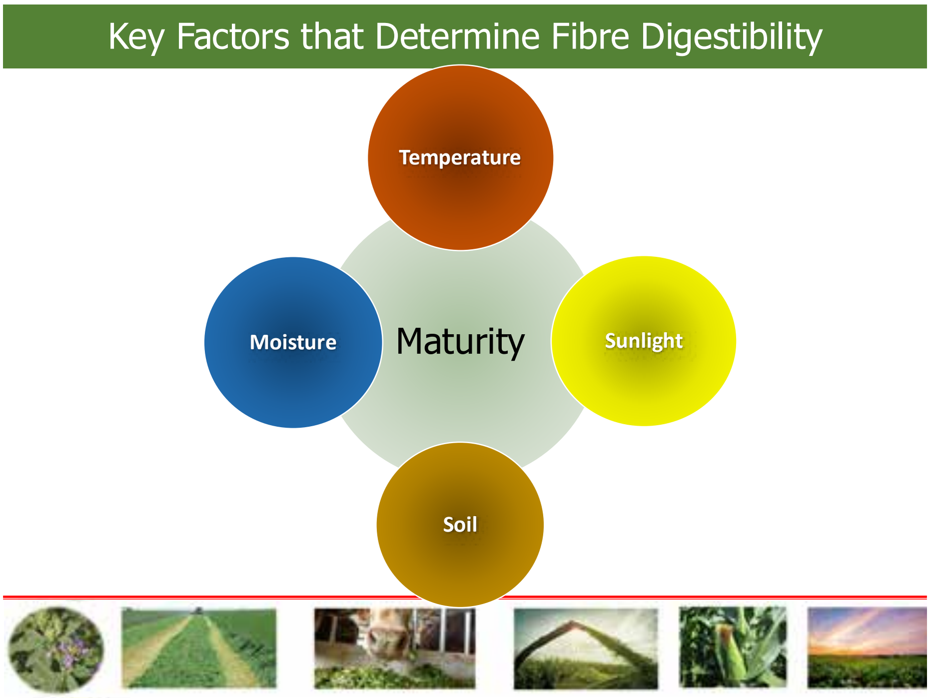


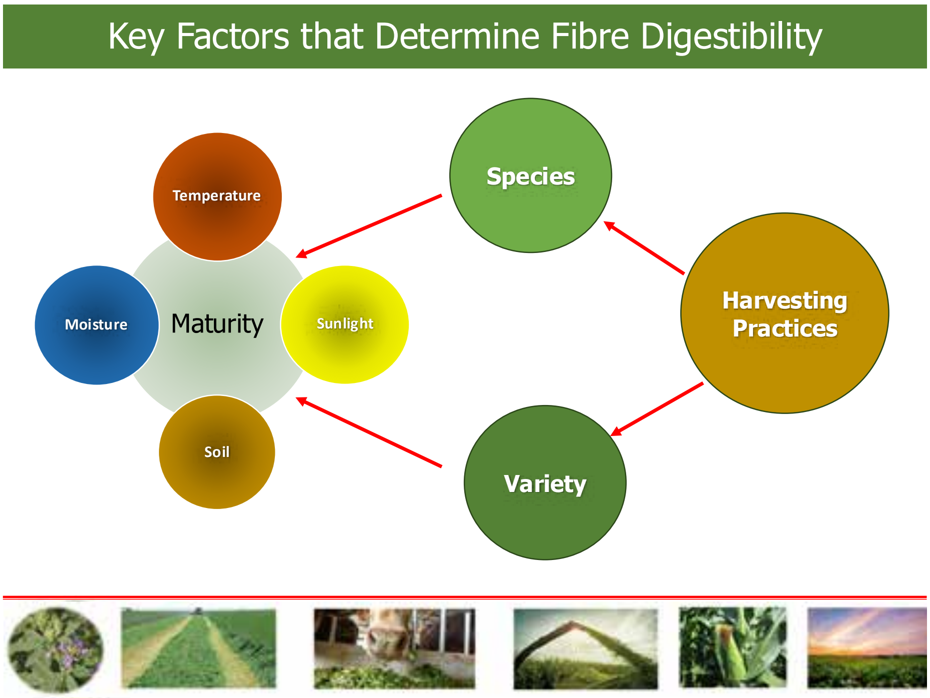
Legumes

Starch is the major energy storage component in the seed of grasses (cool season grass, corn, grain) needed for germination

Oil is the major energy storage component in the seed of legumes (alfalfa, soybean, peas) needed for germination

Alfalfa seeds are **low** starch and high **oil**


Key Factors that Determine Fibre Digestibility
Temperature
Moisture
Maturity
Sunlight
Soil

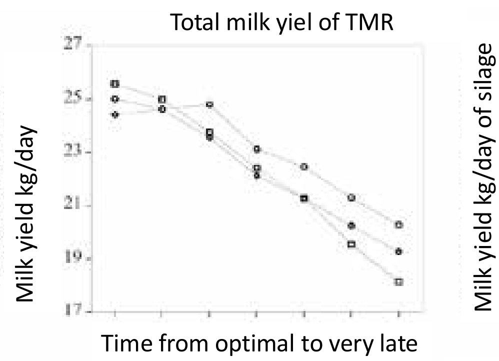

Key Factors that Determine Fibre Digestibility
Temperature
Moisture
Maturity
Sunlight
Soil
Species
Harvesting Practices
Variety

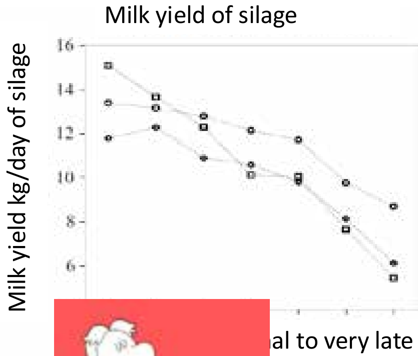
As a plant **matures** several things happen…

1. It grows taller
   - actually capturing more sun energy (photosynthesis) for seed production (reproduction)
   - Stem mass exceeds leaf mass
2. Cell walls thicken (more lignin is deposited in the cell wall)
   - Taller plants need more structural material
   - Mature plants need more support (fibre and lignin) at the **bottom** of plants

Late harvest - consequences

Gruber et al, 2011





Late harvest is loss of money
-less milk from forage
-more expensive if compensated with concentrates

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More yield compensate quality loss?

Lemaire and Belanger 2020

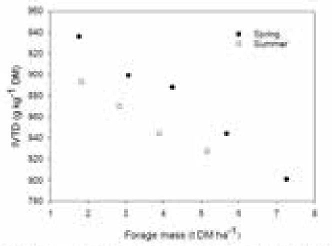
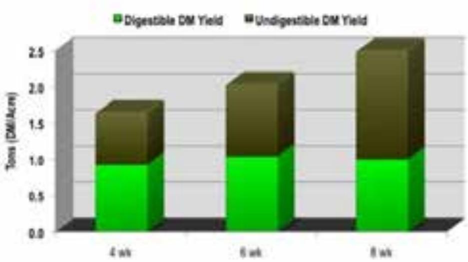


Figure 4. Relationship between in vitro forage digestibility (IVTD) and forage mass (W) of ... during spring and summer regrowth under non-limiting N conditions. Redrawn from Bélan... McQueen [33].



No → yield increase is mainly undigestible low quality forage

University of Georgia 2017

Effects of nitrogen

- Higher digestibility possible
- Yield increase
- Higher digestibility at similar yield
- Strong digestibility decrease when harvested late

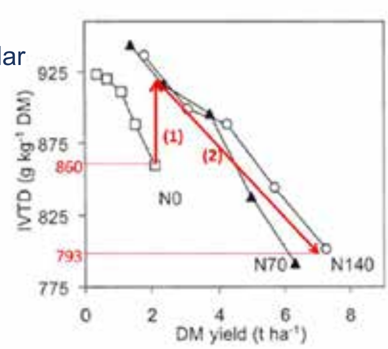
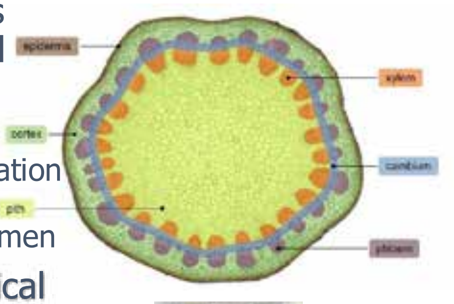


Figure 9. Changes in forage in vitro true digestibility (IVTD) of timothy with increasing forage mass (DM yield) in spring under three different N fertilizer application: N0, 0 kg N ha^{-1}; N70, 70 kg N ha^{-1}; N140, 140 kg N ha^{-1}. Data obtained at Fredericton (45.55° N; 66.36° W; Canada) and redrawn from

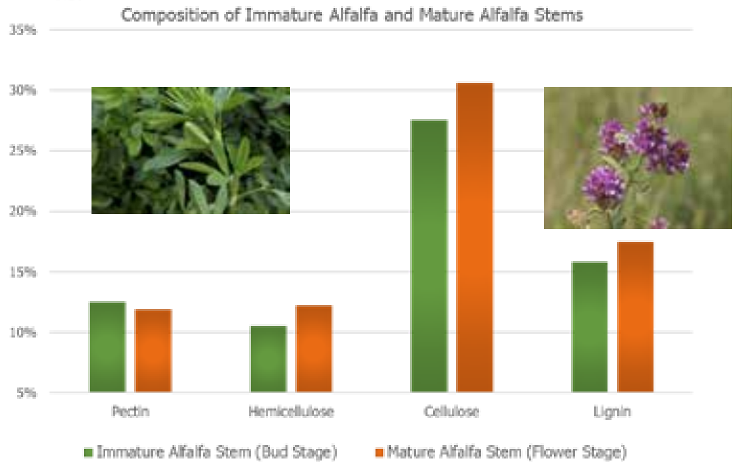
Lemaire and Belanger 2020

What else limits fibre digestibility?

- The **epidermis** of all plants thickens with maturity and develops a **waxy exterior** layer
  - designed to prevent desiccation but becomes a **barrier** to microbial degradation in rumen
- **Abrasion** through **mechanical means** or **cud chewing** is necessary to expose plant material from the waxy coating



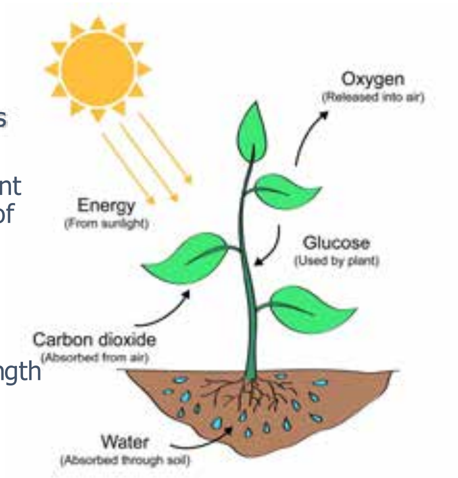
Change in Alfalfa **Stem** with Maturity



Development of Alfalfa (Medicago sativa L.) as a Feedstock for Production of Ethanol and Other Bioproducts
Deborah A. Samac, Hans-Joachim G. Jung, and JoAnn F.S. Lamb

Photoperiod and Light Intensity

- Sunlight promotes carbohydrate production through photosynthesis
- Increasing light **dilutes** the amount of cell wall production **in favour** of non-structural carbohydrates (cell content – sugar and starch).
- Van Soest (1996) calculated that every one-hour increase in day length can increase digestibility by approximately 0.2% units.



Photoperiod and Light Intensity

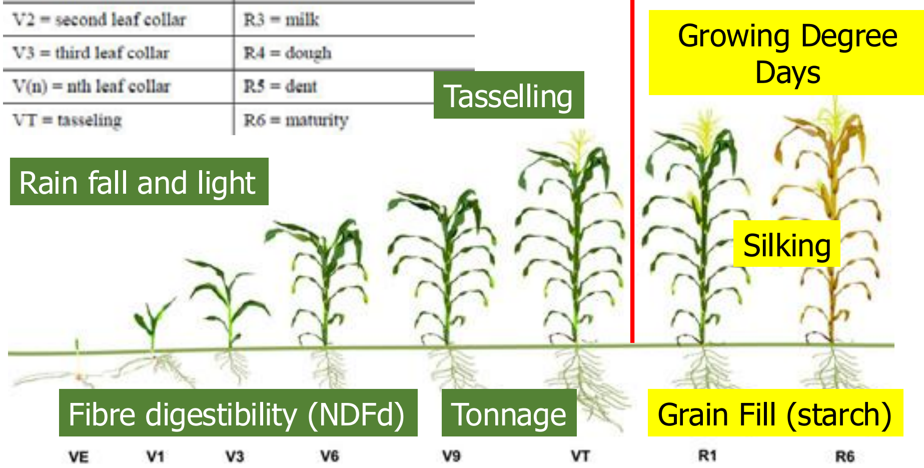
- When a plant has received adequate accumulated light (amount and intensity of light):
  - the reproduction process can be initiated and the vegetative growth halted.
  - But decreasing photoperiod can initiate preservation through root stores

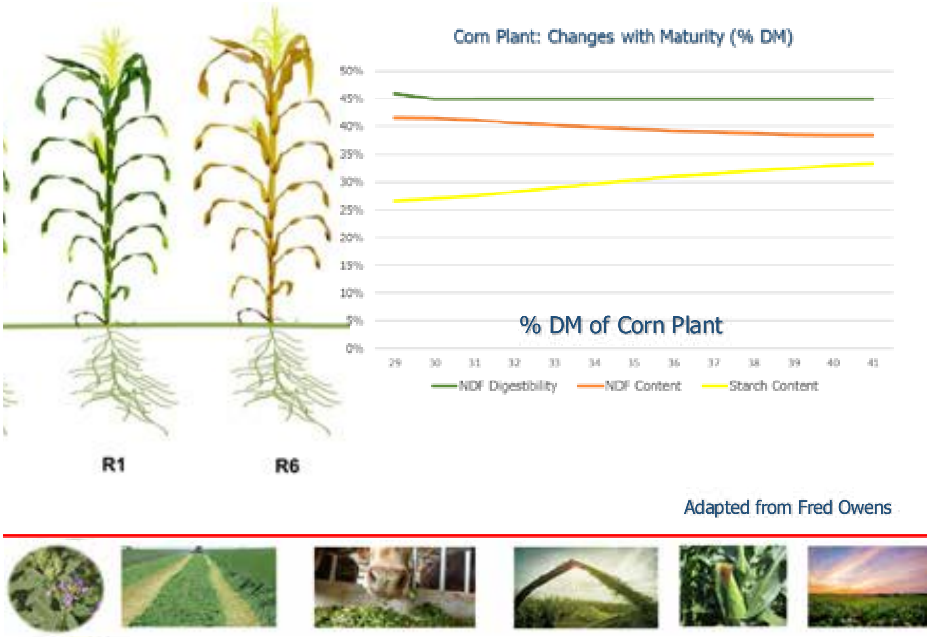
High Temperatures:
Associated with Reduced Fibre Digestibility

- Increased lignification of plant cell walls
    - Increase in intensity of lignification
    - Increased activities of lignin synthetic enzymes
- Increased NDF levels

Think Plant Survival!
Increased Lignin Levels Towards Equator

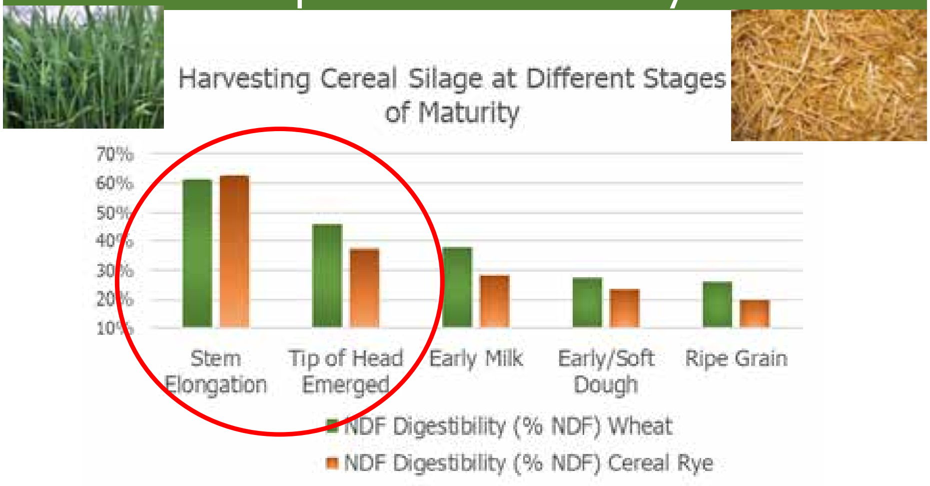
Vegetative Stages	Reproductive Stages
VE = emergence	R1 = silking
V1= first leaf collar	R2 = blister
V2 = second leaf collar	R3 = milk
V3 = third leaf collar	R4 = dough
V(n) = nth leaf collar	R5 = dent
VT = tasseling	R6 = maturity




Corn Plant: Changes with Maturity (% DM)
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
29 30 31 32 33 34 35 36 37 38 39 40 41
% DM of Corn Plant
NDF Digestibility
NDF Content
Starch Content
R1
R6
Adapted from Fred Owens


Harvesting Cereal Crop during Vegetative Stage

Harvesting Wheat and Rye Silage Before Reproductive Maturity



Harvesting cereal silage before reproductive maturity creates a highly digestible grass not straw!

Temperature and Corn Silage

- High temperatures associated with reduced plant digestibility:
  - Increased lignification of plant cell walls
    - Increase in intensity of lignification
    - Increased activities of lignin synthetic enzymes
- Increased water and heat associated with reduced digestibility

Water Stress

- Water deficit reduces growth; therefore delays maturity
  - Stunted plants are often more digestible

Alfalfa

- Increase in leaf:stem ratio
- Cellulose level in cell wall decreased while hemicellulose level increased
- Results: increased digestibility

Different species, different fiber, different reaction to environment

-Fiber is changing during the year
-Different species groups, different fiber contents
-Different species groups react differntly to stress

Sward[1]	NDF g/kg	Moderate stress		Recovery period		Strong stress		Recovery period	
		Control	Stress	Control	Stress	Control	Stress	Control	Stress
Dg	Grasses	611	606	640	635	610	598	524	527
Lp		520	527	551	556	574	590	490	481
Pl	Herbs	273	257	335	335	327	300	244	222
To		297	282	334	341	310	317	283	302
Tr	Legume	340	324	401	394	366	366	334	322

Küchenmeister et al. 2014

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Different legumes, different fiber, different reaction to environment

Table 3. Neutral detergent fibre (NDF) values of legume species (plus *L. perenne*) in monoculture and in mixture with *L. perenne* under different levels of drought stress in spring 2010 (moderate stress), summer 2010 (strong stress) and spring 2011 (strong stress); means (n=4).

Forage plant species	NDF [$g\ kg^{-1}$ DM]											
	Spring 2010 moderate				Summer 2010 strong				Spring 2011 strong			
	Monoculture		Mixture		Monoculture		Mixture		Monoculture		Mixture	
	Control	Stress	Control	Stress	Control	Stress	Control	Stress	Control	Stress	Control	Stress
Birdsfoot trefoil[1]	345	346	513	523	390	383	580	583	384	320	475	452
Marsh birdsfoot trefoil[2]	337	324	560[a]	530[a]	373	354	618[a]	606[a]	364	352	504[a]	504[a]
Black medic[3]	398	376	528	531	383	389	576	578	391	334	480	443
Yellow alfalfa[4]	378	379	535	530	439	425	598	599	395	362	477	483
Sainfoin[5]	358	361	522[a]	530[a]	354	333	631[a]	599[a]	414	351	510[a]	509[a]
White clover[6]	340	324	469	487	366	366	490	554	315	293	411	405
Perennial ryegrass[7]	520	527			574	590			478	468		
LSD value	31.6				35.0				26.0			
ANOVA Summary	*F*-ratio		*P*		*F*-ratio		*P*		*F*-ratio		*P*	
Legume (L)	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]01	
Stand (S)											01	
Drought Stress											01	

- Different legume species, different fiber
- Different legume species react differently to stress (level)
- Differnet legume species react diffently when stress occus in during the year

Table 4. Acid ... stress in sprin... ...f drought

Forage plant												Stress
Birdsfoot tre...												280
Marsh birdsf...												269[a]
Black medic												284
Yellow alfal...												291
Sainfoin[5]												277[a]
White clover[6]	257	252	287	284	274	292	320	337	263	256	291	266
Perennial ryegrass[7]	288	286			328	331			263	251		
LSD value	18.3				21.2				18.8			
ANOVA Summary	*F*-ratio		*P*		*F*-ratio		*P*		*F*-ratio		*P*	
Legume (L)	9.36		< 0.001		6.31		< 0.001		6.46		< 0.001	
Stand (S)	120.93		< 0.001		348.43		< 0.001		1.63		0.206	
Drought Stress (DS)	0.98		0.326		0.35		0.554		22.90		< 0.001	

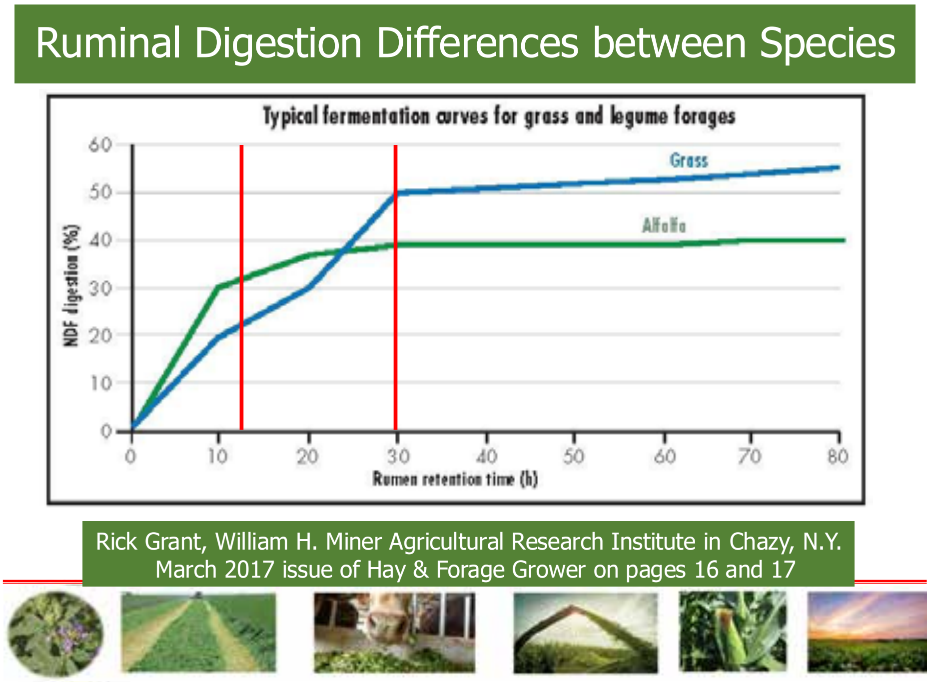
There are some key structural differences between legumes and grasses

Legumes tend to have **lower** fibre digestibility than grasses due to the physical structure of the plant

Legumes are like small trees with central trunk and limb-tip leaves – more structural support in the stem

Grasses are like **reeds** with the leaf having more structural support than an alfalfa leaf

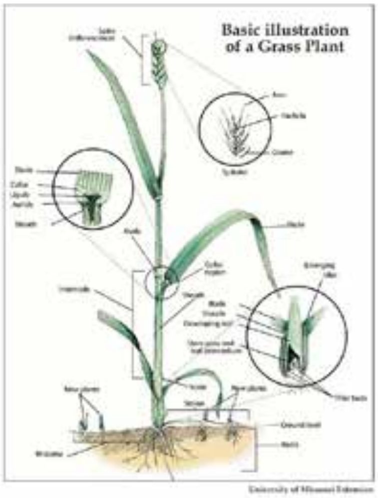

What do we know about grasses and alfalfa when fed to a **dairy cow**?
Alfalfa
1. Legumes typically have more fragile NDF than grasses
2. Particle size declines more rapidly with chewing = higher passage rate and increased DMI.
Grasses
1. Grasses naturally break into long and slender pieces when chewed
2. Grass fibre is "slower" (passage rate) than alfalfa due to structure of the fibre
Grass Blade


Ruminal Digestion Differences between Species
Typical fermentation curves for grass and legume forages
Grass
Alfalfa
NDF digestion (%)
Rumen retention time (h)
0
10
20
30
40
50
60
70
80
Rick Grant, William H. Miner Agricultural Research Institute in Chazy, N.Y.
March 2017 issue of Hay & Forage Grower on pages 16 and 17

Alfalfa Decline in Quality…

- Appearance of 1st flower bud is indication of decline in quality (why?)
  1. Thickening and lignification of the cell walls in the stem
  2. Loss of lower leaves when shading by the higher leaves on stem
- But alfalfa leaves continue (photosynthetic) to grow
  - Legumes will keep producing leaves while flowering.

Grass Decline in Quality…



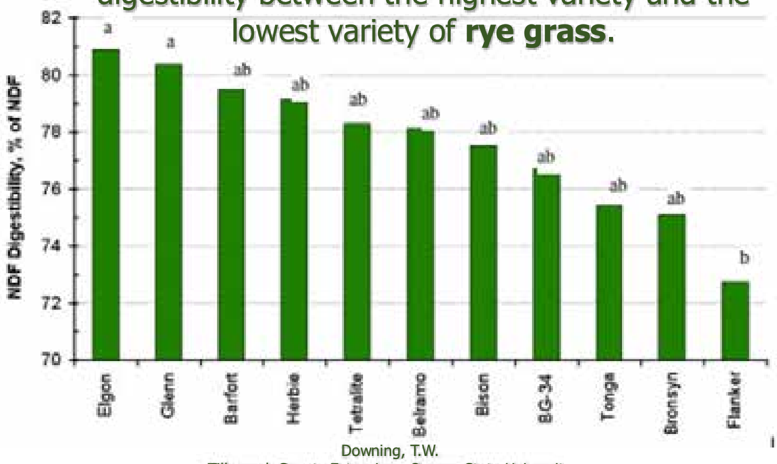
- Perennial grasses lose quality faster than legumes (why?)
  1. Energy diverted to produce flowers & seeds instead of leaves
  2. Grasses completely stop producing leaves once they start to head out and flower
  3. Grasses develop a lignified mid-rib at maturity

Species Differences – what do we know?

1. **Alfalfa**
   - Lower NDF digestibility
   - Can have high levels of pectin.
   - "Fragile" fibre
2. **Grass**
   - Higher NDF digestibility but highly dependant on maturity
   - Can have high sugar content
3. **Corn Silage**
   - Higher NDF digestibility but dependant on growing season "pre-tassel"
   - Low sugar content
   - Highly influenced by cutting height
4. **Grain Silage**
   - NDF digestibility highly dependant on variety, maturity
   - Early cut at boot stage = highly digestible NDF

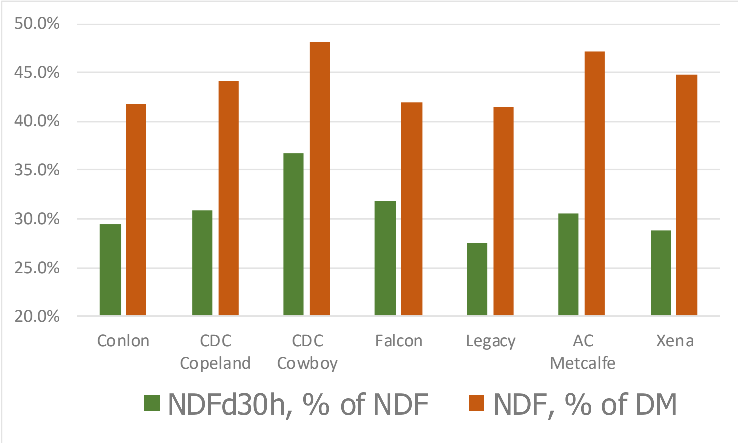
Variety Differences (the future!): Study comparing 11 different rye grass varieties grown under similar environmental conditions:

Researchers saw a **10%** difference in NDF digestibility between the highest variety and the lowest variety of **rye grass**.



Downing, T.W.
Tillamook County Extension, Oregon State University

Are there Differences in Forage Barley Silage digestibility?



