Four-State Dairy Nutrition and Management Conference

June 7 & 8, 2023

Cooperative Extension for:
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Volume 32

2023

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Four State Conference Plenary

U.S. Dairy Industry: Past, Current, and Future

Normand St-Pierre, Ph.D.
Professor Emeritus
The Ohio State University

U.S. Dairy Industry:
Past, Current, and Future

Normand St-Pierre, Ph.D.
Professor Emeritus, The Ohio State University

1

Outline

- Where are we?
- Understanding (sort of) milk pricing.
- Issues with FMMO
- Market update

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Trivia

- In how many states is dairy ranking #1 in share of total farm receipts?
  - 9
  - CA, WI, ID, NY, MI, PA, NM, AZ, VT
- In how many states is dairy ranking #2 in share of total farm receipts?
  - 4
  - TX, CO, UT, NH

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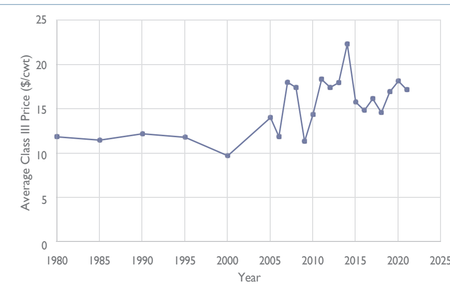
Class III Milk Price



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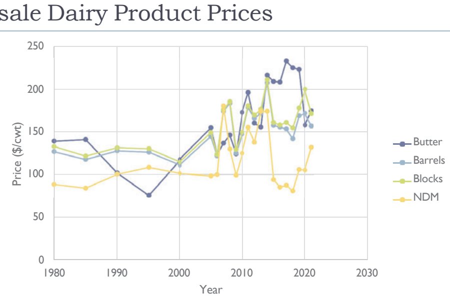
Wholesale Dairy Product Prices



2010-2021 averages: Butter $194.3 Barrels $164.8 Blocks $172.6 NDM $121.5

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Table 23: Federal Market Order Statistics by Market, 2021

Federal Order	Order Number	Producer Deliveries	Utilization Class I	Class II	Class III	Class IV	Uniform Price at 3.5% bf
		(Million #)	(Percent)				
Northeast (Boston)	1	27,045	30%	25%	26%	19%	$17.88
Appalachian (Charlotte)	5	5,289	71%	13%	5%	11%	$19.31
Florida (Tampa)	6	2,444	82%	15%	1%	3%	$21.28
Southeast (Atlanta)	7	4,581	68%	20%	4%	8%	$19.47
Upper Midwest (Chicago)	30	17,940	14%	10%	67%	9%	$16.98
Central (Kansas City)	32	12,992	34%	13%	26%	28%	$16.66
Mideast (Cleveland)	33	18,606	35%	21%	30%	15%	$17.08
California (Los Angeles)	51	23,803	20%	6%	15%	59%	$16.56
Pacific Northwest (Seattle)	124	7,387	22%	6%	32%	40%	$16.67
Southwest (Dallas)	126	12,286	32%	12%	19%	37%	$17.22
Arizona (Phoenix)	131	4,461	31%	11%	18%	41%	$17.24
All Markets Average or Total		**136,836**	**31%**	**15%**	**27%**	**27%**	**$17.33**

Source: USDA / AMS

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Federal Milk Marketing Order Program

- Created in the mid 1930s
  - Two millions+ dairy producers
  - Hundreds cooperatives
  - 100+ orders (milk sheds)
  - All milk "marketed" through CO-OPs
  - Predominant form of milk consumption: fluid

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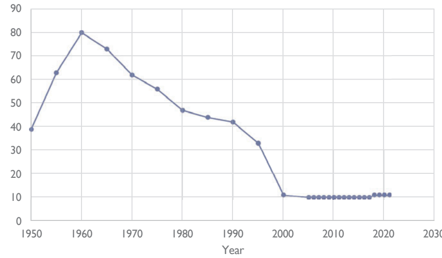
FMMOs: Number of Markets



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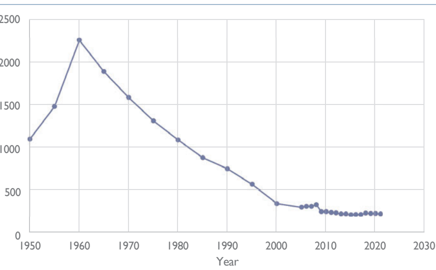
FMMOs: Number of Handlers



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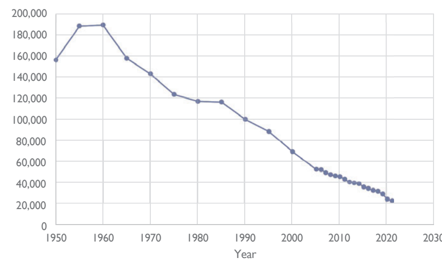
FMMOs: Number of Milk Producers



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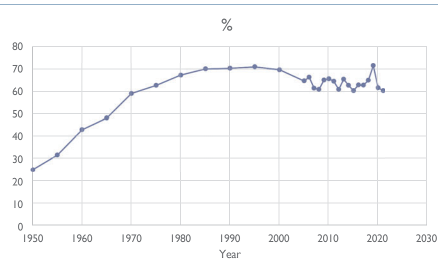
FMMOs: % of U.S. Production



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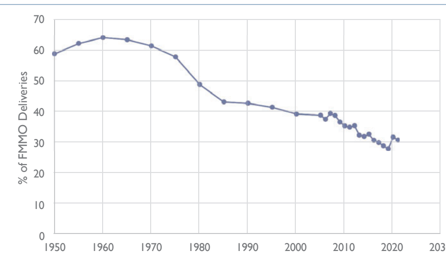
FMMOs: % Class I Utilization



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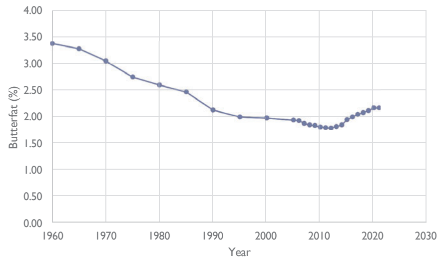
FMMOs: All Fluid Beverages Butterfat Test



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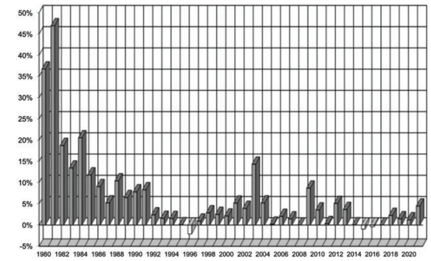
Dairy's Share of Total CCC Outlays (1980 to 2021)



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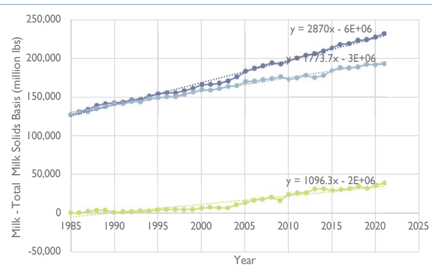
Total Production, Domestic Disappearance and Exports



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Federal Milk Marketing Order Program

Created in the mid 1930s

- Two millions+ dairy producers
- Hundreds cooperatives
- 100+ orders (milk sheds)
- All milk "marketed" through CO-OPs
- Predominant form of milk consumption: fluid

Goal: Orderly marketing of milk

- Dairy producers share equally the premiums paid for milk sold as fluid milk

Some "fixings" over time

- 2000 Farm Bill:
  - End-products pricing
  - Component-based pricing in most FMMOs
- Elimination of price support program

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What determines component prices?

- Answer:

Wholesale prices of:

- Butter
- Cheese blocks
- Cheese barrels
- Dry whey
- Nonfat Dry Milk

Known as *End-Products* Pricing

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From Components to Class Prices?

Class IV	Class IV (Butter-Powder) • Class IV ($/cwt) = (8.685 x NFS$) + (3.5 x Fat$)
Class III	Class III (Cheese) • Class III ($/cwt) = (2.99 x Prot$) + (5.69 x OS$) + (3.5 x Fat$)
Class II	Class II (Soft Products) • Class II ($/cwt) = (8.685 x NFS$) + (3.5 x Fat$) + $0.68
Class I	Class I (Fluid Milk) • Class I ($/cwt) = (0.965 x Skim$) + (3.5 x Fat$) + Class I Differential

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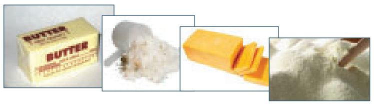
The short story…

- Unregulated, wholesale price of 5 dairy products determine prices of 4 milk components.
- Component prices determine prices of 4 classes of milk.
- Location of handler determines the Class I differential.
- Blend price is the weighed average of the 4 Classes based on their utilization in a Federal Order.



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Must know…

In component-based FMMOs, all producers' milk (regardless of what it was used for) is paid on the value of the components (fat + protein + other solids) plus a Producer Price Differential.

In component-based FMMOs, handlers (i.e., processors) pay milk used based on the value of the fractions in the Class of milk handled.

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Must know…

- In component-based FMMOs, all producers' milk (regardless of what it was used for) is paid on the value of the components (fat + protein + other solids) plus a Producer Price Differential.
- In component-based FMMOs, handlers (i.e., processors) pay based on the value of the fractions in the Class of milk handled.
  - Class I: Butterfat + Skim
  - Class II: Butterfat + Nonfat Solids
  - Class III: Butterfat + Protein + Other Solids
  - Class IV: Butterfat + Nonfat Solids

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Must know…

- Class I
  - Skim milk: Advanced Pricing
  - Butterfat: Advanced Pricing
- Class II
  - Butterfat: Back Pricing
  - Nonfat solids: Advanced Pricing
- Class III
  - Butterfat: Back Pricing
  - Protein: Back Pricing } Class III Nonfat Solids
  - Other Solids: Back Pricing }
- Class IV
  - Butterfat: Back Pricing
  - Nonfat solids: Back Pricing

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FMMO 1 – July 2020

Class I[1]		
Skim milk: Advanced Pricing	$ 13.87/cwt	
Butterfat: Advanced Pricing	$ 1.8348/lb	
Class II		
Butterfat: Back Pricing	$ 1.9653/lb	
Nonfat solids: Advanced Pricing	$ 0.7956/lb	
Class III		
Butterfat: Back Pricing	$ 1.9583	
Protein: Back Pricing	$ 5.6294	$2.04
Other Solids: Back Pricing	$ 0.1492	
Class IV		
Butterfat: Back Pricing	$ 1.9583	
Nonfat solids: Back Pricing	$ 0.7959	

[1] At Suffolk County (Boston): Class I differential: $3.25/cwt

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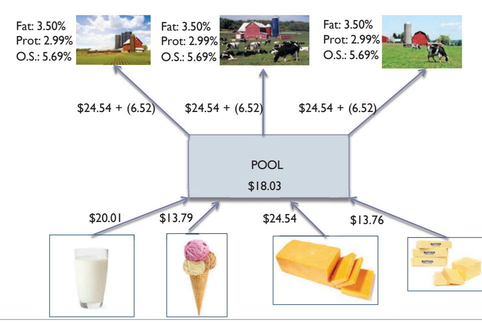

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Factors for Negative PPD

- Rapid increase in Class III (or Class IV) prices
- Depooling of Class III (or Class IV) milk when Class III (or Class IV) price is greater than what the pool price would be.

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Must know…

- In FMMOs, Class I *MUST* be pooled
- In FMMOs Class II, III and Class IV do not have to be pooled
  - Generally beneficial to Co-op and producers when Class III and Class IV prices are below Class I.
  - Not so when Class III (or Class IV) exceeds Class I
  - … Depooling!
  - Rules for pooling/depooling are specific to each Order

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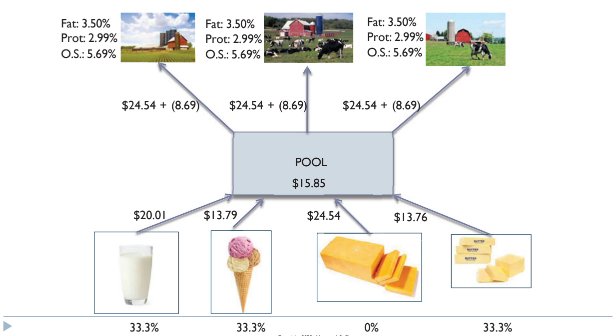

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March 2020 vs. March 2021 – FMMO 30

	2020	2021
Class I	245,279,826	219,159,910
Class II	60,865,752	213,389,547
Class III	2,085,347,261	355,467,968
Class IV	154,090,070	176,490,188
TOTAL	2,545,582,909	964,507,613

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Explaining PPDs…

I'd rather try to explain triple integrals in polar coordinates…

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2023 Proposed FMMO Modernization (NMPF)

- Return to 'higher of' Class I mover
- Discontinue use of barrel cheese in the protein component price formula
- Extend current 30-d reporting to 45 d on forward price sales of dry whey and NFDM
- Update the milk component factors in Class III and IV
- Develop process to ensure that make-allowance are reviewed more frequently
- Change current make-allowance:
  - Cheese $0.24 Butter $0.21 Dry whey $0.23 NFDM $0.21

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Like fixing an old, worn-out car…
… or rearranging the chairs on the Titanic…

- Make-allowance transfer most of market risks to producers.
- System is entirely based on domestic prices.
- Pooling cannot be enforced (make-allowance)
- Class I and Class II skim are forward priced. All others are backward priced.
- Producers are paid for components, but some is taken back by PPD.
  - Cannot hedge PPD
  - Class III hedging doesn't even hedge price for milk going to Class III (Class III is at 3.5% butterfat, 2.99% protein, and 5.69% other solids)

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Class III at $19/cwt…

Butterfat ($/lb)	Protein ($/lb)	Other Solids ($/lb)	Class III ($/cwt)
2.75	2.75	0.20	19.00
3.50	1.88	0.20	19.00
2.12	3.50	0.20	19.00
2.43	2.75	0.40	19.00
2.75	2.38	0.40	19.00
3.00	2.85	0.00	19.00
5.43	0.00	0.00	19.00
0.00	6.35	0.00	19.00
0.00	0.00	3.34	19.00

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The World…

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World Milk Production - 2021

	Million lbs
India	438,720
European Union	328,440
United States	226,258
China	83,665
Russia	70,592
Brazil	61,344
New Zealand	48,491
Mexico	28,709
Argentina	26,235
Canada	22,392
Australia	19,989
TOTAL all countries	2,116,151

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Price Quotations[1] (US$/lb)

	European Union	Oceania	U.S.
Butter	2.31	2.26	2.41
SMP	1.21	1.33	1.18
WMP	1.72	1.47	2.10
Cheddar	1.88	2.11	1.61

[1]Prices as of May 14, 2023

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Main Exporting Countries[1] (Volume in kMT)

Countries	Butter (oil)	Cheese	SMP	WMP
New Zealand	75	64	95	206
European Union	46	197	129	33
U.S.A.	8	67	131	3
Australia	1	19	21	6
United Kingdom	9	28	9	2
Uruguay	2	4	3	25

[1]Total for Jan-Feb 2023

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Main Importing Countries[1] (Volume in kMT)

Countries	Butter (oil)	Cheese	SMP	WMP
China	21	26	75	96
United Kingdom	11	80	2	4
Saudi Arabia	9	43	3	23
Indonesia	2	3	26	17
European Union	15	27	5	4
U.S.A.	13	27	0	3

[1]Total for Jan-Feb 2023

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Table 2. Six-month strip of dairy futures at closing time on Friday 5/19, and changes in their 6-month averages from the prior Friday closings[1].

	Cheese ($/lb)	Butter ($/cwt)	Dry Whey ($/cwt)	NDM ($/cwt)	Class III ($/cwt)	Class IV ($/cwt)
May	1.669	243.775	38.000	114.975	16.19	18.10
June	1.678	242.300	34.100	116.000	16.06	18.19
July	1.754	243.775	32.000	116.525	16.63	18.17
August	1.852	246.400	32.300	118.900	17.56	18.64
September	1.918	249.000	33.500	121.500	18.30	18.90
October	1.964	250.000	35.200	124.000	18.80	19.17
Average	1.806	245.875	34.183	118.650	17.26	18.53
Weekly Change	-0.038	-2.283	-2.258	-2.763	-0.51	-0.21

[1] Futures prices on the Chicago Mercantile Exchange

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Table 3. Translation of futures dairy product prices into futures component prices (on 5/19/23).

	Butterfat ($/lb)	Protein ($/lb)	Other Solids ($/lb)	Nonfat Solids ($/lb)
May	2.74	1.84	0.19	0.97
June	2.73	1.89	0.15	0.98
July	2.74	2.12	0.12	0.99
August	2.78	2.40	0.13	1.01
September	2.81	2.58	0.14	1.04
October	2.82	2.71	0.16	1.06
Average	2.77	2.26	0.15	1.01
Weekly Change	-0.03	-0.09	-0.02	-0.03

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The Future…

- For the next 6 months… my W.A. GUESSES…
  - Class III at ~$16.00-$18.00/cwt (slowly rising)
  - Class IV (and II) at ~$18.00-$19.00 (NDM/SMP?...)
  - Butterfat at $2.75/lb (steady… quite certain)
  - Protein at $2.25-$2.50/lb (rising… but uncertain)
  - Other solids at ~ $0.15 to $0.20 (moderately certain… $ loosing)
  - Nonfat solids at $1.00- (steady; moderately certain)

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The more I get to know people…
the more I realize why Noah only let animals on the boat!

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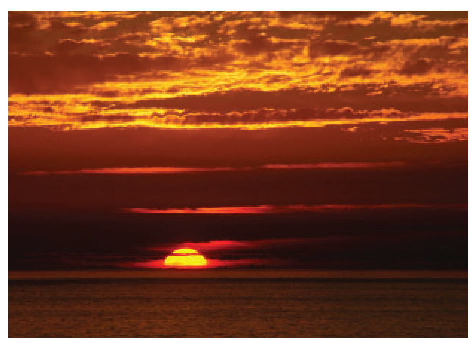

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Peri-Partum Inflammation: Where Everything Begins

Dr. Adrian Barragan
Penn State University

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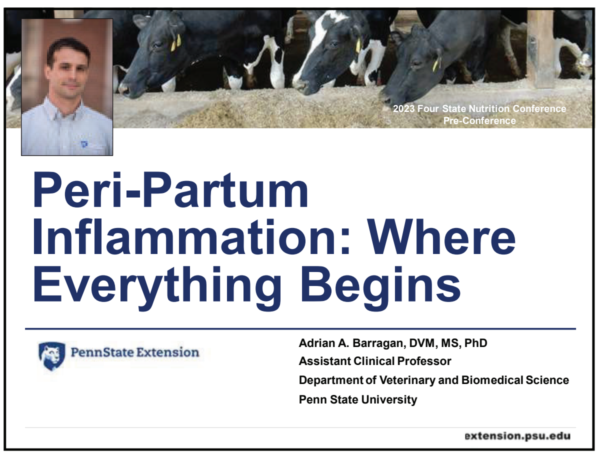

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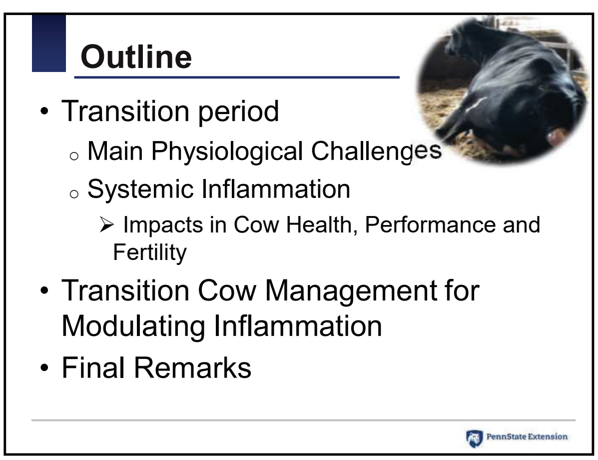

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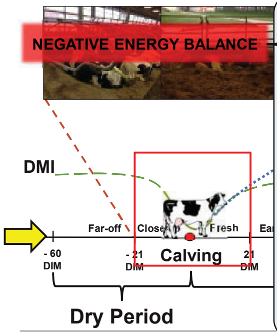
Transition Period



Physiological Challenges

- ↓ Dry matter intake (DMI)
- ↑ Energy and nutrients demands
  - ↓ **Energy** → increased risk of ketosis
  - ↓ **Ca^{++}** → increased risk of hypocalcemia
- Systemic inflammation
- Impaired immune system
  - Increase risk of infectious diseases

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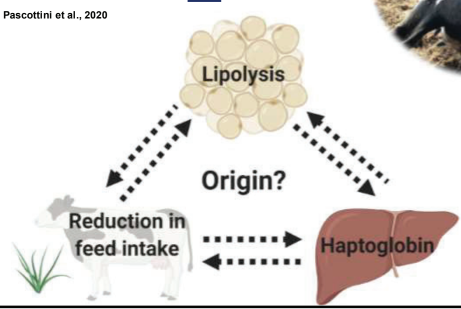
Which Came First, The Chicken or The Egg?

Pascottini et al., 2020



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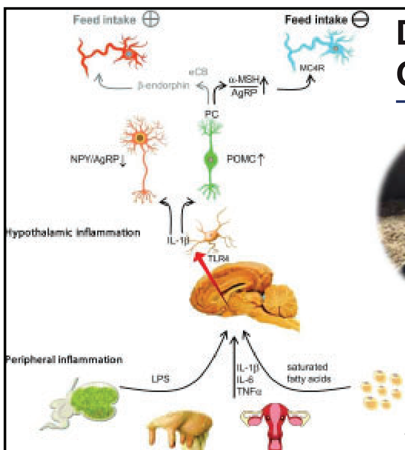
Drop in DMI: Origins



Kuhla, 2020

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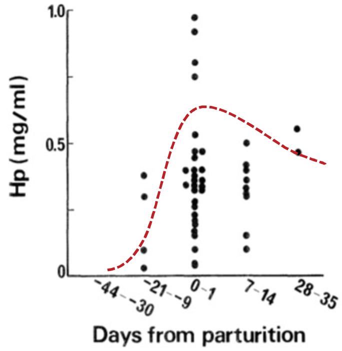
Transition Cow Inflammation



Adapted from Uchida et al., 1993

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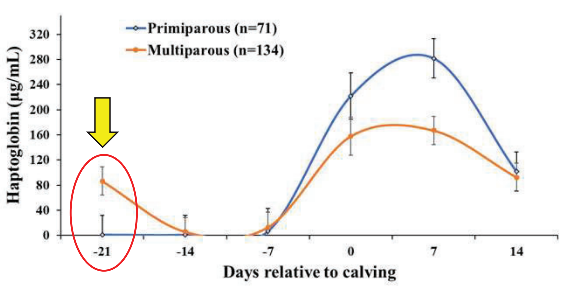
Transition Cow Inflammation



Barragan et al., 2023 (*Unpublished data*)

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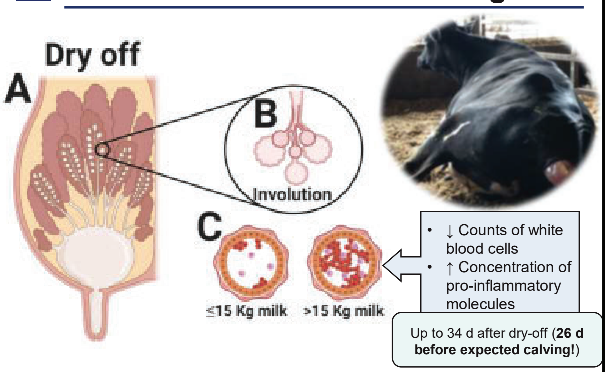
When Does Inflammation Origin?



Pascottini et al., 2020, Mezzetti et al., 2020

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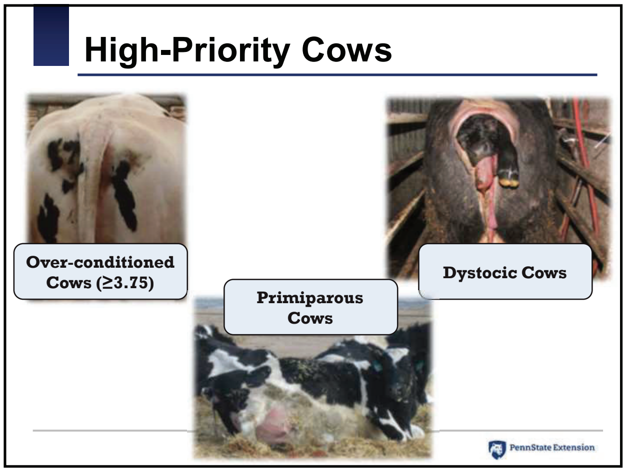
High-Priority Cows
Over-conditioned Cows (≥3.75)
Primiparous Cows
Dystocic Cows
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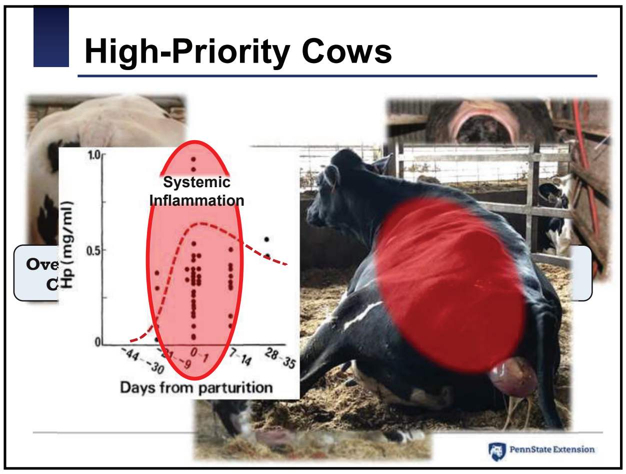
High-Priority Cows
Systemic Inflammation
Hp (mg/ml)
Days from parturition
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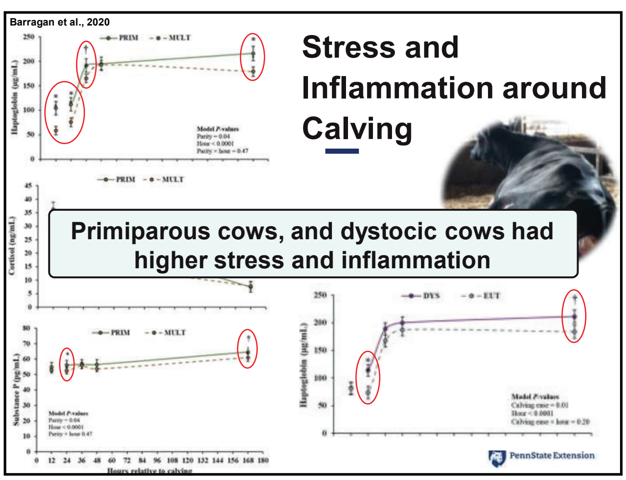
Barragan et al., 2020
Stress and Inflammation around Calving
Primiparous cows, and dystocic cows had higher stress and inflammation
PRIM
MULT
DYS
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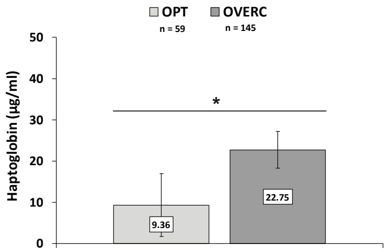
Pre-Partum Inflammation and BCS



Barragan et al., 2023 (*unpublished data*)

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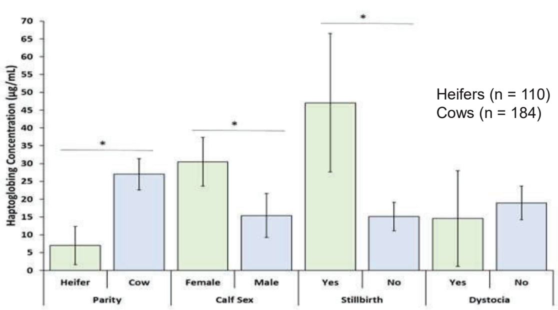
Pre-Partum Inflammation and Calving Events



Shabloski et al., 2022

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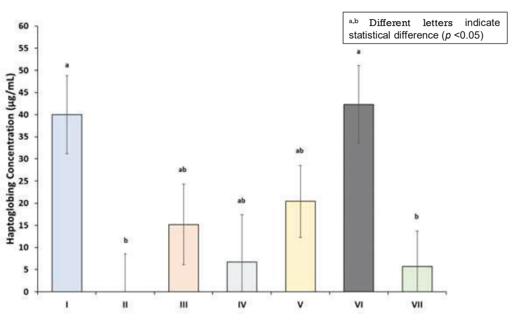
Pre-Partum Inflammation and Farm Management



Shabloski et al., 2022

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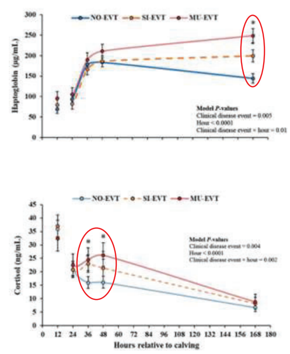
Barragan et al., 2020

Impact of Inflammation on Cow Health



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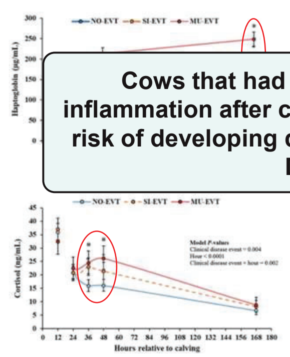
Barragan et al., 2020

Impact of Inflammation on



Cows that had higher stress and inflammation after calving were at a higher risk of developing diseases in the first 60 DIM

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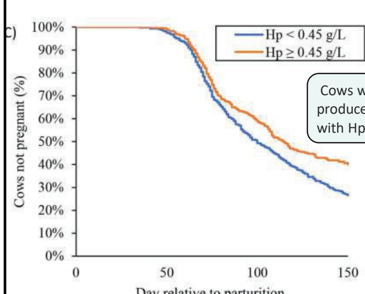
Impact of Inflammation on Cow Performance



Cows with Hp concentrations ≥0.45 g/L produced ***492 kg less*** ME305 milk than cows with Hp concentrations <0.45 g/L ($P < 0.001$).

Kirwin et al., 2022

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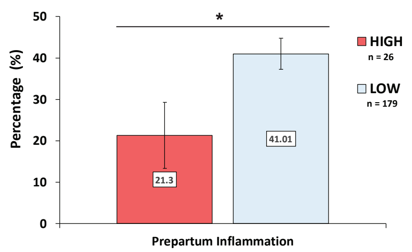
Pre-Partum Inflammation and Pregnancy rate at 1st Service



Barragan et al., 2023 (*unpublished data*)

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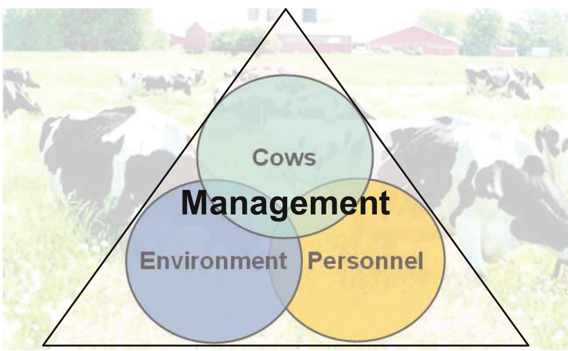
Transition Cow Management for Modulating Inflammation



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Commingling

- First lactation heifers have to compete with bigger and stronger mature cows
  - ↓ Inflammation (multiparous cows)
- Combined with high stocking density (primiparous cows)
  - ↓ Feed intake
  - ↓ Milk yield
  - ↓ Lying time
  - ↑ Risk for diseases

Huzzey et al., 2006; Nordlund et al., 2006; Kerwin et al., 2022

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Stocking Density

Overstocking at feed bunk → ↑ Metabolic diseases
Overstocking at stalls → ↑ Lameness

- Feed bunk space (30” per cow)
- Two-row free stall barns (close-up and fresh pens)
- Stocking density by group
  - Close-up: 80% (for each 10% ↑ 80% → ↓1.6 ld/d 1[st] lact cows)
  - Fresh: 80-85%

Nordlund et al., 2006; Nordlund, 2011

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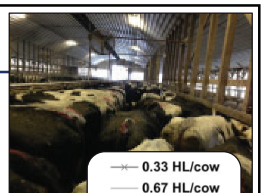
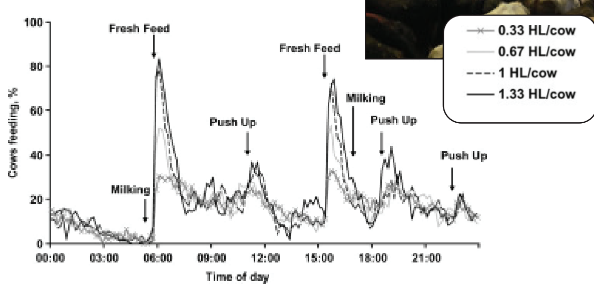
Stocking Density and Dry Matter Intake





Huzzey et al., 2006

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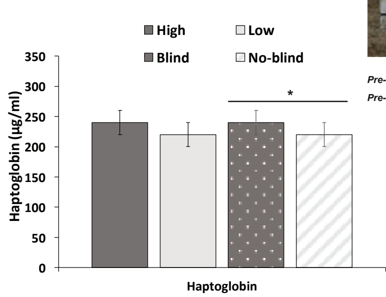
Stocking Density and Inflammation



Pre-partum stocking density P = 0.11
Pre-partum blind P = 0.04

Adapted from Creutzinger et al., 2021

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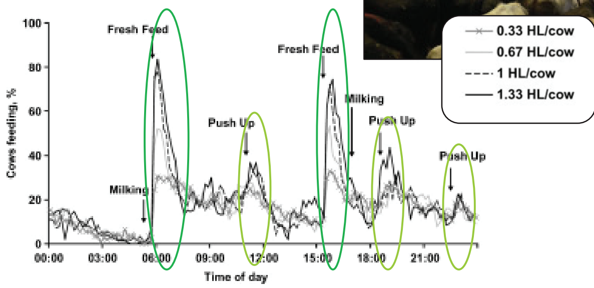
Stocking Density



Huzzey et al., 2006

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Feed Bunk Management

- Feed frequency
  - ↓ Inflammation (1xd; close-up primiparous cows)
  - ↑ Dry matter intake (≥2xd)
- Feed push-ups every 2-4 h)
  - <5 x day ↓ inflammation (fresh primiparous cows)
  - Every 30 min → 2 h after fresh feed delivery
    - ↑ Dry matter intake

Kirwin et al., 2022, Grant, 2019

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Nutrition Management for Low Inflammation

Pre-partum
- ↑ % of particles on the 19-mm sieve
- ↓ Metabolizable energy

Post-partum
- ↓ Physically effective undigested NDF
- ↓ Fermentable carbohydrates diets
- ↑ Forage NDF
- Ensure adequate diet ME and metabolizable protein

Kirwin et al., 2022

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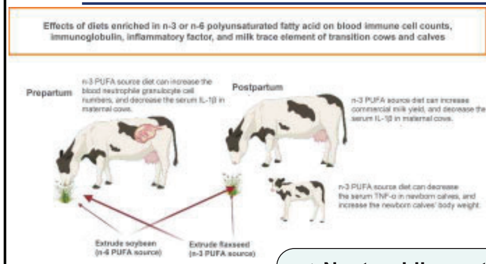
Prepartum Polyunsaturated Fatty Acids



- ↑ **Neutrophil counts in dams***
- ↓ **Interleukin-1β in dams***
- ↓ **TNF-α in calves**

***Only multiparous cows**

Sun et al., 2022

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Anti-Inflammatory Strategies

- Preventive treatment during first days after calving
- NSAID use most common approach
  - Flunixin meglumine
  - Meloxicam
  - Aspirin
- Most studies reported benefits in multiparous cows

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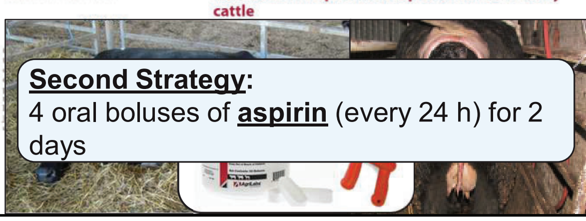
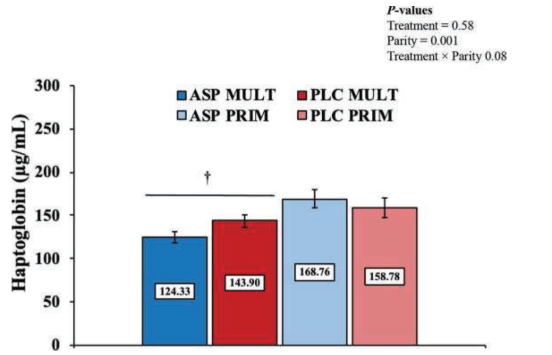
First Strategy:
2 oral boluses of **aspirin** 2xd (every 12 h) for 2 days



Second Strategy:
4 oral boluses of **aspirin** (every 24 h) for 2 days

30

Systemic Inflammation



Barragan et al., 2020

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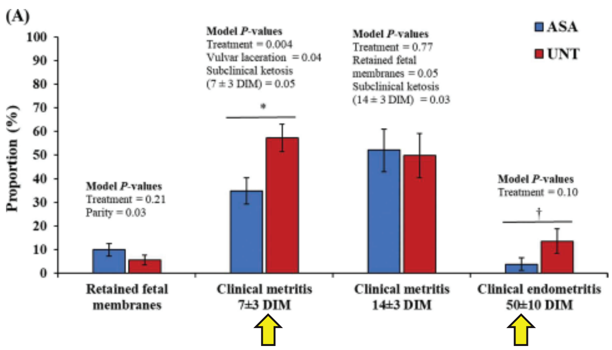
Prevention of Diseases



Barragan et al., 2021

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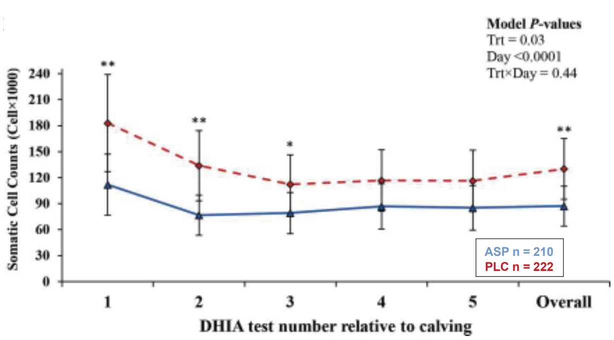
Somatic Cell Counts



Barragan et al., 2020

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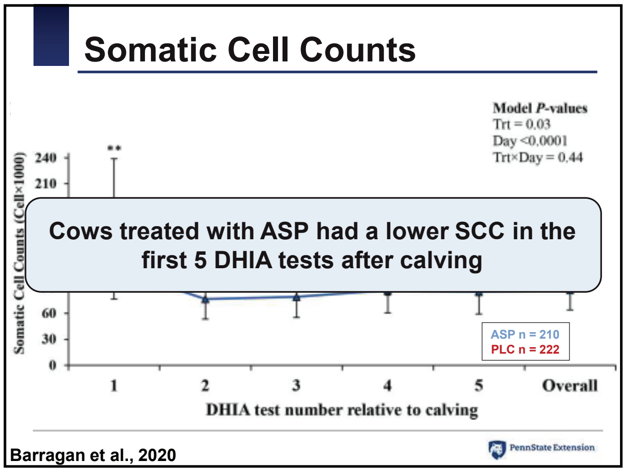
Somatic Cell Counts
Model P-values
Trt = 0.03
Day <0.0001
Trt×Day = 0.44
Somatic Cell Counts (Cell×1000)
240
210
60
30
0
**
Cows treated with ASP had a lower SCC in the first 5 DHIA tests after calving
ASP n = 210
PLC n = 222
1
2
3
4
5
Overall
DHIA test number relative to calving
Barragan et al., 2020
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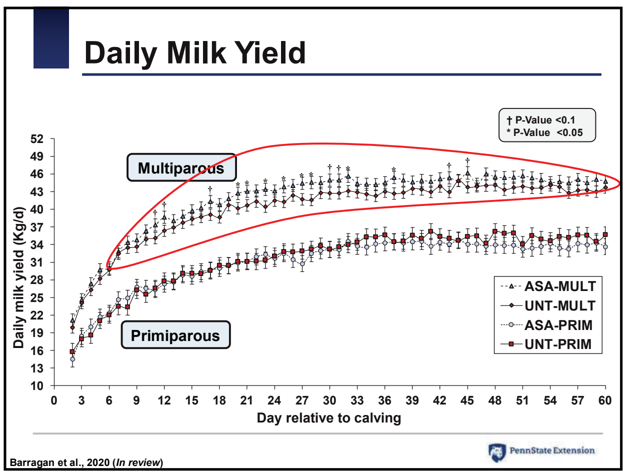
Daily Milk Yield
† P-Value <0.1
* P-Value <0.05
Multiparous
Primiparous
ASA-MULT
UNT-MULT
ASA-PRIM
UNT-PRIM
Daily milk yield (Kg/d)
52 49 46 43 40 37 34 31 28 25 22 19 16 13 10
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60
Day relative to calving
Barragan et al., 2020 (In review)
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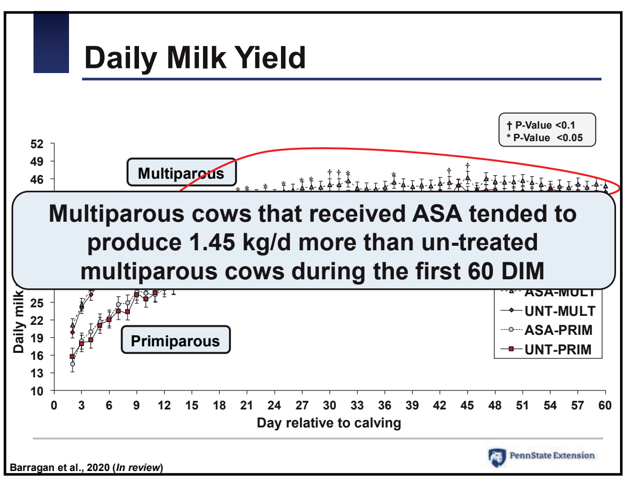
Daily Milk Yield
† P-Value <0.1
* P-Value <0.05
Multiparous
Multiparous cows that received ASA tended to produce 1.45 kg/d more than un-treated multiparous cows during the first 60 DIM
Primiparous
UNT-MULT
ASA-PRIM
UNT-PRIM
52 49 46 25 22 19 16 13 10
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60
Day relative to calving
Barragan et al., 2020 (In review)
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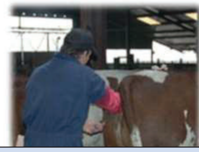
What About Fertility?