Conclusion: There are differences in barley silage varieties

T. McAllister, Agriculture and Agri-Food, Lethbridge, AB.

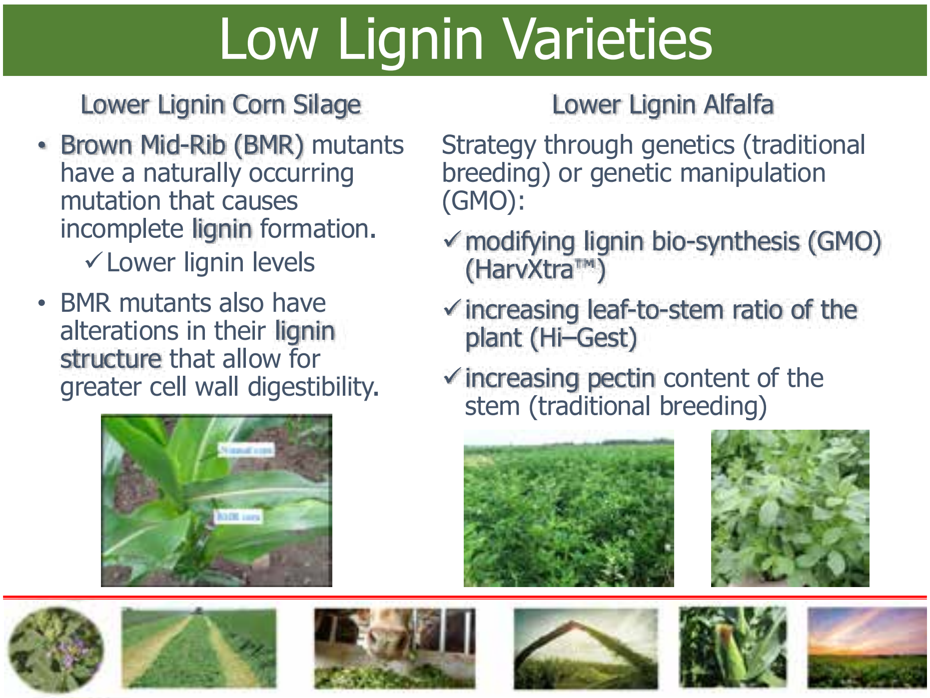
Genetic Improvements in Forage Fibre Digestibility

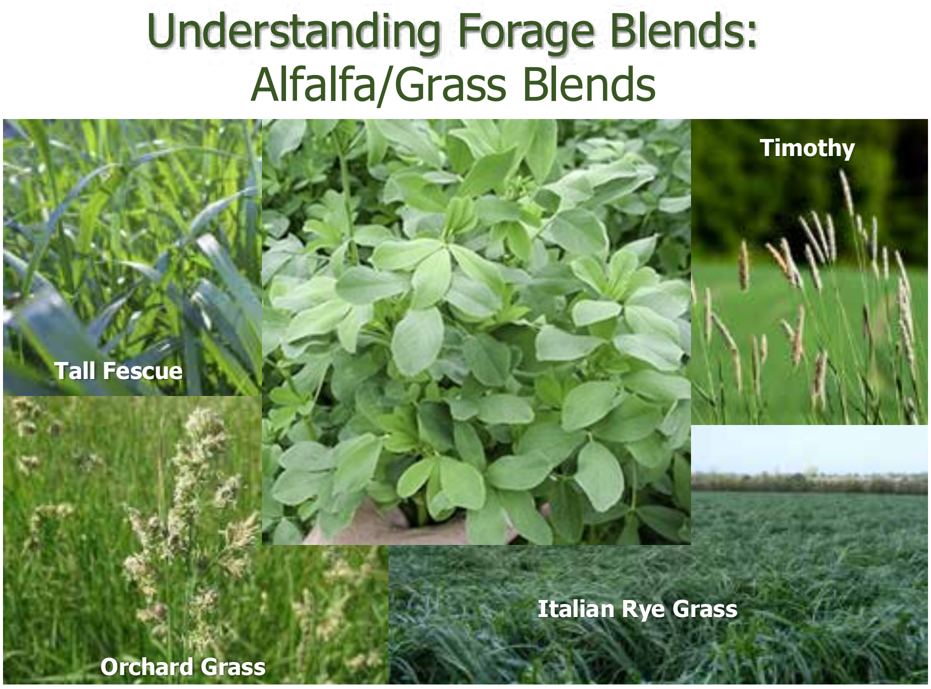
Grasses

- BMR Corn Silage
  - Lower lignin
- BMR Sudan Grass
  - Lower lignin
- Tetraploid Grasses
  - Broader softer leaf then diploid

Alfalfa

- HarvXtra (GMO)
  - Modified lignin bio-synthesis
- Hi-Gest
  - Increased leaf-stem ratio


Low Lignin Varieties
Lower Lignin Corn Silage
• Brown Mid-Rib (BMR) mutants have a naturally occurring mutation that causes incomplete lignin formation.
✓Lower lignin levels
• BMR mutants also have alterations in their lignin structure that allow for greater cell wall digestibility.
Lower Lignin Alfalfa
Strategy through genetics (traditional breeding) or genetic manipulation (GMO):
✓modifying lignin bio-synthesis (GMO) (HarvXtra™)
✓increasing leaf-to-stem ratio of the plant (Hi–Gest)
✓increasing pectin content of the stem (traditional breeding)


Understanding Forage Blends:
Alfalfa/Grass Blends
Timothy
Tall Fescue
Italian Rye Grass
Orchard Grass

Legume/Grasse Mixes Change Over Time…

There are "thinning" differences between grass species:

Fescues:

did not thin as rapidly as the alfalfa

- % of grass plants tended to increase as the season progresses.

Orchardgrass

has lower germination and declined at about the same rate as the alfalfa

- % of grass plants remained at similar ratios as the season progressed.

What do we know about grasses and alfalfa when fed to a **dairy cow**?

1. Legumes typically have more fragile NDF than grasses, and their particle size declines more rapidly with chewing = higher passage rate and increased DMI.
2. Grasses naturally break into long and slender pieces when chewed compared with legumes
3. Grass fibre is "slower" (passage rate) than alfalfa due to **structure** of the fibre
4. Grasses have higher hemicellulose but lower pectin = less "fast" CHO and more "moderate" CHO

What do we know about grasses and alfalfa when fed to a **dairy cow**?

NDFd 30 ~ 45%

Alfalfa

NDFd 30 ~ 60%

Grass

NDFd 30 > 65%

Winter Cereal

Key grass species…

Annual Species
- Corn silage
- Sorghum
- Sorghum/Sudan
- Wheat
- Rye
- Triticale
- Italian Rye (Annual Rye Grass)

Perennial Species
- Fescues
- Orchard
- Timothy
- Rye Grass
- Broome Grass

Key grass species…

Warm Season Grass (C_4)
- Corn silage
- Sorghum
- Sorghum/Sudan
- Bermuda Grass
- Switch Grass
- Pearl Millet
- Rye Grass

Warm-season grasses are specifically triggered by daylengths so latitudes should be considered in selecting warm-season grass species.

Cool Season Grass (C_3)
- Fescues
- Orchard
- Timothy
- Rye Grass
- Italian Rye
- Wheat
- Triticale

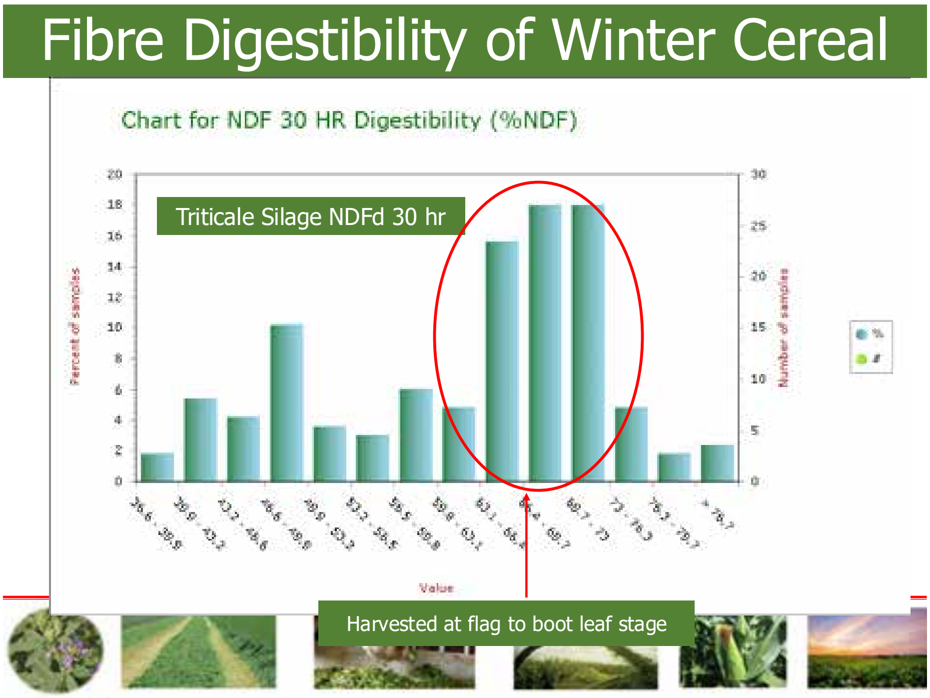
Cool-season grasses are productive in the spring and fall because of the cooler temperatures during the day and night, shorter photoperiods, and higher soil moisture.

Cover/Nurse Crop Strategy…

New Seeding
- Oats
- Oats and Peas
- Grain (Wheat/Oats)
- BMR Sudan

Bare Soil
- Winter Wheat
- Winter Triticale
- Winter Rye
- Fall Forage Oats
- Italian Rye Grass


New Seeding with Oats and Peas

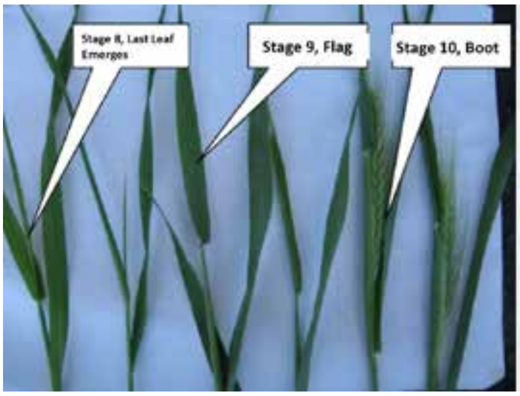

Fibre Digestibility of Winter Cereal
Chart for NDF 30 HR Digestibility (%NDF)
Triticale Silage NDFd 30 hr
Percent of samples
Number of samples
Value
Harvested at flag to boot leaf stage

Is there an opportunity for **winter/fall** stands of cereal grains?

Winter Cereals –

Rye, Triticale, Wheat

- Planted in the fall and harvested in the spring at flag leaf to early boot stage
- Needs N
- Needs water
- Needs cooler weather
- Should be planted before the 15th of September to ensure optimum yield



Flag Leaf
(completely unrolled)

Flag Leaf Ligule

Grain Head
(just begun to swell in stalk)

Photo: Courtesy of David Coates

When to Harvest Triticale


Consider Wheat, Triticale or Cereal Rye…
Harvest is recommended at flag leaf to boot stage for lactating cows

Whole crops late harvest

Landwirtschaftskammer NRW 2015

Figure 5. Changes in small grain components with advancing maturity.

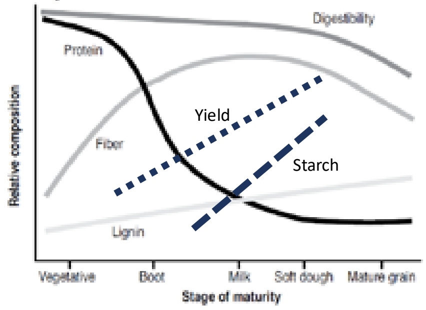


Table 7. Yield and quality of barley silage harvested at boot or two cutting heights at soft dough stage.

	Boot	Soft dough (6 inches)	Soft dough (10 inches)
Yield (lb DM/acre)	3,295	7,813	5,614
ADF, % DM	31.1	33.9	29.3
NDF, % DM	49.1	52.6	53.8
CP, % DM	16.6	9.1	8.9
Lignin, % DM	5.7	6.9	6.0

Source: Acosta, et al. 1991. *Journal of Dairy Science.* 74:167–176.

Impact of Cutting Height on Fibre Quality

- Alfalfa
  - Increase in leaf:stem ratio
  - Increase in NDF digestibility
- Grass
  - Increase in NDF digestibility
- Corn Silage
  - Increase in starch content
  - Decrease in NDF
  - Increase in NDF digestibility
- Cereal Silage
  - Increase in starch content
  - Decrease in NDF

Why?
The bottom of the plant has more structural support, than the top of the plant – especially with advancing maturity.

Fibre Digestibility Impact of Cutting Height
Arlington, Wisconsin, 2010

Arlington Wisconsin Study	NDF %	NDFd %	Yield (% of Total Plant	
Whole Plant (Ear and Stover)	53	54	100%	
Stover Biomass				
Above ear-node segment (54 to 98 inches) (137 to 249 cm)	75	55	20.00%	
Mid-segment (26 to 54 inches) (66 to 137 cm)	74	50	11.11%	
Low-segment (6 to 26 inches) (15 to 66 cm)	76	46	8.88%	**13.32%**
Ground segment (0 to 6 inches) (0 to 15 cm)	76	36	4.44%	
Total Yield of the Stover (stalk)			44.43%	

Questions?

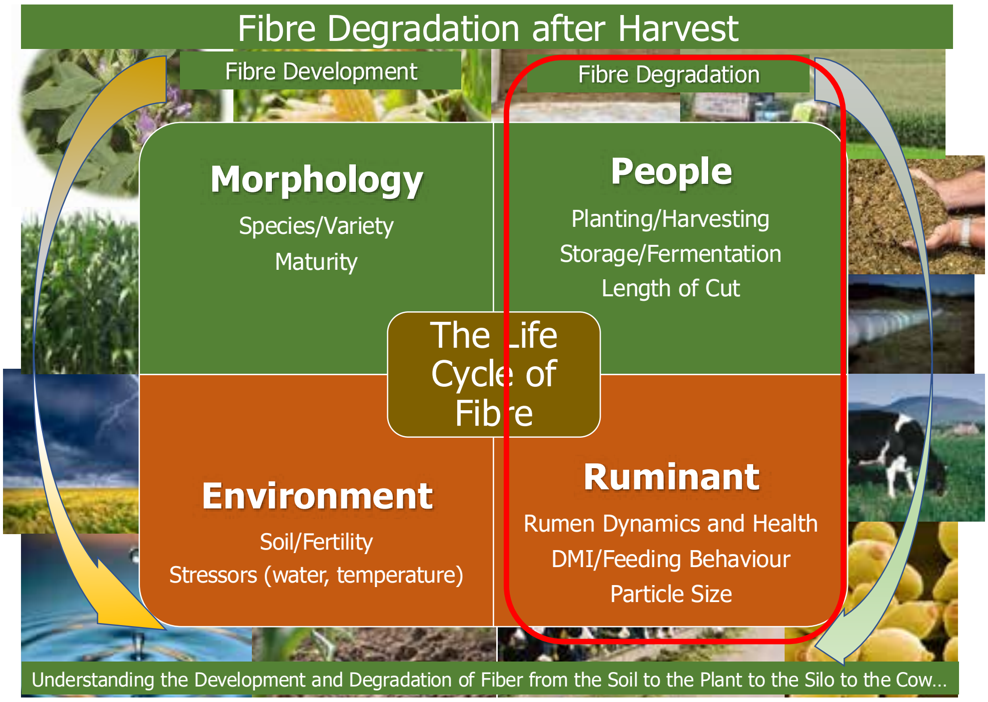
CO SPEAKERS: BILL WOODLEY AND AURÉLIEN PIRON

- Role of fiber: physical and digestion
- Management of rumen fermentation , feeding software and LEVUCELL SC model

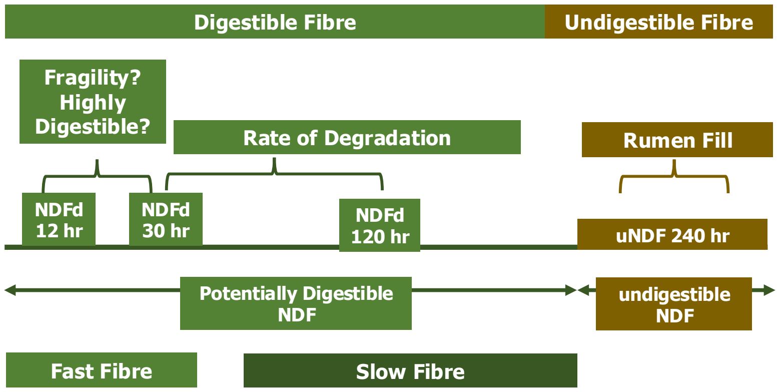
Lactating Cows: Fibre Management

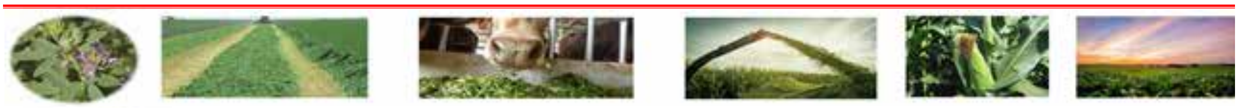
Impact of Cow Dynamics on Fibre Digestibility

Bill Woodley



What does NDF Digestibility Look Like?





The digestibility of the fibre fraction is a highly variable

Animal factors:

- ✓Rate of passage
- ✓Cud chewing
- ✓Rumen function and SARA

Plant factors:

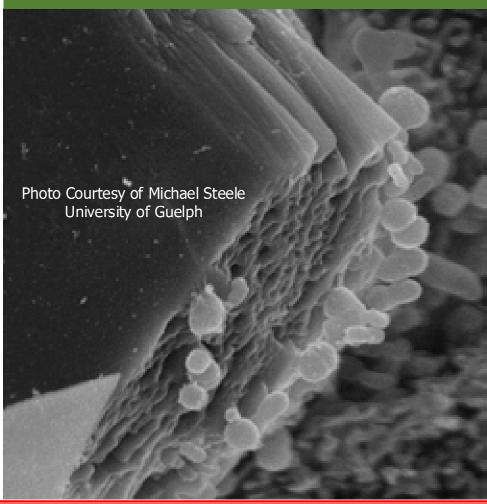
- ✓Length of cut
- ✓Species
- ✓Varieties
- ✓Weather

Key Factors that Determine Fibre Digestibility

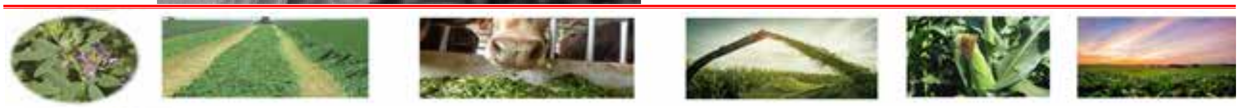
But…
particle size or chop length can impact:

- Digestibility
- Passage rate

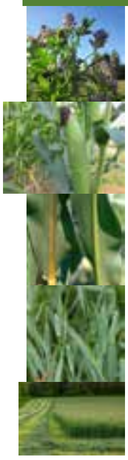
Shorter Length-of-Cut Offers More Opportunity for Bacterial Attachment



- Ruminal bacteria attach:
  - first to cut end of fibre
    - Digest cell content until they “hit” the indigestible cell wall
  - attach to any abrasions created through cud chewing



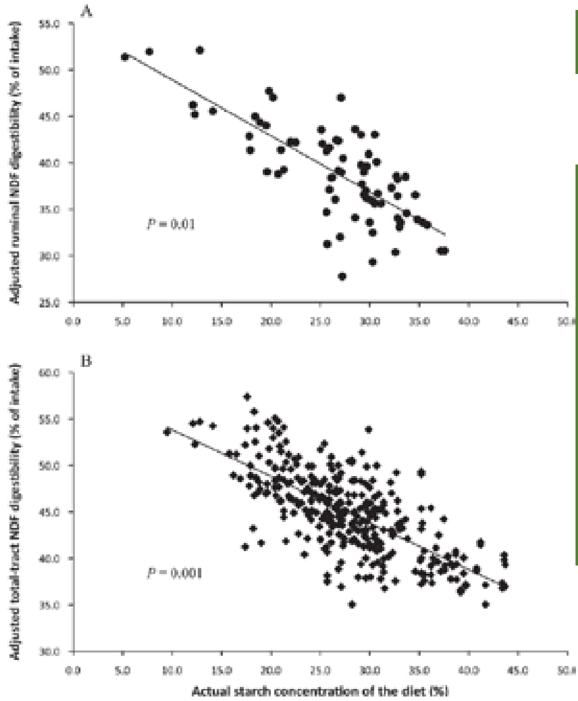
Quality Goals for NDFd30



- Alfalfa >45%
  - Maturity, environment
- Corn Silage >55%
  - Cutting height, environment (pre-tassel)
- BMR Corn Silage >65%
  - environment
- Grass >60%
  - maturity
- Winter Cereals >65%
  - maturity

Rethinking fiber degradability and particle size…

- Value in integrating forage (un)degradability and particle size to better predict DMI
  - Adjust particle size/chop length as forage maturity and moisture change.
- Need to understand how fiber content and particle size affect balance between eating time and resting/rumination.



Conundrum:

As NDF digestibility deceases:

1. Need to feed more energy (starch)to maintain milk production.
2. High starch can lead to decrease in total tract NDF digestibility

Impact of Starch Content and Digestibility in Dairy Cattle Diets **Luiz F. Ferraretto** Department of Animal Sciences, University of Florida

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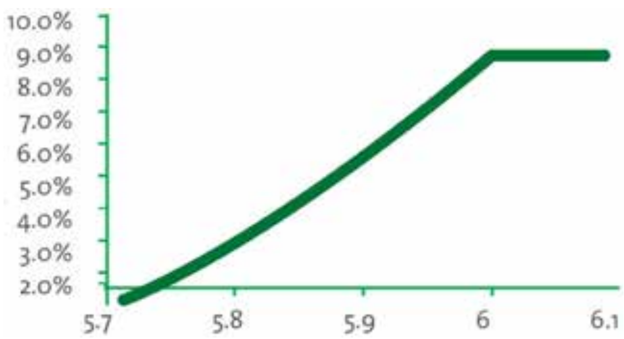
Fibre digestibility is highly linked with rumen pH



Effect of ruminal pH on NDF digestion rate for at optimal rumen pH ***(Fox et al 2003)***

→ +1% dietary starch = -0.1 unit rumen pH= -3% dNDF
(Noziere et al., 2010; mentioning D. Sauvant, unpublished synthesis of literature data)

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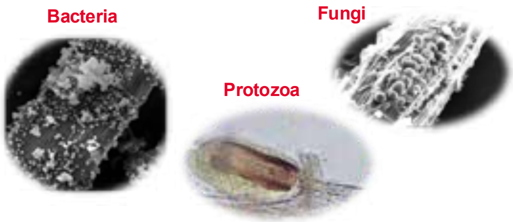
AP 10

Rumen microbiota is responsible for fiber degradation

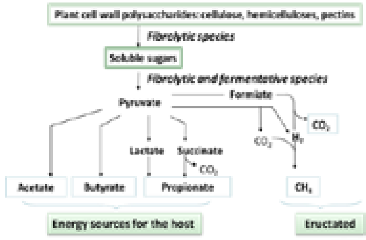
Feed the cow ⇔ Feed the bugs



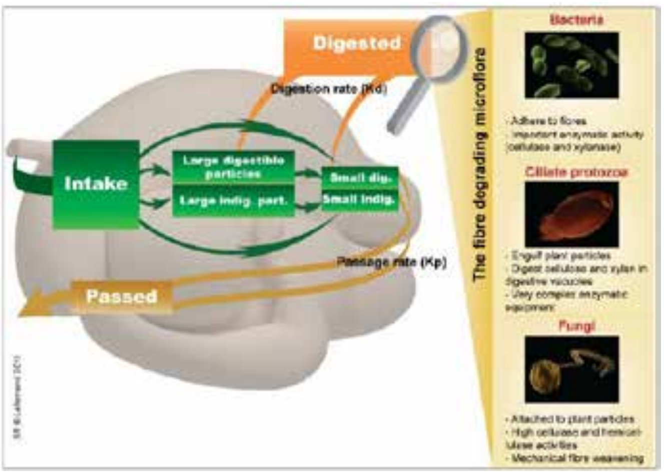
- **No host enzyme** specific to fiber degradation
- Only **specific** microorganisms degrade fiber
- The **rumen is the main site** of degradation

- The bulk of the rumen community **depends** critically on primary fibrolytic species

- Fiber-degrading populations **grow slowly**, most of them are **strict anaerobes**



Factors affecting fiber digestibility

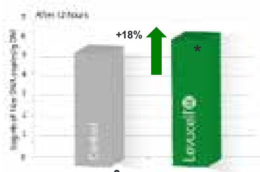


Complex microbes interactions interact **with fiber degradation kinetics.**

Case study : effect of Levucell SC CNCM I1077

The colonization of forage by fungi

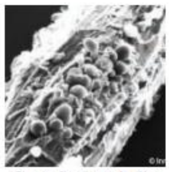
Number of specific cellulolytic bacteria** linked to forage



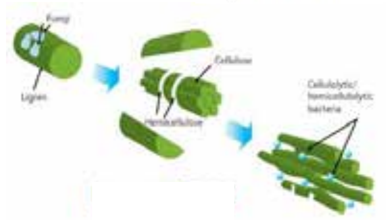
* p<0.05

** *Butyrivibrio fibrisolvens*

The effect of CNCM I-1077 on fibrolytic activity of bacteria and funghi .



Rumen fungi attached to a plant cell wall ©INRA



Chaucheyras-Durand F. et al., INRA France, 2010 ,
J Dairy ScJ. Anim. Sci. 88 (S2)/J. Dairy Sci. 93 (S1) : 145

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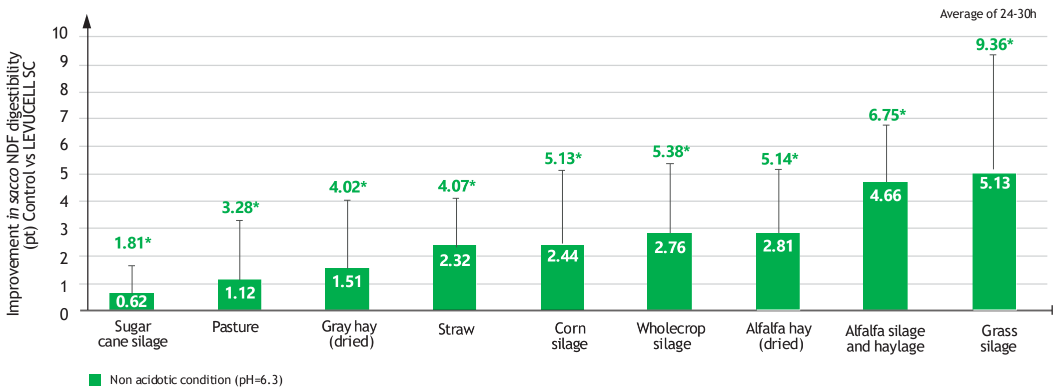
Fiber degradation: *S. cerevisiae* CNCM I-1077

LEVUCELL SC improves NDFd *in vivo*



*Upper limit to is equivalent of +1 standard deviation
Data shared is an average of eight scientific work. This dataset is based on 364 global forage samples, full reports are available upon request.

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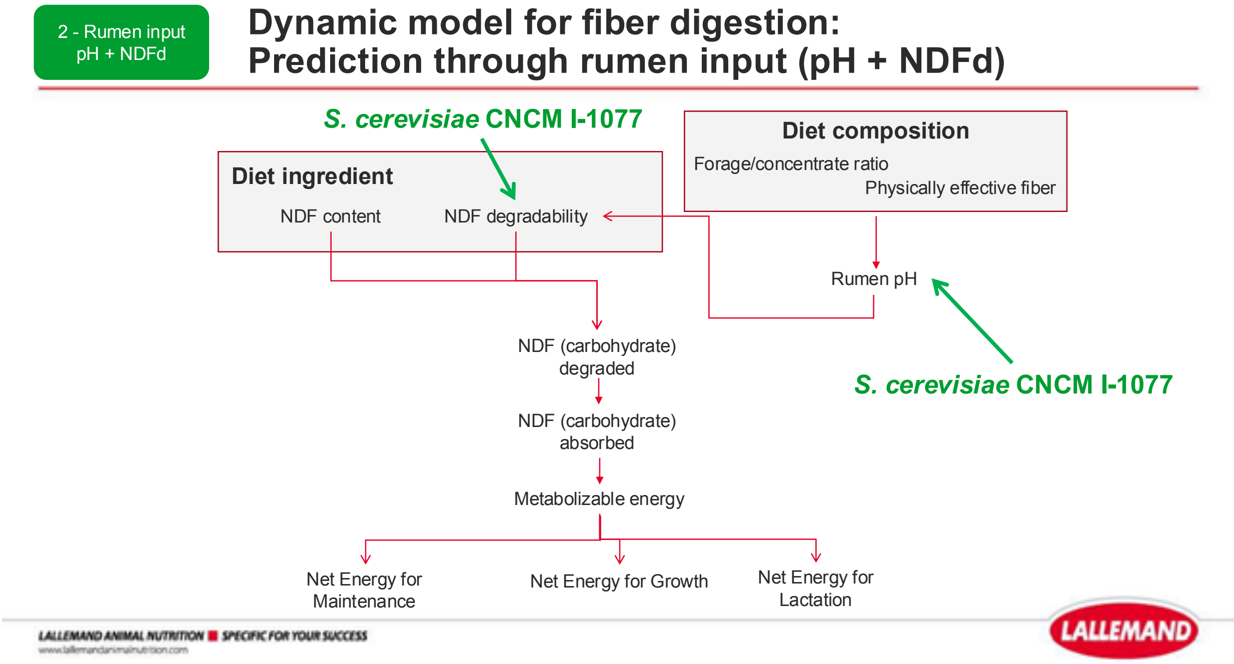
Role of fiber: physical and digestion

Bill WOODLEY and Aurélien PIRON



TRIAL SUMMARY: RUMEN BUFFERS

Dairy Rumen Buffer : Sodium bicarbonate or LEVUCELL SC

(MB de Ondarza, 2011)

OBJECTIVE

To evaluate the impact of LEVUCELL SC on acidosis prevention in real commercial farm with innovative pH bolus sensor.
To evaluate effect of LEVUCELL SC on feed efficiency of high producing dairy cows in comparison to sodium bicarbonate as positive control.