Aspirin cows:
- Became pregnant 20 days sooner
- Tended to have 5% less pregnancy losses at first service



Parameter	Study Group		P-Value
	ASA (n=121)	UNT (n=125)	
DIM to conception	105.56±11.53	125.43±10.42	0.01
Number of services to conception	2.29±0.45	2.71±0.40	0.17
Pregnancy per AI at first service	23.88±7.92	17.93±6.31	0.40
Pregnancy loss at first service	1.03±1.06	6.04±2.62	0.10

Barragan et al., 2020 (*In review*)

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Pre-Partum Targeted Anti-Inflammatory Treatment

Study will assess prepartum aspirin regimens to improve cow health, performance

pennsylvania
DEPARTMENT OF AGRICULTURE

USDA NIFA
United States Department of Agriculture
National Institute of Food and Agriculture

Treatment Approach:
1 oral administration of either aspirin or meloxicam at 14±3 days before expected calving date

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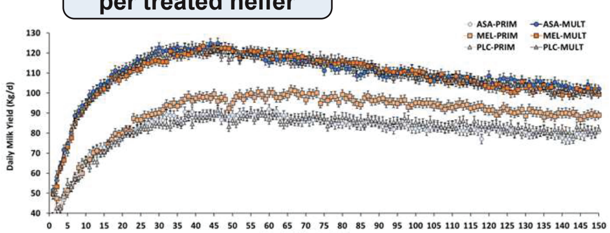
Daily Milk Yield Results

~1,650 lbs. more milk per treated heifer



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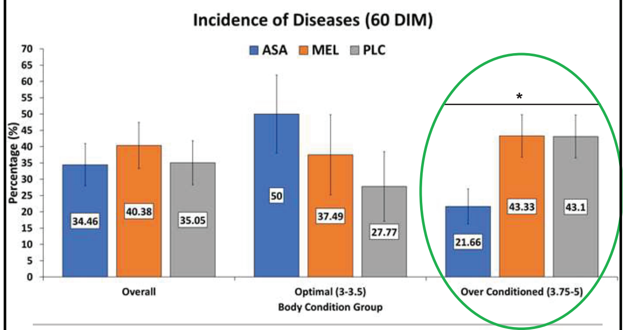
Incidence of Diseases



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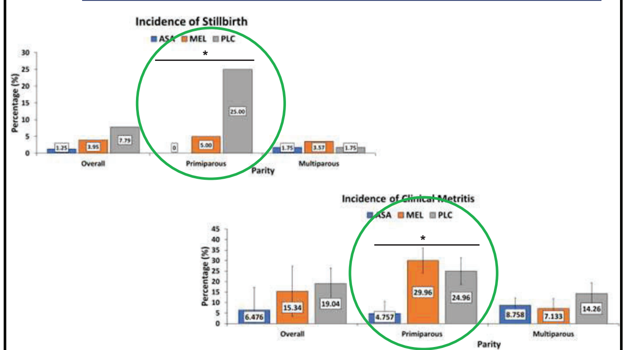
Incidence of Diseases



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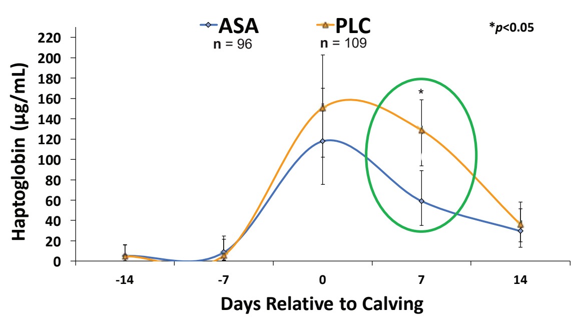
Systemic Inflammation



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Final Remarks

- Dairy cows physiologically experience important challenges during the transition period
- Inappropriate nutrition, poor environment management, and high incidence of diseases can impair health and reproductive performance in dairy cows in early lactation
- Proactive management, aimed at maximizing DMI and decreasing inflammation, is key for optimal animal welfare and production in dairy farms

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Follow-up

EMAIL skype WhatsApp TeamViewer Dropbox

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Email: axb779@psu.edu

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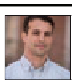

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Thank you

PennState Extension

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Penn State University

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Factors that influence colostrum

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Factors that influence colostrum production and quality

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Four-State Dairy Nutrition & Management Conference
GRAND RIVER CENTER
Dubuque, IA June 7-8, 2023

1

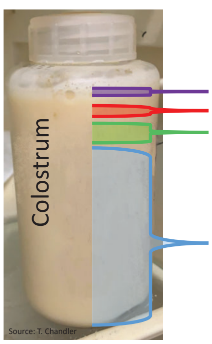
Why does colostrum matter?

- Has the largest influence on calf health and survival pre-weaning[1]
- Prevention of diarrhea, pneumonia, umbilical disease
- ~34% of calves experience a health disorder preweaning[2]
- ~5% of US dairy calves die preweaning[2]

[1]Godden et al., 2019, [2]Urie et al. 2018

2

What is colostrum?



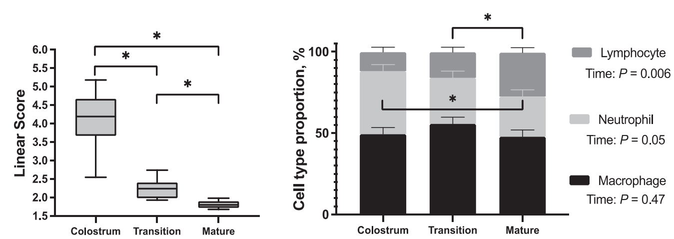
- Other
- Minerals (~ 1%) (Ca, Mg, P, Na, K, Cl, S)
- Solids (~ 23%):
  - Fat (~5/7%) [PUFA, ω-3]
  - Protein (~14%) [casein, albumin, IgG >> IgA, IgM]
  - Lactose (~2.7%) [oligosaccharides]
- WATER (76%)

- Micronutrients (trace minerals, vitamins)
- Growth factors, hormones (insulin, IGF, ...)
- Immune cells (macrophages, neutrophils, lymphocytes)
- Antimicrobial peptides, complement proteins
- Enzymes, protease inhibitors
- miRNA
- ?

Based on Godden et al., 2019, Mann et al., 2020, van Niekerk et al. 2021

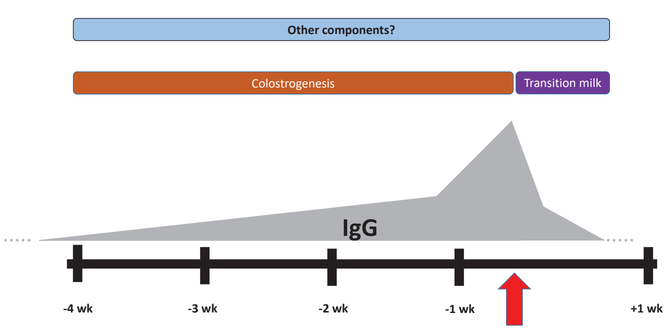
3

Colostral immune cells



Chandler et al., 2023, linear score and leukocyte proportions in first milking, and milk at 3-4 DIM, and 6-7 DIM, n= 13

4



Based on McGuirk and Collins, 2004, Schalich et al., 2021

5

Herd-level variability of colostrum production

- Median colostrum **yield** across sample of farms
  - 2.5 to 7.6 kg for primiparous cows
  - 4.0 to 7.7 kg for multiparous cows
- Mean **Brix %** across sample of farms:
  - 22.2 to 27.9 % for primiparous
  - 22.0 to 28.8% for multiparous

Westhoff et al. 2023; 97 to 2,120 samples/farm, 18 farms

6

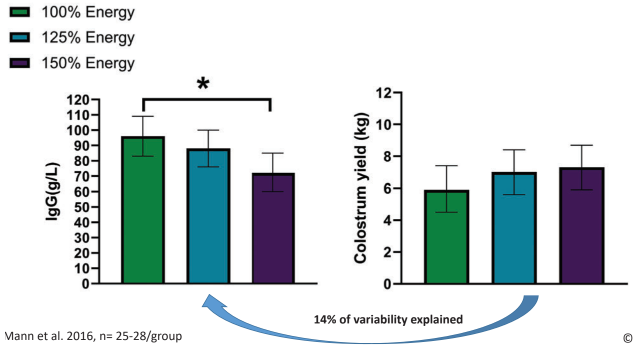
Dry period nutrition

- Energy/starch[1,2,3] higher yield with moderate starch in close-up

[1]Mann et al. 2015, [2]Fischer-Tlustos et al. 2021 (Abstr.), [3]Westhoff et al., 2023

7

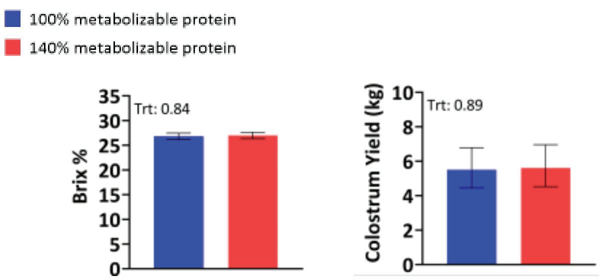
Effect of altering energy density (starch %) 4 wks prepartum



Mann et al. 2016, n= 25-28/group

8

Effect of altering metabolizable protein supply 3 wks prepartum



Westhoff et al. 2023 unpublished, n= 45-47/group

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Dry period nutrition

- Energy/starch[1,2]
- Protein/MP[3]
- Fatty acid supplementation[4,5]
- Trace mineral/vitamin/choline supplementation[6,7]

[1]Mann et al. 2015, [2]Fischer-Tlustos et al. 2021 (Abstr.), [3]Westhoff et al., 2023, [4]Uken et al., 2021, [5]García et al., 2014, [6]Van Emon et al., 2020, [7]Swartz et al. 2022

10

Maternal metabolic status and parturition

- Negative liver health indicators associated with lower colostrum quality[1]
- Cows with high colostrum yield (>6 L) had higher prepartum serum [BHB] and antioxidant potential[2]
- Live birth and twin pregnancies higher yield[3]

ımmler et al., 2021, [2]Rossi et al., 2023, [3]Westhoff et al. 2023

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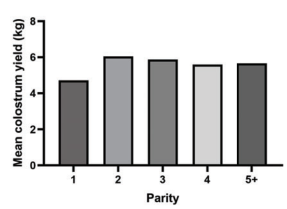
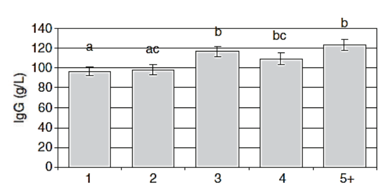
Parity



Westhoff et al.,2023, n=18,343



Conneely et al.,2013, n=704

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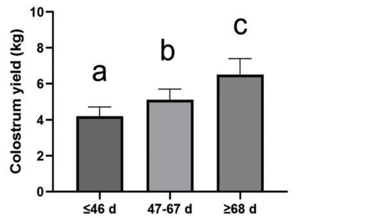
Length of dry period



Westhoff et al.,2023, n=12,553

- 28 d vs. 56 d: 3.3 vs. 6.1 kg[1]
- 40 d vs. 60 d and 34 d vs. 55 d: no difference in [IgG][2,3]
- 0 d vs. 30 and 60 d: significantly lower [IgG], lower volume[4]

[1]O´Hara et al., 2019, [2]Shoshani et al., 2014, [3]Watters et al., 2009, [4]Mayasari et al., 2015

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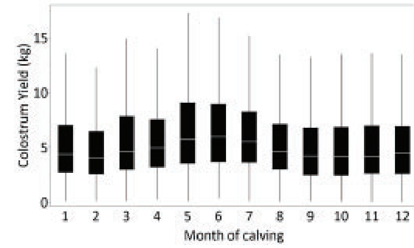
Seasonality (convenience sample 18 NY farms)

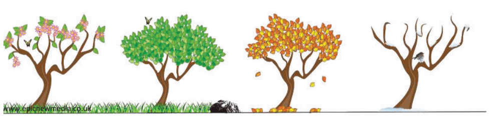


Westhoff et al., 2023; box and whisker plots for monthly colostrum yield (kg, n=18,929)

14

THI and light exposure prepartum

- higher THI (ØTHI > 69.2) 7 d before calving higher yield[1]
- higher light intensity (ØLux > 154) 14 d before calving higher yield[1]
- THI in the last wks before calving → mixed effects[2,4]
- Non-cooled cows under heat stress → mixed effects on [IgG][3]



[1]Westhoff et al., 2023, [2]Zentrich et al., 2019, [3]Tao et al., 2019, [4]Shivley et al., 2018

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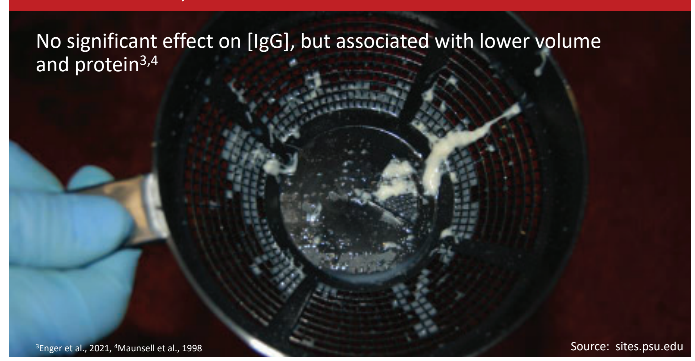
Intra-mammary infection

No significant effect on [IgG], but associated with lower volume and protein[3,4]



[3]Enger et al., 2021, [4]Maunsell et al., 1998

Source: sites.psu.edu

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Harvest

- Presence of calf and use of oxytocin no effect on yield, but higher [IgG][1]
- Best milking routine to harvest colostrum?

Source: T. Westhoff

[1]Sutter et al., 2019

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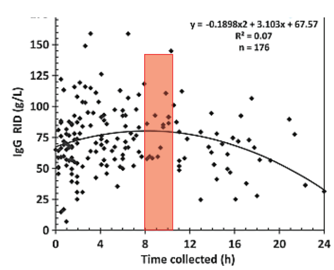
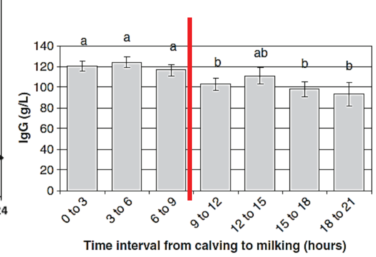
Time to harvest





Quigley et al., 2013, n=176

Conneely et al., 2013, n=704

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Refrigeration and freezing

Refrigeration:
- Short-term storage for several days, best only 1 day
- Label with date and Brix% and organize in fridge accordingly
- Shelf-life can be improved by adding potassium sorbate
- Use individual feeding portion containers

Freezing:
- Long-term storage (6-12 months)
- Do not use frost-free freezers (thaw cycles)
- Freeze and thaw in individual portions
- Preferable to heat thawed colostrum in waterbath 45-60°C
- Waterbath is not a storage tank!
- Colostral cells become non-viable

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Bacterial contamination?

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Heat treatment

- 60°C for 60 min[1]
- Does not produce a sterile product! Reducing contamination is key
- Improves storability (8 d at 4°C)[3]
- May improve IgG uptake[1,4]
- Controls *Mycoplasma*, *Salmonella*, *E.coli*, reduces M.a.p.[2]
- Rapid cool down
  - ice for bags, frozen bottles in colostrum buckets

↓overgrowth of (heat-stable) bacteria
- Colostral cells become non-viable[5]

[1]Godden et al., 2019, [2]Godden et al., 2006, [3]Bey et al., 2007, [4]Shivley et al., 2018, [5]Chandler et al. 2023

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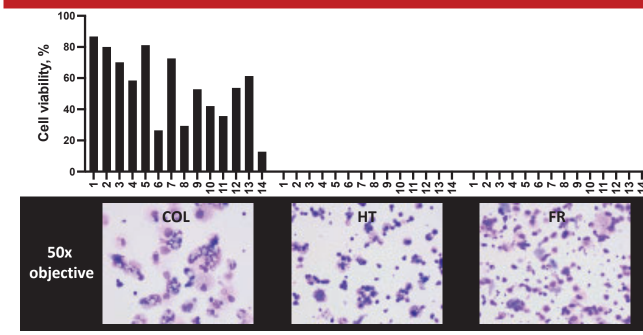
Cell viability



Chandler et al, 2023

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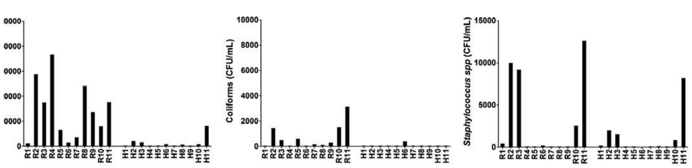
Heat treatment of colostrum ≠ sterilization



Median reduction in total bacterial counts = 93% (45-100%)

- **Highest reduction for coliforms**
- **Lowest reduction for *Staphylococcus* spp.**

nn et al. 2020: Bacterial counts of 11 paired heat-treated (60°C, 60 min) vs. raw colostrum

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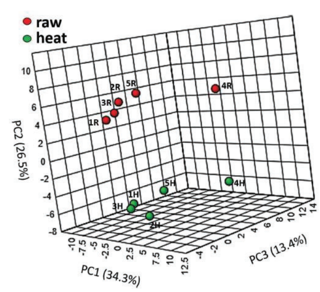
Heat treatment and colostrum proteome



Mann et al. 2020: PCA of proteomics results of 5 paired heat-treated vs. raw colostrum samples

Relative change in heat treated samples:

↓
- Insulin, IGF-I
- IgA (but not IgG)
- Complement proteins
- Fibrinogen
- Trypsin inhibitors
- Enyzmes
- Transport proteins (Iron, lipid, steroid hormone, Vit A
- …

↑
- Protease inhibitors
- Milk protein (casein)
- Acute phase proteins
- …

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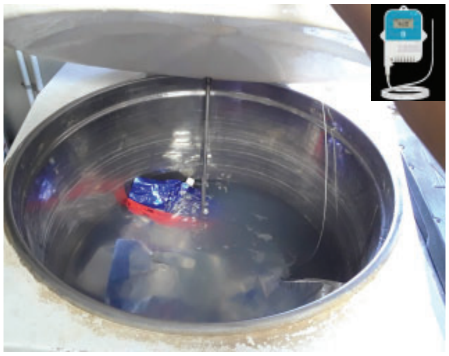
Temperature control



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Colostrum quality on farm?

Compared with gold standard RID IgG	Brix refractometer	
Correlation (r)	0.61 -0.79[1-5]	
	Brix (≥ 21%)	Brix (≥22%)
Sensitivity (< 50 g/L)	74.4-92.9[4,5]	54.2-91.1[3,4]
Specificity (≥ 50 g/L)	65.5-100.0[4,5]	79.3-91.9[3,4]

artier et al. 2015, [2]Mann et al., 2016, [3]Bielmann et al., 2010, [4]Quigley et al., 2013, [5]Morrill et al., 2015

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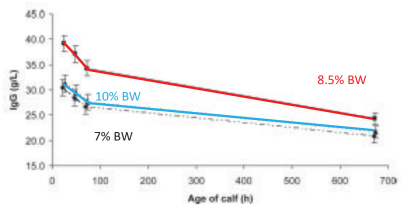
Colostrum feeding recommendations

- How much?

  8.5% BW may be superior to 10% BW[1]



~ 44 kg Holstein calf = 3.74 L (~1 gallon)

Careful with recommendations of 12% BW and above (5.3 L for a 44 kg calf...)

[1]Conneely et al., 2014

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Colostrum feeding recommendations

- When?
  - Gut open for > 24 h[1], highest uptake IgG <u>in the first 1-4 h</u>[2]
  - Prolonged local effects
- How?
  - Temperature is very important
  - Bottle/Suckling →Abomasum; Tube →Rumen

    3L bottle vs. rumen no difference in IgG transfer[3]

[1]Hare et al. 2002, [2]Fischer et al., 2018, [3]Desjardins-Morrissette et al., 2018

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Quantify: Evaluation of success of colostrum program consensus guidelines

Proposed category	Proposed IgG concentration (g/L)	Equivalent STP (g/dL)	Equivalent serum Brix (%)	Proposed proportion of calves in category
Excellent	≥ 25.0	≥ 6.2	≥ 9.4	> 40
Good	18.0 to 24.9	5.8 to 6.1	8.9 to 9.3	~30
Fair	10.0 to 17.9	5.1 to 5.7	8.1 to 8.8	~20
Poor	< 10.0	< 5.1	< 8.1	< 10

Source: Godden et al., 2019

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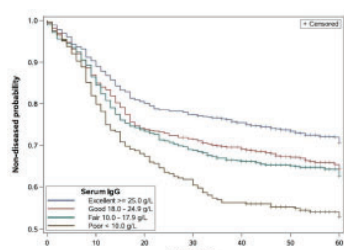
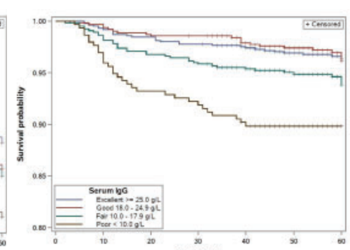
Disease and survival probability by category

Disease



Survival



Source: Lombard et al., 2020 Concensus recmmendations, NAHMS 2014 data

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Summary

- Colostrum – more than IgG
- Colostrum production is variable between animals and farms
- Dry cow nutrition and management affect colostrum production
- Individual metabolism has an effect within a group
- Time to harvest non-linear relationship with colostrum yield and quality
- Post-harvest management changes non-IgG colostral components

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Knowledge gaps

- Little known about colostrogenesis of non-IgG components
- Colostrum production rarely recorded on farms
- Best practices for colostrum harvest need evidence
- Seasonal variation not fully understood, but light and THI play a role
- Biological relevance of non-IgG components and influence of post-harvest alterations require research

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Acknowledgements:
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Managing fresh cows to reduce the impact of hypocalcemia & ketosis

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Managing fresh cows to reduce the impact of hypocalcemia & ketosis

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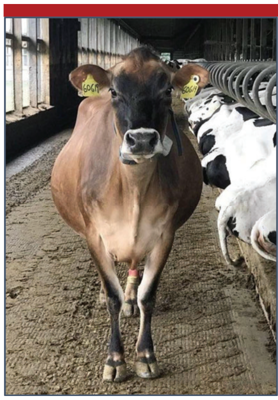


Overview

- So you did a great job with your dry cows program – don't !@#$ it up in the fresh cow pen!
- Hypocalcemia: physiology, calcium dynamics, testing
- Ketosis: physiology, when & how to test
- Important considerations in fresh pen management

3

- Many cows producing >100 lbs by end of 1st week
- Lactation initiates massive change in nutrient and macromineral demands
- Our job: provide the environment to support needs
- Today: focus on hypocalcemia and ketosis
  - → Who do we worry about and when do we worry?

4

Early lactation calcium demands & physiological response

5

Calcium demands of milk production

Daily maintenance = 21 g Ca

Colostrum = 23 g Ca

100 lbs milk = 56 g Ca

- Human recommended dietary allowance = 1,000 mg Ca
- 1 cup milk = 300 mg Ca

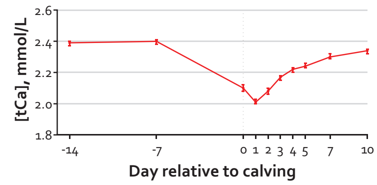
6

How do we decide which cows are hypocalcemic, and should we worry about them?

7

Is subclinical hypocalcemia bad?

- When to test:
  - At calving?
  - At 24 hrs?
  - At 48 hrs?
  - Later?