MATERIAL AND METHODS

LOCATION Commercial free-stall barn dairy, Vermont, North East USA
YEAR 2011
DURATION Spring 2011, 10 week trial, with 6 weeks adaptation, and 4 weeks for measurement
ANIMALS 120 multiparous cow divided in 2 groups
DIETS Corn silage (32.5%), haylage (22.6%), straw (3.4%), and grain (41.5%).
TREATMENTS 1/ Sodium bicarbonate (170g/animal/day)
2/ LEVUCELL SC (0.5g/animal/day)

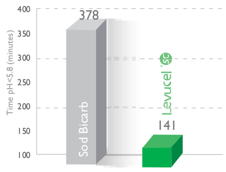
NDF	32.8%
ADF	19.8%
CP	17.8%
Starch	27.3%
NFC	39.9%

Role of fiber: physical and digestion

Bill WOODLEY and Aurélien PIRON

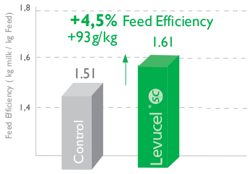
RESULTS

LEVUCELL SC reduces duration of acidosis vs sodium bicarbonate



Rumen pH	LEVUCELL® SC	Sodium Bicarbonate
Mean Daily pH	**6.22**	6.03 ***
Time pH <5.8 (minutes)	**141**	378***

LEVUCELL SC improves feed efficiency (+4.5%)



Milk Yield & Components	LEVUCELL® SC	Sodium Bicarbonate
Pen Dry Matter Intakes (kg/day)	26.07	26.29
Milk Yield (Kg/day)	41.91	39.83
Milk Fat %	3.62	3.65
Milk Protein%	2.98	3.01
Milk component Yield [Solids : Fat + Protein] (kg/day)	2.82	2.71
Feed Efficiency	**1.61**	**1.51**

CONCLUSION
These results indicate that for milk cows fed under non stressed conditions (no environment for acute acidosis), LEVUCELL® SC at 0.5 grams (1×10^{10} cfu) per milk cow daily has significantly raised pH, increased milk yield (+2.08 kg) and feed efficiency (+93 g/kg feed).

Validation test

NDS PROFESSIONAL

BASED ON NDF DIGESTIBILITY OF CORN SILAGE, HAYLAGE AND STRAW IMPROVEMENT, THE PREDICTION OF LEVUCELL SC EFFECT ON NET ENERGY OF LACTATION AND MILK PRODUCTION IS ACCURATE

In the case of *Saccharomyces cerevisiae* CNCM I-1077, nutrient concentration predictions is made through rumen input (coupling effect of pH and NDFdigestibility). The response varies with forage types (NDFd effect) and starch concentration (rumen pH effect).

	PREDICTED		MEASURED	
	Control 170g bicarb	LEVUCELL SC	Control 170g bicarb	LEVUCELL SC
Fiber digestibility (%NDF)	33.8	38.2 (+13.0%)		
Average rumen pH	6.05	6.30	6.03	6.22
Time spend with rumen pH<5,8 (min/d)	313	65	378	141
Energy of Lactation supply (NEL/kg DMI)[c]	1.58	1.62 (+2.5%)		
Metabolizable Energy Milk (kg/d)[c]	39.7	41.2 (+3.8%; +1.5kg)	39.8	41.9 (+5.3%; +2.1kg)

[c] *sub-model for evaluating the NDFd and the rumen pH effects of LEVUCELL SC, developed into a platform based on CNCPS 6.5 model - NDSProfessional; RUM&N, Italy*

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Practical example : Levucell SC inclusion into Saudi Arabia

- Without Levucell SC

- With Levucell SC

+0.91kg of milk

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Penn State Particle Size Separator

Top Tray: > 19 mm

Second Tray: > 8 mm

Third Tray: > 4 mm

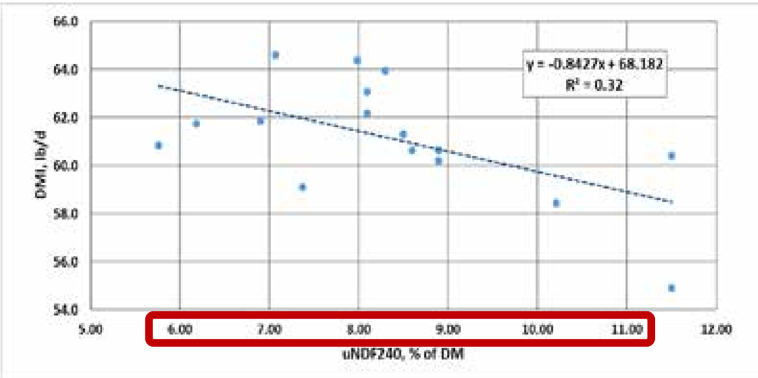
Bottom Pan: < 4 mm

peNDF= *3 trays X total NDF in diet*

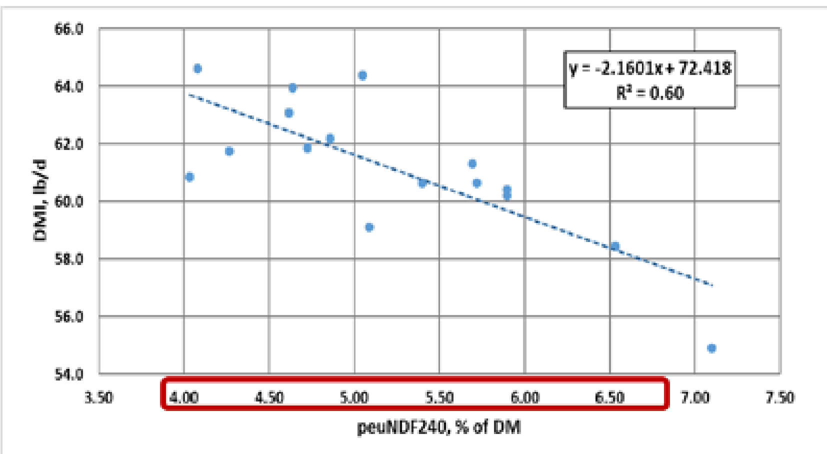
peuNDF= *3 trays X total uNDF in diet*

New Concept: can we use **peuNDF** as a predictor of DMI and Milk?

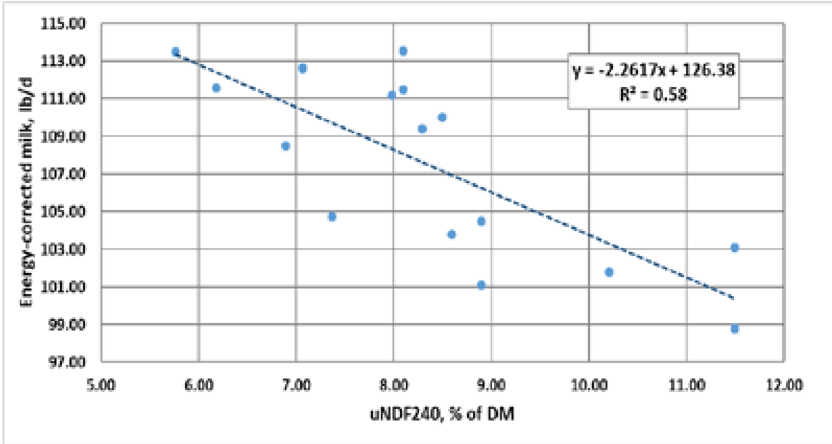
Dietary uNDF240 and DM Intake



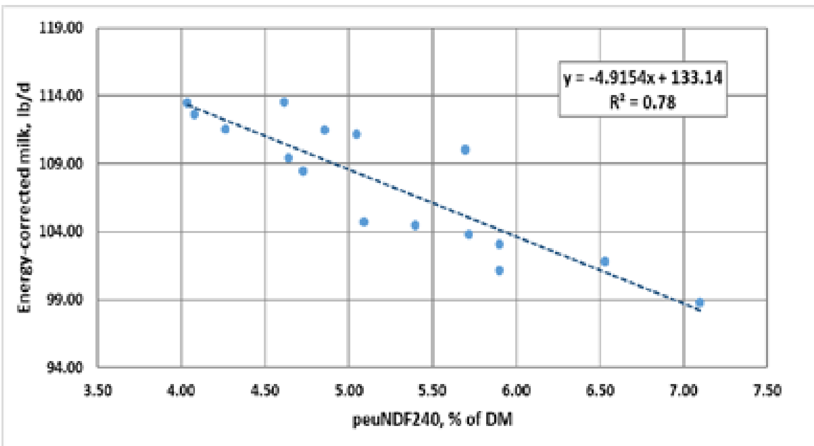
Dietary peuNDF240 and DM Intake

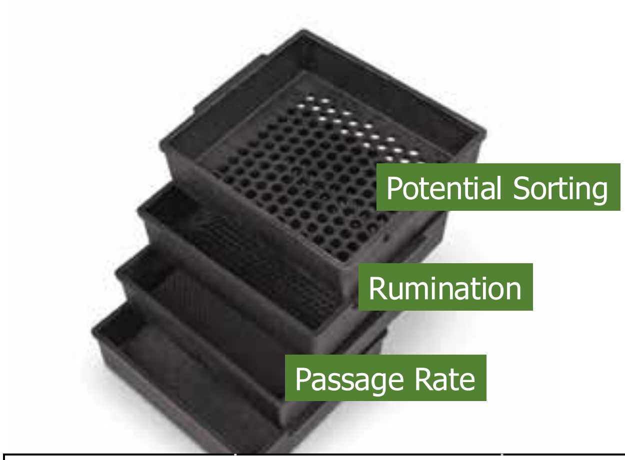


Dietary uNDF240 and ECM Yield

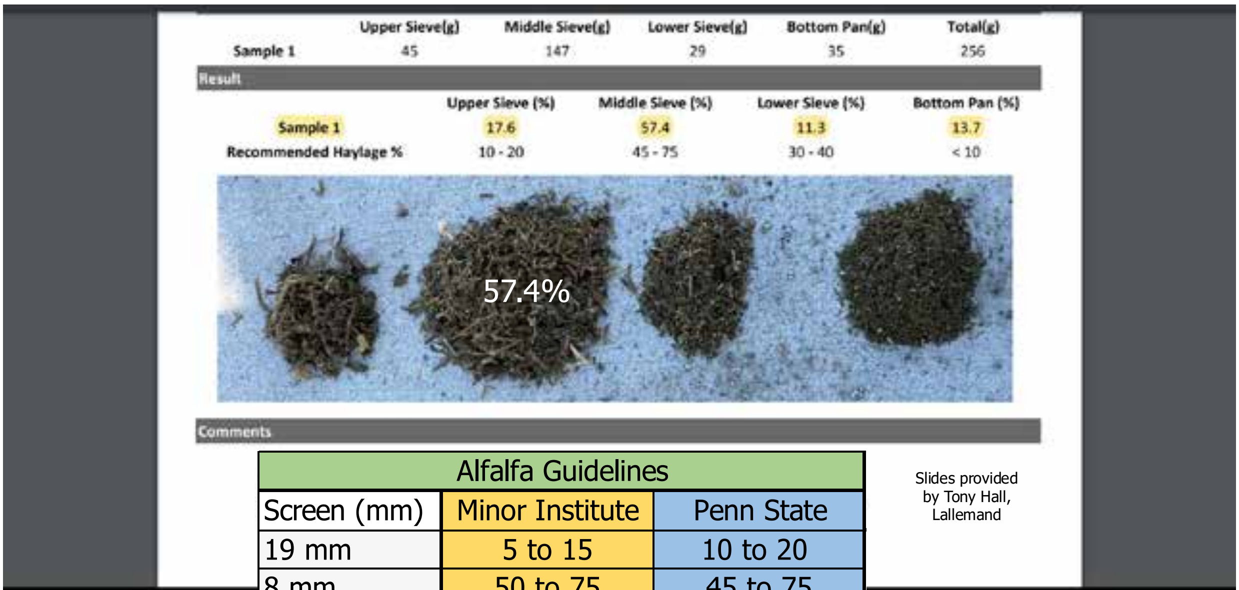


Dietary peuNDF240 and ECM Yield



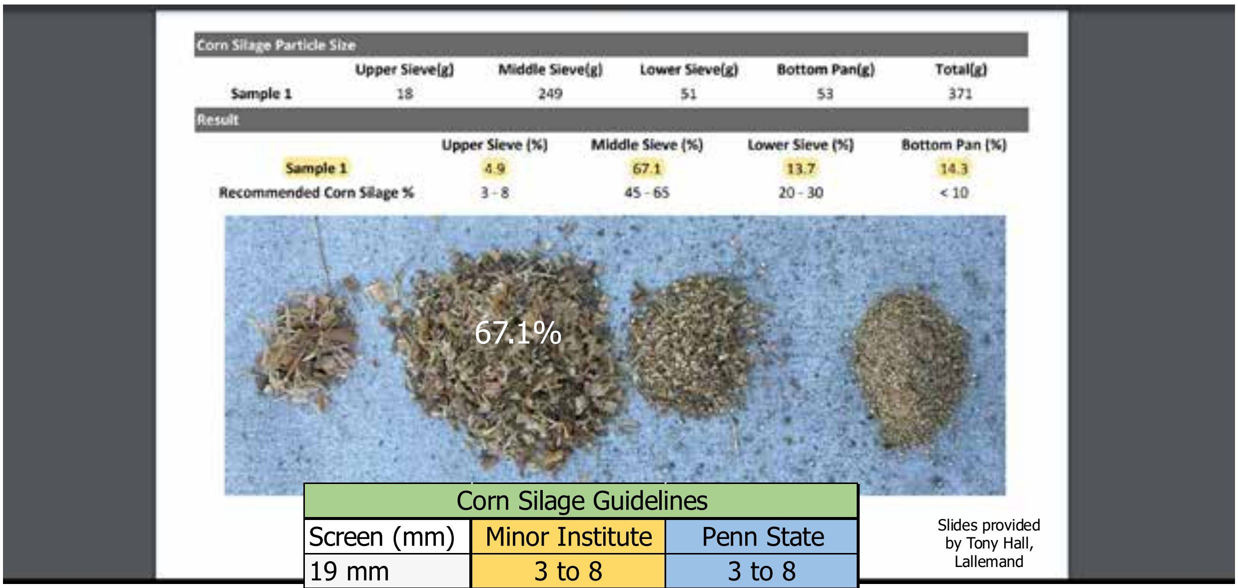


TMR Guidelines			
Screen (mm)	Minor Institute	Penn State	PEF
19 mm	< 5	2 to 8	> 70
8 mm	> 50	35 to 50	
4 mm	10 to 20	10 to 20	
Pan	25 to 30	30 to 40	< 30

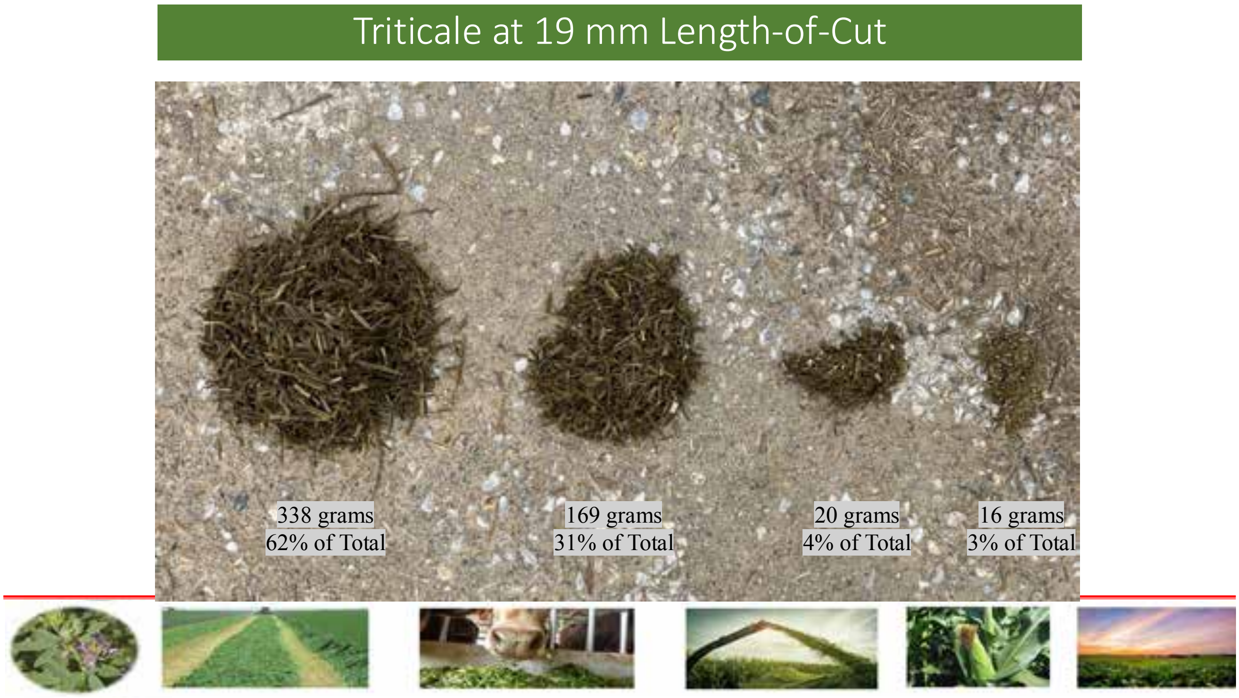


Alfalfa Guidelines		
Screen (mm)	Minor Institute	Penn State
19 mm	5 to 15	10 to 20
8 mm	50 to 75	45 to 75
4 mm	25 to 30	30 to 40
Pan	< 5	< 10

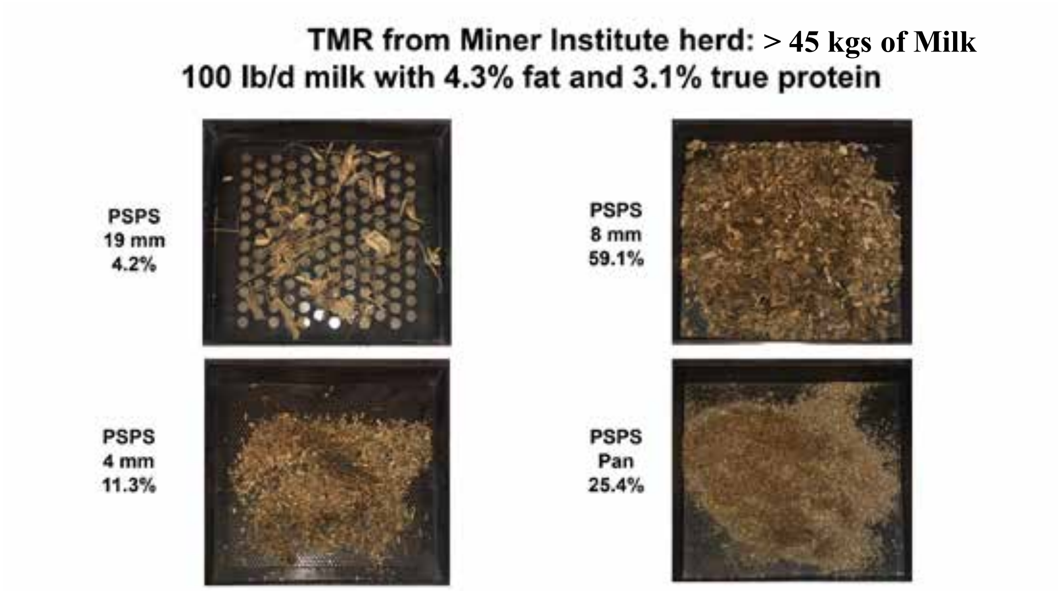
Slides provided by Tony Hall, Lallemand



Corn Silage Guidelines		
Screen (mm)	Minor Institute	Penn State
19 mm	3 to 8	3 to 8
8 mm	50 to 65	45 to 65
4 mm	30 to 40	20 to 30
Pan	< 5	< 10



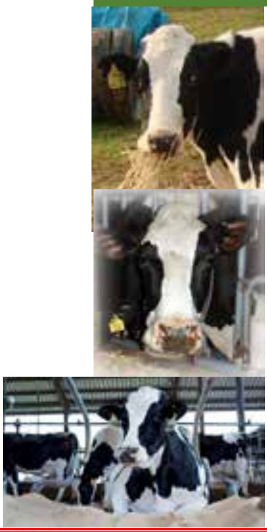
Role of fiber: physical and digestion
Bill WOODLEY and Aurélien PIRON



Understanding Length of Cut and the Importance on the Mechanics of Rumination

- Key Strategy for TMR Feeding:
  - Produce a homogeneous mix of forages and grains that will:
    - reduce sorting
    - optimize digestibility
    - Optimize rumen function
  - Appropriate **length of cut** of forages:
    - Between **12-19 mm** (1/2 inch to 3/4 inch)
    - **>25** mm may lead to sorting and inefficiencies

What is Rumination?



Eating

Cud Chewing

Recumbent Cud Chewing

Behavior responses to increasing diet forage content (Jiang et al., 2017)

Item	40% Forage	50% Forage	60% Forage	70% Forage	Difference	
DMI, kg/d	22.36	21.46	20.28	18.64	-3.72	↓
Eating, min/d	286	292	342	393	107	↑
Rumination, min/d	426	454	471	461	35	↑
Total chewing, min/d	712	745	813	853	141	↑
Resting, min/d	728	695	627	587	-141	↓

✓ **As forage levels increase, chewing time (largely eating time) increases at the expense of resting time**

#1. Understanding Rumination - Eating

Eating (ideal 3-5 hours/day)

- Long material is reduced in length through a "shearing" action
- Need to reduce particle size to enter and then exit the rumen
- Eating time is strongly and positively related to forage particle size over a range of diets and studies (Grant and Ferraretto, 2018)

#2. Understanding Rumination – Cud Chewing

Cud Chewing

- Bolus is regurgitated and then chewed:
  - Further reduce particle size
  - "abrade" the fiber to allow for bacterial attachment
- Cud chewing generates more saliva production than eating
  - Improves rumen pH

#3. Understanding Rumination – Recumbent Cud Chewing

Recumbent Cud Chewing

- **80%** or more of the cow's ruminating behavior occurs while she is lying down or sternally **recumbent**
- Management that **reduces** lying time will also reduce rumination.
- Cows that accomplish more ruminating in stalls and lying down have:
  - higher rumen pH
  - eat more dry matter
  - produce milk with greater fat and protein content

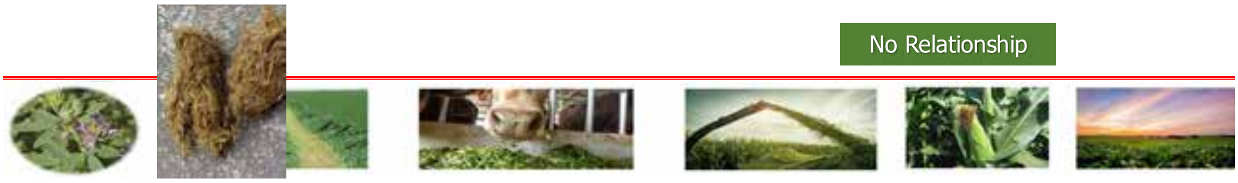
Understanding Eating Time Effect on Rumination

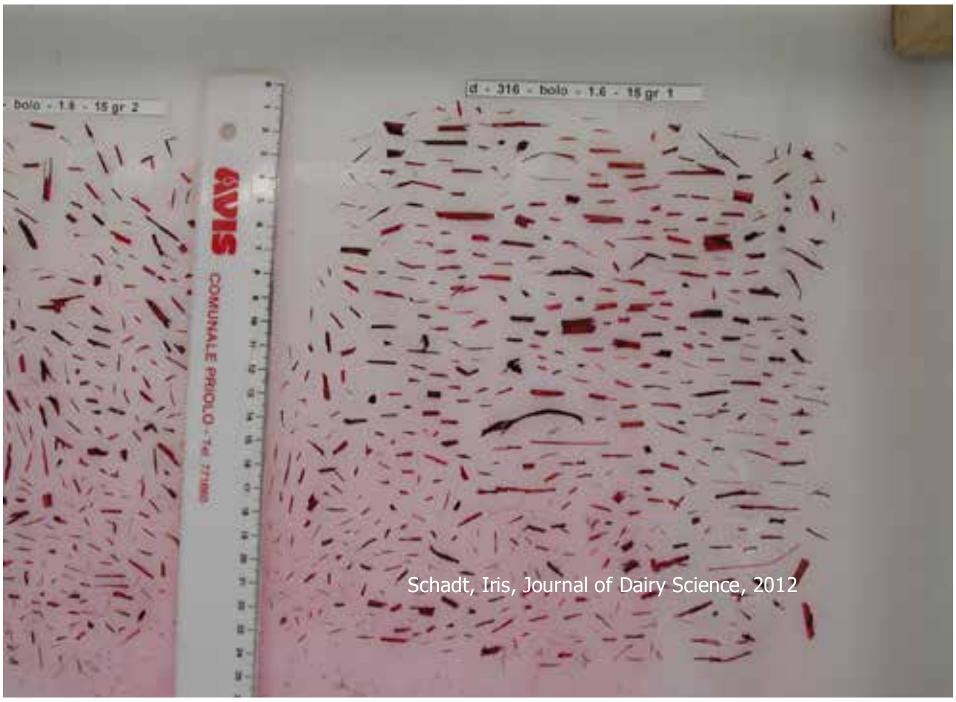
Eating time 3-5 h/d encourages natural feeding behavior (Grant and Albright, 2001).