- What cut-point to use:
  - Definition of "normal"
  - Based on health and production outcomes

8

Calcium dynamics

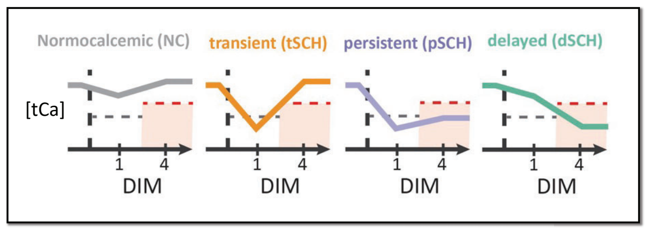
- Postpartum calcium dynamics differ between cows!
- Can we quantify what this difference means?
- Parity ≥2: cohort based on DIM 1 & 4

Normocalcemic	1 DIM [Ca] ⬆	4 DIM [Ca] ⬆
Transient SCH	1 DIM [Ca] ⬇	4 DIM [Ca] ⬆
Persistent SCH	1 DIM [Ca] ⬇	4 DIM [Ca] ⬇
Delayed SCH	1 DIM [Ca] ⬆	4 DIM [Ca] ⬇

Neves et al., JDS, 2018; McArt and Neves, JDS, 2020

9

Calcium dynamic groups



Courtesy: J. A. Seminara; McArt and Oetzel, *VCNA*, 2023

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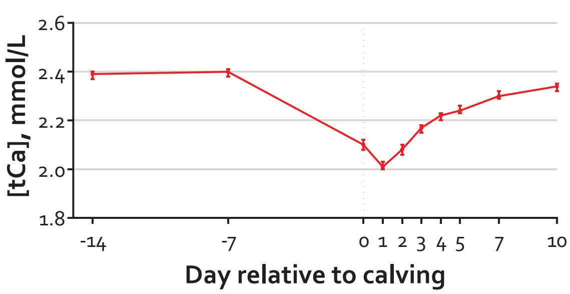
Calcium dynamics



(tCa: 1 mmol/L = 4 mg/dL)

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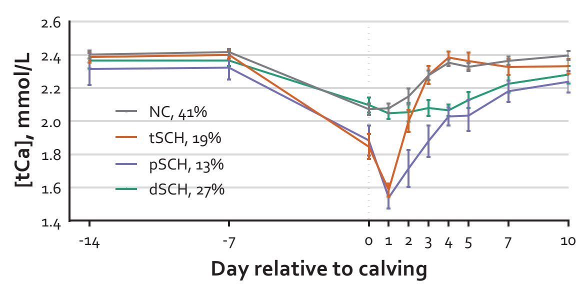
Calcium dynamics: parity ≥2



Error bars represent ± SD.

McArt and Neves., J Dairy Sci 103:690-701.

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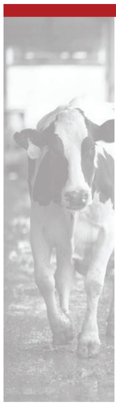

Disease: parity ≥2

	Metritis	Displaced abomasum	Herd Removal
NC, n = 109	6%	2%	1%
tSCH, n = 50	4%	2%	2%
pSCH, n = 34	18%	12%	3%
dSCH, n = 70	13%	9%	13%

McArt and Neves, J Dairy Sci, 2020

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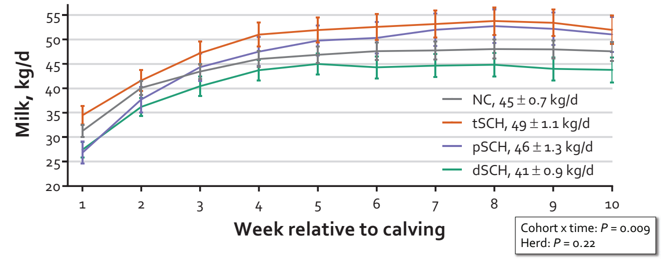
Milk yield: parity ≥2



Error bars represent 95% confidence intervals.

McArt and Neves., J Dairy Sci, 2020

14

Calcium dynamics – they matter!

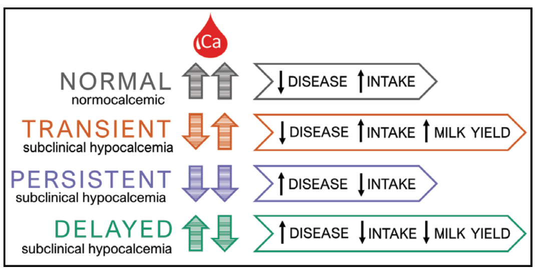


Figure: The dynamics of blood Ca measured on days 1 and 4 in milk and the outcomes associated with different classifications of subclinical hypocalcemia. Courtesy: C. Seely

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How can you use on-farm testing?

- No current practical, on-farm testing methods
- Routine herd-level monitoring: ⬆ ⬇ ➡
  1) Dynamics: 1 or 2 DIM & 4 DIM
  2) Hypocalcemia: 4 DIM
     - >8.8 mg/dL = 😀
     - ≤8.8 mg/dL = ☹
- Store in a working fridge!
- Submit to lab all at once after appropriate sample size

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What do we do with this information?

- Farm management team – is there a problem?
- Assess prefresh management
- Assess fresh pen management, cow comfort, and nutrition
- What kind of calcium supplementation should we give?

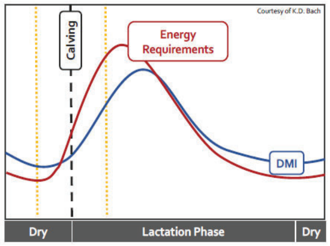
17

Early lactation energy demands & physiological response

18

Energy deficit

- Dairy cows enter a period of energy deficit during the transition period
- Increased energy demand in early lactation



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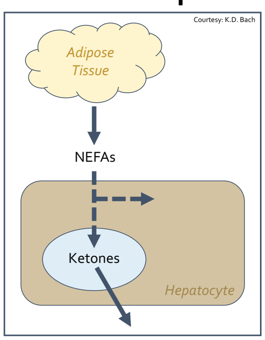
The bovine metabolic athlete

- Cow needs ~53 Mcal of metabolizable energy to produce 45 kg milk.
- If I ran a marathon, I'd need ~3.2 Mcal.
- Adjusted for body weight, cows run more than a marathon a day!
- Now get up tomorrow and do it again.

20

Normal adaptation to energy demands



Energy-related metabolites:

- Non-esterified fatty acids (NEFA)
- Ketones
  - Acetone
  - Acetoacetate
  - β-hydroxybutyrate (BHB)

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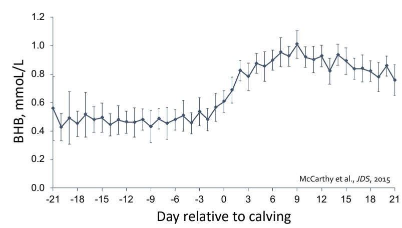
Some cows can manage this, some cannot.



- All dairy cows enter energy deficit
- Some adapt
- Some do not adapt ➔ excessive elevation of ketones

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Hyperketonemia vs. ketosis

- Hyperketonemia → Associated with increased risk for additional diseases
  - Not necessarily a disease
  - No distinguishing clinical signs
  - Elevation of blood ketones

  >80% of cases
- Ketosis → A disease
  - Abnormal clinical signs:
    - Decrease in appetite
    - Weight loss
    - Decrease in milk production
  - Elevation of blood ketones

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Is hyperketonemia bad?
If so, when?

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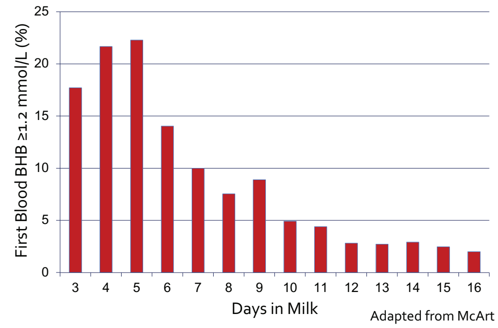
Individual animal consequences of hyperketonemia

- Higher risk for adverse health events
  - Metritis (~3 times)
  - Displaced abomasum (~ 8 times)
  - Culling (~3.5 times)
- Decrease milk yield in early lactation
  - ~ 2 kg per cow per day
- Poorer reproduction
  - ~30% lower preg risk to 1st insemination

Duffield et al., 2009; Ospina et al., 2010; Chapinal et al., 2012; McArt et al., 2012

25

Incidence of hyperketonemia by DIM



Adapted from McArt et al., 2012, *JDS*

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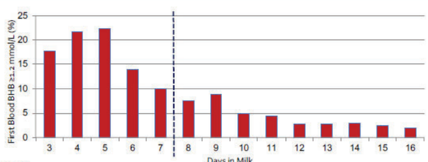
Association of DIM at onset



- Risk of adverse events different
  - Cows first ketotic from 3 to 7 DIM >> 8 to 16 DIM
  - Cows first ketotic from 8 to 16 DIM = non-ketotic cows
- Milk yield different
  - Cows first ketotic from 3 to 7 DIM << 8 to 16 DIM (-2 to -3 kg/d)
  - Cows first ketotic from 8 to 16 DIM >> non-ketotic cows (1 to 2 kg/d)

McArt et al., *JDS*, 2012; Vanholder et al., *JDS*, 2015; Rodriguez et al. *JDS*, 2022

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Measuring hyperketonemia: who, when, & how

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Applications of hyperketonemia testing

- Identifying individual hyperketonemic cows
  - Cow-side test for treatment decisions
- Identifying herds with hyperketonemia problems
  - Herd-level testing for management decisions

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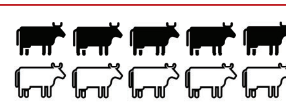
Historical ketosis diagnosis

Sweet smell of breath
- Acetone
- Other volatile compounds
- Not everyone can smell it!

This test for ketosis is only ~ 50% sensitive.



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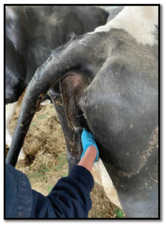
How should we test for ketones?

Three fluids can be sampled:

Urine



Milk

Blood

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Blood ketone testing

- Gold standard = laboratory blood BHB
  - Serum, EDTA plasma, heparinized plasma
  - Expensive, lag in time to result
- Handheld BHB meters
  - 1.5 µl of whole blood (or serum/plasma)
  - Excellent sensitivity and specificity
- Quantitative result
- ~US$1.00 to $3.00 per test

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Hints for on-farm electronic meter use

- *Treat your meter AND strips with respect!*

- Read the manual
- Keep meters and strips warm
- Routinely calibrate and/or quality check

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Blood ketone testing:

- Commonly used thresholds:
  - Hyperketonemia ≥1.2 mmol/L
  - Severe hyperketonemia ≥3.0 mmol/L
- Location of sampling
  - Tail vessels = jugular vein
  - Milk vein ~ 0.3 mmol/L lower
  - Ear/vulva prick
- Time of sampling is important!!

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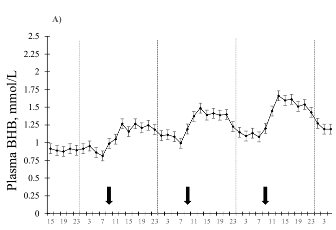
Circadian pattern to blood BHB:



Plasma BHB for multiparous Holstein cows (n=28) between 3 and 14 DIM fitted with jugular catheters and sampled bihourly for 5 days. Dashed grey lines depict 24 h and arrows indicate time of feed delivery. Panel A) plasma BHB for all cows; Time $P < 0.001$. Panel B) plasma BHB by HYK group; Group $P < 0.001$, Time × Group $P = 0.39$.

rtesy of C. R. Seely; Seely et al., *Animal*, 2022

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Applications of hyperketonemia testing

- Identifying individual hyperketonemic cows
  - Cow-side test for treatment decisions
- Identifying herds with hyperketonemia problems
  - Herd-level testing for management decisions

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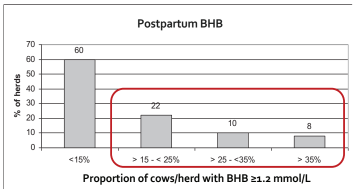
Hyperketonemia at the herd level

- Herds with ≥15 to 25% of sampled cows with elevated postpartum BHB
  - Increased postpartum disease
  - Poorer reproduction
  - Lower milk production

<u>40%</u> of herds above herd alarm level!



Ospina et al., *JDS*, 2010; Chapinal et al., *JDS*, 2012; Kerwin et al., *JDS*, 2022

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Determining herd-level prevalence

- Number of cases of ketosis measured on a single day/ number of cows measured on that day
- *Example:*
  - 20 cows between 3-9 d in milk are measured for ketosis on 06/07/2023
  - 5 diagnosed as ketotic on 06/07/2023
  - Prevalence = 5/20 = 25%
- Most common method of herd-level monitoring
- For ketosis, prevalence is lower than incidence
- Multiply prevalence by 2 to 2.5 to estimate incidence

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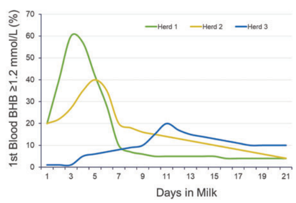
Interpretation of herd-level BHB monitoring

- Goal ≤15% prevalence of cows with BHB ≥1.2 mmol/L
  - Treat hyperketonemic cows according to farm protocols
  - Consider blanket treatment if prevalence is ≥40%
- Monitor prevalence over time
- Prevalence estimates in smaller herds much more variable
- Blood or milk



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How do we reduce dyscalcemia and hyperketonemia in our herds?

40

Fresh cow nutrition

- <u>Access to water</u>
- Access to fresh feed!
- High starch diet with good rumen health/fiber
- Monensin (largest time of impact)
- Other dietary supplements: rumen-protected choline, branched-chain amino acids

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Fresh cow comfort

- Heifers separate from cows if possible
- Stocking density <85%
- Heat abatement
- Good health monitoring

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Fresh pen management is key!

- Ketones and calcium concentrations are great markers of early lactation maladaptation
- Optimize fresh cow disease prevention strategies
- Goal:
  - ↑ cow welfare
  - ↓ disease
  - ↑ milk production
  - ↑ farm profitability

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Summary

- Excessive energy deficit and persistent/delayed hypocalcemia are prevalent.
- Routine monitoring is important.
- Fresh period management and nutrition is key.
- Optimize these to reduce impacts of hypocalcemia and hyperketonemia.

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Acknowledgements

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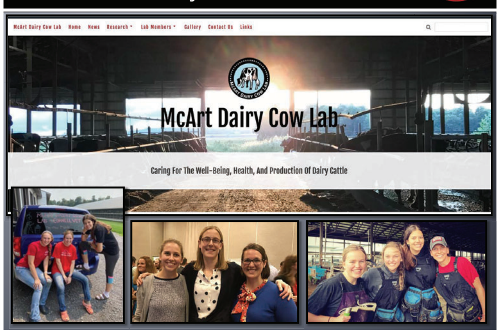
jmcartdvm



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New Concepts in Prenatal and Neonatal Calf Nutrition

Dr. Mike Steele
University of Guelph

New Concepts in Prenatal and Neonatal Calf Nutrition

Michael A. Steele
Professor
Department of Animal Biosciences
UNIVERSITY of GUELPH

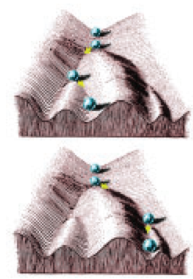
DAIRY at GUELPH

1

"Early Life Programming"

"...early adaptation to a stress or stimuli that permanently changes the physiology and metabolism of the organism and continues to be expressed even in the absence of the stimulus/stress that initiated them..."

Patel and Srinivansan, 2002

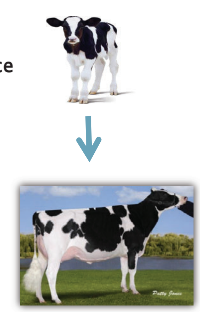


Adapted from Conrad's Waddington epigenetic landscape

2

Early Life Nutrition

- Dietary regimes in early life influence lifetime productivity
- 1kg of pre-weaning ADG = 1,540 kgs of milk in first lactation Soberon et al., 2012



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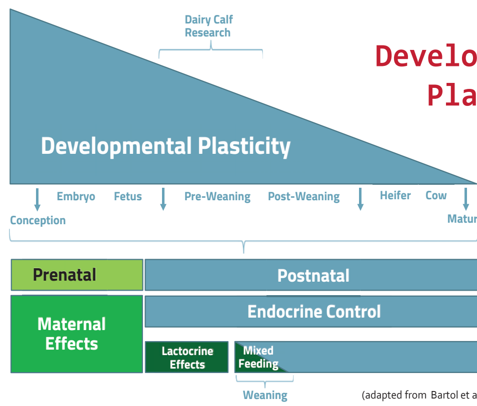
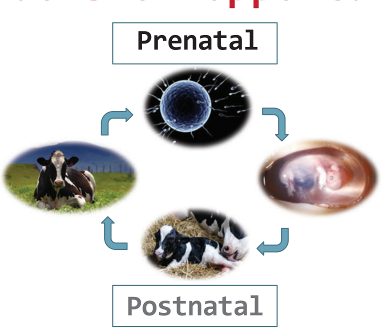
Developmental Plasticity



(adapted from Bartol et al., 2013 and van Niekerk *et al.*, 2021)

4

Windows of Opportunity



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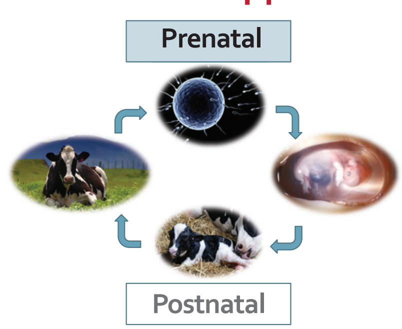
Windows of Opportunity



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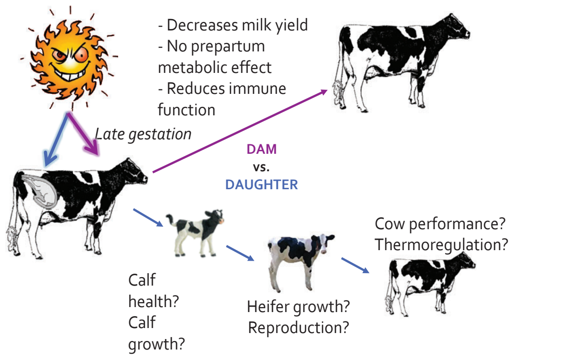
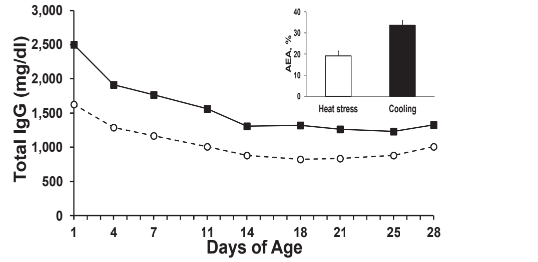


Slide Courtesy of Dr. Dahl

7

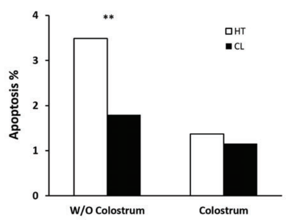
Cooling Improves Total IgG and AEA

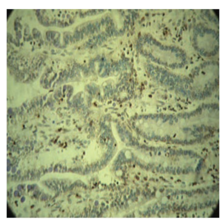


(Tao et al., 2013)

8

In Utero HT Accelerates Gut Closure

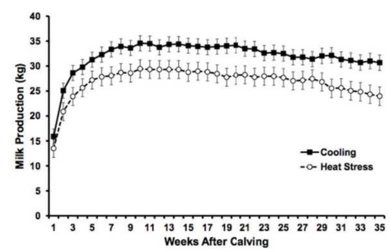




(Ahmed et al., 2021)

9

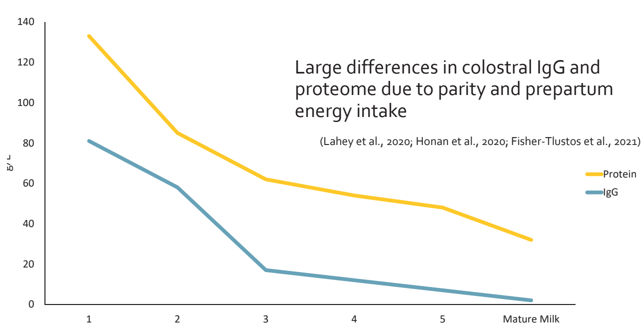
In Utero Heat Stress Reduces Milk Production



(Monteiro et al., *J. Dairy Sci.* 99:8443-8450)

10

Colostrum and Transition Milk



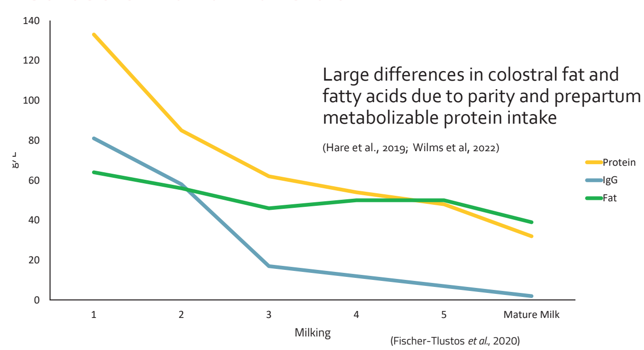
Large differences in colostral IgG and proteome due to parity and prepartum energy intake

(Lahey et al., 2020; Honan et al., 2020; Fisher-Tlustos et al., 2021)

(Fischer-Tlustos *et al*, 2020)

11

Colostrum and Transition Milk



Large differences in colostral fat and fatty acids due to parity and prepartum metabolizable protein intake

(Hare et al., 2019; Wilms et al, 2022)

(Fischer-Tlustos *et al*, 2020)

12

Summary

- Early life stimuli may have long lasting effects (Pre- and Postnatal)
- Epigenetic effects occur in that calf, and can be transmitted to future offspring
- Prepartum management of the cow to improve calf health and performance needs to be considered

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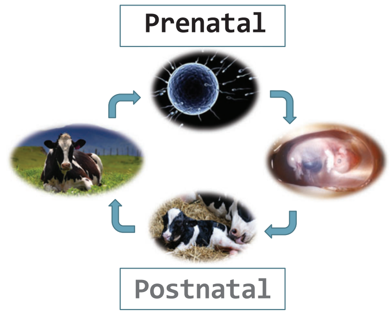
Windows of Opportunity



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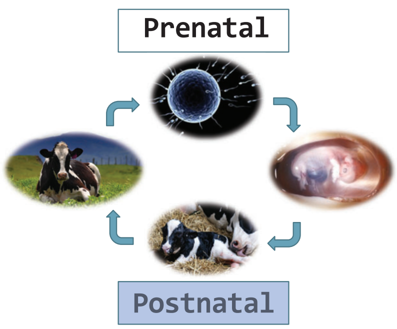
Windows of Opportunity



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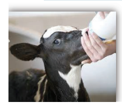
Colostrum Intake

	2 L colostrum	4 L colostrum
n	37	31
ADG, kg	0.80	1.03 *
Age at conception, (months)	14.0	13.5 ns
Survival through 2nd lact., (%)	75.7	87.1 *
Milk yield through 2nd lact., (kg)	16,015	17,042 *

*P<0.05; ns P>0.1



Inadaquate colostrum intake reduces lifetime production

(Faber et al., 2005)

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Failure in passive immune transfer...