No Relationship with Feed Particle Size and Masticated Bolus (Cud) Particle Size

Comparison of Feed Particles and Bolus (Cud) Length		
Feed Sample	Feed	Masticated Bolus (Cud)
	Mean Particle Length (mm)	
Rye Grass Dry Hay		
Long		10.3
Chopped at 50 mm	42.2	9.9
Retained on 19 mm Screen (PSPS)	43.5	10.7
Retained on 8 mm Screen (PSPS)	25.1	10.8
Retained on 1.18 mm Screen (PSPS)	9.7	8.1
Grass Silage	13.8	11.8
Corn Silage	12.0	11.2
Total Mixed Ration	13.1	12.5
Source: Schadt and co-workers, Journal of Dairy Science, 2012		

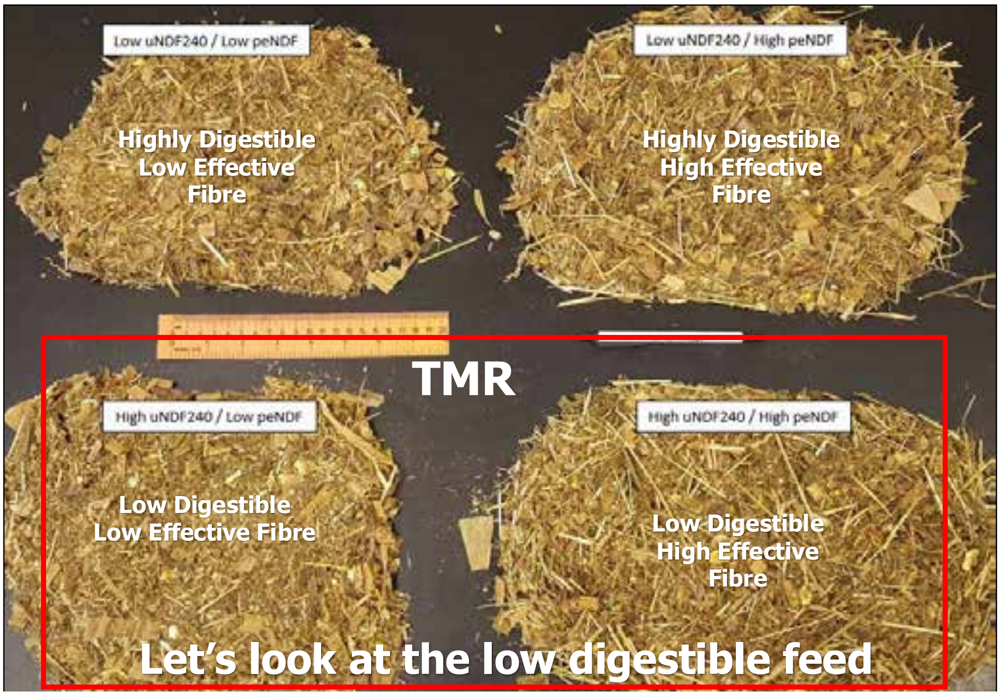
No Relationship





Schadt, Iris, Journal of Dairy Science, 2012


Coarse Timothy Hay
Fine Timothy Hay


Low uNDF240 / Low peNDF
Highly Digestible
Low Effective
Fibre
Low uNDF240 / High peNDF
Highly Digestible
High Effective
Fibre
TMR
High uNDF240 / Low peNDF
Low Digestible
Low Effective Fibre
High uNDF240 / High peNDF
Low Digestible
High Effective
Fibre
Let's look at the low digestible feed

Impact of uNDF240 and peNDF (2018)

Particle Size Reduction During Eating and Effect on Chewing Behaviour

		Mean Particle Size		Eating and Rumination			Performance	
Particle Size	Digestibility (uNDF240)	TMR (mm)	Cud (mm)	Eating Time min/day	Eating Time min/kg of DMI	Chewing Time min/day	Milk kg	DMI kg
Fine	**High** (8.5%) *uNDF240*	9.36	7.96	255	9.09	523	47.0	27.5
Coarse		10.42	7.46	263	9.62	527	45.7	27.3
Fine	**Low** (11.5%) *uNDF240*	9.19	7.51	279	10.08	532	46.4	27.6
Coarse		11.55	7.78	**300**	**11.86**	545	**44.6**	**24.9**

2018 MINER INSTITUTE STUDY: UNDIGESTED & PHYSICALLY EFFECTIVE FIBER

Increased Eating Time Adversely Affected Resting Time

Recommendations for Length of Cut

- What to consider:
  1. Maturity
  2. Fragility
  3. Moisture content

Recommendations for Length of Cut

Maturity

- As plant matures, lignin accumulates to "build" structure
- Allows plant to support seed production without lodging
- uNDF240 values largely relate to maturity

1. Mature crops can be processed with shorter length-of-cut
2. Immature crops can be processed with longer length-of-cut

Note: corn silage is harvested at MATURITY

Recommendations for Length of Cut

Fragility

- resistance of particles to breakdown during chewing
- Grasses and corn silage have more resistant structure (less fragile). This slows passage rate.
- Two main forages exhibit fragility:

1. Alfalfa due to leaf structure and "breakable" stem
2. BMR corn silage due to low lignin levels and fragile lignin structure

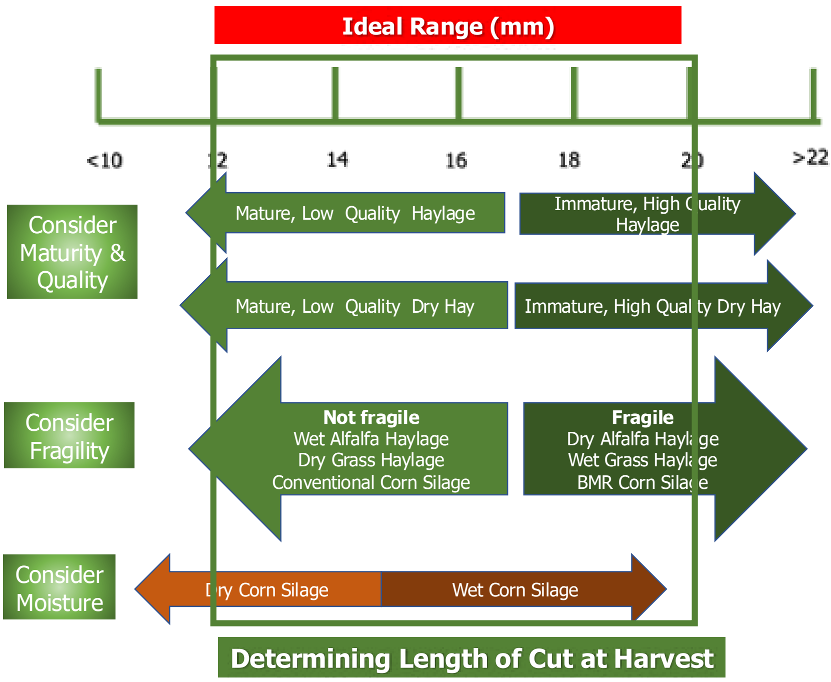
Fragile forages can be harvested with longer length-of-cut

Recommendations for Length of Cut

Moisture/Dry Matter Content of Forage

- Moisture in plant material typically improves the structure
- Drier material may also need to be chopped finer to improve packing in bunk

1. Alfalfa: drier alfalfa appears to be more fragile. Increase length-of-cut as plant dries
2. Corn silage: drier corn silage highly related to plant maturity and increase starch content. But >40% DM lower starch digestibility, difficult to ferment
3. Winter Cereals: Wetter triticale (<30% DM) needs to be cut longer to prevent leaching



Global Variation in Corn Silage Length-of-Cut

- Varies from 4 mm to 38 mm (shredlage)
- Why the variation?
- Short
  - Improves starch digestion?
  - Improves packing?
  - Reduces sorting
  - Compact feeding?
- Long
  - Improves cud chewing?
  - Reduce straw (with shredlage)?

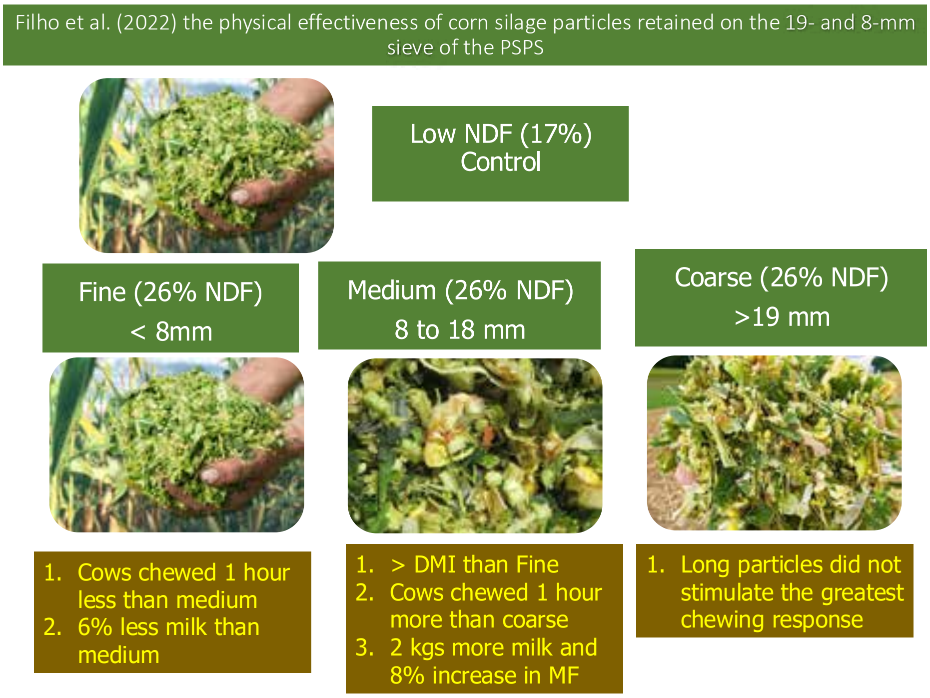
Meta-Analysis of Corn Silage Harvesting Practices

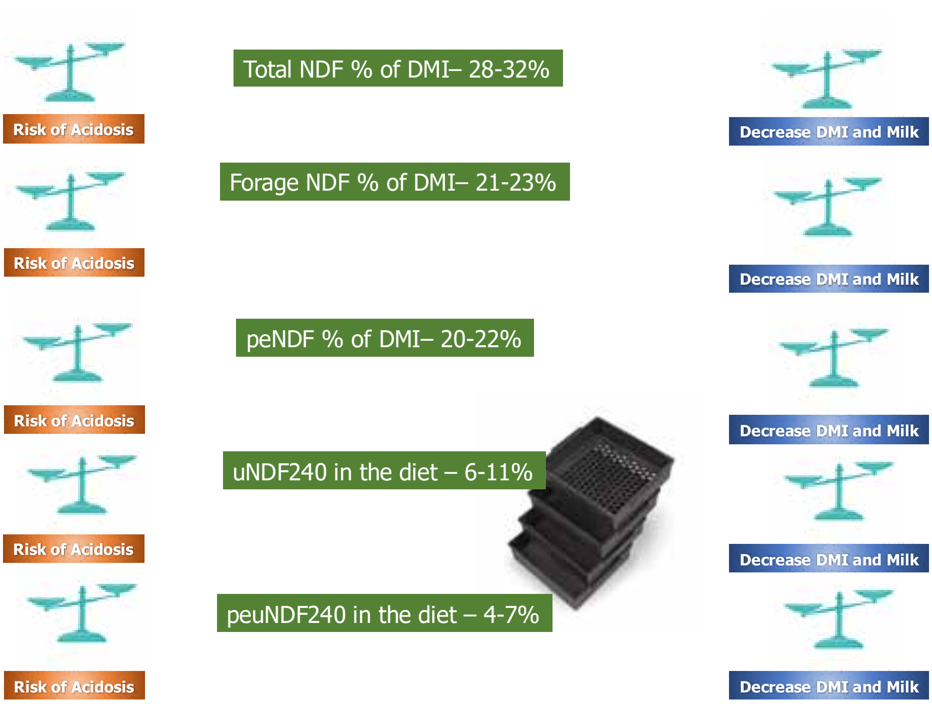
L.F. Ferraretto and R.D Shaver 2012

- LOC (theoretical length of cut) content defined as:
  - 4.8 to 6.4 mm (0.19 to 0.25 inches)
  - 9.3 to 11.1 mm (0.37 to 0.44 inches)
  - 12.7 to 15.9 mm (0.50 to 0.63 inches)
  - 19.0 to 19.5 mm (0.75 to 0.77 inches)
  - 25.4 to 28.6 mm (1.00 to 1.13 inches)
  - ≥ 32.0 mm (1.26 inches)

High Passage Rate (first two ranges)
Typical Range (middle two ranges)
Potential Sorting (last two ranges)

What did they find?
Milk and milk fat were unaffected by LOC
Ruminal NDF digestibility was unaffected (P=0.27) by LOC
BUT – Kernel Processing (KP) is critical to improve **starch degradability**
Not Length-of-Cut

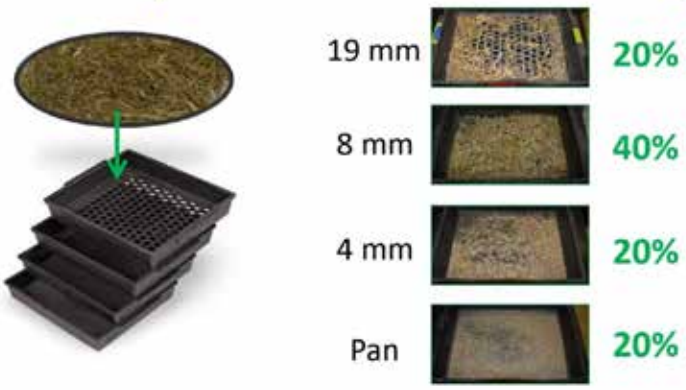

Filho et al. (2022) the physical effectiveness of corn silage particles retained on the 19- and 8-mm sieve of the PSPS
Low NDF (17%) Control
Fine (26% NDF) < 8mm
Medium (26% NDF) 8 to 18 mm
Coarse (26% NDF) >19 mm
1. Cows chewed 1 hour less than medium
2. 6% less milk than medium
1. > DMI than Fine
2. Cows chewed 1 hour more than coarse
3. 2 kgs more milk and 8% increase in MF
1. Long particles did not stimulate the greatest chewing response


Risk of Acidosis
Total NDF % of DMI– 28-32%
Decrease DMI and Milk
Risk of Acidosis
Forage NDF % of DMI– 21-23%
Decrease DMI and Milk
Risk of Acidosis
peNDF % of DMI– 20-22%
Decrease DMI and Milk
Risk of Acidosis
uNDF240 in the diet – 6-11%
Decrease DMI and Milk
Risk of Acidosis
peuNDF240 in the diet – 4-7%
Decrease DMI and Milk

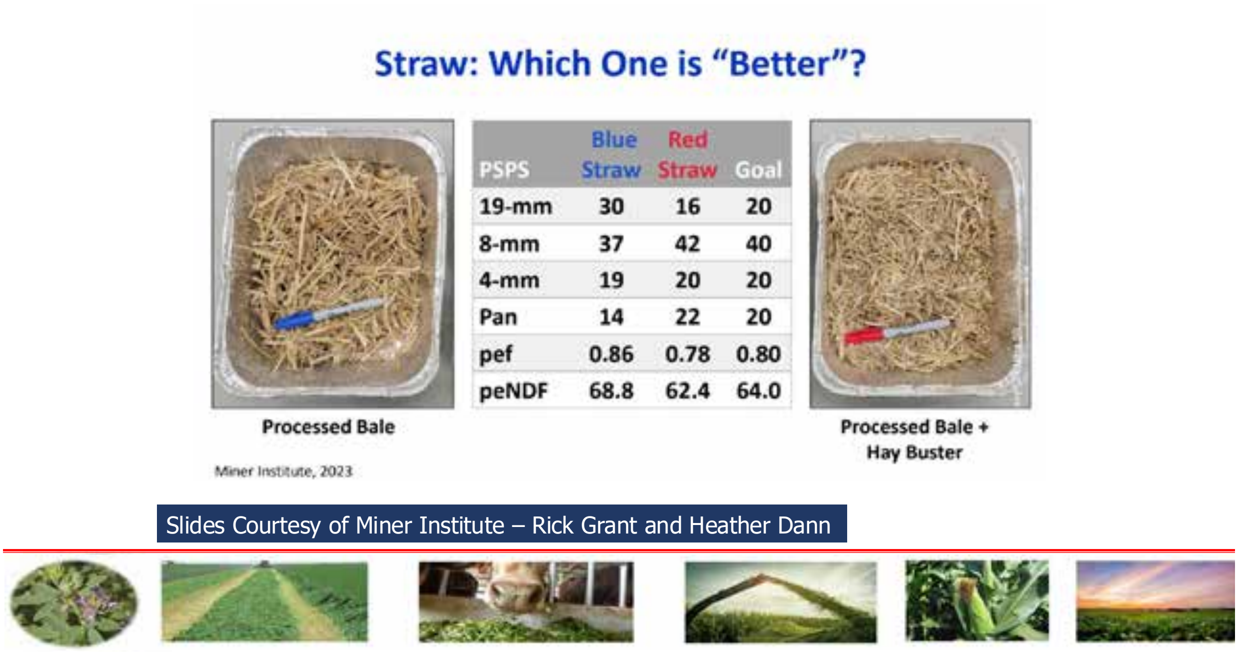
When to feed Straw?

- "Instinctive" feeding!
  - Loose manure
  - Always fed straw
  - High passage rate
  - High milk: low milk fat
- Does peuNDF240 give us a better guideline?
  - < 4% of DMI is "danger zone"
  - Very highly digestible forages may require straw

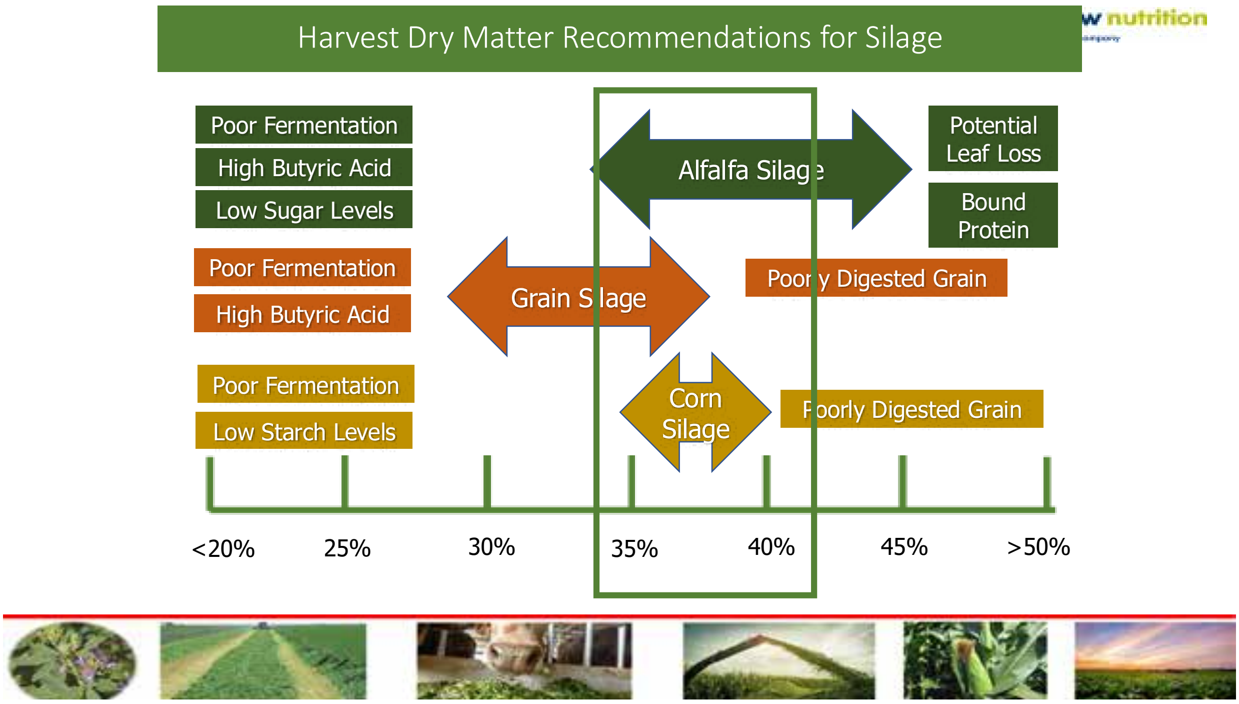
Straw and Hay Particle Size to Minimize Sorting



Slides Courtesy of Miner Institute – Rick Grant and Heather Dann



PSPS	Blue Straw	Red Straw	Goal
19-mm	30	16	20
8-mm	37	42	40
4-mm	19	20	20
Pan	14	22	20
pef	0.86	0.78	0.80
peNDF	68.8	62.4	64.0

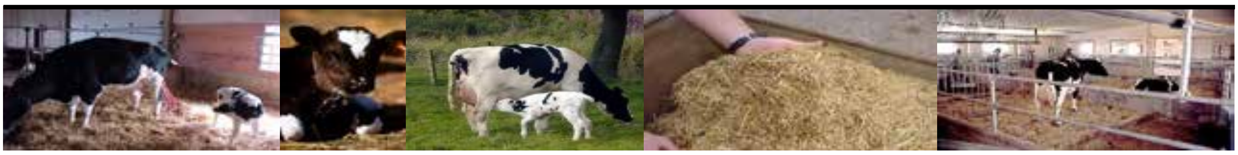


CO SPEAKERS: BILL WOODLEY AND AURÉLIEN PIRON

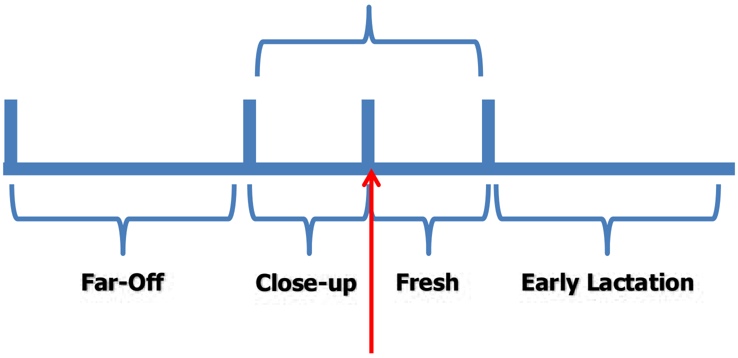
- Re-thinking the transition cow

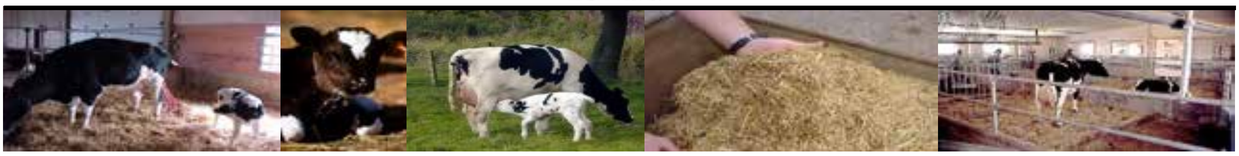
Re-Thinking the Transition Cow

Bill Woodley
Woodley Dairy Direction
woodleydairy@gmail.com

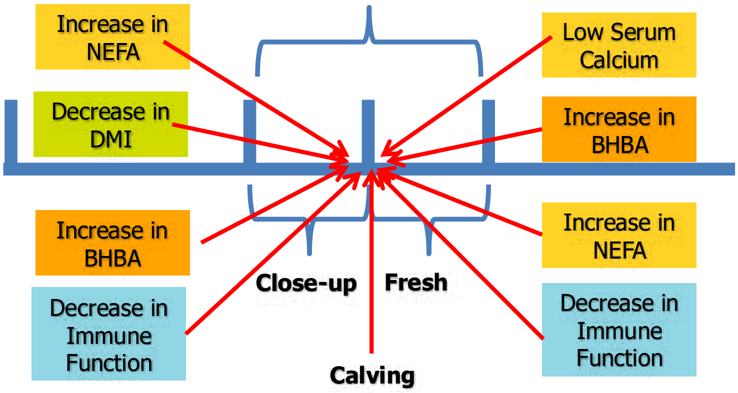


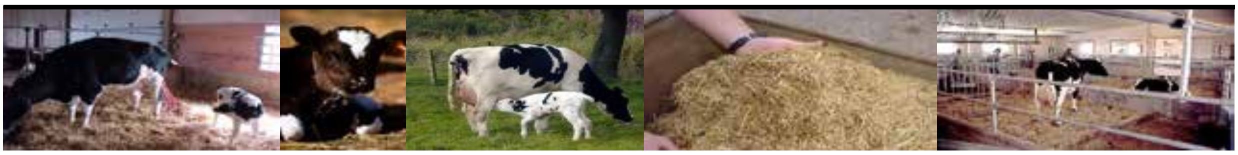
The **Transition** Period…





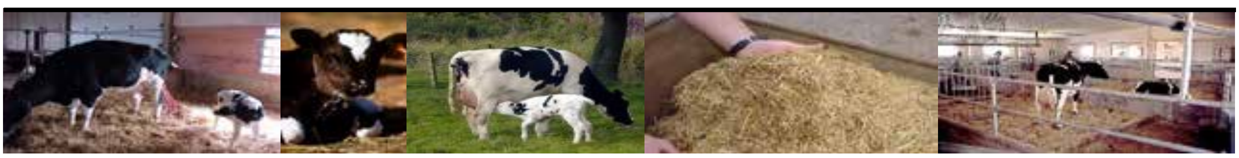
The Transition Period…





What are the potential outcomes of a **poor** dry cow program?

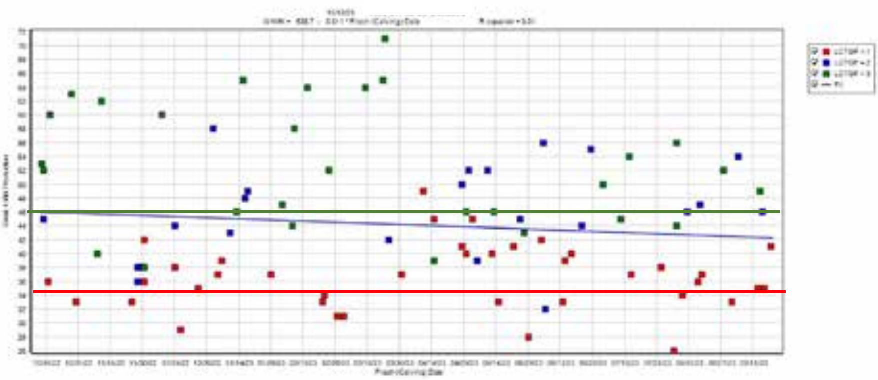
1. Increase in metabolic disorders
   - Milk fever, ketosis, SARA
2. Loss of milk
   - Why do cows lose milk?
3. Poor reproduction
   - Is poor reproduction link to the transition success?

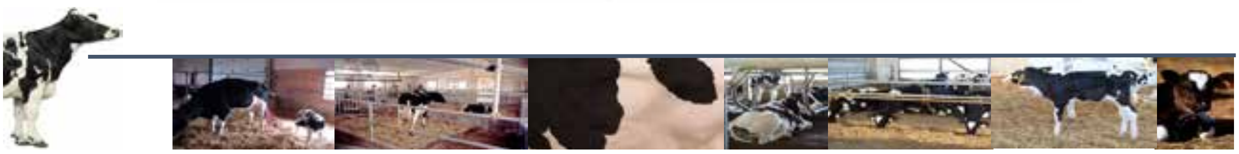


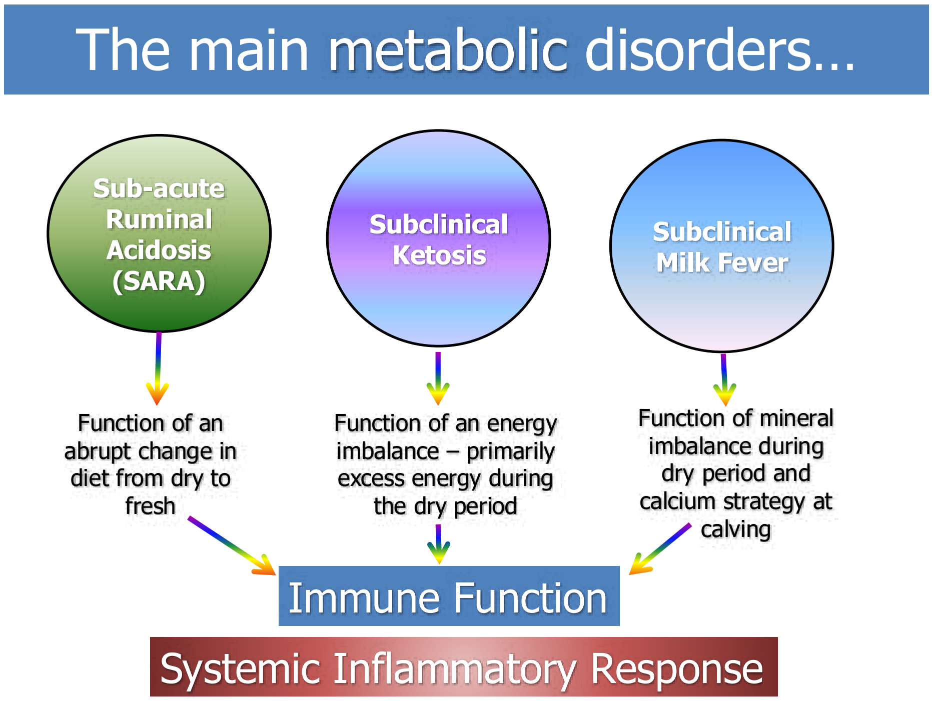
Measurements of Success

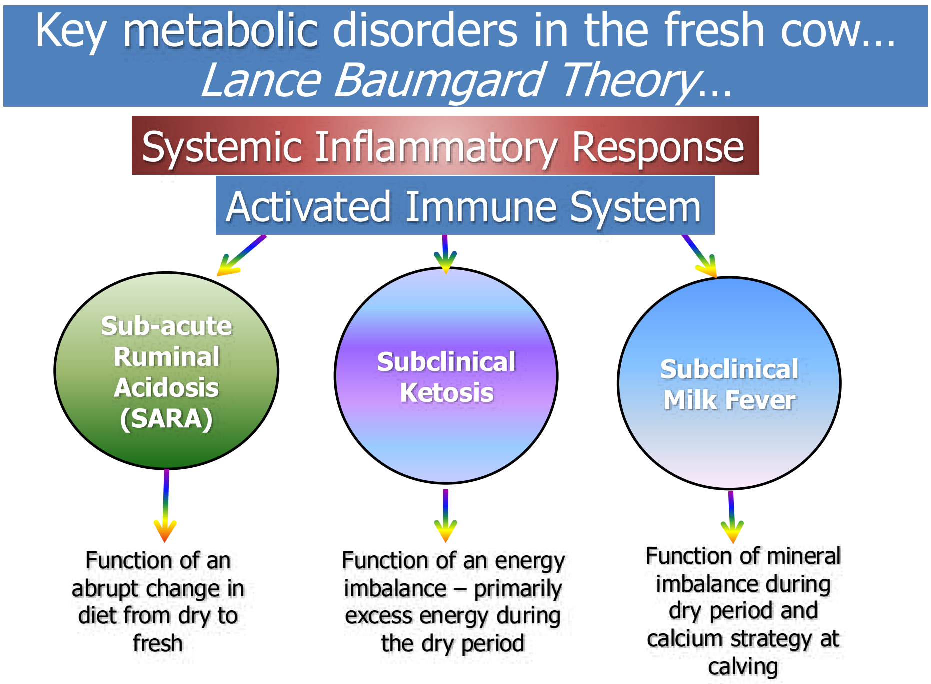
1. Decrease in metabolic disorders
   - Sub-clinical hypocalcemia or SARA are difficult to measure
   - Sub-clinical ketosis can be measured
2. Improvement in milk
   - 4 week milk
   - Transition Cow Index
3. Improved reproduction
   - Improved PR
     - PR=HDR x CR

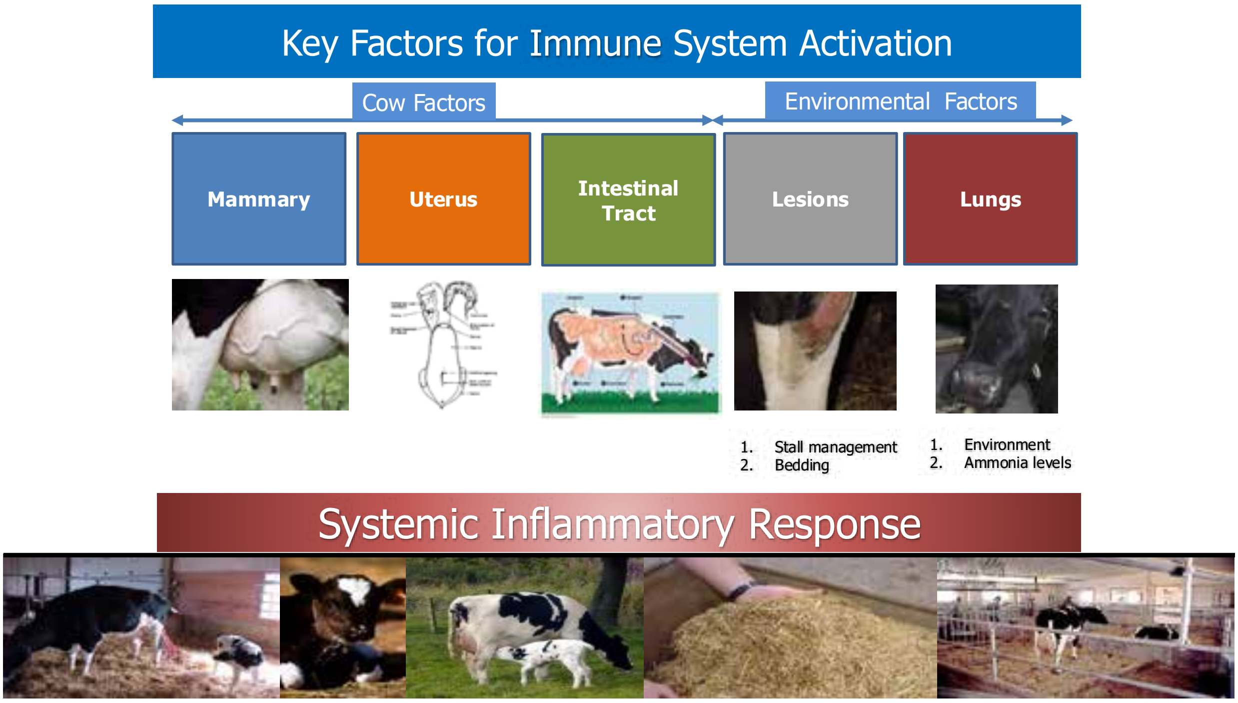
4 Week Milk Production

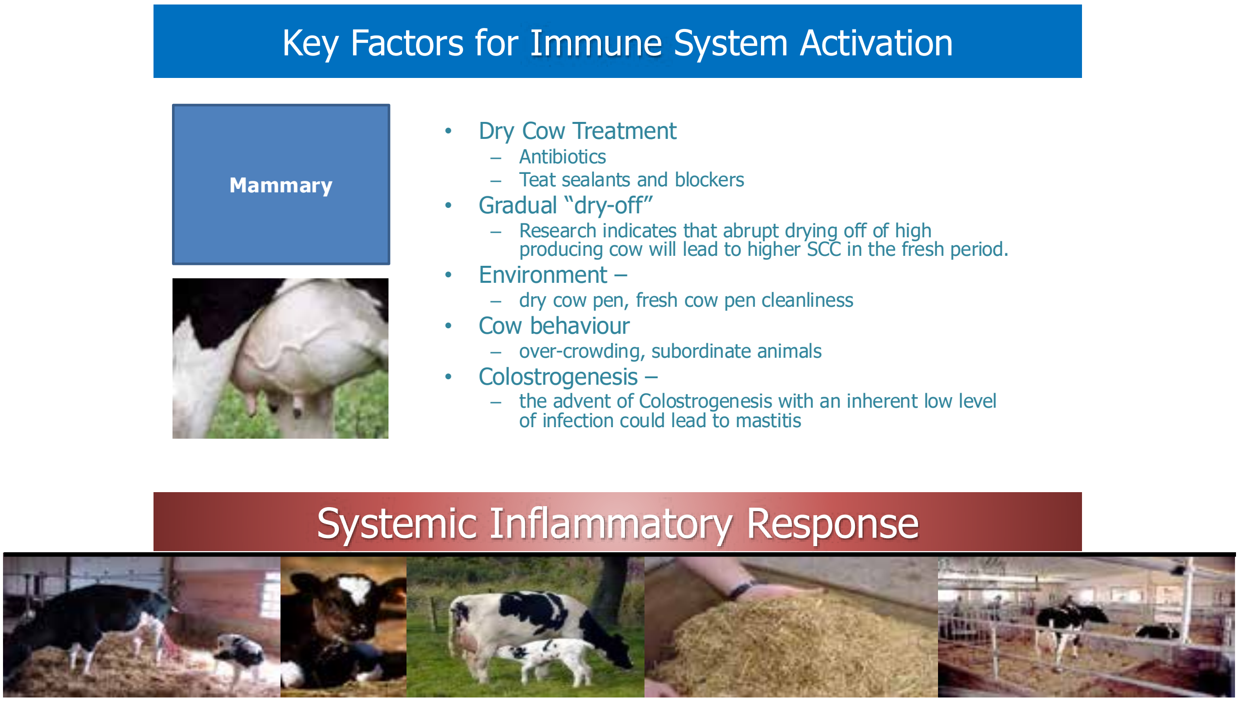





The main metabolic disorders…
Sub-acute Ruminal Acidosis (SARA)
Subclinical Ketosis
Subclinical Milk Fever
Function of an abrupt change in diet from dry to fresh
Function of an energy imbalance – primarily excess energy during the dry period
Function of mineral imbalance during dry period and calcium strategy at calving
Immune Function
Systemic Inflammatory Response

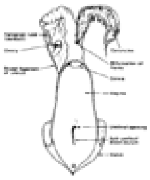

Key metabolic disorders in the fresh cow…
Lance Baumgard Theory…
Systemic Inflammatory Response
Activated Immune System
Sub-acute Ruminal Acidosis (SARA)
Subclinical Ketosis
Subclinical Milk Fever
Function of an abrupt change in diet from dry to fresh
Function of an energy imbalance – primarily excess energy during the dry period
Function of mineral imbalance during dry period and calcium strategy at calving


Key Factors for Immune System Activation
Cow Factors
Environmental Factors
Mammary
Uterus
Intestinal Tract
Lesions
Lungs
1. Stall management
2. Bedding
1. Environment
2. Ammonia levels
Systemic Inflammatory Response


Key Factors for Immune System Activation
Mammary
• Dry Cow Treatment
– Antibiotics
– Teat sealants and blockers
• Gradual "dry-off"
– Research indicates that abrupt drying off of high producing cow will lead to higher SCC in the fresh period.
• Environment –
– dry cow pen, fresh cow pen cleanliness
• Cow behaviour
– over-crowding, subordinate animals
• Colostrogenesis –
– the advent of Colostrogenesis with an inherent low level of infection could lead to mastitis
Systemic Inflammatory Response

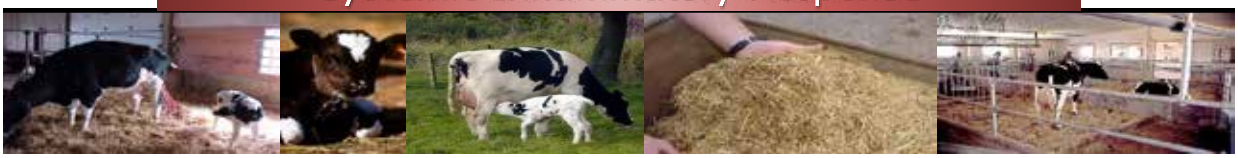
Key Factors for Immune System Activation

Uterus



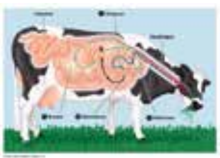
- Over-conditioned dry cows
  - Difficult calving
  - Calving assistance Goal <20%)
  - Dystocia
- Calving Pen Management
  - Pen cleanliness
  - Manager protocols

Systemic Inflammatory Response



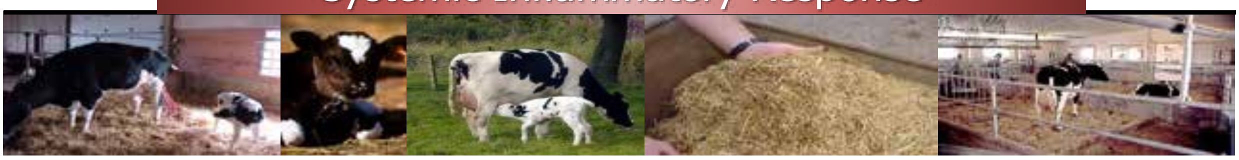
Key Factors for Immune System Activation

Intestinal Tract



- SARA
  - Sub-acute ruminal acidosis in the fresh cow
  - Excess starch in the fresh cow diet
  - Abrupt transition
  - Poor intake in dry period
  - Particle size of TMR
  - Forage hygiene
  - Mycotoxins
  - Heat Stress

Systemic Inflammatory Response



Dry cows suffer from heat stress.
What are the consequences?

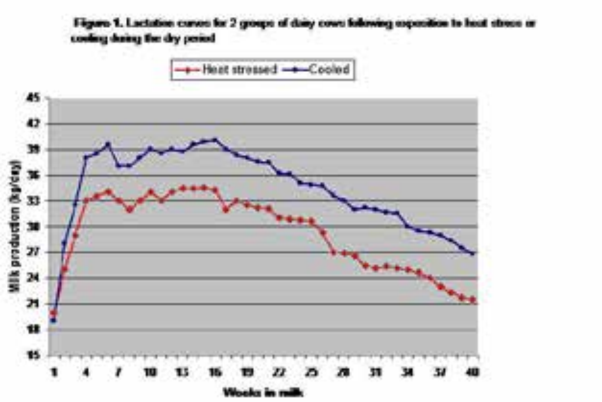
The dairy cow produces less milk plus there is a carry-over effect. Heat stressed dry cows had a lower number of functional mammary secretory cells (MEC) – involution and subsequent growth effected

- (Do Amaral et al. 2009)
  - “cooled” dry cows averaged 7.5 kg/day more milk
  - “cooled” dry cows produced more 3.5% fat corrected milk through 210 DIM
- (Tao et al. 2011)
  - “cooled” dry cows averaged 5.0 kg/day more milk
  - “cooled” dry cows consistently produced more milk through 280 days in milk

Legacy Effect

Today’s Decision Influences Future Productivity

Dry cows suffer from heat stress.
What are the consequences?



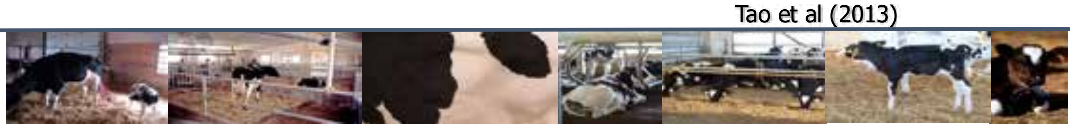
Tao et al., J. DairySci. 94:5976–5986

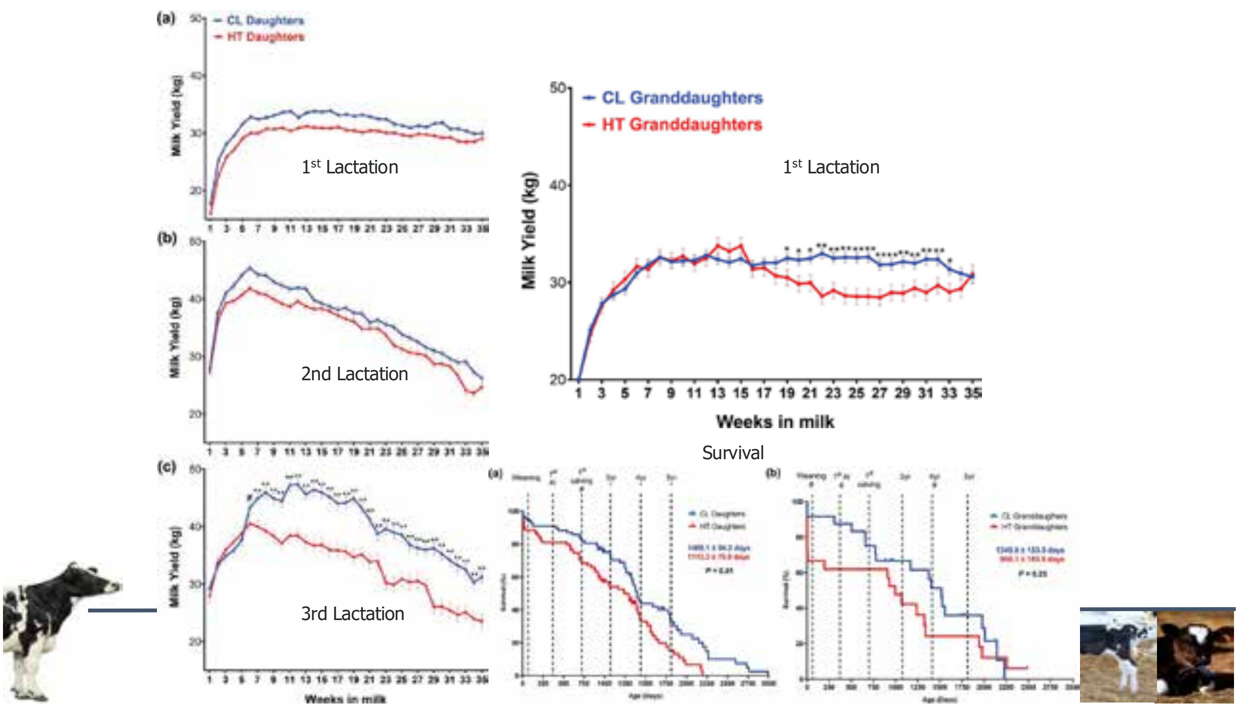
Dry cows suffer from heat stress.
What are the consequences?

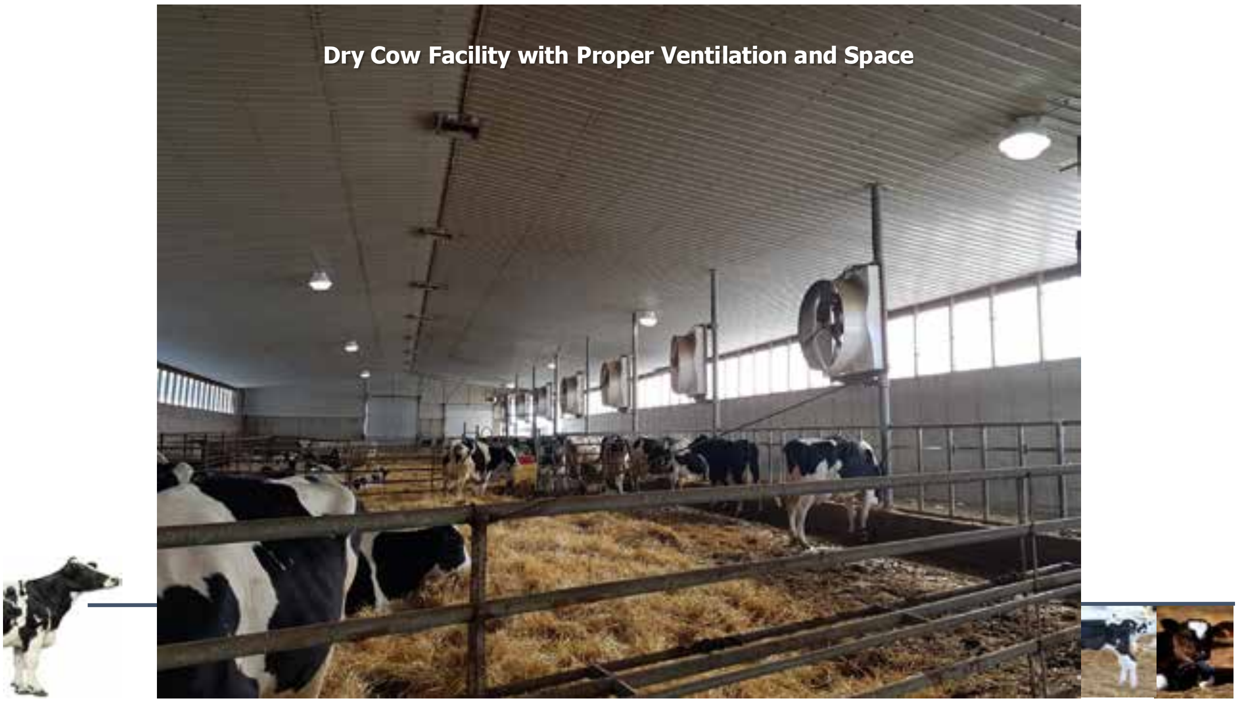
Heat stressed dry cows have a shorter gestation period *(up to 7 days)*, compared to cows that were cooled……

- lower calf birth weights
- Calves from heat stressed dry cows had lower serum IgG concentration and efficiency of absorption
- Weaning weights were lower *(78.5 kg vs 65.9 kg)* and 7 month weights were lower *(154.6 kg vs 146.4 kg)*
- ***What will happen in 2 years?***
- *in utero heat stressed heifers produced less milk to 35 weeks of the 1st lactation compared with cooled heifers*
- *26.8 vs. 31.9 :* ***5.1*** *kgs!*

Tao et al (2013)



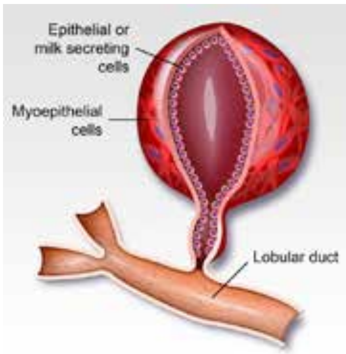




Why do metabolic disorders lead to **milk loss**?

Disruption of the Mammary Epithelium Cell (MEC) development

1. Loss of peak milk
2. Loss of persistency



Mammary Epithelium Growth in Fresh Period determines milk production lactation curve

Why do metabolic disorders lead to **milk loss**?

Potential shunting of glucose to "fuel" the immune system

1. Loss of energy to support milk production
2. Stoakes et al, 2015 estimated that during a severe immune challenge = 2 kgs of glucose/24 hour period= milk loss of 28 kgs

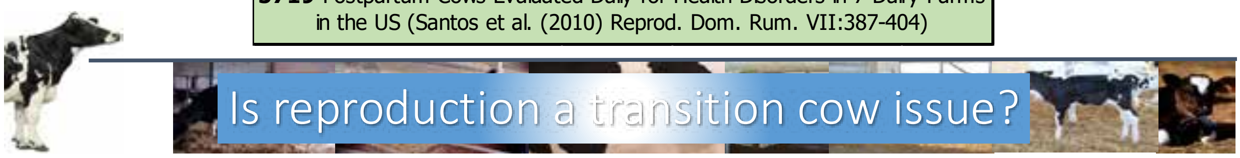
When a cow's immune system is activated, there is an energy cost for an **inflammatory response**

What about the impact of the transition period on reproduction?

Is poor reproduction a transition cow issue?

Health Problems in the 1st 60 DIM and it's Effect on Pregnancy/AI in Lactating Dairy Cows (Dr. Jose Santos, University of Florida)			
Category	**Pregnant** %	Adjusted OR (95% CI)	*P*
Healthy	51.4	1.00	
1 case of disease	43.3	0.79 (0.69-0.91)	0.001
> 1 case of disease	34.7	0.57 (0.63-0.88)	<0.001
Type of Health Problem			
Calving Problem	40.3	0.75 (0.63-0.88)	<0.001
Metritis	37.8	0.66 (0.56-0.78)	<0.001
Clinical Endometritis	38.7	0.62 (0.52-0.74)	<0.001
Fever Postpartum	39.8	0.60 (0.48-0.65)	<0.001
Mastitis	39.4	0.84 (0.64-1.10)	<0.001
Clinical Ketosis	28.8	0.50 (0.36-0.68)	<0.001
Lameness	33.3	0.57 (0.41-0.78)	<0.001
Pnuemonia	32.4	0.63 (0.32-1.27)	0.20
Digestive Problem	36.7	0.78 (0.46-1.34)	0.38

5719 Postpartum Cows Evaluated Daily for Health Disorders in 7 Dairy Farms in the US (Santos et al. (2010) Reprod. Dom. Rum. VII:387-404)



Is reproduction a transition cow issue?

Reproductive Parameter	Subclinical Hypocalcemia	Mastitis	Subclinical Ketosis
Reduced Pregancy			✓
Impaired Pregnancy Rate	✓		
Altered Estrous Cycle		✓	
Impaired Pregnancy Rate at 1st AI	✓		✓

Why is Dry Matter Intake Important?

Pre-Calving

1. Improve DMI post-calving
2. Reduction of metabolic disorders
3. Stronger start to lactation

Post-Calving

1. Higher 4 week milk and peak milk
2. Reduction of metabolic disorders
3. Decreased NEB (negative energy balance)

Improving Dry Matter Intake

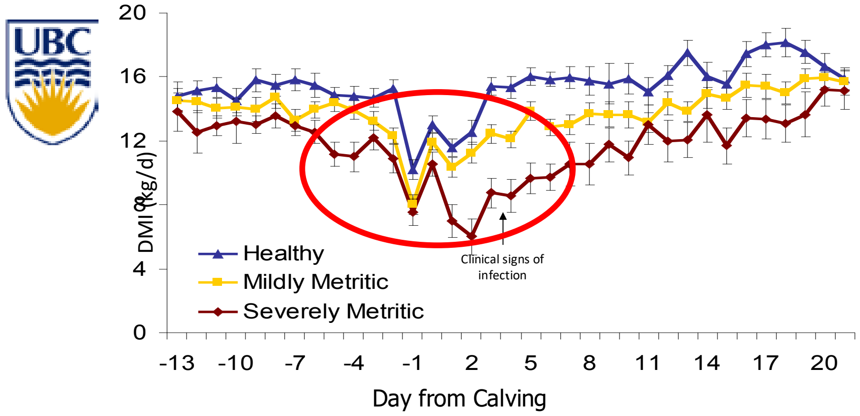
Pre-Calving

1. Control body condition
2. Reduce particle size
3. Adequate bunk and bedding pack space
4. Reduce metabolic disorders

Post-Calving

1. Reduce starch in fresh cow diet
2. Adequate bunk space
3. <80% stocking density
4. Reduce metabolic disorders

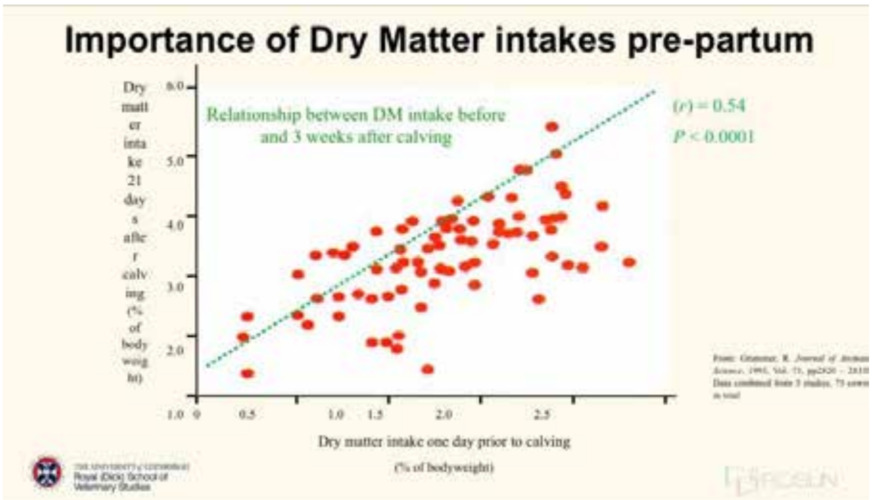
Healthy cows behave differently than unhealthy cows

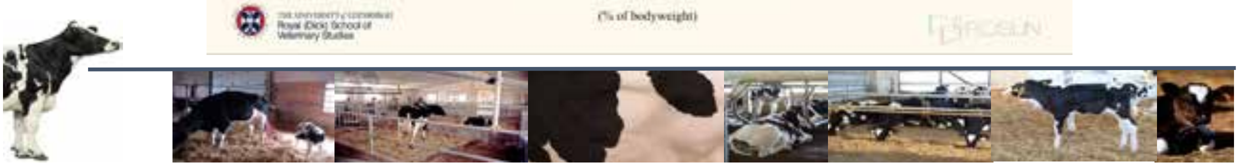


Cows with post-partum metritis had lower DMI during the post- and pre-partum periods

Huzzey et al. 2007, J. Dairy Sci. 90: 3220-3233

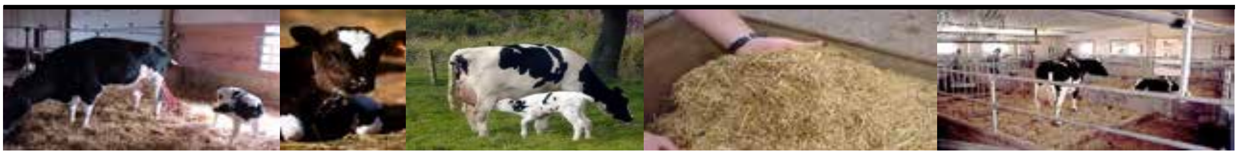
Relationship of DMI Pre-Calving to DMI Post-Calving





The key strategy…

- Control energy intake while encouraging high DMI prepartum
- Encourage high DIM after calving through Fresh Cow Strategy
- Carefully formulate mineral content to reduce subclinical hypocalcemia
- Develop a "seamless" transition from close-up to fresh
- Minimizing key metabolic concerns



Excessive energy intake during the dry period …

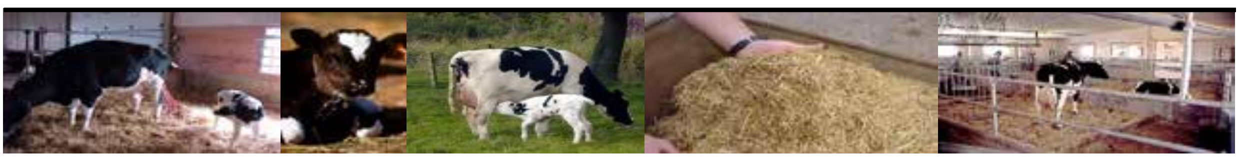
Lower fresh cow DMI
slower starts in milk production (Douglas et al., 2006; Dann et al., 2006)

Higher NEFA (fat) in blood
more triglyceride in the liver after calving (Douglas et al., 2006; Janovick Guretzky et al., 2006)

Decreased immune function
Controlling energy intake during the dry period improved **neutrophil** function (Graugnard et al., 2008)

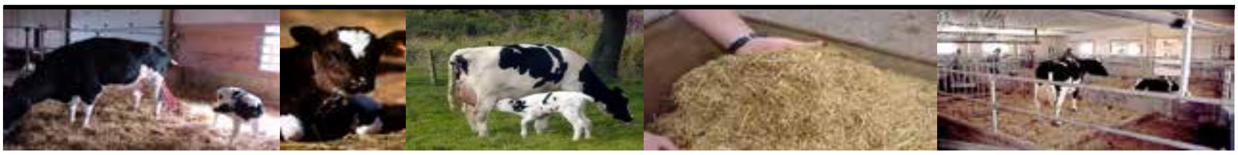
Greater deposition of fat in dry cow
Moderate overfeeding leads to an increase in internal adipose tissues as compared to cows fed a high-straw diet to control energy intake at requirements (Nikkhah et al., 2009)

Increased ketones (BHBA)
(Drackely)



Impact of Subclinical Ketosis (Blood BHBA ≥1.2 mmol/L)

1. Milk Loss (Duffield et al. 2009) – 1.86 kg < at 1st test (BHBA ≥ 1.4 mmol/L
2. Increased Risk for Early Lactation Removal (McArt al 2012) - 3X's in 1st 30 days
3. Increased Risk of Disease (Duffield et al. 2009) – Metritis 3.4X's and DA 2.6X's
4. Increased Risk of Poorer Reproduction (R.B. Walsh et al,2006) -Probability of pregnancy was reduced by 50% in cows experiencing SCK in both 1st and 2nd week



Subclinical Ketosis Strategy

Avoid Weight Gain in Dry Period

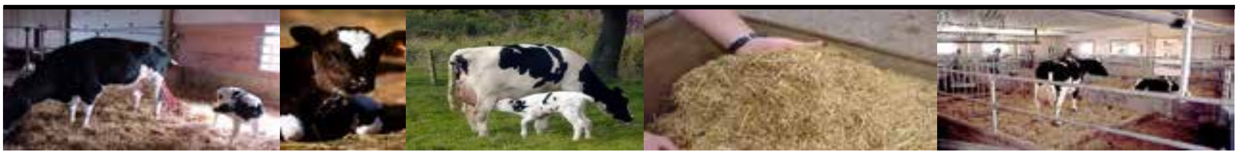
- Controlled energy diet
  - 68-72 mJs/day or 15-18 mcals/day
- Monitor DMI
- Limit days dry
- Feed non-sortable TMR

Reduce Weight Loss in Fresh Period

- Encourage high DMI in fresh period
- Improve transition from dry cow diet to the fresh or lactating diet

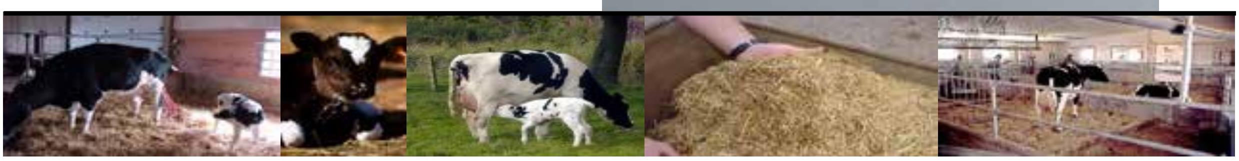
Improving the Transition from the Dry Cow Ration to the Milking Ration….