- **Delayed age at first calving**
  Waltner-Toews et al., 1986
- **Decreased milk and fat production at first lactation**
  Nocek et al., 1984; Robinson et al., 1988; Faber et al., 2005
- **Decreased average daily gain to 180 days**
  DeNise et al., 1989; Soberon et al., 2011
- **Negatively impacts feed efficiency**
  Soberon et al., 2011

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Colostrum Basics

(Fischer-Tlustos *et al.,* 2021)

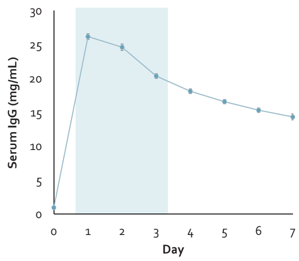
18

ASSESSING PASSIVE TRANSFER ON FARM

Serum total protein (STP)
>5.2 g/dl = passive transfer

TPI category	Serum IgG category (g/L)	Equivalent TP (g/dL)	Equivalent Brix %
Excellent	≥25.0	≥6.2	≥9.4
Good	18.0–24.9	5.8–6.1	8.9–9.3
Fair	10.0–17.9	5.1–5.7	8.1–8.8
Poor	<10.0	<5.1	<8.1

Lombard et al., 2020



Sample calves for passive transfer on days 1-3 after birth – after day 4 is too late

(Cantor *et al.,* 2022)

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Colostrum – Is it all the same?

	Colostrum Types		
	Fresh	Pasteurized	Dried
Pros	• Tailored for the calf • All bioactive molecules and cells	• Can affect the quality • Reduce bacterial load	• Convenient • Clean and consistent
Cons	• Opportunity for contamination • Difficult to test quality	• Destroys healthy bacterial and immune/developmental cells • Bioactive molecules may become less active (if not managed properly)	• Destroys healthy bacterial and immune/developmental cells • Bioactive molecules may become less active • Some products are missing major macronutrients

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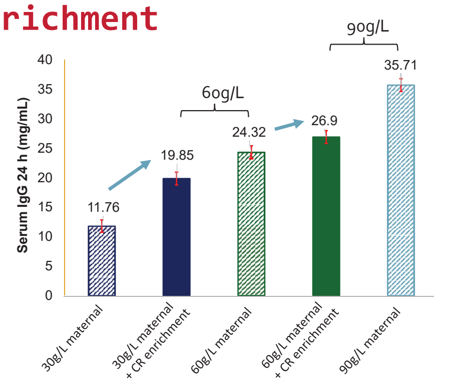
Colostrum Enrichment

GOOD QUALITY COLOSTRUM
>50 g of IgG/L
>200 g of IgG total
~3-4 L of good quality colostrum

Enriching low-quality colostrum with CR may be a feasible strategy to ensure passive transfer



(Lopez *et al.,* 2022)

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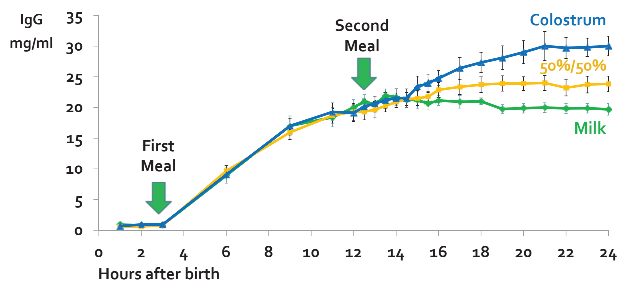
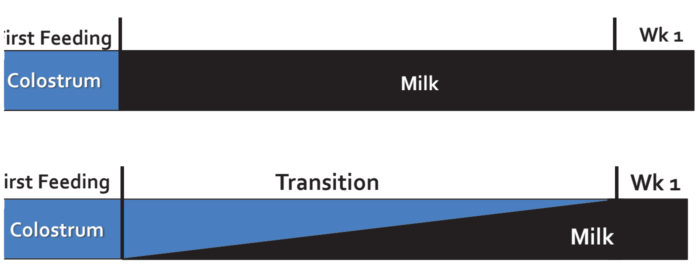
Feeding a Second Meal of Colostrum



(Hare et al., 2020)

22

From Colostrum to Milk



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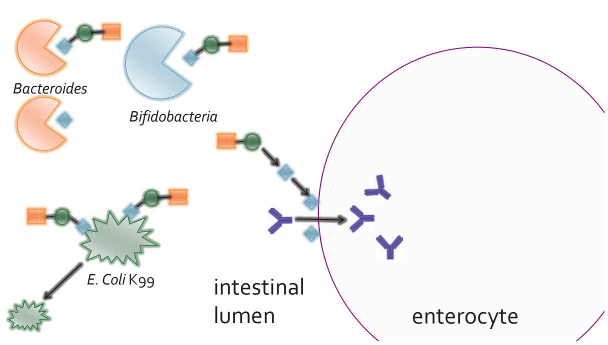
Colostrum Oligosaccharides



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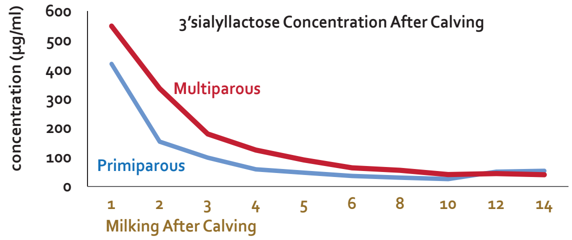
Oligosaccharides – Transition



Oligosaccharides are produced in higher concentrations immediately after parturition

(Fischer et al., 2020)

25

Fatty Acids – Transition

PUFA	%FA Change from colostrum to whole milk
Omega-6 FA	**↓36.2%**
Omega-3 FA	**↓43.9%**
Linoleic acid	↓29.8%
α-Linolenic acid	No change
Arachidonic acid	↓71.6%
EPA	↓72.2%
DHA	↓67.4%

(Wilms et al., 2021)

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From Colostrum to Milk

	Unit	Colostrum Milking					Mature Milk
		1	2	3	4	5	
Dry Matter	%	24.5	19	16	15.5	15.3	12.2
Fat	%	6.4	5.6	4.6	5	5	3.9
Protein	%	13.3	8.5	6.2	5.4	4.8	3.2
Essential Amino Acids	mM	390	230	190	140	115	
Lactoferrin	g/L	1.84	0.86	0.46	0.36		
Insulin	µg/L	65	35	16	8	7	1
Growth Hormone	µg/L	1.5	0.5				
Insulin-like growth factor I	µg/L	310	195	105	62	49	

Improved health status in calves fed transition milk

(Conneely et al., 2014)

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Extended Colostrum Feeding

50% Colostrum/50% Milk
Days 2-3
- ↑ intestinal development
- ↑ IgG after 12h of life
- ↓ risk of mortality

10% CR/90% MR
Days 2-14
- ↑ body weight
- ↑ average daily gain
- ↓ risk of mortality

(Pyo *et al.*, 2020; Hare *et al.*, 2021; McCarthy *et al.*, 2022)

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Summary

- Colostrum management can have lifelong consequences
- Improving colostrum quality, quantity, quickness and cleanliness when feeding is essential
- Colostrum and transition milk include an array of bioactive molecules such as hormones, antimicrobials peptides, oligosaccharides and fatty acids that are tailored for the calf

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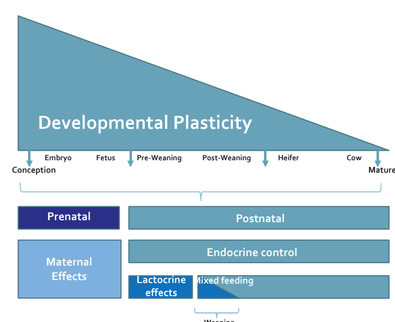
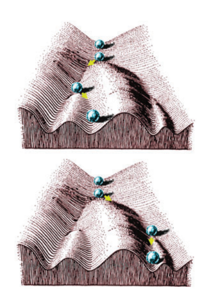
Developmental Plasticity





(Adapted from Bartol et al., 2013)

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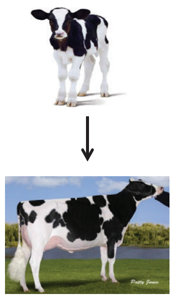
Early Life Nutrition



- Dietary regimes in early life influence lifetime productivity
- 1 kg of pre-weaning ADG = 1,540 kgs of milk in first lactation

(Soberon et al., 2012)

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Milk Feeding… What Are We Doing?

vs

Calf nurses:	6-8 times	1-3 times
Time per meal:	5-10 min.	1-3 min.
Milk consumption:	16%-24% BW as milk	8%-10% BW as milk
Milk intake DM:	Up to 1.59 kg	Around 0.45 kg
Feeding method:	Teat	Teat or Bucket
Weaning method:	Gradually (4-6 mths)	Abrupt (6-8 wks)

(Hafez and Lineweaver, 1958)

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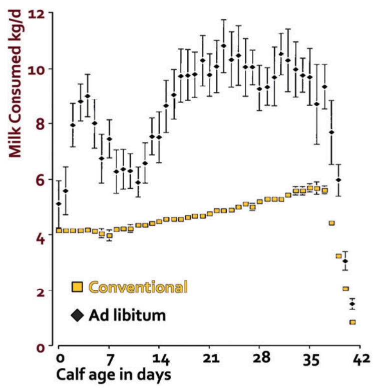
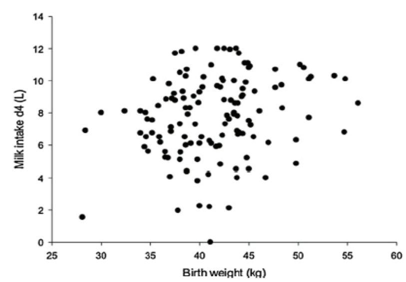
Normal Pre-Weaning Milk Intake



sper and Weary, 2002)

33

Normal Pre-Weaning Milk Intake



(de Passille et al., 2016)

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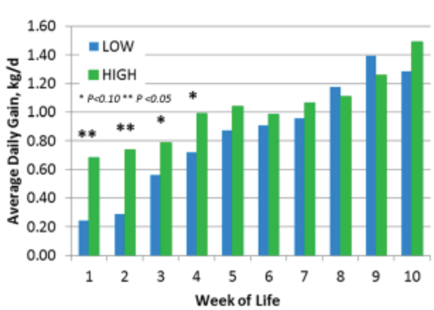
5 (Low) vs 10L (High)



(Haisan et al., 2018)

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Milk Supply & Organ Development

RESTRICTED: 0.6 kg/d MR **ENHANCED:** 1.3 kg/d MR

	Restricted (n=6)	Enhanced (n=6)	P value
Birth weight, kg	39.2	39.7	0.90
Weight at 54d, kg	61.0	83.2	< 0.01
MJ above maintenance, MJ	3.7	15.7	< 0.01

(Soberon and Van Amburgh, 2011)

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Milk Supply & Organ Development

RESTRICTED: 0.6 kg/d MR   **ENHANCED:** 1.3 kg/d MR

	Restricted (n=6)	Enhanced (n=6)	P value
Pancreas, g	32.90	29.47	0.61
Pancreas, % of BW	0.06	0.04	0.11
Liver, kg	1.35	2.35	< 0.01
Liver, % of BW	2.23	2.84	< 0.01
Kidney, g	183.60	319.72	0.02
Kidney, % of BW	0.30	0.38	0.09
Mammary gland, g	75.48	337.58	< 0.01
Parenchyma, g	1.10	6.48	< 0.01
Parenchyma, % of BW	0.002	0.008	< 0.01

(Soberon and Van Amburgh, 2011) Cornell University

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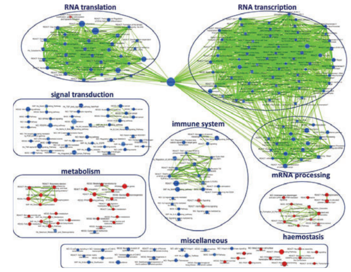
Change in Gene Expression Profiles

	Changed (P<0.01)
Mammary	654
Fat	1045
Liver	176
Bone marrow	435
Muscle	651
Pancreas	103



(Hare et al. 2019; Leal et al., 2019)

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Feeding Large Meals

- Calves typically nurse 6-12 times per day in the first weeks of life (Jensen, 2004)
- Larger meals fed less frequently increase the risk of:
- Abomasal inflammation & lesions
  - Milk overflow into the rumen
  - Ruminal acidosis, decreased passage rate and digestion

(Berends et al., 2012; 2015)

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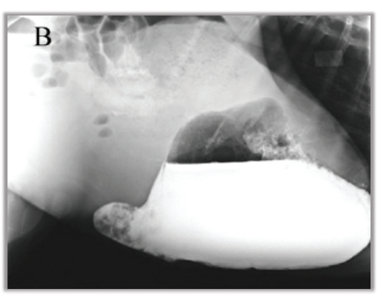
Abomasal Capacity

- Young calves fed 2 litres of milk per meal (3 x)
- Offered ad libitum meal of milk with barium sulfate
- Most calves drank more than 5 litres with no evidence or ruminal overflow



(Ellingsen et al., 2016)

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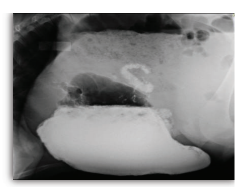
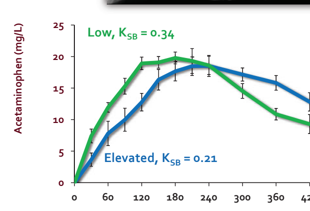
Larger Meal Size and Insulin Sensitivity



Compared calves fed elevated (8L/d) vs low (4L/d) plane of milk 2x per day

- No evidence of post-prandial hyperglycemia and hyperinsulinemia
- No difference in glucose tolerance
- Slower (41% reduction, P = 0.02) abomasal emptying rates during the pre-weaning phase

(MacPherson et al., 2016)



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Best Innovation in Calf Feeding in Recent Years:

2 L 3 L 4 L

3-L and 4-L nursing bottles!

Allows us to design feeding system to meet calf requirements

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Should Intake be The Same?

Slide Courtesy of Dr. VanAmburgh

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Amount of Milk Replacer/Milk Dry Matter Required to Meet Maintenance Requirements (kg/d)

BW kg	Temperature, °C						
	20	10	0	-10	-15	-20	-30
27	0.27	0.36	0.41	0.45	0.5	0.54	0.64
36	0.36	0.41	0.5	0.59	0.64	0.68	0.77
45	0.45	0.5	0.59	0.73	0.77	0.82	0.91
55	0.5	0.59	0.68	0.77	0.86	0.91	1.05

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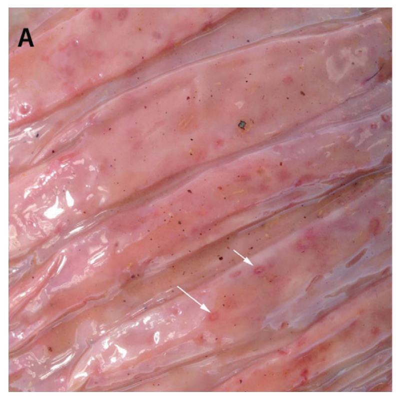

Inconsistent Milk Feeding Leads to Abomasal Lesions

Slide Courtesy of Dr. Smith

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Slide Courtesy of Dr. Smith

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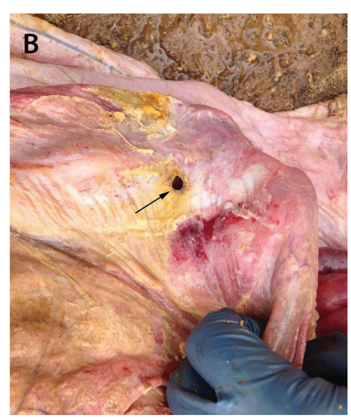

Slide Courtesy of Dr. Smith

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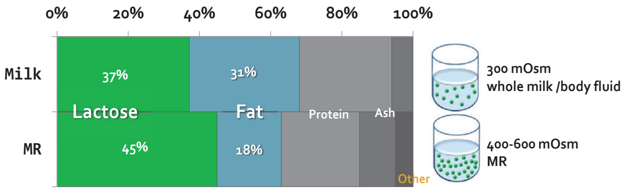
Milk Replacer vs. Whole Milk

Most MR are high in lactose and osmolarity, low in fat compared with whole milk



- Higher lactose results in increased gastric emptying and decreased insulin sensitivity in the first week of life

(Welboren et al., 2021)

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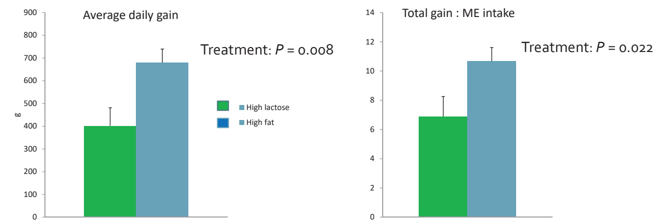
Growth



Calves fed the high fat MR gained more per unit of ME intake after energy requirements for maintenance were met, more energy was available to be retained

(Welboren *et al.*, 2021)

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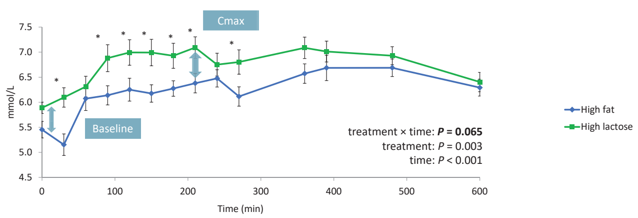
Postprandial Glucose



Greater quantities of MR containing more lactose entered the small intestine in high lactose calves

(Welboren *et al.*, 2021)

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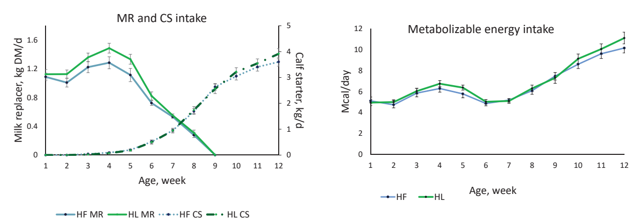
High fat in milk replacer has lower intake (*ad lib*)

High Fat vs. High Lactose



(Echeverry-Munera *et al.*, 2021)

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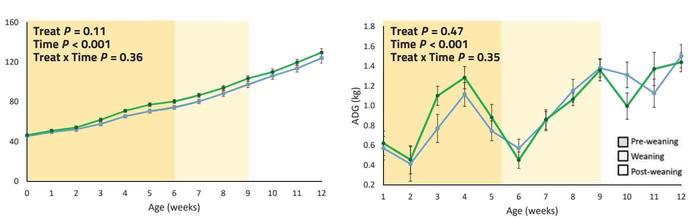
High Fat vs. High Lactose



(Echeverry-Munera *et al.*, 2021)

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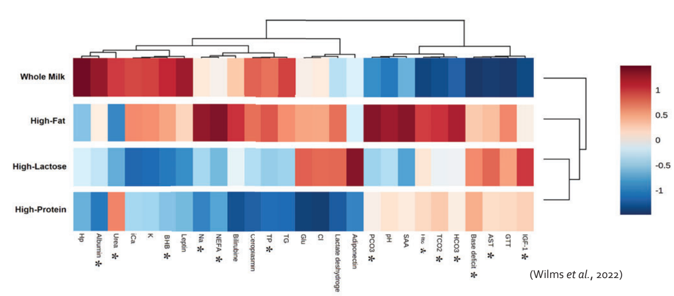
Minimal differences in growth but large differences in metabolic fingerprint



(Wilms *et al.*, 2022)

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What is Happening in Infant Nutrition These Days?

- Breastfeeding reduces the risk of metabolic syndrome throughout life

(Horta, 2007)

- Lowering protein in infant formulas was associated with reduced risk of obesity in early childhood

(Weber, 2014)

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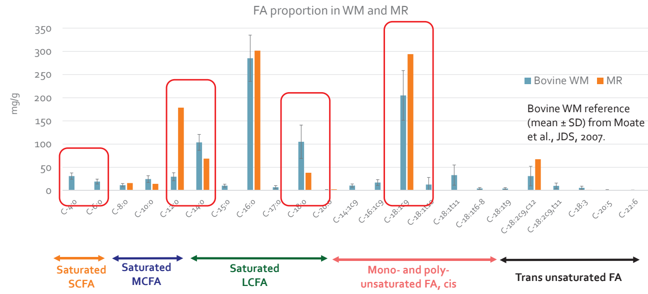
Palmitic & Oleic are The Most Abundant FA in Bovine Milk



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Summary

- **Large quantities of milk in early life when starter intake is depressed promotes growth**
- **If feeding times per day is limited, the calf can regulate by decreasing abomasal emptying**
- **The environmental temperature has a large impact on milk feeding regimens**
- **Some milk replacer formulations may be causing gut health and metabolic problems in calves**

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Economics of Transition Cow Health

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Economics of Transition Cow Health

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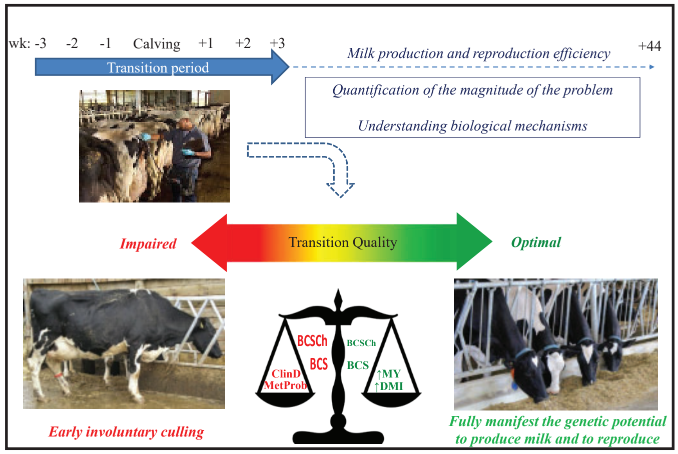
Four State Dairy Nutrition and Management Conference
Dubuque, IA - June 7, 2023

eribeiro@uoguelph.ca



Transition Quality Features

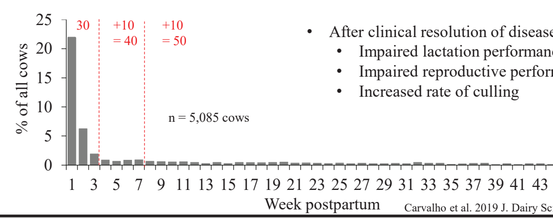
Parameter	Impaired	Optimal
Length of dry period	< 30, > 60 days	40-50 days
BCS at dry-off	> 3.5	3.0-3.5
BCS at calving	< 3.0, > 3.5	3.0-3.5
Calving	Dystocia, twins	Eutocia, single calf
Feed intake	Poor appetite	Good appetite
Postpartum loss of BCS	≥ 1 unit	< 1.0 unit
Health	Clinical disease	No clinical disease
	HypoCa, HyperKeto	No metab. problems

Impaired ← Transition Quality → *Optimal*

Postpartum Clinical Diseases – ClinD (Collective Effect)

● RP ● Metritis ● Mastitis ● Lameness ● Digestive problem ● Respiratory problem

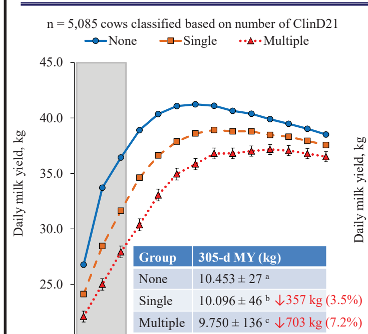
Window	Average
By 305 DIM	~ 50%
By 60 DIM	~ 40%
By 21 DIM	~ 30%



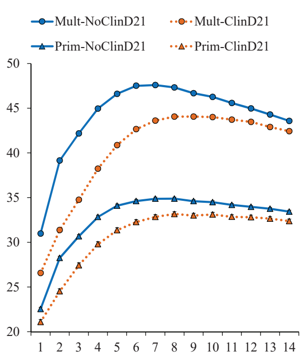
- Most cases are solved shortly after diagnosis
- During clinical presentation of the disease:
  - Expenses with drugs, supplies, labor
  - Cow welfare concerns
  - Toll on farmer and staff well-being
- After clinical resolution of disease:
  - Impaired lactation performance
  - Impaired reproductive performance
  - Increased rate of culling

Carvalho et al. 2019 J. Dairy Sci. 102:11701–11717

Long-term Consequences of ClinD on Lactation Performance



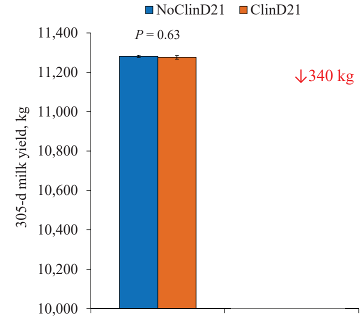
Cows that left the herd before 100 DIM did not contribute with 305-d MY data

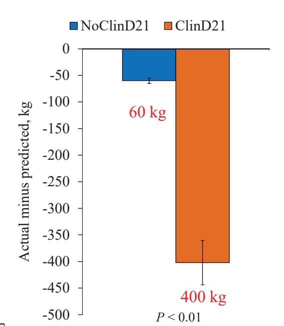


Carvalho et al. 2019 J. Dairy Sci. 102:11701–11717

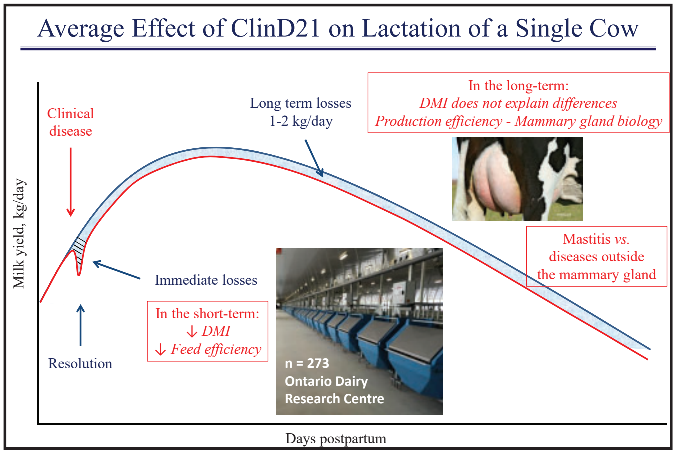
Effect of ClinD21 on 305-d Yield in First Lactation Cows: Genomic Prediction *vs.* Actual Production

n = 2,415 primiparous cows

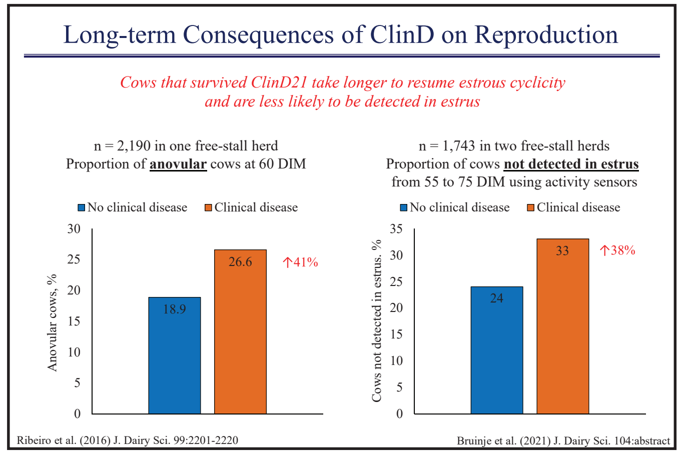




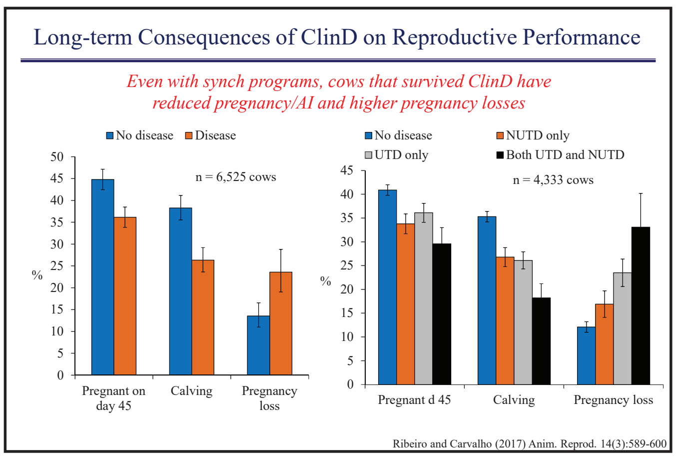
Carvalho et al. 2019 J. Dairy Sci. 102:11701–11717



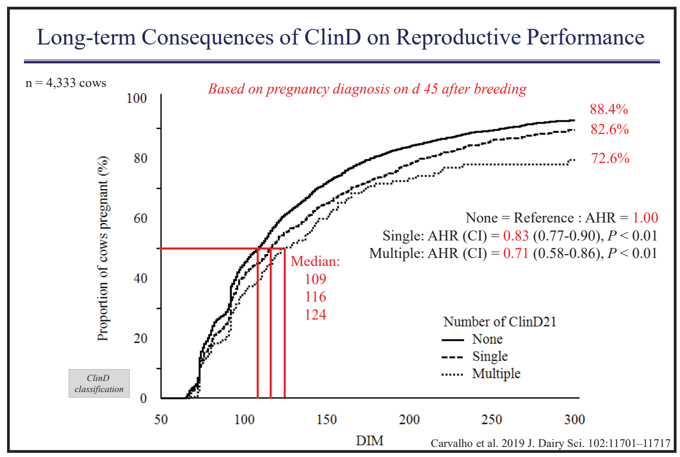
Average Effect of ClinD21 on Lactation of a Single Cow
Clinical disease
Long term losses 1-2 kg/day
In the long-term:
DMI does not explain differences
Production efficiency - Mammary gland biology
Milk yield, kg/day
Immediate losses
Mastitis vs. diseases outside the mammary gland
In the short-term:
↓ DMI
↓ Feed efficiency
Resolution
n = 273
Ontario Dairy
Research Centre
Days postpartum



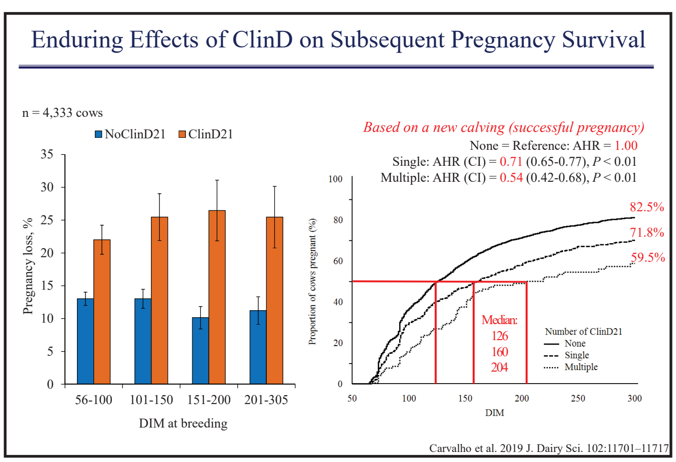
Long-term Consequences of ClinD on Reproduction
Cows that survived ClinD21 take longer to resume estrous cyclicity
and are less likely to be detected in estrus
n = 2,190 in one free-stall herd
Proportion of anovular cows at 60 DIM
n = 1,743 in two free-stall herds
Proportion of cows not detected in estrus
from 55 to 75 DIM using activity sensors
No clinical disease
Clinical disease
Anovular cows, %
18.9
26.6
↑41%
Cows not detected in estrus, %
24
33
↑38%
Ribeiro et al. (2016) J. Dairy Sci. 99:2201-2220
Bruinje et al. (2021) J. Dairy Sci. 104:abstract



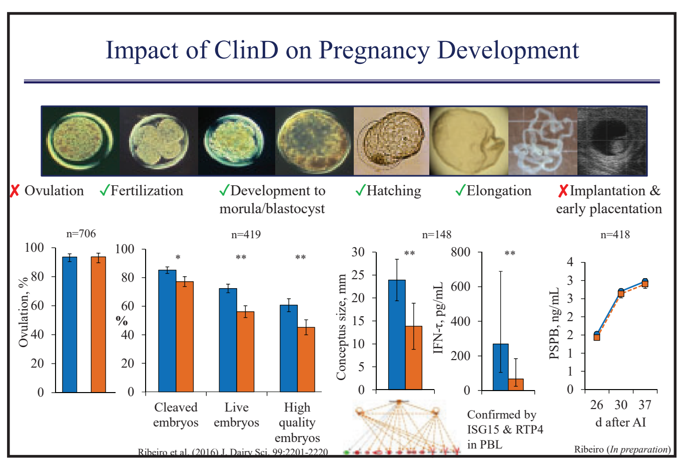
Long-term Consequences of ClinD on Reproductive Performance
Even with synch programs, cows that survived ClinD have
reduced pregnancy/AI and higher pregnancy losses
No disease
Disease
n = 6,525 cows
Pregnant on day 45
Calving
Pregnancy loss
No disease
NUTD only
UTD only
Both UTD and NUTD
n = 4,333 cows
Pregnant d 45
Calving
Pregnancy loss
Ribeiro and Carvalho (2017) Anim. Reprod. 14(3):589-600



Long-term Consequences of ClinD on Reproductive Performance
n = 4,333 cows
Based on pregnancy diagnosis on d 45 after breeding
88.4%
82.6%
72.6%
Proportion of cows pregnant (%)
None = Reference : AHR = 1.00
Single: AHR (CI) = 0.83 (0.77-0.90), P < 0.01
Multiple: AHR (CI) = 0.71 (0.58-0.86), P < 0.01
Median:
109
116
124
Number of ClinD21
None
Single
Multiple
ClinD classification
DIM
Carvalho et al. 2019 J. Dairy Sci. 102:11701–11717

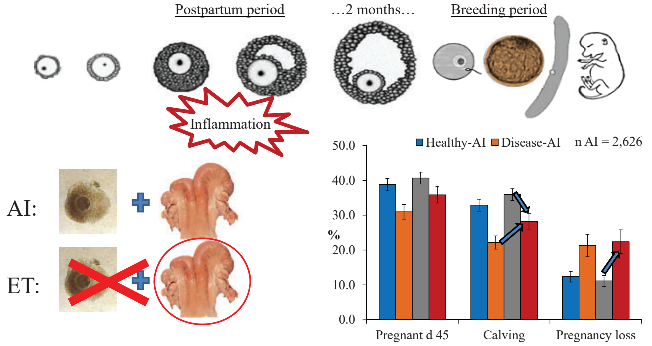


Enduring Effects of ClinD on Subsequent Pregnancy Survival
n = 4,333 cows
NoClinD21
ClinD21
Pregnancy loss, %
56-100
101-150
151-200
201-305
DIM at breeding
Based on a new calving (successful pregnancy)
None = Reference: AHR = 1.00
Single: AHR (CI) = 0.71 (0.65-0.77), P < 0.01
Multiple: AHR (CI) = 0.54 (0.42-0.68), P < 0.01
82.5%
71.8%
59.5%
Median:
126
160
204
Number of ClinD21
None
Single
Multiple
Carvalho et al. 2019 J. Dairy Sci. 102:11701–11717



Impact of ClinD on Pregnancy Development
✗ Ovulation
✓Fertilization
✓Development to morula/blastocyst
✓Hatching
✓Elongation
✗Implantation & early placentation
n=706
n=419
n=148
n=418
Ovulation, %
Cleaved embryos
Live embryos
High quality embryos
Conceptus size, mm
IFN-τ, pg/mL
Confirmed by ISG15 & RTP4 in PBL
PSPB, ng/mL
d after AI
Ribeiro et al. (2016) J. Dairy Sci. 99:2201-2220
Ribeiro (In preparation)

Oocyte Quality *vs.* Uterine Environment
Should I Use ET to Bypass the Oocyte Quality Problem?



Ribeiro et al. (2016) J. Dairy Sci. 99:2201-2220

Should the Voluntary Waiting Period (VWP) be Extended to Avoid The Carryover Problems of ClinD21?

The short answer is **NO** because

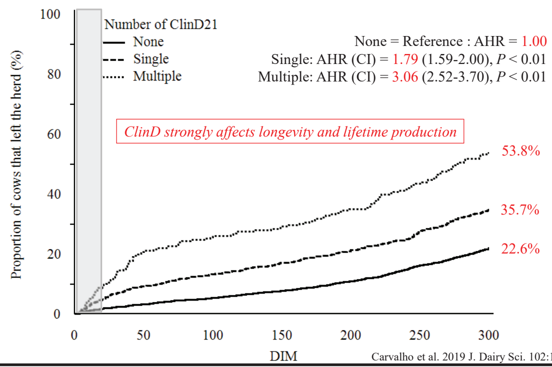
- ClinD effects on pregnancy per AI seem to last through 100-150 DIM
- ClinD effects on pregnancy losses seem to last through 200-305 DIM
- VWP is determined based on the optimal time for pregnancy
  - Compared to healthy cows, cows with ClinD have
    - Reduced milk production
    - Reduced 21-d preg rate

Two reasons to shorten the VWP, not to extend VWP

Ribeiro et al. (2012) Anim. Reprod. 3:370-387

Long-term Consequences of ClinD21 on Culling

n = 5,085 cows



Carvalho et al. 2019 J. Dairy Sci. 102:11701–11717

Economics of ClinD21

- Budget + sensitivity analyses for individual cows (n = 5,085)

Antonatti et al. 2022 J. Dairy Sci.105 (Suppl. 1):42.

Revenue
- Milk sales (kg × price)
  - Mod $0.44/kg
  - Low $0.35/kg
  - High $0.53/kg

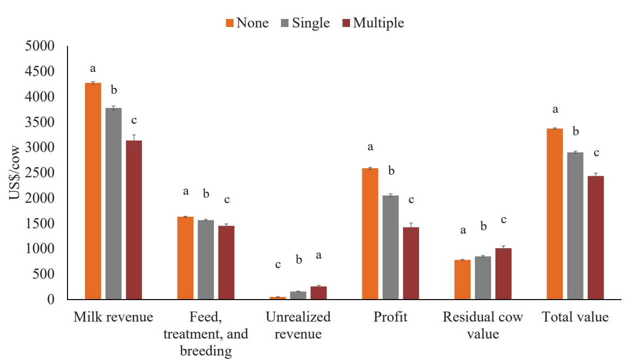
Expenses
- Feed costs (DMI × cost/kg)
  DMI based on NE
  TMR=1.6 Mcal/kg
  Milk=0.69Mcal/kg
  0.08 Mcal/MBW
  Cost/kg of DM:
  - Mod $0.26/kg
  - Low $0.22/kg
  - High $0.30/kg
- Treatment costs*
- Breeding costs*
**Include labor, drugs, and supplies*

Unrealized revenue
- Milk withdraw (kg × price)
- Salvage value for cows that died
  - Mult = $1,100
  - Prim = $1,009

Residual cow value
- Cumulative cash flow projection for each cow and her replacements until 4,000 d after the start of the experiment.
- Daily model by DeVries et al. (2016):
  Parity
  Preg status
  DIM censored

= *Profit in the 305-d lactation cycle* + *RCV* = *Total value*

Economics of ClinD21 (US$)



Antonatti et al. 2022 J. Dairy Sci.105 (Suppl. 1):42.

Sensitivity Analyses with Milk Price and Feed Cost: Total Value Difference between ClinD21 and NoClinD21

	Feed Cost ($/kg)					
	Low (0.22)		Moderate (0.26)		High (0.30)	
Milk Price ($/kg)	noClinD21	ClinD21	noClinD21	ClinD21	noClinD21	ClinD21
Low (0.352)	2751.45[a] (±10.28)	2316.85[b] (±15.51)	2518.2[illegible] (±9.48[illegible]	[illegible]112.55[b] [illegible]14.31)	2284.95[a] (±8.80)	1908.24[b] (±13.28)
Moderate (0.44)	3599.81[illegible] (±14.1[illegible]	[illegible]039.09[b] [illegible]21.32)	3366.57[a] (±13.08)	2834.79[b] (±19.75)	3133.32[a] (±12.09)	2630.48[b] (±18.25)
High (0.528)	4448.18[a] (±18.51)	3761.33[b] (±27.93)	4214.93[a] (±17.36)	3557.02[b] (±26.20)	3981.69[a] (±16.24)	3352.72[b] (±24.51)

$377 ↓17%

$502 ↓15%

$687 ↓15%

Canada US$ 0.585/L

$740 ↓15%

[a, b] $P < 0.01$ *within price/cost scenario*

Antonatti et al. 2022 J. Dairy Sci.105 (Suppl. 1):42.

Why Do Economics of ClinD21 Matter?

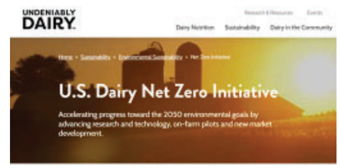
- For planning and decision making…
- Cost of ClinD21 = US $500 per case
  - Current scenario: 30% of cows with of ClinD21
  - Goal: reduce to 20% (10 percentage points difference)
- Room for investment:
  - Herd size × percentage reduction in ClinD21 × average cost of ClinD21:
    - Example: 2,000 calvings/year × 10% = 200 fewer cows with ClinD21
      200 * $500 = $100,000/year
- How do I get there:
  - Low hanging fruit opportunities: little to no cost
    - Example: feed bunk management, maternity management
  - Continuous investment: $/cow/d
    - Example: transition diet for 42 d → $100,000 ÷ 2,000 cows ÷ 42 d = $1.19/cow/d
  - Lump-sum investment: cost recovery analyses
    - Example: infrastructure investment of $500,000 to recover cost in 7 years

The Benefits Go Beyond Our Calculations…

Today, it is still difficult to put a $$$ value on:
- New revenue opportunities (e.g. beef on dairy using beef semen or embryo transfer)
- Environmental impact
- Farmer wellbeing
- Consumer acceptability

Possible additional benefits of managing for less ClinD21:
- Health and performance of cows without ClinD21

Possible additional effects of ClinD:
- Health and performance on subsequent lactation cycles
- Feed efficiency
- Progeny



Carbon Footprint (g of CO_{2eq} per kg of milk)

- From birth to first calving: ~5,000 kg of CO_{2eq}
- Dilution of emissions associated with the calf/heifer period:

Number of Lactations	1	2	3	5	8
kg CO_{2eq} (CF[1]) per cow	10,200	15,400	20,600	31,000	46,600
g CO_{2eq} (CF[1]) per kg milk	1280	960	860	770	730

[1]CF = carbon footprint (CO_2 × 1; CH_4 × 23; N_2O × about 296).

- Dilution of emissions associated with energy intake for maintenance:

Parameter	Dry Matter Intake (kg/d)				
	10	15	20	25	30
Energy intake (MJ NE_L/d)	70	105	140	175	210
Energy maintenance (% of total NE_L[†]-intake)	53.9	35.9	26.9	21.5	18.0
Theoretical milk yield (3.3 MJ NE_L/kg milk)	9.8	20.4	31.0	41.6	52.2
MJ NE_L/kg of milk including energy for maintenance	7.1	5.1	4.5	4.2	4.0
Protein yield (g/cow and day)	333	694	1054	1414	1775
Methane emission[♦]					
(g/d)	240	360	480	600	720
(g/kg milk)	24.5	17.6	15.5	14.4	13.8
Carbon footprint (CF)[§] (g of CO_{2eq}/kg of milk)	825	605	530	495	475

[†] NE_L, net energy lactation; [♦] According to Flachowsky and Brade [3]: 24 g of CH_4/kg DM intake (DMI) for all diets; [§] Calculated on the basis of the greenhouse gas potential of CH_4 (CO_2 × 23) and the calculations by Dämmgen and Haenel [41].