- Dry cow ration and milking cow ration are quite different but should "look" similar…
  - Are the 2 diets too far apart?
    - both nutritionally and physically
  - Dry cow ration is high fibre "on-paper" but should physically present like the lactating TMR

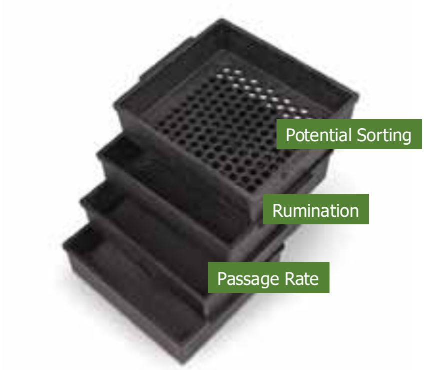


Improving the Transition from the Dry Cow Ration to the Milking Ration….

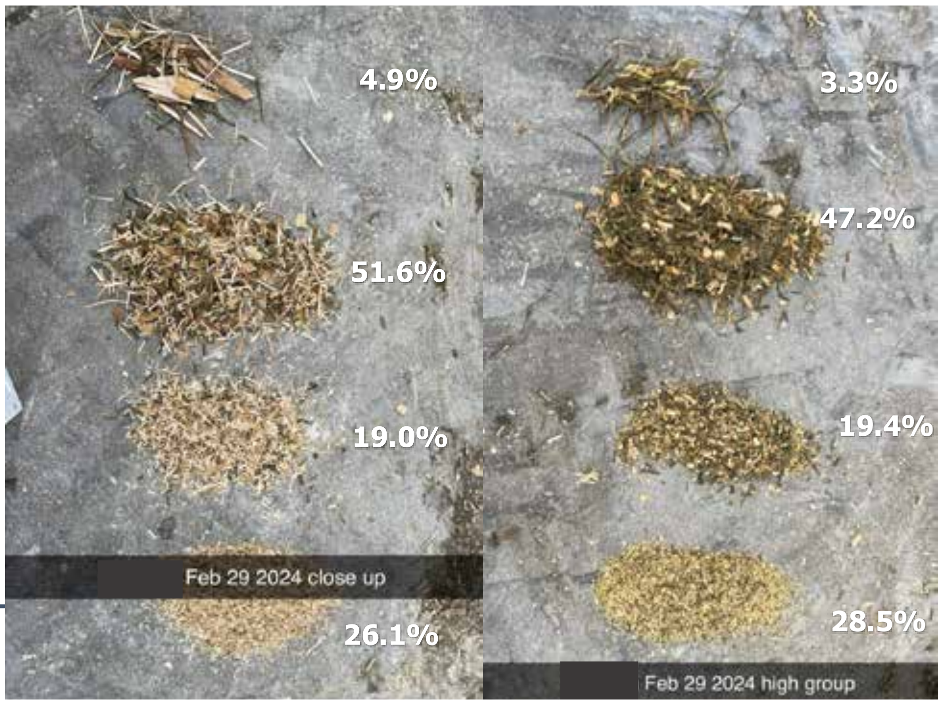
- Particle size is key driver to improve the transition
  - **Short** particle size increases passage rate
  - Increased passage rate increases DMI

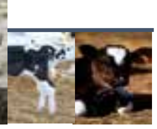


Updated Recommendations for PSPS



Suggested Silage Particle Size Distributions, Rick Grant, Miner Institute				
Screen (mm)	TMR	Corn Silage	Alfalfa Silage	Grass Silage
19 mm	< 5	3 to 8	5 to 15	5 to 15
8 mm	>50	50 to 65	50 to 75	50 to 75
4 mm	10 to 20	30 to 40	25 to 30	20 to 30
Pan	25 to 30	< 5	< 5	< 5






Straw and Hay Particle Size to Minimize Sorting
19 mm
20%
8 mm
40%
4 mm
20%
Pan
20%
Slides Courtesy of Miner Institute – Rick Grant and Heather Dann

Effects of wheat straw chop length in high-straw dry cow diets on intake, health, and performance of dairy cows across the transition period

J. Dairy Sci. TBC:1–18
https://doi.org/10.3168/jds.
2019-17033

C. D. Havekes,[1] T. F. Duffield,[2] A. J. Carpenter,[1] and T. J. DeVries[1]*
[1]Department of Animal Biosciences, University of Guelph, Guelph, Ontario, N1G 2W1, Canada [2]Department of Population Medicine, University of Guelph, Guelph, Ontario, N1G 2W1, Canada

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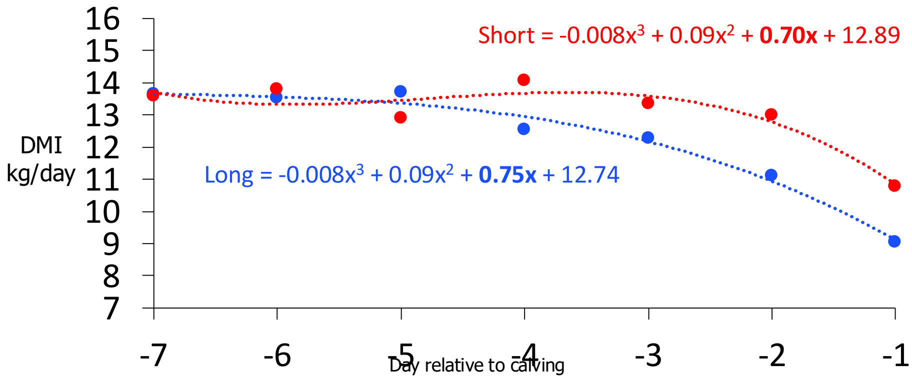
Long particle length had a greater drop in DMI leading up to calving

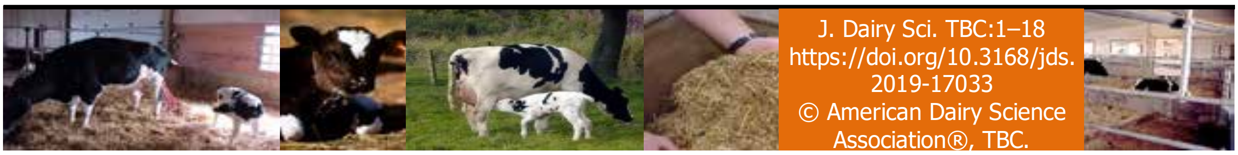


** Bolded coefficients differ by treatment at P<0.001*

Havekes et al. 2019. JDS. In press.

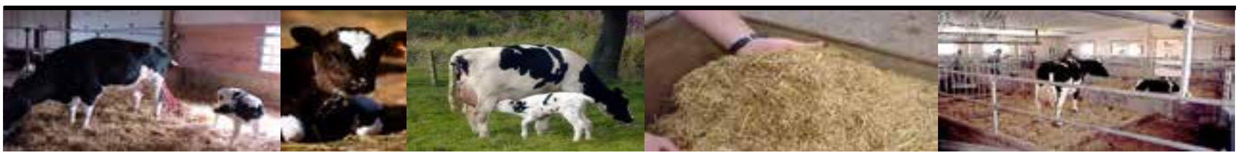
Cows fed a high-straw dry cow diet with a smaller, straw particle size had:

- improved DMI during the dry period
- sorted feed less
- maintained more consistent intake in the week leading up to calving
- had more stable rumen pH in the first week post calving
- had lower blood BHB (ketone) levels 3 week post calving.



Sub-Acute Ruminal Acidosis

- SARA
  - Negatively affects ability of rumen epithelium to absorb volatile fatty acids (VFA)
  - Decreases fiber digestion through changes in the microbial population
  - Causes inflammation and may lead to "leaky gut"



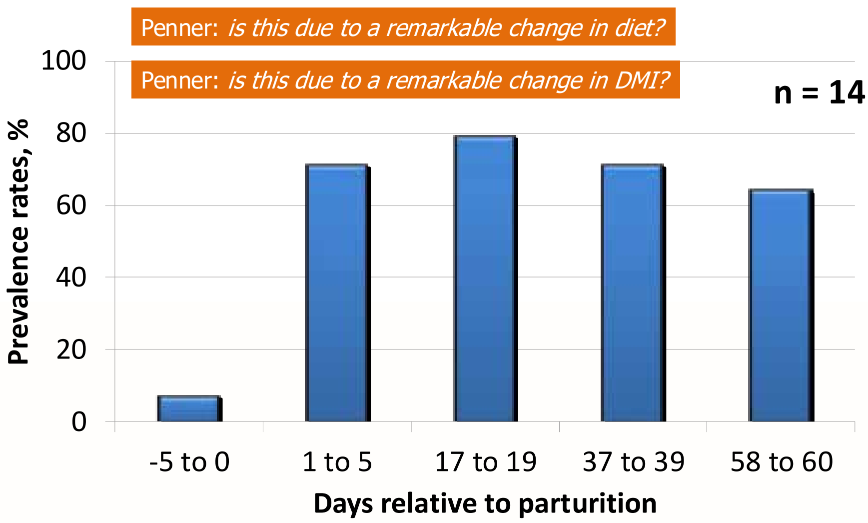
Increased Risk of Ruminal Acidosis (SARA) in Fresh Cow

- Large changes in dietary composition and intake during the transition period
  - Fermentable carbohydrate – starch!
  - Is there too much of a DMI difference between the dry cow and the fresh cow?

How much **starch** in the dry cow?

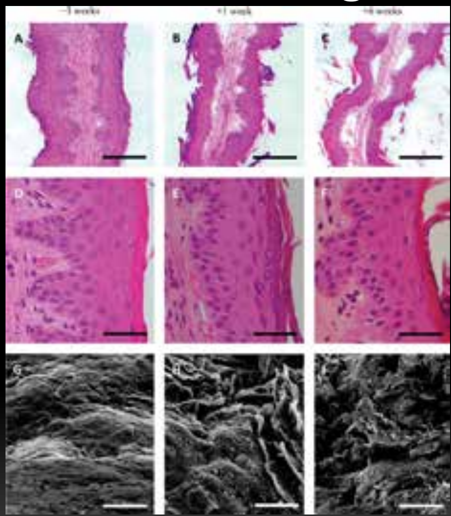
How much **starch** in the Fresh cow?

Prevalence and Severity of SARA in the Fresh Cow



Penner et al., 2007; JDS

Rumen Epithelium During Transition

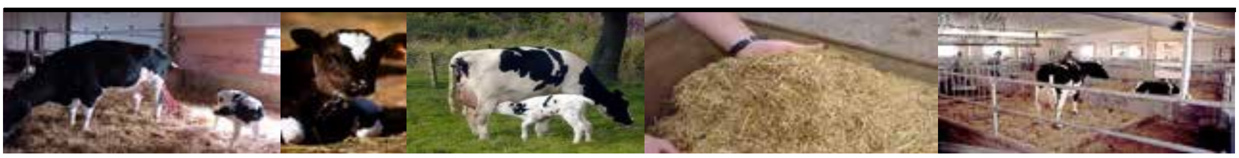


200µm 200µm 200µm

Journal of Dairy Science Volume 98, Issue 4, April 2015, Pages 2583-2595, Steele

How to Improve DMI in the Fresh Period

- Controlled energy dry cow diet
  - Helps control sub-clinical ketosis
  - Improves DMI
- Reduce Starch Level
  - Sugar
  - Non-Forage Fibre sources
- Mineral Strategy for dry and fresh cows
  - Controlling Sub-Clinical Milk Fever



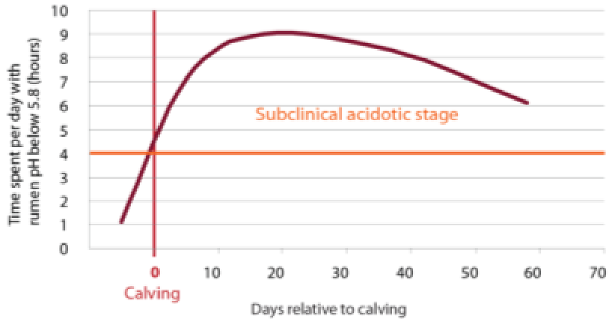
What is the Impact of High Starch Levels in the Fresh (0-21 days postpartum) Diets?

- Lead to SARA
- Reduce DMI (through satiety – feeling "full")
- Increase systemic inflammation and immune response
- Potentially lower milk

Can we replace some of the starch for the Fresh Cow?

Controlling Starch Levels in the Diet

Challenge: High risk of low rumen pH



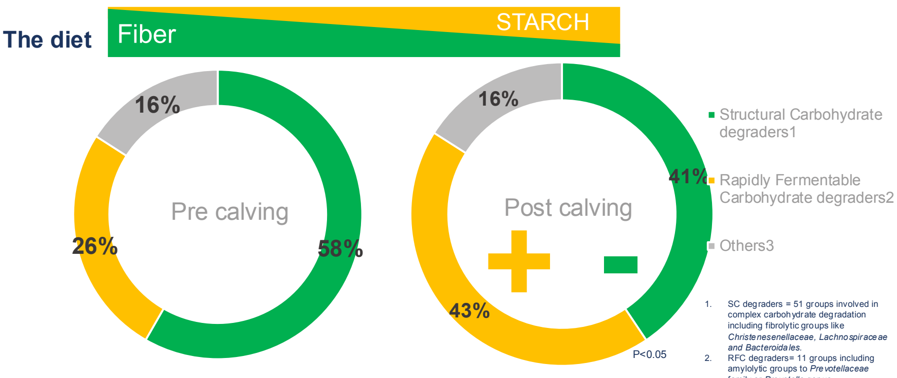
- Higher energy diets lead to a reduction in rumen pH and increased time under the subacute acidosis threshold

(Plaizier, 2008)

LALLEMAND ANIMAL NUTRITION ■ SPECIFIC FOR YOUR SUCCESS 47 LALLEMAND 47

Challenges: diet change lead to microbiota modifications

RUMEN MICROBIOTA BALANCE



1. SC degraders = 51 groups involved in complex carbohydrate degradation including fibrolytic groups like *Christenesenellaceae, Lachnospiraceae and Bacteroidales.*
2. RFC degraders= 11 groups including amylolytic groups to *Prevotellaceae* family or *Prevotella* genus
3. Others : non-identified microbiota

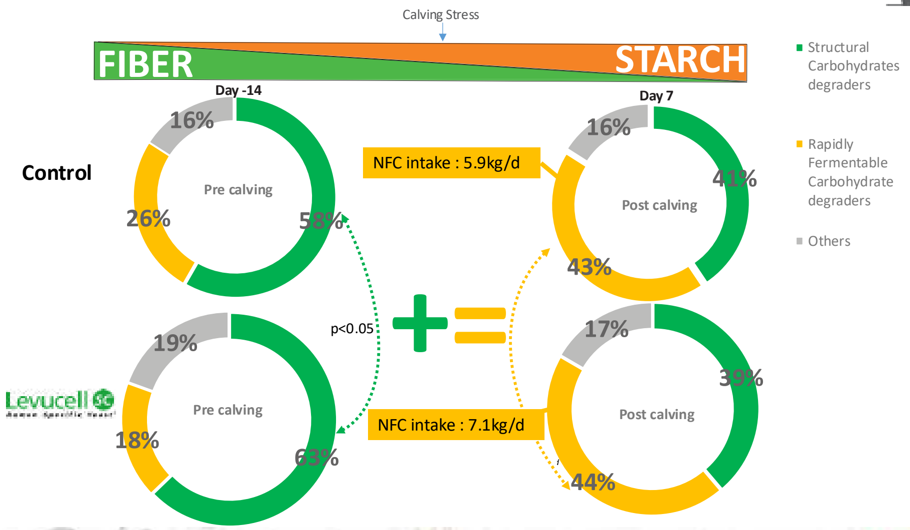
After calving:

- Decrease of structural carbohydrate (including fibrolytic) degraders
- Increase of rapidly fermentable carbohydrate (including amilolytic) degraders

Bach et al, 2019 ; Derakhshani et al, 2017; Zhu et al, 2017; Tajima et al., 2001; Penner & al 2007

LALLEMAND ANIMAL NUTRITION ■ SPECIFIC FOR YOUR SUCCESS 48 LALLEMAND

Solution: LEVUCELL SC fed 1 month before parturition helps maintain a stable rumen microflora



LALLEMAND ANIMAL NUTRITION SPECIFIC FOR YOUR SUCCESS

TS_D.cow_Transition_IRTABLANCA 2019 49
Bach et al, 2019

LALLEMAND

Solution: LEVUCELL SC helps maintain rumen pH to optimum non acidotic levels

The lower the control is (acute level) the higher the effect of **LEVUCELL SC** is

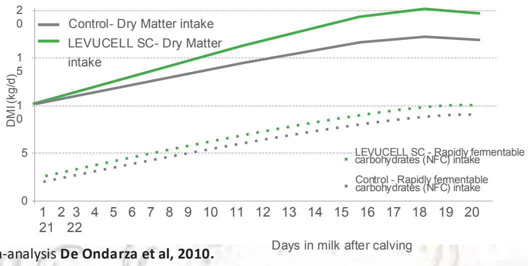
LALLEMAND ANIMAL NUTRITION SPECIFIC FOR YOUR SUCCESS

LALLEMAND

LEVUCELL SC improves post-calving dry matter intake milk

- In this trial performed during early lactation, LEVUCELL SC-fed cows are producing 6 liters of extra milk, that could be partly explained by a higher DMI of 2.5 kg/head/day.

	Control	LEVUCELL SC	P
Dry Matter intake post calving (kg/d)	15.7	18.2	<0.05
NFC intake post calving (kg/d)	*6.7*	*7.6*	
Milk performance (kg/d)	32.7	38.7	<0.05



REMINDER

Meta-analysis[1] shows that LEVUCELL SC is not increasing dry matter intake (DMI) of mid to late lactating dairy cows. During transition, LEVUCELL SC may improve digestive comfort which results in a higher DMI and milk performance.

TS_D.cow_Transition_IRTABLANCA 2019

[1]- Meta-analysis **De Ondarza et al, 2010.**

LEVUCELL SC for calving transition & early lactation

Energy-corrected milk yield* (+ 1,2 kg)

Body weight loss around calving (+0.4 kg/day)

Energy balance (milk yield and weight)=3.71 Mcal/d

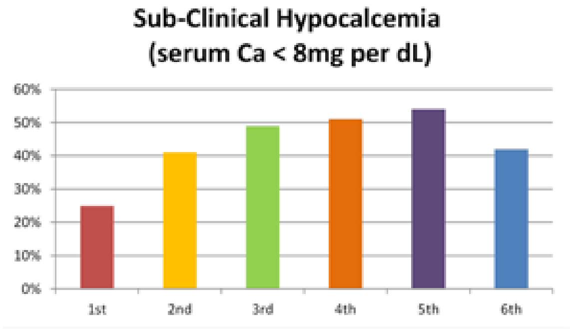
Recommanded dosage: min 10x10⁹ CFU/head/d

Bach A., IRTA, Spain, 2012; Schwarz. F.J. and Ehle T., University of of Weihenstephan, Germany 2002; Temim S., Veterinary college of Alger, Algeria 2009,

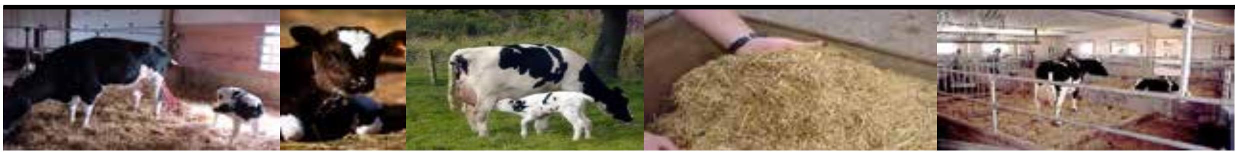
Subclinical Hypocalcemia…

- Subclinical hypocalcemia can be defined as: **low** blood calcium levels (< 8 mg/dl) post-partum

Data suggests that a "blanket" treatment would be best?

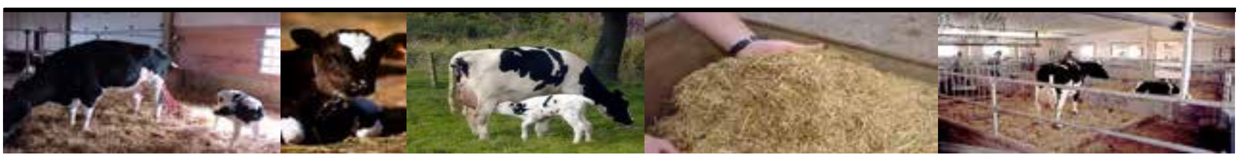


Blood collected from 1,462 cows (480 herds, 21 States) within 48 Hours of calving
Heather Dann, Miner Institute



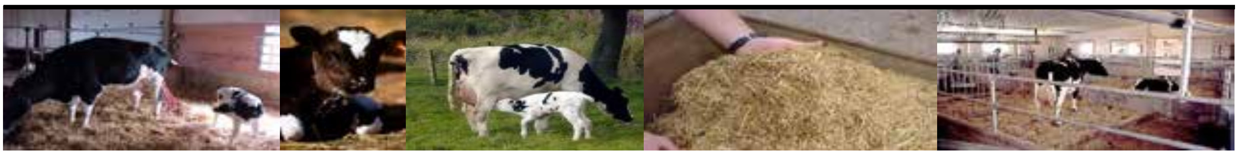
Subclinical Hypocalcemia…

- **Low** blood calcium levels (< 8 mg/dl or <2.0 mmol/l) will have:
  - a negative impact on **DMI** in the fresh period
- Leads to a "cascading" effect on metabolic functions with a subsequent increase in metabolic disorders such as:
  - Activated immune system
  - Increased NEFA and BHBA (subclinical ketosis)
  - Displaced abomasum
  - Retained placenta
  - Metritis.
  - Decreased reproductive performance



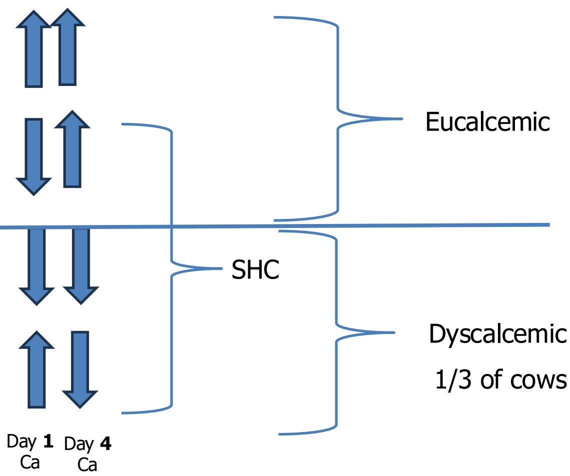
Subclinical Hypocalcemia…

- **Problem:**
  - **How** to define subclinical milk fever
  - **When** to test for subclinical milk fever
    - Suggestion: wait for 2-4 days not 1st 24 hours

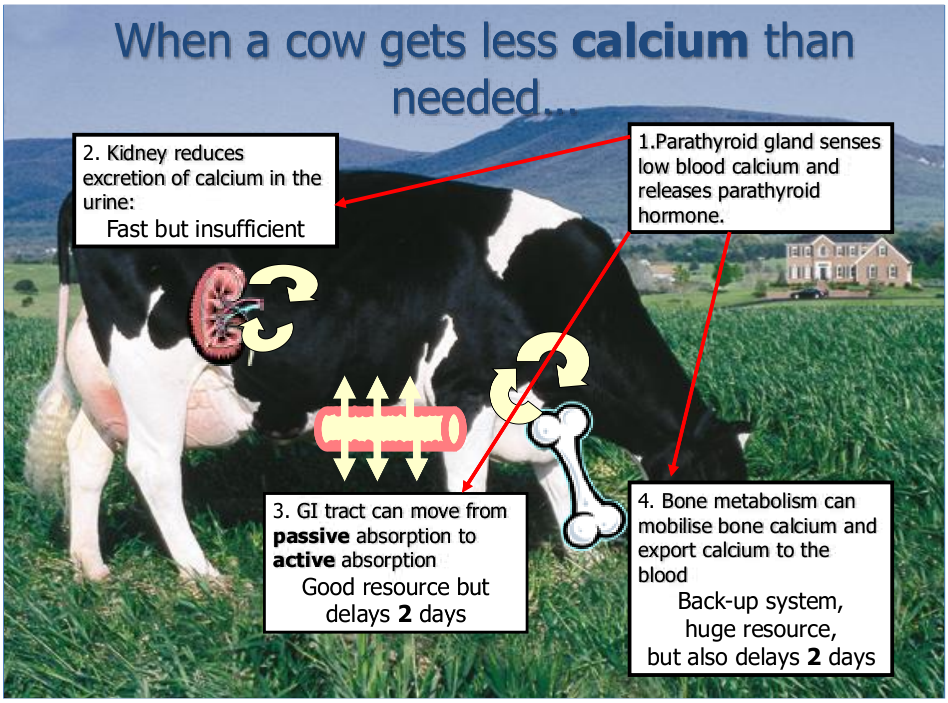


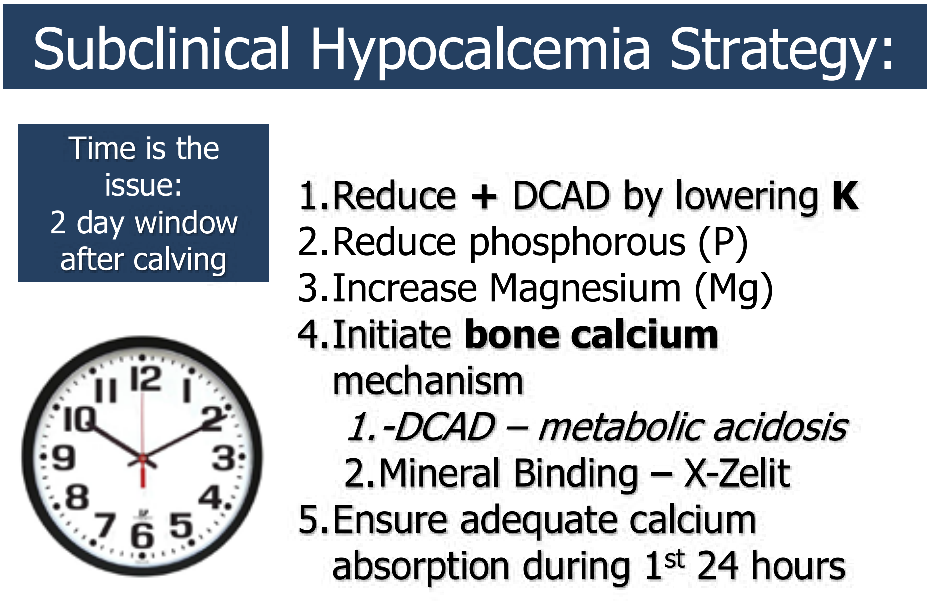
Calcium Dynamic Groups

- Normal
- Transient
- Persistent
- Delayed



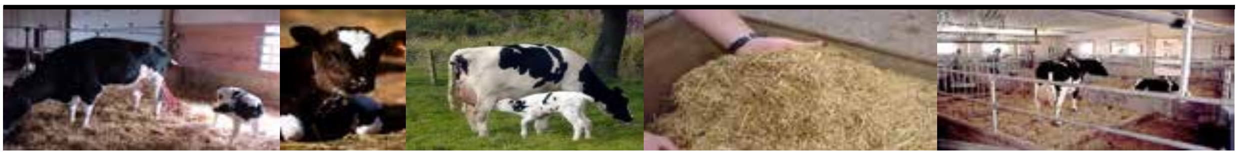
C.R Seely, Cornell, 2023


When a cow gets less **calcium** than needed...
2. Kidney reduces excretion of calcium in the urine:
Fast but insufficient
1.Parathyroid gland senses low blood calcium and releases parathyroid hormone.
3. GI tract can move from **passive** absorption to **active** absorption
Good resource but delays **2** days
4. Bone metabolism can mobilise bone calcium and export calcium to the blood
Back-up system, huge resource, but also delays **2** days