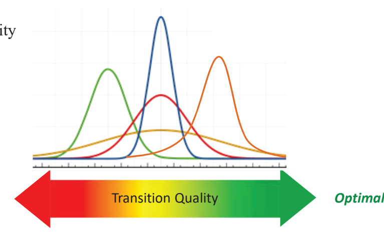
von Soosten et al. (2020) Dairy 1:20-29; doi:10.3390/dairy1010003

The Benefits Go Beyond Our Calculations…

Improvements in transition management:
↑ Production efficiency
↑ Lifetime production
↓ Environmental impact

↑ Animal welfare
↓ Use of antibiotics
↓ Use of repro hormones
↑ Stewardship
↑ Consumer acceptability

↑ Farmer wellbeing
↑ Profitability



Prevention of Clinical Diseases

- Genetics
  - Include health, reproduction, and longevity traits into the selection program

- Infrastructure
  - Invest in cow comfort, cleanness
  - Minimize stress (environmental, social, biological)

- Management of cows and personnel training
  - Dry-off management, pen moves,…
  - Interventions in the maternity pen
  - Nutrition

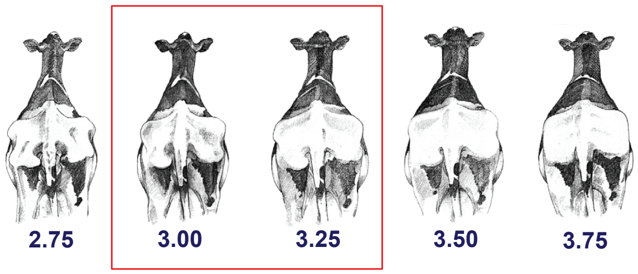
Nutritional Management of Transition Cows

Monitoring BCS
Feed bunk management

Feed ingredients, formulation, and consistency of TMR delivery:
- Forage quality and particle size
- Protein source (RDP, RUP, MCP)
- Energy density of pre- and postpartum diets
- Mixing equipment and procedures

Supplements:
- Anionic salts or zeolites in prepartum diet
- Rumen protected choline, AA, and vitamins
- Alternative sources of trace minerals (organic and hydroxy TMs)
- Fatty acids

Monitoring BCS at Dry-off and Calving



Figures: Courtesy of Elanco Animal Health

Loss of BCS during Dry Period Is Associated with Postpartum Health Problems and Poorer Performance

n = 16,104 dry-offs from 9,950 Holstein cows in two free-stall herds in CA

Item	Change of BCC during the dry period				*P*
	≥ +0.25 (small gain)	0 (no change)	-0.25 a -0.5 (small lost)	≤ -0.75 (large lost)	
Clinical disease, %	15.0[a]	17.4[a]	24.7[b]	34.2[c]	< 0.01
P/AI, %	41.9[a]	33.1[b]	28.3[c]	20.8[d]	< 0.01
Culling by 60 DIM,%	5.1[a]	4.5[a]	7.6[b]	15.4[c]	< 0.01
BCS at dry-off, 1-5 scale	3.29	3.51	3.75	4.08	< 0.01
BCS at calving, 1-5 scale	3.58	3.47	3.37	3.19	< 0.01

Chebel and Ribeiro 2016 Vet Clin Food Anim 32 (2016) 267-284

Early Diagnosis of Disease + Most Effective Treatment

- Goal:
  - Minimize the consequences of disease
- How?
  - Identify a sick cow (or one that will become sick) as soon as possible
  - Treat with the most effective protocol
- Why?
  - Days in the hospital pen
  - Severity of a clinical case
  - Number of clinical cases

Positively associated with subsequent reductions in performance

⟶ *Avoid prolonged lock-up time & excessive handling*

Automated Monitoring Systems:

Take Home Messages

- Transition quality is a spectrum, complex to quantify, and has a large impact on subsequent performance and production efficiency
- Suboptimal transition limits the cow's ability to manifest her full genetic potential to produce milk and to reproduce, which impairs longevity and lifetime production
- Investments in transition management, when effective, normally result in excellent ROI and should be considered as part of programs aiming better sustainability
- In addition to prevention, early diagnosis and effective treatment of ClinD are also important to minimize the consequences of diseases

Acknowledgments

NSERC CRSNG
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OCE Where Next Happens
ourofino saúde animal
Rehagro
Ontario Agri-Food Innovation Alliance
University of Guelph Food from Thought

Thanks for your attention! eribeiro@uoguelph.ca

Penny-wise, dollar fools:
Goofy things that we do in dairy nutrition…

Normand St-Pierre, Ph.D.
Professor Emeritus
The Ohio State University

Penny-wise, dollar fools:

Goofy things that we do in dairy nutrition…

N. St-Pierre, Ph.D.

Professor Emeritus, The Ohio State University

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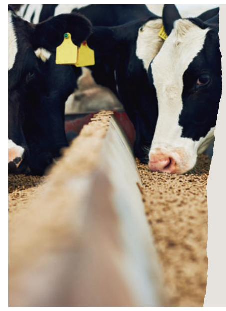


- 1: You don't feed **a cow** but a **bunch of cows**!

2

In a large High group pen..

Body weight: 1,300 to 1,800 lbs

Milk yield: 70 to 140 lbs/d

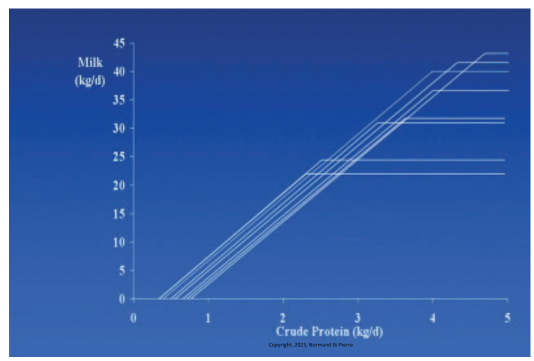
Butterfat: 3.4 to 4.4%

Protein: 2.8 to 3.4%

Other solids: 5.6 to 5.9%

So which cow do you balance the ration for?

3



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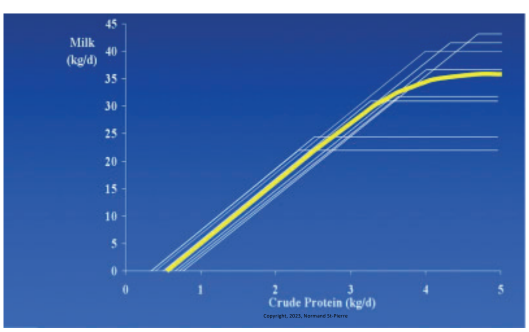
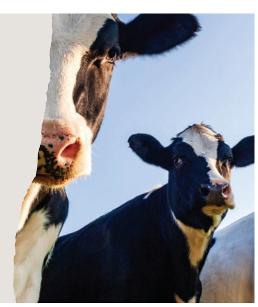


5

- Determining where on this curve (or group of curves) are the cows on a given farm.

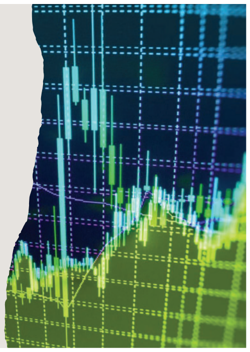


6

The Art of Nutrition

- Determining where on this curve (or group of curves, are the cows on a given farm.
- Supply the nutrient at a level where the slope of the curve is equal to the ratio of the price of the input over the price of the output.

(good luck…)



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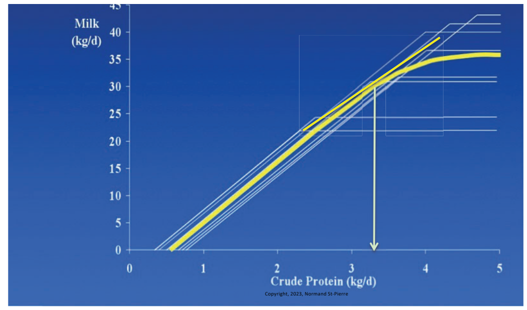

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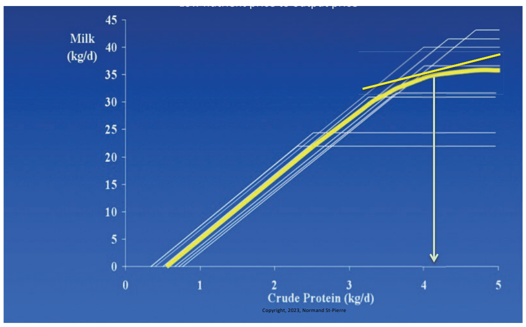
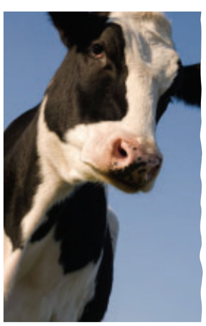


9

Goofy #1

- We really don't know where we are on the response curve…
- If you put a "target" cow in your nutrition software and the predicted milk output is the same as that of the pen, then
- **… the model is WRONG!!!**

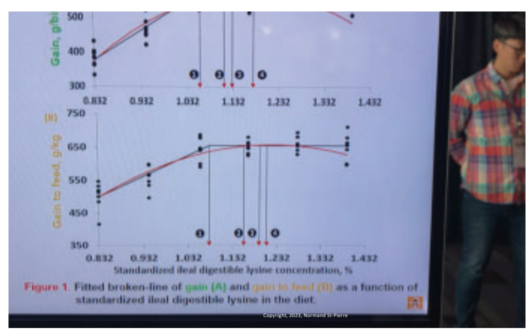
10



Goofy #2

- We strongly believe that cows have nutritional **requirements**…
- … but we have a hard time defining "requirements"…

11



12

Goofy #2

- To have ***a*** requirement, the response curve must break at some point.
- If the response is smooth and reaches a maximum (i.e., the requirement), the laws of economics say that you would never supply the nutrient at the requirement level – **always less** – unless the nutrient is free, or the value of milk is infinite…
- Wouldn't this be a welfare issue?
  - "Freedom from hunger and thirst".

13

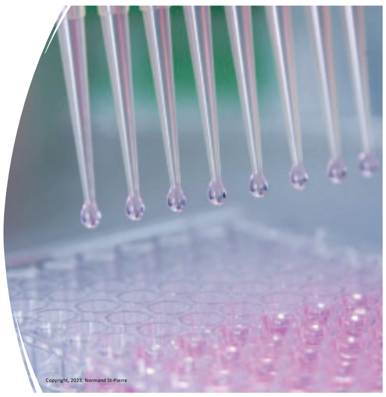
Goofy #2

A **requirement** means something very different than **to require!**

14

Goofy #3

- We ignore **analytical variation**
  - i.e., what is the precision of the assay?



15

Goofy #3

- What is the precision of a Kjeldahl assay? — AV = 2% minimum
- What is the precision of a NDF assay? — AV = 5% minimum
- What is the precision of AA assay?
- What is the precision of an NDF digestibility in situ per time point assay?

16

Apparent variation in Lys content (% as is)

	Lab #1	Lab #2
August	7.79	7.44
	7.67	7.69
September	7.69	6.93
	7.71	7.25
October	8.00	7.92
	8.03	7.76
Mean	7.82	7.50
C.V. (%)	**2.1**	**4.9**

17

Goofy #3

- What is the precision of a Kjeldahl assay? — AV = 2% minimum
- What is the precision of a NDF assay? — AV = 5% minimum
- What is the precision of AA assay? — AV = 2 - 4%
- What is the precision of an NDF digestibility in situ per time point assay? — Don't know…

18

Goofy #4

- We keep sampling feeds, but we really haven't figured out what to do with the results.

19

Stochastical Control of diets

- Inconsistency of rations (variation) results in significant production losses. (?)
- Variation in forage composition is a root cause
- Q: How often should forages be analyzed for their nutritional content?

20

Total Quality Cost

- Costs while process is in-control (i.e., forage composition hasn't changed)
- Costs while process is out-of-control (i.e., forage composition has changed)
- Costs of investigating and fixing the process (diet changes)
- Time spend in-control (process dependent)
- Time spent out-of control (design dependent)

21

Control of Nutrition

Q: How often should forages be analyzed for their nutritional content?

- Incorrect question
- What is the optimum sampling design?
  - Frequency of sampling (h)
  - Number of samples to be taken (n)
  - How much do nutritional analyses have to change before process is considered out-of control? (L)

22

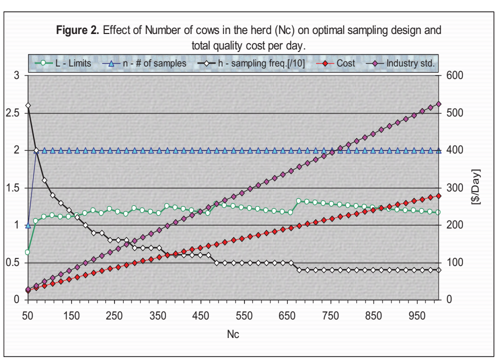


Figure 2. Effect of Number of cows in the herd (Nc) on optimal sampling design and total quality cost per day.

23

Goofy #4

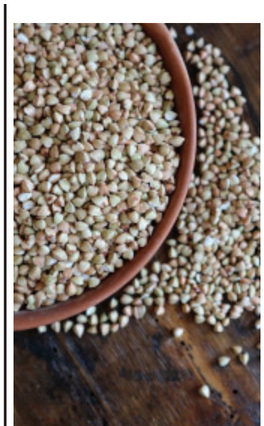
- We confuse noise with signal
  - Whole linted cottonseed really doesn't vary much.
  - Most of the variation is in the lab sub-sampling.

24

Goofy #5

- We ignore composition variance…
- Yet we are afraid that feeds vary!
- **The contribution of a feed to the total diet variance grows with the square of its inclusion rate.**
  - ***Doubling* the feeding rate *quadruples* its contribution to the total variance.**

25



Goofy #6

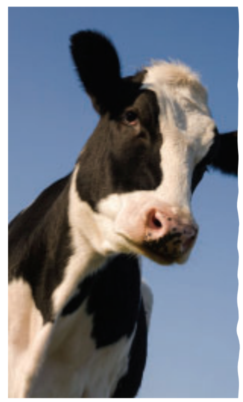
- When you have a hammer, everything looks like a nail.
- When you are a nutritionist, everything is due to nutrition.
  - Butterfat… protein… really!!!

26

Goofy #7

- But it works!
- So, the Earth is flat because Illinois looks awfully flat!
  - Ruminal fermentation does not obey first-order kinetics… so we create multiple pools to mimic curvature with a series of flat surfaces.

27



Dairy Nutrition

- We do a lot of goofy things…
- … and we make it sound very complicated…
- … I guess that we could call it job security…

28

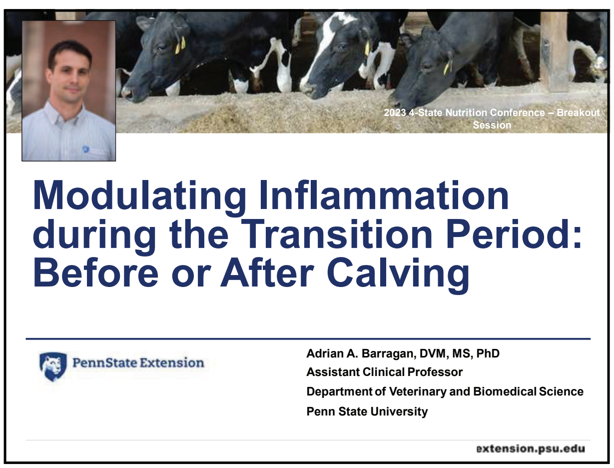
Adieu… mes amis!

29

Modulating Inflammation During the Transition Period: Before or After Calving

Dr. Adrian Barrigan
Penn State University

1



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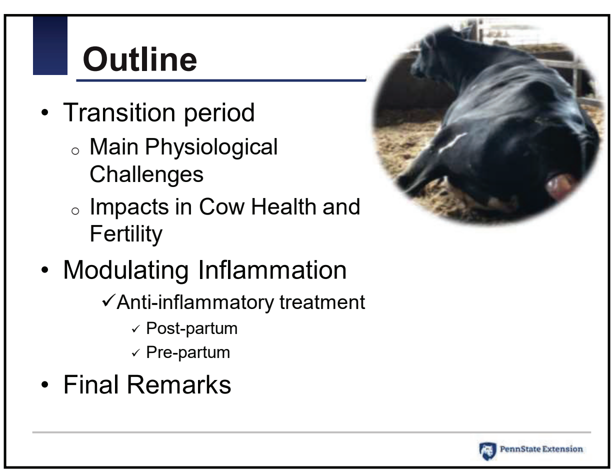

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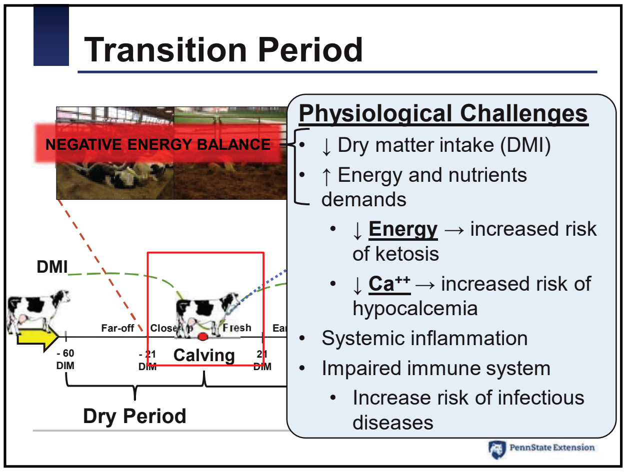
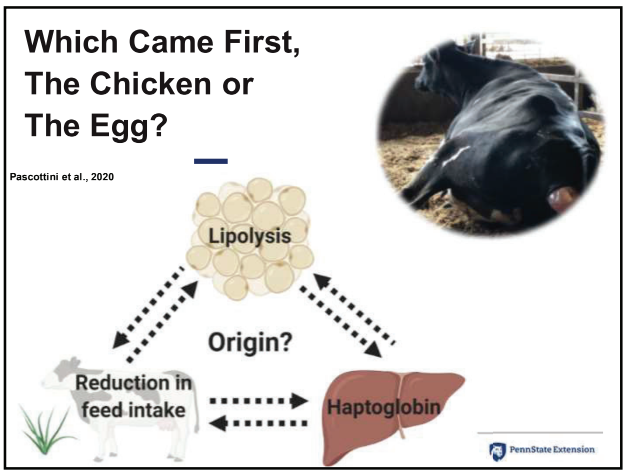
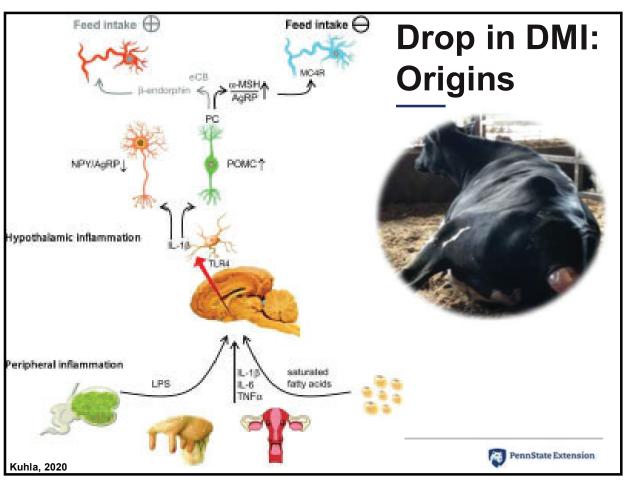

Transition Period
NEGATIVE ENERGY BALANCE
DMI
Far-off
Close-up
Fresh
- 60 DIM
- 21 DIM
Calving
21 DIM
Dry Period
Physiological Challenges
• ↓ Dry matter intake (DMI)
• ↑ Energy and nutrients demands
• ↓ Energy → increased risk of ketosis
• ↓ Ca++ → increased risk of hypocalcemia
• Systemic inflammation
• Impaired immune system
• Increase risk of infectious diseases
PennState Extension

4


Which Came First, The Chicken or The Egg?
Pascottini et al., 2020
Lipolysis
Origin?
Reduction in feed intake
Haptoglobin
PennState Extension

5


Drop in DMI: Origins
Feed intake
Feed intake
eCB
β-endorphin
α-MSH
AgRP
MC4R
PC
NPY/AgRP
POMC
Hypothalamic inflammation
IL-1β
TLR4
Peripheral inflammation
LPS
IL-1β
IL-6
TNFα
saturated fatty acids
Kuhla, 2020
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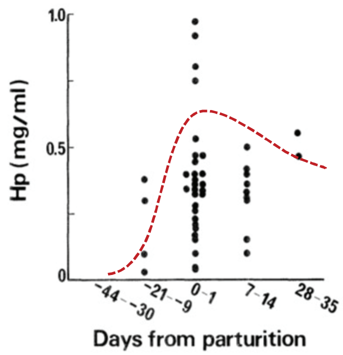
Transition Cow Inflammation



Adapted from Uchida et al., 1993

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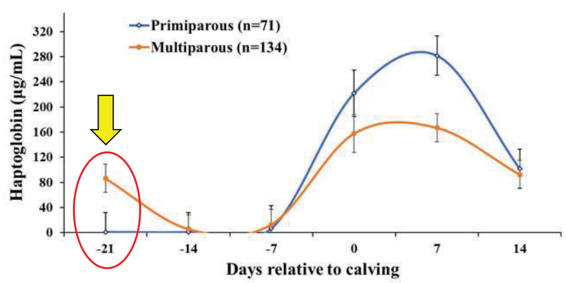
Transition Cow Inflammation



Barragan et al., 2023 (*Unpublished data*)

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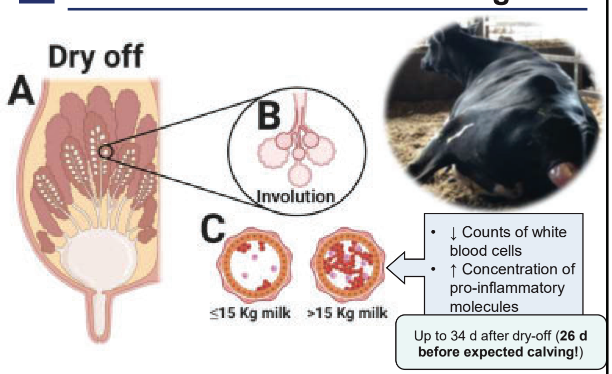
When Does Inflammation Origin?