Subclinical Hypocalcemia Strategy:
Time is the issue:
2 day window after calving
1.Reduce **+** DCAD by lowering **K**
2.Reduce phosphorous (P)
3.Increase Magnesium (Mg)
4.Initiate **bone calcium** mechanism
1.-DCAD – metabolic acidosis
2.Mineral Binding – X-Zelit
5.Ensure adequate calcium absorption during 1st 24 hours

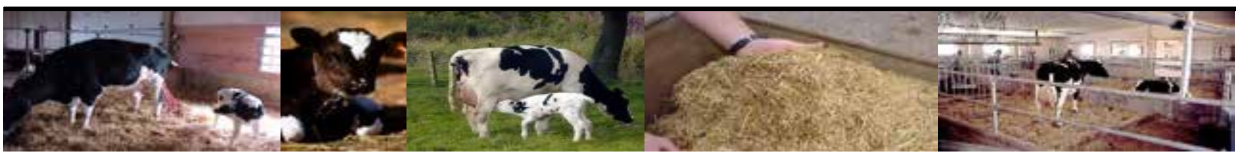
Overall Mineral Strategy to Improve Calcium Balance

- Lower potassium - <1%
  - Advantage – can use less anionic ingredients
- Lower phosphorous - < 0.30%
- Increase magnesium - >0.45%
- Calcium level less important < 0.8%
  - Elevated calcium associated with hypocalcemia

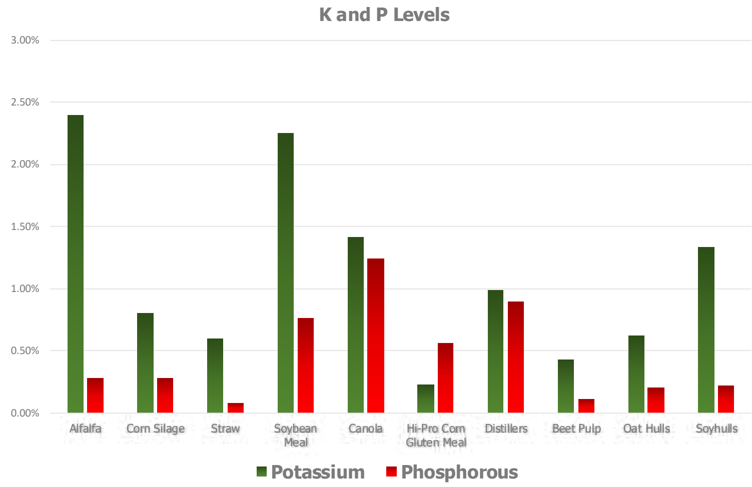


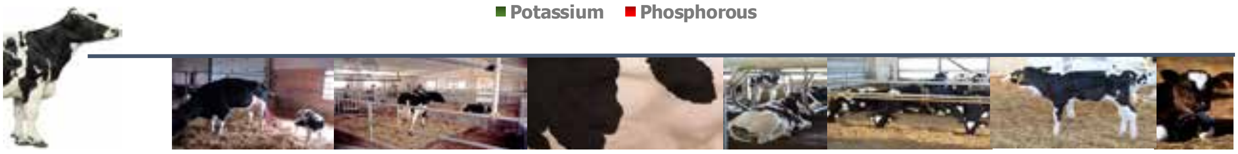
New Mineral Information

- Phosphorous homeostasis
  - Binding phosphorous with Zeolite has shown improvement in blood calcium post partum
  - Elevated phosphorous associated with low blood calcium post partum



Reducing K and P Levels – Ingredients Selection



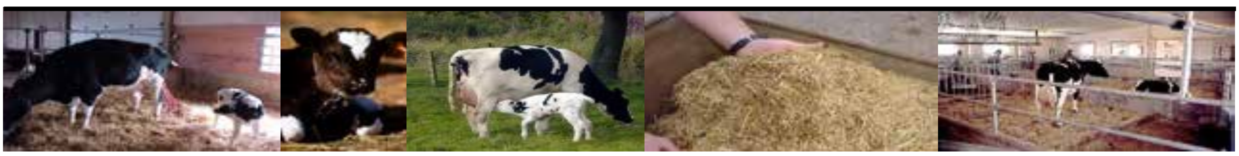


Meta-Analysis of Negative DCAD Diets

Meta-analysis of the effects of prepartum dietary cation-anion difference on performance and health of dairy cows

J. E. P. Santos,[1,2]* I. J. Lean,[3] H. Golder,[3] and E. Block[4]
[1]Department of Animal Sciences, University of Florida, Gainesville 32611 [2]DH Barron Reproductive and Perinatal Biology Research Program, University of Florida, Gainesville 32611 [3]Scibus, Camden, NSW, Australia 2570 [4]Arm & Hammer Animal Nutrition, Princeton, NJ 08543

J. Dairy Sci. 102:1–21 https://doi.org/10.3168/jds.**2018**-14628



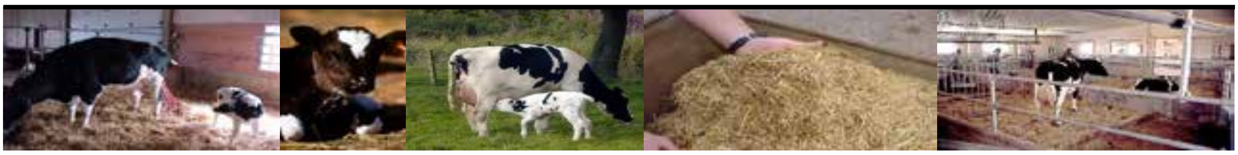
Conclusions from Meta-analysis on DMI and Production

Reducing the DCAD of diets fed to prepartum cows **reduced** DMI prepartum but **increased** postpartum intake.

1. Prepartum DMI decrease is likely a function of metabolic acidosis
2. Postpartum DMI increase a function of increased milk production
3. Reducing the prepartum DCAD from 200 to −100 mEq/kg predicted a **0.7 kd/d (1st calf heifers)** and **0.4 kg/d (mature cows)** reduction in DMI in Holsteins.

Multi-parous (mature) cows produced more milk, FCM, fat, and protein when fed acidogenic diets prepartum,

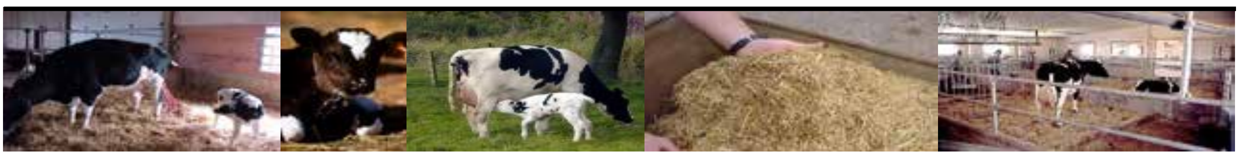
1. but a similar response was **not** observed in 1st Calf Heifers (nulli-parous)



Conclusions from Meta-analysis on Hypocalcemia

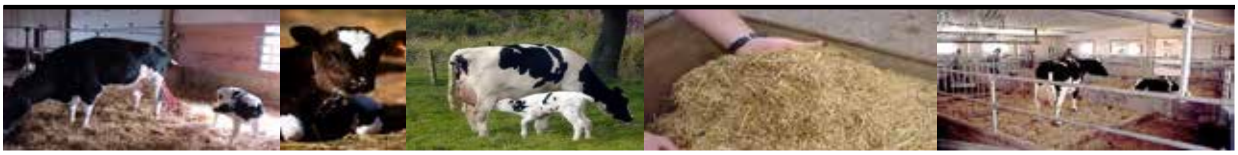
Reducing the DCAD **reduced** the incidence of **milk fever** in **mature** cows and the incidence of retained placenta and metritis in **all** cows but:

1. Subclinical hypocalcemia was not analyzed in any of the meta-analysis because it didn't meet the inclusion criteria of the study



Conclusions from Meta-analysis on Impact of Mineral Balance

- **increasing** dietary **Ca** tended to **increase** the risk of milk fever in parous (heifers) cows, particularly in those fed diets with positive DCAD.
- There appeared to be a positive role for increased **Mg** intake in increased **milk fat** yield and in reducing the risk of **retained placenta**



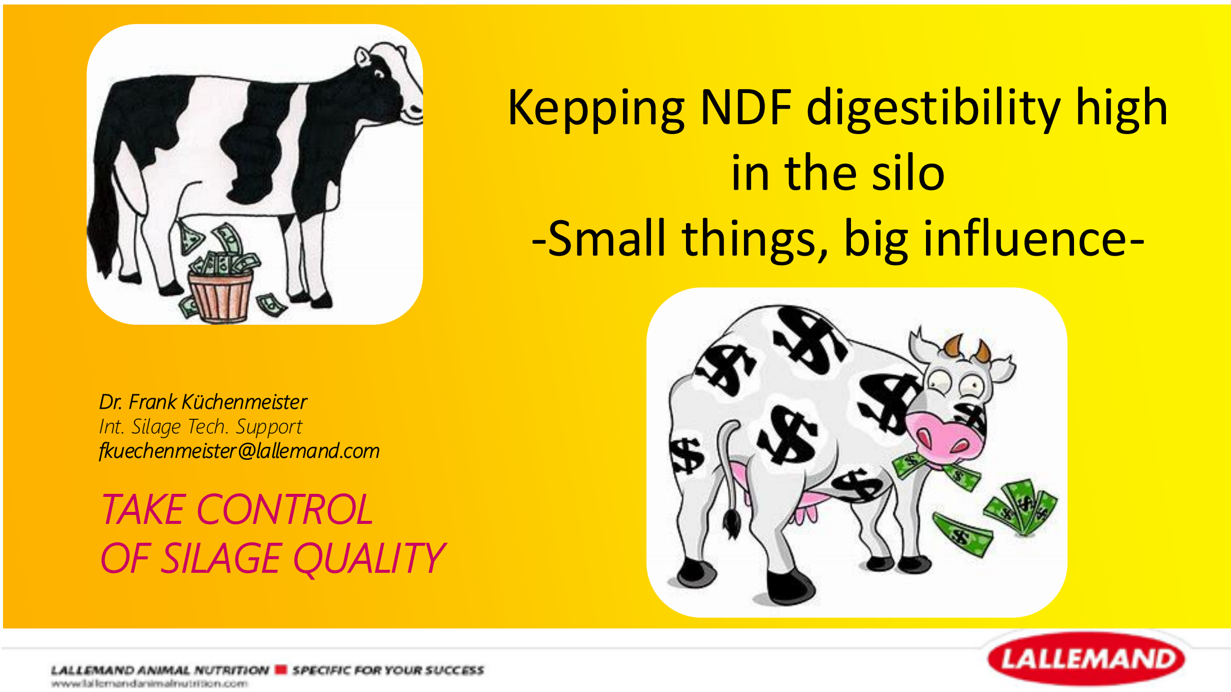
Calcium Bolus Research

1. Little evidence of improvement in milk production or reproduction with animals giving calcium bolus
2. There are subpopulations of cows that react differently to calcium bolus
   - High producing cows in previous lactation – BENEFIT
   - Low producing cows in previous lactation – NEGATIVE
   - Lame cows or high BCS – BENEFIT
   - Heifers – NEGATIVE/NEUTRAL
3. Delayed use of bolus – 1st day or day 2-3?
   - No differences except in 3rd lactation animals!

Future: targeted approached for administration of calcium bolus – both timing and individual animals

FRANK KUECHENMEISTER

Keeping NDF digestibility high in silo


Kepping NDF digestibility high in the silo
-Small things, big influence-
Dr. Frank Küchenmeister
Int. Silage Tech. Support
fkuechenmeister@lallemand.com
TAKE CONTROL
OF SILAGE QUALITY
LALLEMAND ANIMAL NUTRITION
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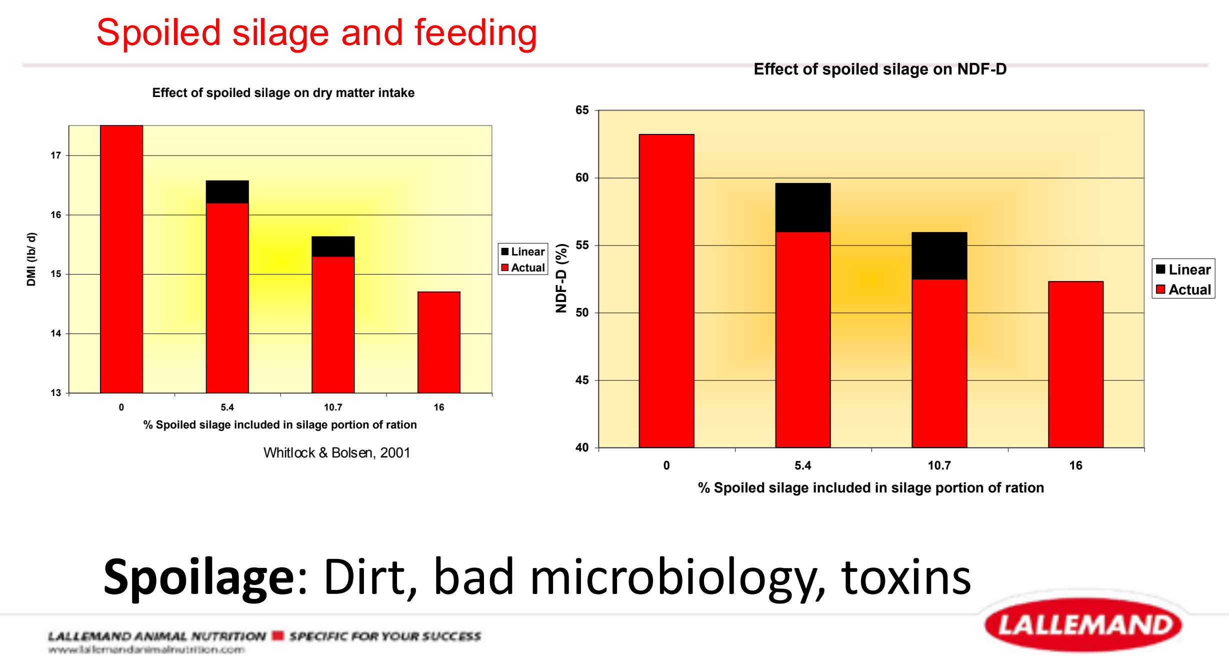
Spoiled silage and feeding
Effect of spoiled silage on dry matter intake
DMI (lb/ d)
17
16
15
14
13
0
5.4
10.7
16
% Spoiled silage included in silage portion of ration
Linear
Actual
Whitlock & Bolsen, 2001
Effect of spoiled silage on NDF-D
NDF-D (%)
65
60
55
50
45
40
0
5.4
10.7
16
% Spoiled silage included in silage portion of ration
Linear
Actual
Spoilage: Dirt, bad microbiology, toxins
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Placing the silo

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Silo structure

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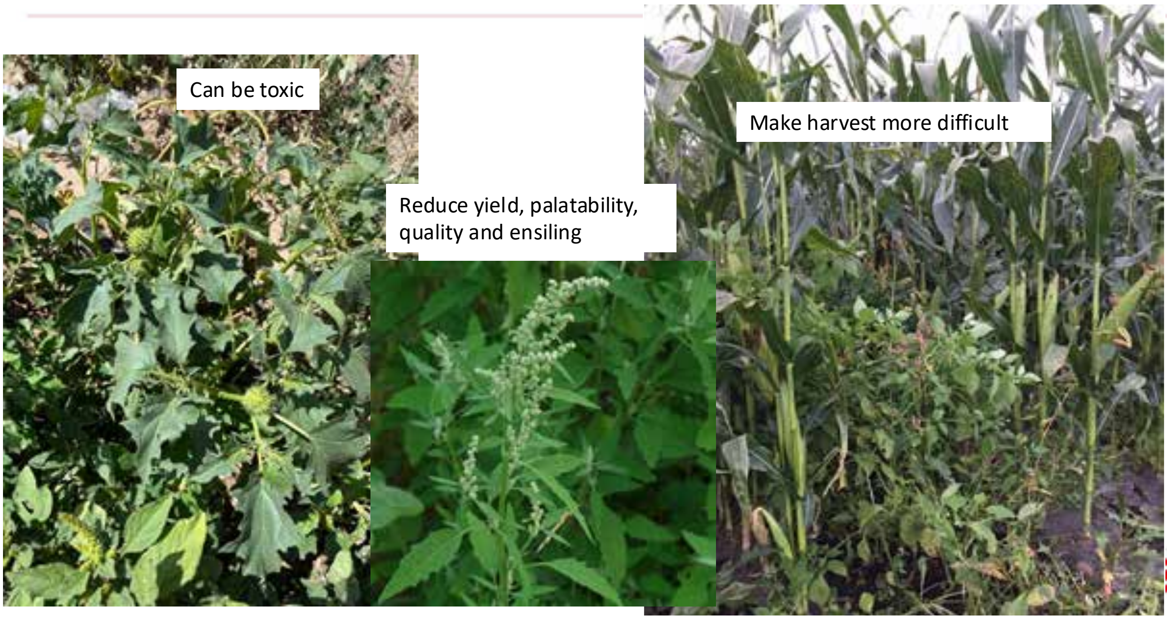
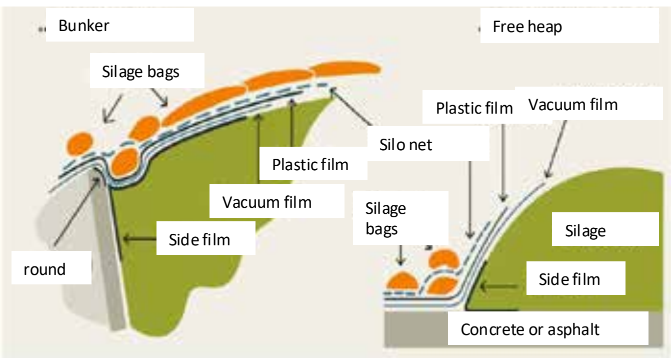
Weeds



Sealing



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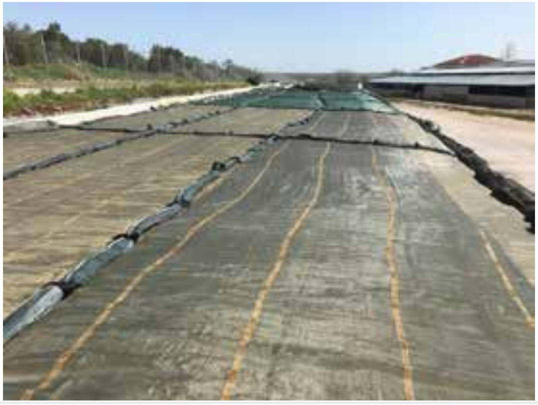
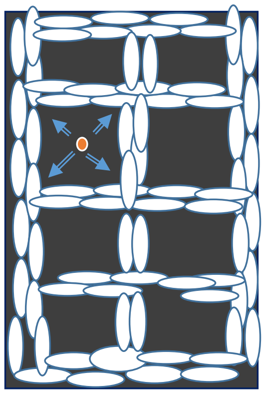
Covering

- Optimal: double layer of sand bags
- Depending on bunker size: horizontal and vertical lines





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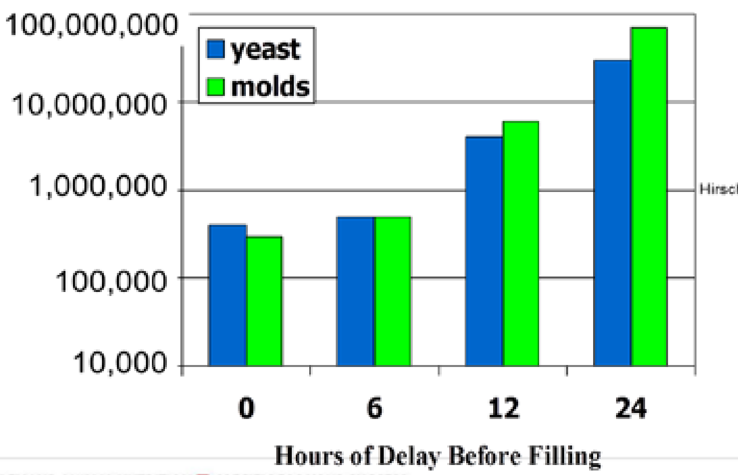
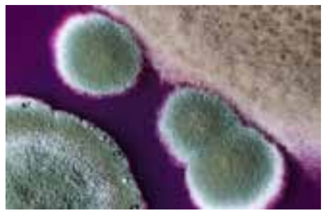
Long oxygen influence

Delayed filling influences the level of contaminations



Hirsch and Kung, 1999



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Feed out

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De-covering for feed out

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Work clean!

That is not for cooking........

Avoid soil contamination

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Very good ensiling conditions

Fermentation characteristics	Negative Control			Lalsil Combo HC		
	mean	st.dev.	≠	mean	st.dev.	≠
DM at desiling (g/kg FM)	336.59	9.66	a	359.62	0.42	b
Ammonia (g/kg DM)	2.881	0.104	a	2.054	0.028	b
Ammonia nitrogen / total nitrogen	7.88	1.12	a	5.83	0.12	b
pH	4.73	0.16	a	4.07	0.01	b
Lactic acid (g/kg DM)	41.42	3.30	a	88.22	5.11	b
Acetic acid (g/kg DM)	5.25	1.76	a	25.18	1.96	b
Butyric acid (g/kg DM)	bdl[a]			bdl[a]		
Propionic acid (g/kg DM)	bdl[a]			bdl[a]		
1,2-propanediol (g/kg DM)	0.00	0.00	a	2.67	1.87	b
Ethanol (g/kg DM)	46.02	4.47	a	17.32	5.60	b

Demey et al. 2016

- Control has good ammonia values, inoculant makes it even better
- pH in control a little high
- Alcohol in control a huge problem

Nutritional characteristics	Negative Control			Lalsil Combo HC		
	mean	st.dev.	≠	mean	st.dev.	≠
NEL (MJ/kg DM)	6.04	0.07	a	6.33	0.05	b
dOM (%)	86.32	0.84	a	87.60	1.06	a

Very good ensiling conditions

- There are always conditions a farmer can‘t influence
- E.g. too low amount of natural lactic acid bacteria

Table 1. Characteristics of fresh forage

	g/kg FM
Dry matter (g/kg FM)	351.8
	g/ kg DM
Crude protein	213.2
Crude Ash	84.1
Crude Fat	22.1
NDF	460.0
ADF	199.8
WSC	169.8
NEL (MJ/kg DM)	6.2
dOM (%)	88.4
Yeast	6.6e+05
Moulds	5.0e+04
LAB	6.5e+03

Demey et al. 2016

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Fermentation – Losses?

- Grass Harvested 10^{th} of May.
- High DM average of 54.8%
  - Average protein 21.2%
  - High sugar levels 11.5 %
  - 46.6% aNDFo
  - 6.9 MJ NEL
- **Treatments.**

Control and treated

- 3 opening times (16, 57, 90 days)
- 18 bales total

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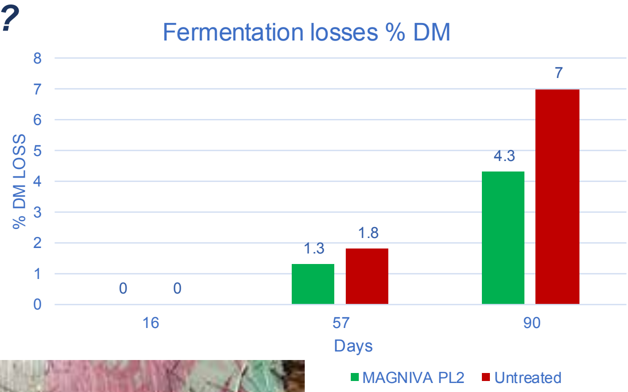
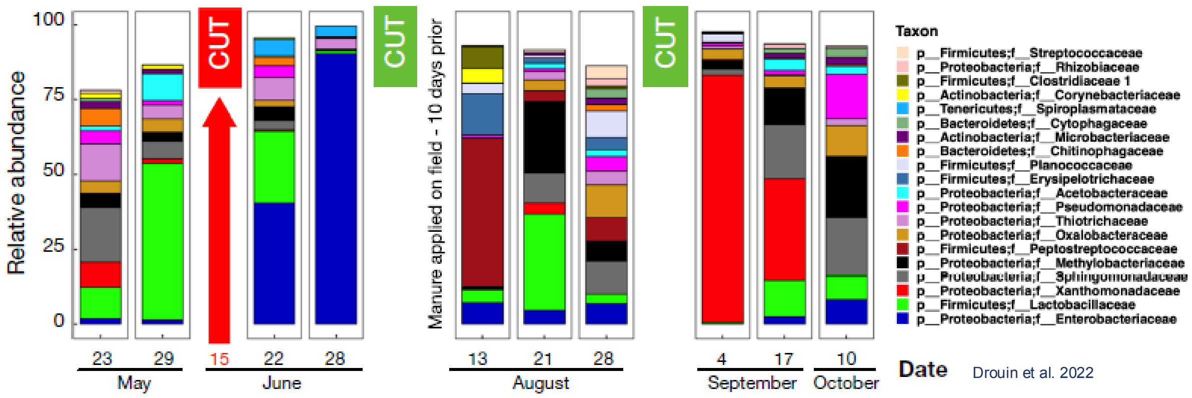
Fermentation – Losses?

- High value silage
- 2.7 % losses → silage price
- Inoculant price



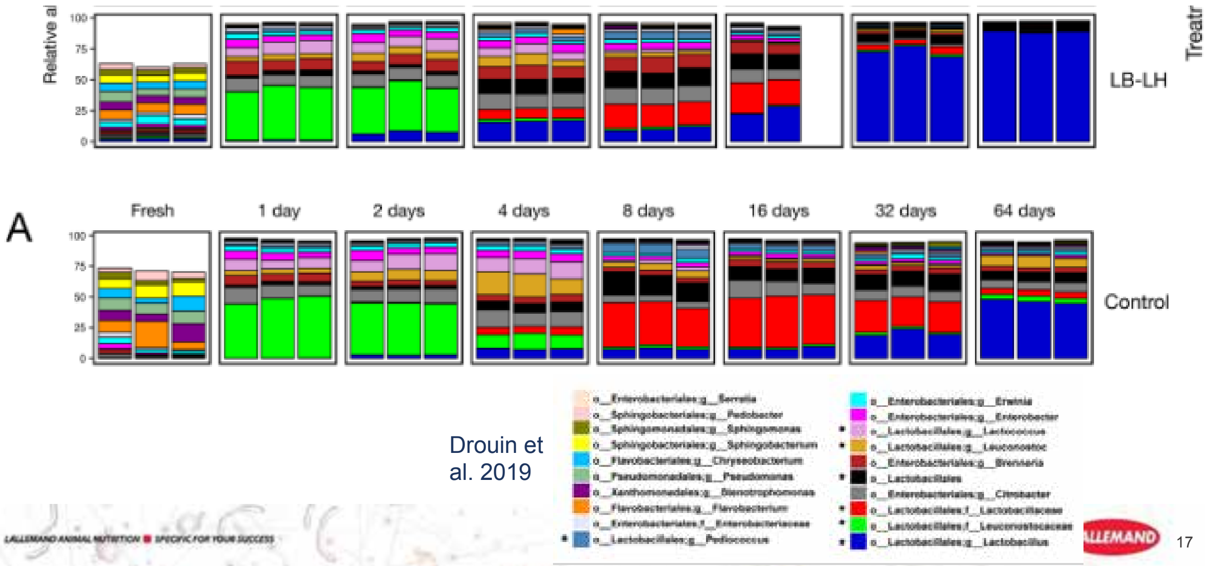
Natural bacteria on plants - Alfalfa

16S Amplicons - epiphytic microflora

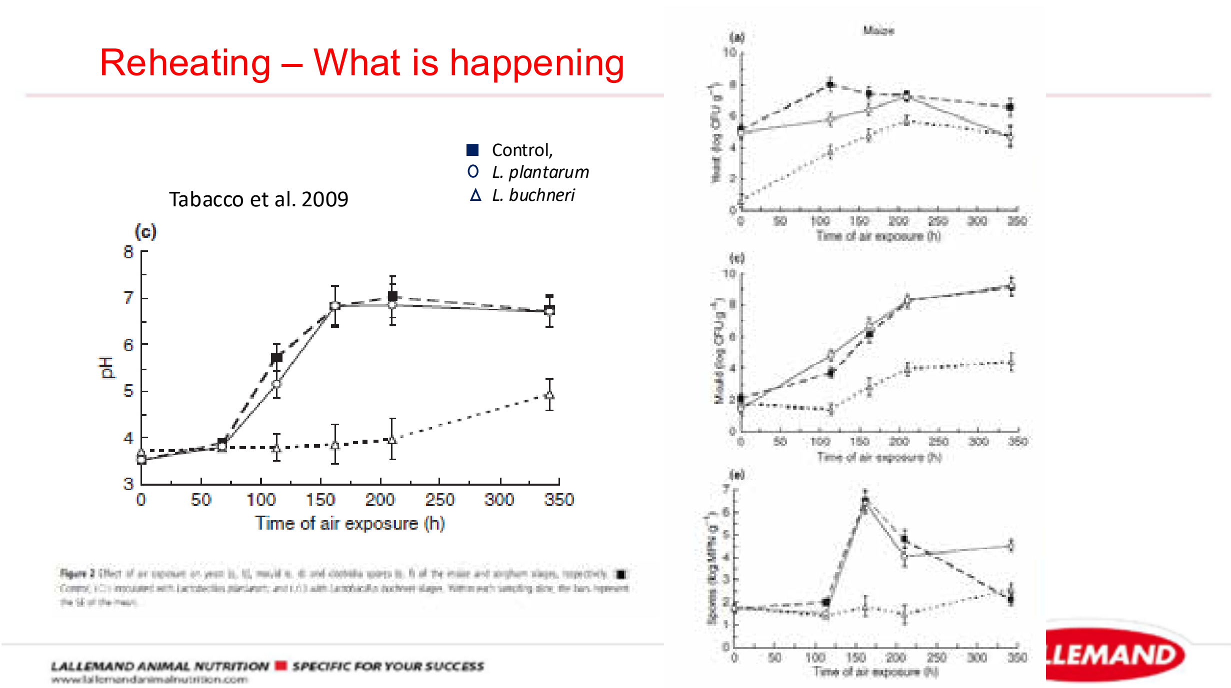


Drouin et al. 2022

Fermentation maize – Clean silage



Reheating at feed out


Reheating – What is happening
Tabacco et al. 2009
Control,
L. plantarum
L. buchneri
(c)
pH
Time of air exposure (h)
Maize
(a)
Yeast (log CFU g⁻¹)
Time of air exposure (h)
(c)
Mould (log CFU g⁻¹)
Time of air exposure (h)
(e)
Spores (log MPN g⁻¹)
Time of air exposure (h)
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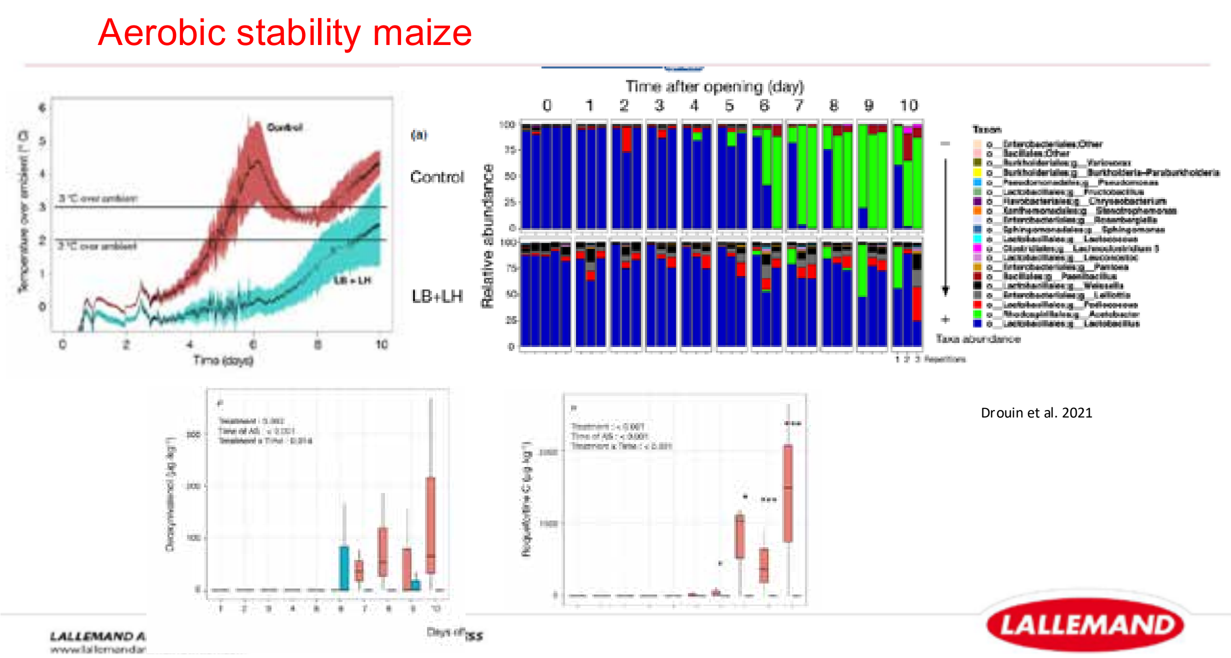
Aerobic stability maize
Control
LB + LH
3 °C over ambient
2 °C over ambient
Time (days)
(a)
Control
LB+LH
Relative abundance
Time after opening (day)
Taxa abundance
Drouin et al. 2021
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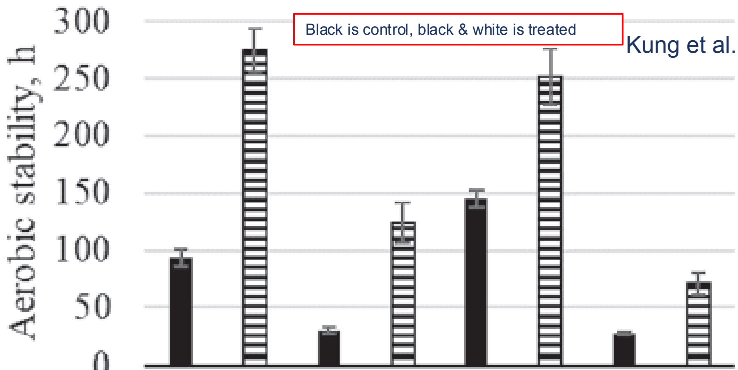
Silage inoculant and management



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What about dry forages?

Same as silage:

- work clean
- no contaminations
- Check microbiology

High quality optimal harvested

Table 1: Characteristics of wheat and barley straw at field and different storage time

	Field		Day 1		Day 30		Day 100	
Crop	Wheat	Barley	Wheat	Barley	Wheat	Barley	Wheat	Barley
Dry matter g/kg	91.4	88.1	89.7	89.6	88.0	87.2	84.0	83.9
Water activity	-	-	0.38	0.22	0.58	0.47	0.72	0.66
Yeast CFU/g	8.5×10^5	8.5×10^5	2×10^6	5×10^5	5×10^5	2.1×10^5	4×10^4	8×10^5
Bacteria CFU/g	1.8×10^7	3.7×10^6	4×10^7	6.2×10^6	1×10^7	$4.4\ 10^6$	6.7×10^6	4.6×10^6

Küchenmeister & Rahn 2023

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Summary

- Contaminations can ruin everything
- Management is very important for NDFd
  - Field/agronomy (crops, harvest etc.)
  - Preparation, planning, making
  - Control microbiology in forages by an inoculant

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AURÉLIEN PIRON

Rumen fermentation, acidosis and leaky gut

Rumen fermentation, acidosis and leaky gut

Aurélien PIRON

Rumen fermentation acidosis and leaky gut

Rumen health and SARA

High concentrate diet

↓

VFAs

Lactate

Decrease in rumen pH

↓

SARA

Profound **changes in microbiota (richness, diversity, structure and activities)**
Reduction in fiber digestion
Selection of **acid-resistant species**

Changes in rumen walls integrity

↑

Inflammatory response, increase in energy demand

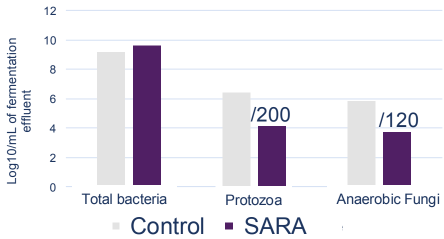
↑

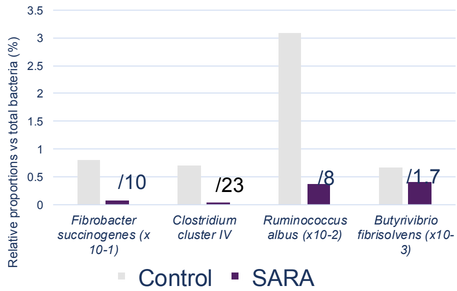
Increased risk of secondary diseases (bloat, diarrhea, laminitis, mastitis, etc.)

Fernando et al. 2010 AEM; Silberberg et al. Animal 2013; Pourazad et al. Animal 2016; Plaizier et al. 2017 Microb Ecol

Rumen health and SARA : fibrolytic populations

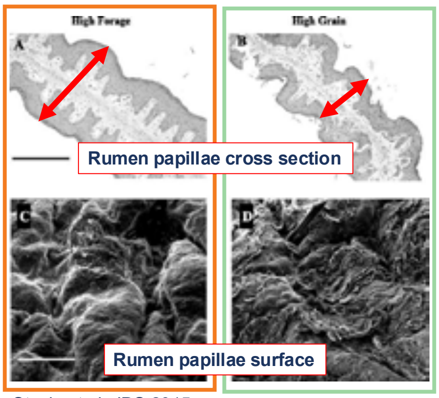
- Low pH reduces fibrolytic populations of the rumen microbiota
- IN VITRO (RUSITEC) model simulating rumen fermentations





Mickdam et al. 2016

Rumen health and SARA : rumen wall



Steele et al. JDS 2015

Acid load

- Decrease in rumen epithelium thickness
- Increase in lesions, papillae erosion
- Tight junction genes down regulated

→Leaky ruminal epithelium

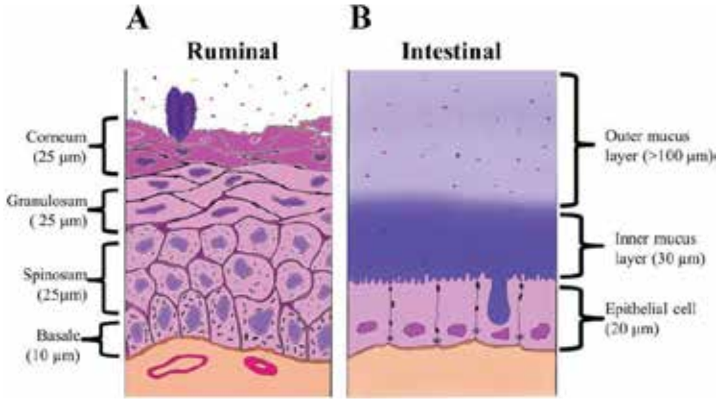
(Liu et al. AJPRegu 2013; Meissner et al. JDS 2017)

Translocation of toxins, inflammatory molecules and even bacteria

Potential impact on inflammation status, laminitis, liver abcess and also on behaviour.

Gastrointestinal Epithelium => Gut Barrier

- Reticulo-rumen and omasum
  - Stratified squamous epithelium
    - 4 distinct strata
    - Multiple layers (maybe > 10 layers thick)
      - 85 um separating "outside" from self
    - No mucus
- Rest of GIT
  - Columnar epithelium
    - Single layer epithelium
      - 20 um separating "outside" from self
    - Mucus lined



Steele et al., 2016 JDS

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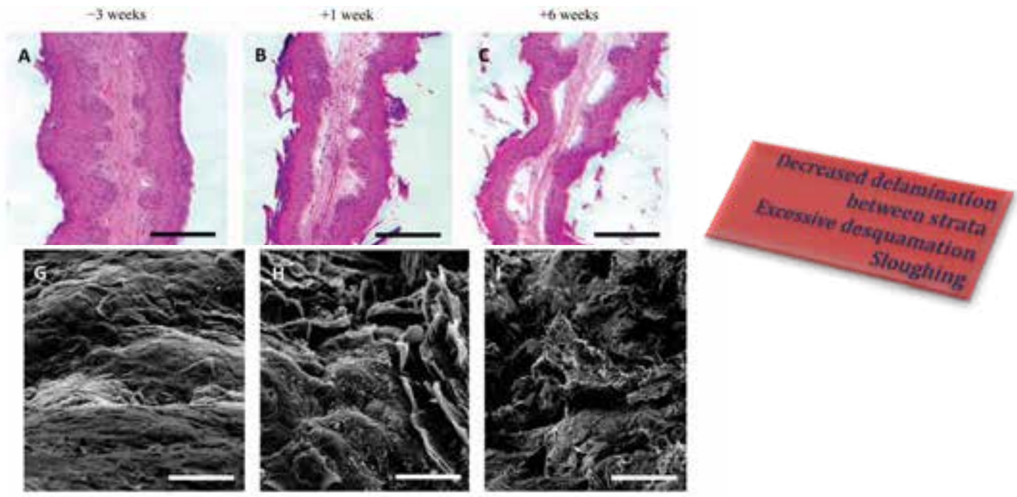
Rumen health and SARA : transition



STEELE ET AL. 2015

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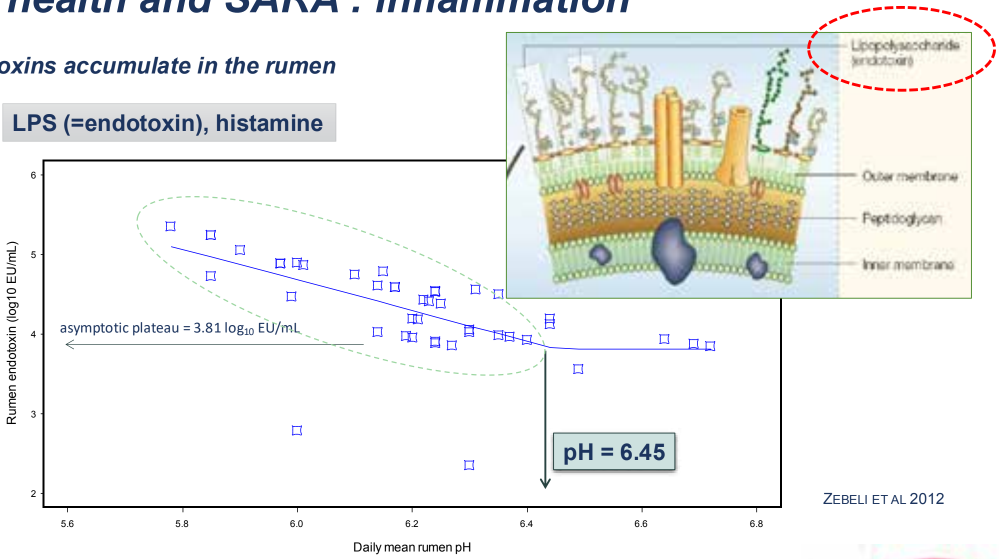
Rumen health and SARA : inflammation

At low pH, toxins accumulate in the rumen

LPS (=endotoxin), histamine



ZEBELI ET AL 2012

Rumen health and SARA… and lower gut

GOATS	0 % grain	60% grain
pH Rumen	6.4	**5.5**
pH Colon	8.5	**7.0**
SCFA Rumen (µmol/ml)	113	129
SCFA Colon (µmol/g)	20	**78**

- Increase in *Clostridium* cluster I proportion (*C. perfringens*)
- Increase in LPS concentration in the colon

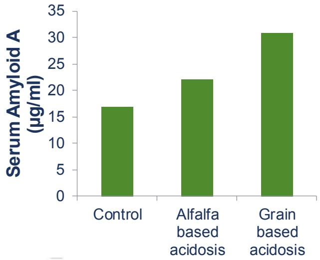
(Metzler-Zebeli et al 2013)

« Leaky » gut

Rumen health and SARA : inflammation

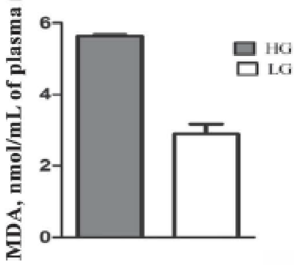
- Higher acute phase protein

Li et al, CJAS 2012



- Increased oxidative stress

Abaker et al, JDS 2017; Golder et al, JDS2013



LEVUCELL SC for calving transition & early lactation

Energy-corrected milk yield* (+ 1,2 kg)

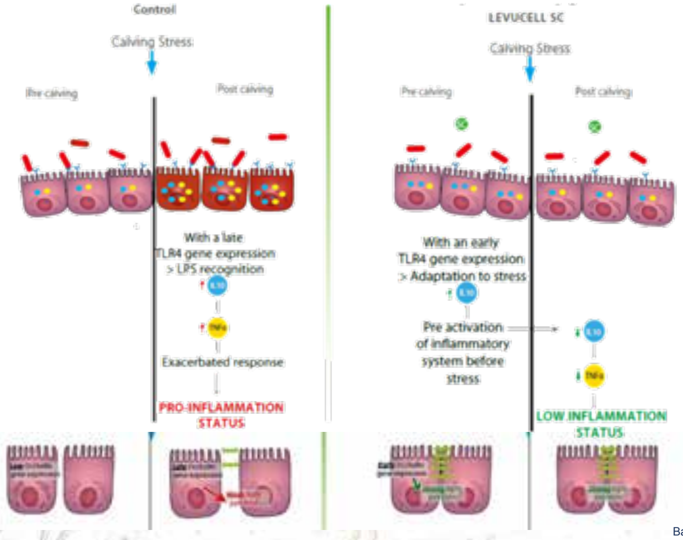
Body weight loss around calving (+0.4 kg/day)

Energy balance (milk yield and weight)=3.71 Mcal/d

Recommanded dosage: min 10x10⁹ CFU/head/d

Bach A., IRTA, Spain, 2012; Schwarz. F.J. and Ehle T., University of of Weihenstephan, Germany 2002; Temim S., Veterinary college of Alger, Algeria 2009,

Solution: LEVUCELL SC prepares the rumen to face the challenge



Bach et al, Journal of Dairy Science 2018 and 2019

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Rumen health and SARA : heat stress

- Under high THI scores, there is an increase of rumen and rectal temperature; respiratory rate may indicate an altered microbial fermentation
- The rumen temperature remains high and takes time to recover after a heat stress period

	Thermal neutral	Heat stress	p
Respiration rate (breaths/min)	28	105	0.001
Rumen pH	6.55	6.43	0.003
Rectal temperature (°C)	38.6	39.0	0.001

J. Dairy Sci. 98:4646–4658
http://dx.doi.org/10.3168/jds.2014-8819
© American Dairy Science Association®, 2015.

Using wireless rumen sensors for evaluating the effects of diet and ambient temperature in nonlactating dairy goats

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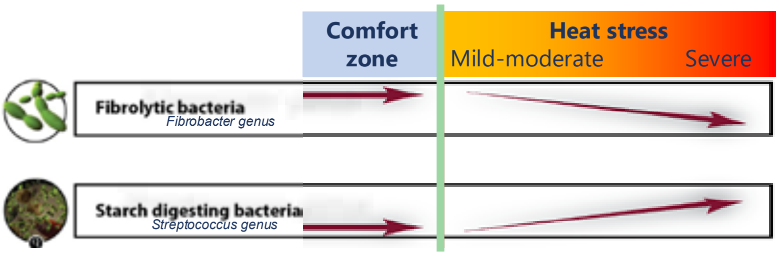
Rumen health and SARA : heat stress

- The ruminant physiological responses to elevated THI, or heat stress, will greatly increase her risk of SARA.
- A shift of microbiota will affect rumen and feed efficiency.



(Tajima et al., 2007; Uyeno et al., 2010)

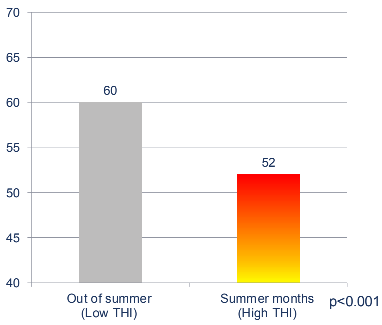
Rumen health and SARA : heat stress

- **For 10 points of difference of THI: decrease rumination time by 1 hour per day**

Transponders for activity and rumination

Mathew Haan, Penn State Extension published 02/11/2016

Ruminating activity
% of cows lying cow, which are ruminating

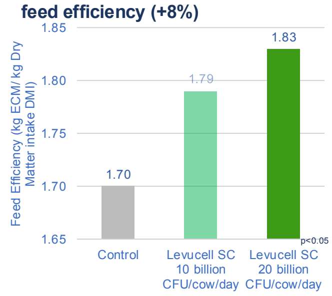


Lallemand internal database/ 556 audits

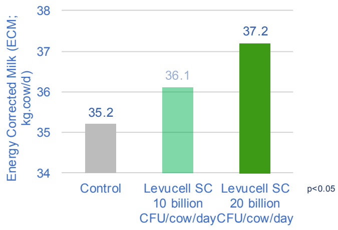
LEVUCELL SC improves feed efficiency of dairy cows

- **Ration:** Corn silage (41.4%), alfalfa hay (10.2%), brewer's grains wet (5.2%) and grain mix (43.2%)
- **Temperature-Humidity Index (THI): 60 days at THI 80** (severe Heat stress; e.g.30°C; 65%HR)

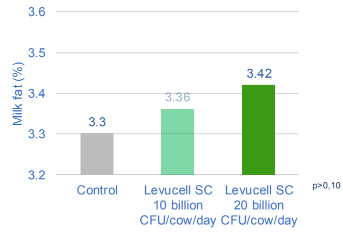
- **LEVUCELL SC significantly increases feed efficiency (+8%)**



- **LEVUCELL SC significantly increases milk yield (+2.0kg/cow/day)**



- **with LEVUCELL SC, despite milk production increase, milk fat is numerically improved**



LSC_TS_DairyHeatStress_Florida_2020

Perdomo et al, 2020

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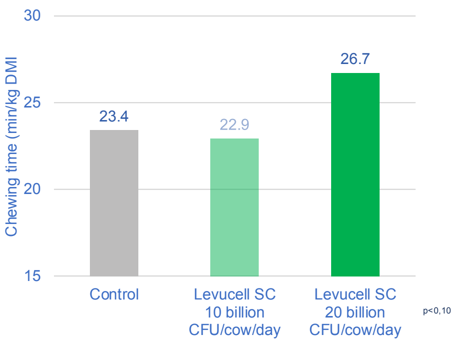
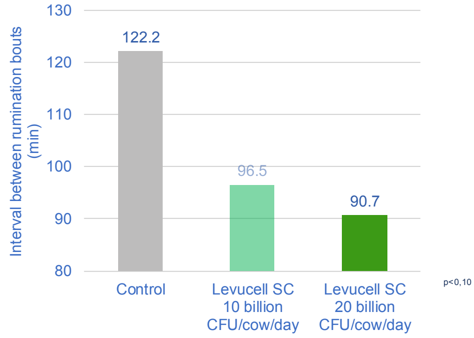
LEVUCELL SC improves eating behavior

… at 20 billion CFU = the recommended dosage

- **Increased chewing activity at the recommended dosage**



- **Improved rumination behavior with reduced time between rumination bouts**



Perdomo et al, 2020

LSC_TS_DairyHeatStress_Florida_2020

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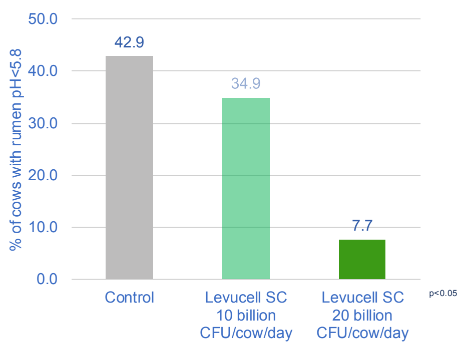
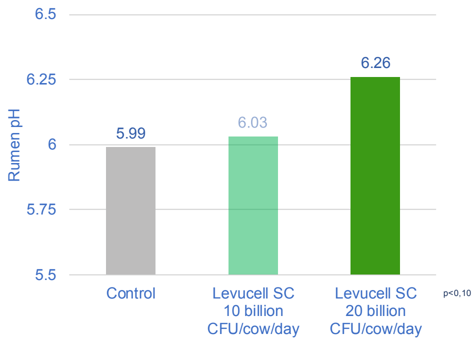
LEVUCELL SC improves rumen efficiency

- **Reduced % of cows with rumen pH<5.8**



Perdomo et al, 2020

- **Increased rumen pH**



LSC_TS_DairyHeatStress_Florida_2020

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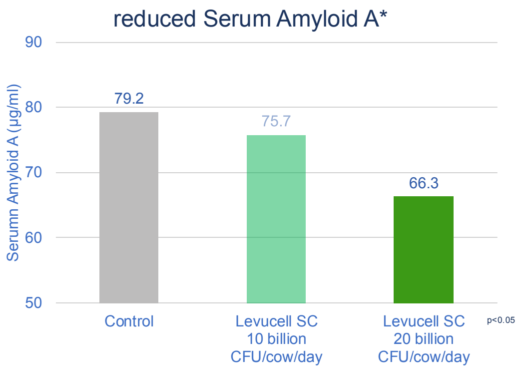
LEVUCELL SC reduces inflammation risks



Perdomo et al, 2020

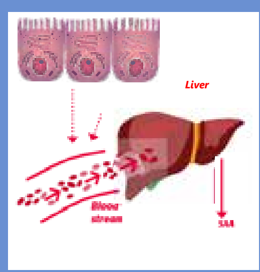
To KNOW MORE on advanced mechanisms of inflammation

Rumen epithelium

1) LEVUCELL SC helps lower inflammation of the rumen wall (Bach *et al.*, 2018)

2) LEVUCELL SC helps reduce the transfer of inflammation messengers (cytokines) into the blood

3) LEVUCELL SC reduces inflammatory compounds like amyloid A, which is excreted by the liver



*Serum amyloid A (SAA) is secreted by the liver: Its high level demonstrates an episode of inflammation

LSC_TS_DairyHeatStress_Florida_2020

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What LEVUCELL SC is doing in the rumen when fed from 1 month before parturition?

- **Ensures a safe diet transition**
- **Allows increase in intake of highly fermentable CHO**
- **Stabilizes rumen microbiota and improves rumen pH**
- **Improves rumen epithelium integrity**
- **Reduces rumen epithelium inflammation**
- **Supports ruminal function**

CONTACT

If you have any questions or issues regarding the meeting,
please ask your Lallemand representative or send us a message at

ruminant@lallemand.com

During the event, you will receive notifications on WhatsApp, about organization.

Joe Agnatios : +33 6 72 68 03 02

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