Pascottini et al., 2020, Mezzetti et al., 2020

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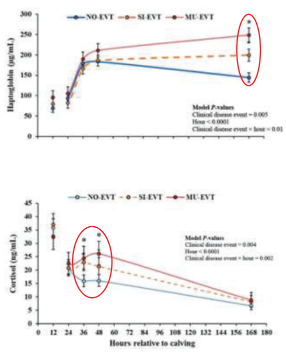
Barragan et al., 2020

Impact of Inflammation on Cow Health



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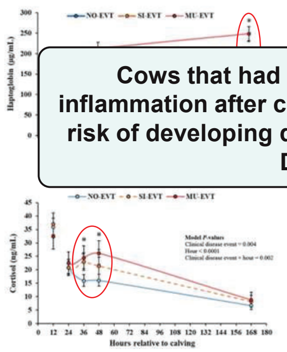
Barragan et al., 2020

Impact of Inflammation on



Cows that had higher stress and inflammation after calving were at a higher risk of developing diseases in the first 60 DIM

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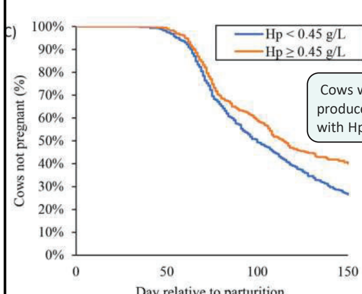
Impact of Inflammation on Cow Performance



Cows with Hp concentrations ≥0.45 g/L produced ***492 kg less*** ME305 milk than cows with Hp concentrations <0.45 g/L (*P* < 0.001).

Kirwin et al., 2022

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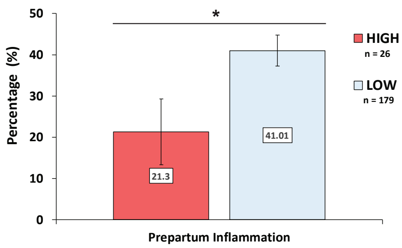
Pre-Partum Inflammation and Pregnancy rate at 1st Service



Barragan et al., 2023 (*unpublished data*)

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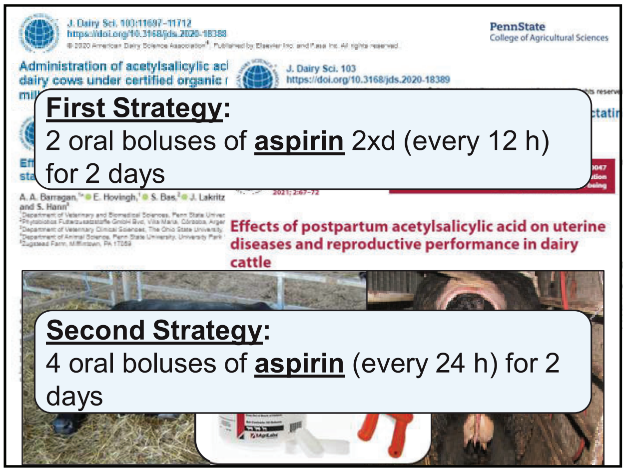
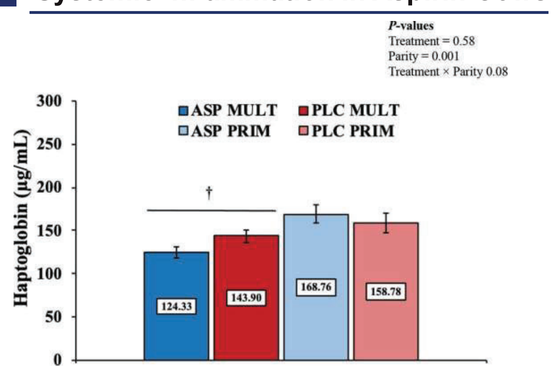


14

Systemic Inflammation in Aspirin Cows



Barragan et al., 2020

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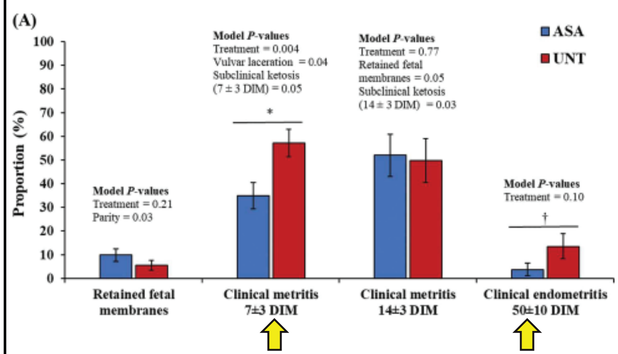
Prevention of Diseases



Barragan et al., 2021

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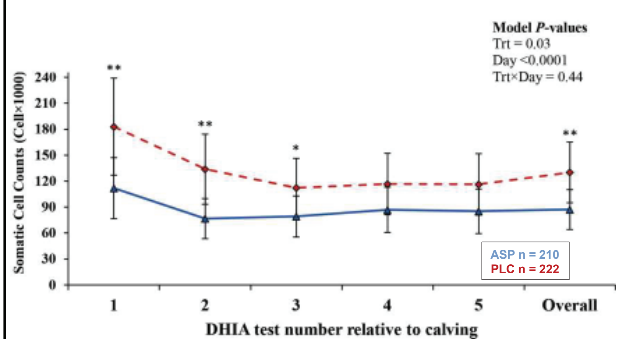
Somatic Cell Counts



Barragan et al., 2020

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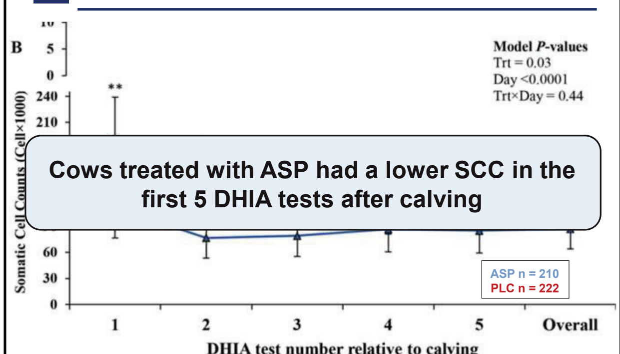
Somatic Cell Counts



Barragan et al., 2020

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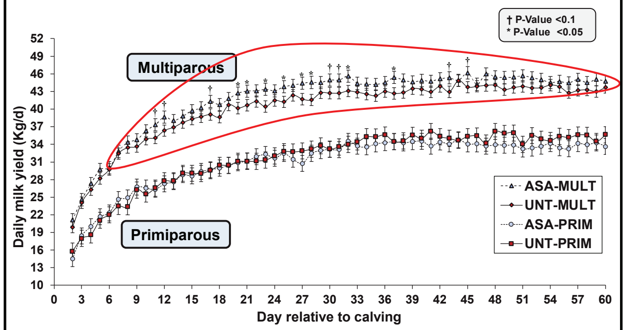
Daily Milk Yield



Barragan et al., 2020

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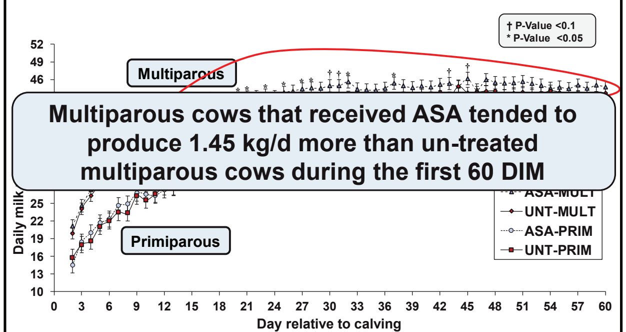
Daily Milk Yield



Barragan et al., 2020

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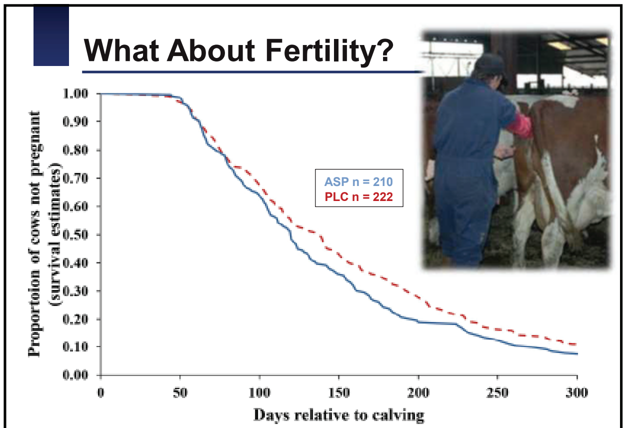
What About Fertility?



Barragan et al., 2020

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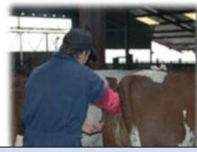
What About Fertility?



Aspirin cows:
- Became pregnant 20 days sooner
- Tended to have 5% less pregnancy losses at first service

Parameter	Study Group		P-Value
	ASA (n=121)	UNT (n=125)	
DIM to conception	105.56±11.53	125.43±10.42	0.01
Number of services to conception	2.29±0.45	2.71±0.40	0.17
Pregnancy per AI at first service	23.88±7.92	17.93±6.31	0.40
Pregnancy loss at first service	1.03±1.06	6.04±2.62	0.10

Barragan et al., 2020

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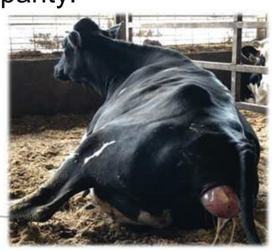
Post-partum Aspirin Trials: Summary of Findings

- ↓ Inflammation in **multiparous cows**
- ↑ Milk production in **multiparous cows**
- Improve regardless of parity:
  - Uterine health
    Udder health
    Metabolic status
  - Reproductive performance



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Pre-Partum Targeted Anti-Inflammatory Treatment

Study will assess prepartum aspirin regimens to improve cow health, performance

pennsylvania DEPARTMENT OF AGRICULTURE

USDA NIFA

United States Department of Agriculture National Institute of Food and Agriculture

Treatment Approach:
1 oral administration of either aspirin or meloxicam at 14±3 days before expected calving date

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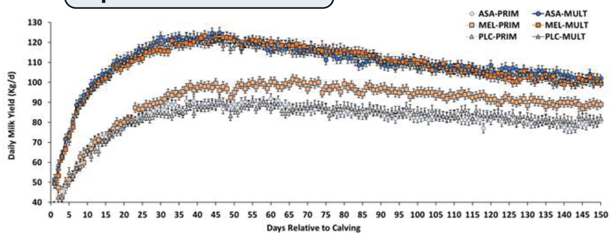
Daily Milk Yield Results

~1,650 lbs. more milk per treated heifer



Jimenez et al., 2023 (*in preparation*)

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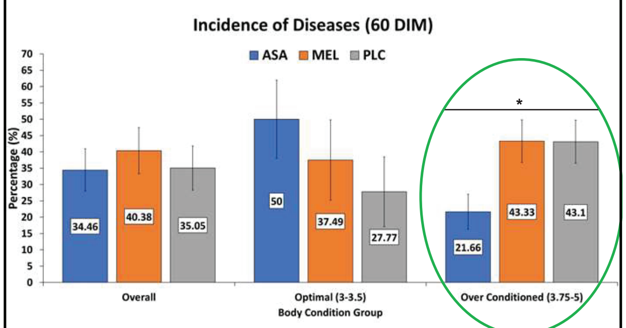
Incidence of Diseases



Jimenez et al., 2023 (*in preparation*)

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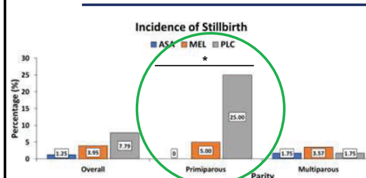
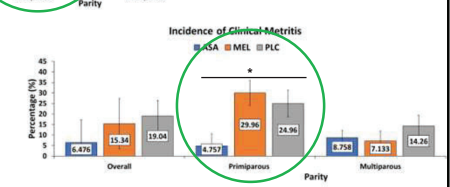
Incidence of Diseases





Jimenez et al., 2023 (*in preparation*)

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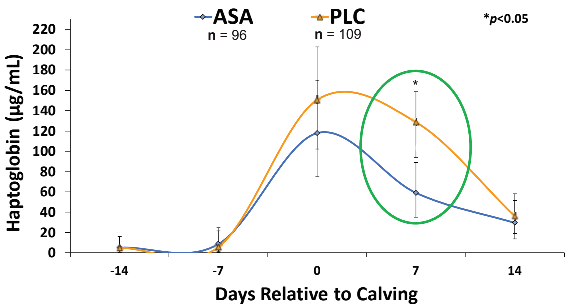
Systemic Inflammation



Jimenez et al., 2023 (*in preparation*)

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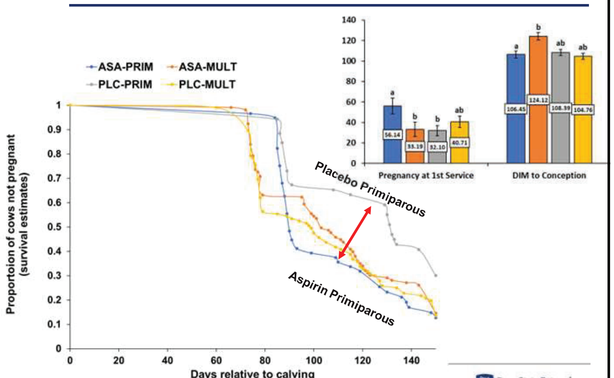
Reproductive Performance



Jimenez et al., 2023 (*in preparation*)

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Pre-partum Aspirin Trials: Summary of Findings

- ↑ Milk production in **primiparous cows**
- ↓ Incidence of diseases in **primiparous** and over conditioned cows
- Improve reproductive performance in **primiparous cows**

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Final Remarks

- Systemic inflammation is one of the biggest physiological challenges for dairy cows during the transition period
- Pre-partum anti-inflammatory treatment may be more beneficial to primiparous cows, while post-partum anti-inflammatory treatment may yield more benefits for multiparous cows.
- Proactive management, aimed at improving cow comfort and preventing diseases in the early lactation period, is key for optimal animal welfare and production in dairy farms

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Follow-up

EMAIL

skype

WhatsApp

TeamViewer

Dropbox

Tel: 814.863.5849
Email: axb779@psu.edu

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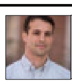

Adrian A. Barragan, DVM, MS, PhD
Assistant Clinical Professor
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Email: axb779@psu.edu

Thank you

PennState Extension

Department of Veterinary and Biomedical Sciences
College of Agricultural Sciences
Penn State University

extension.psu.edu

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New Concepts in Weaning and Postweaning Calf Nutrition

Dr. Michael A. Steele
Department of Animal Biosciences
University of Guelph

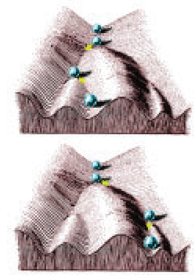
Postweaning Calf Nutrition

Michael A. Steele, Professor
Department of Animal Biosciences, University of Guelph

1

"…early adaptation to a stress or stimuli that permanently changes the physiology and metabolism of the organism and continues to be expressed even in the absence of the stimulus/stress that initiated them…"

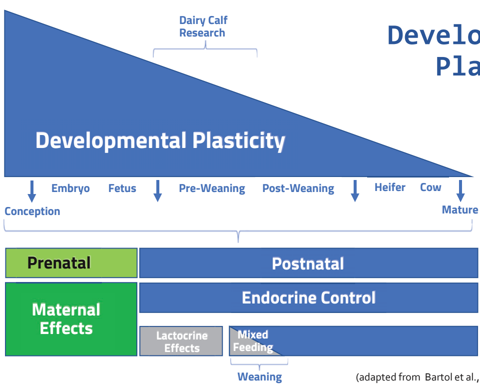
Patel and Srinivansan, 2002



Adapted from Conrad's Waddington epigenetic landscape

2

Developmental Plasticity

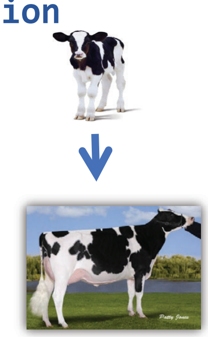


(adapted from Bartol et al., 2013 and van Niekerk *et al.*, 2021)

3

Early Life Nutrition

- Dietary regimes in early life influence lifetime productivity
- 1kg of pre-weaning ADG = 1,540 kgs of milk in first lactation Soberon et al., 2012

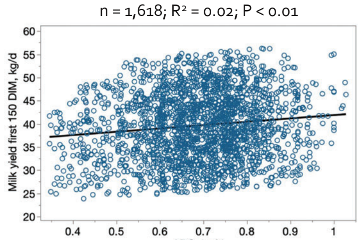


4

Dry feed intake = critical for growth

- ADG during the post-weaning period has been positively correlated with future milk production (Shamay et al., 2005; Bach and Ahedo, 2008)

n = 1,618; R^2 = 0.02; P < 0.01

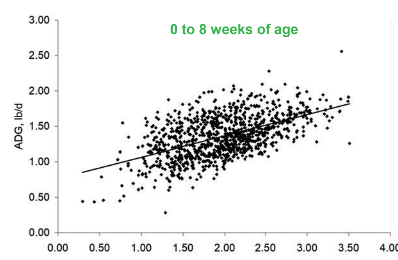


70-120 d
Slope 11 vs. 7

(Bach et al., 2021)

5

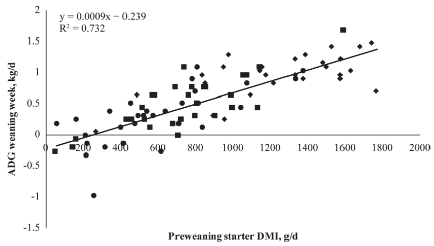
Dry feed intake = critical for growth



Results from 20 published trials from 2007-2009
(Bateman *et al.*, 2012)

6

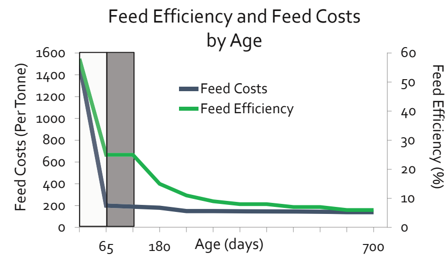
Dry feed intake = critical for growth



(Stamey *et al.*, 2012)

7

The Investment of Raising Replacements

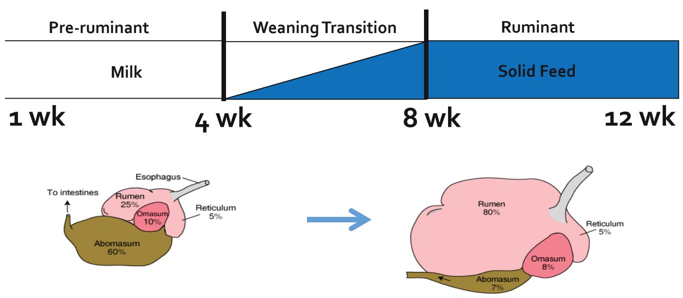


$2,000 investment

(Bach et al., 2013)

8

Pre and Post-Weaning

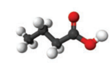


9

Rumen Development

- Consumption of solid feed
  (Khan et al., 2011)

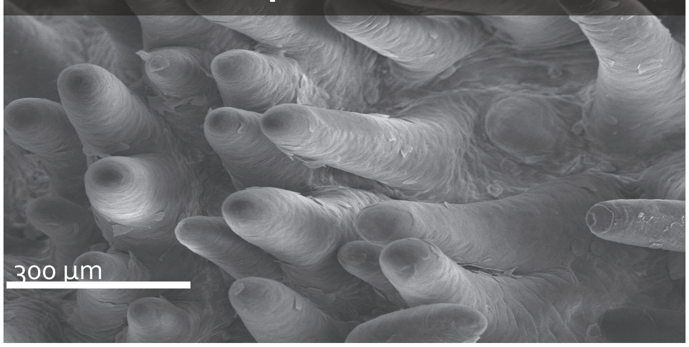
- Volatile fatty acids
  - Cellular growth
  - Blood flow
    - (Baldwin and McLeod, 2000)



- The age of the calf (Lane et al., 2002)

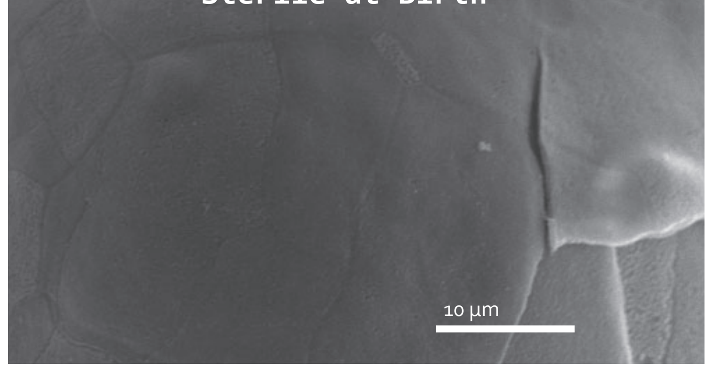
10

Rumen Papillae - Birth



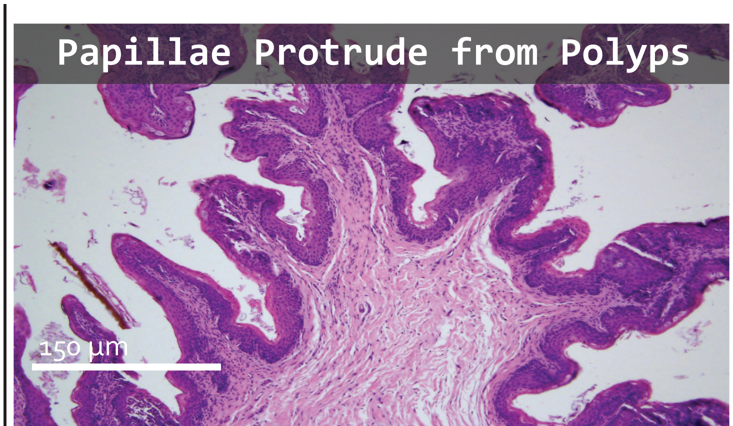
11

Sterile at Birth



12

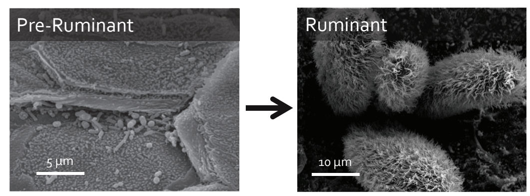
13



14

15

Pre-ruminant to Ruminant

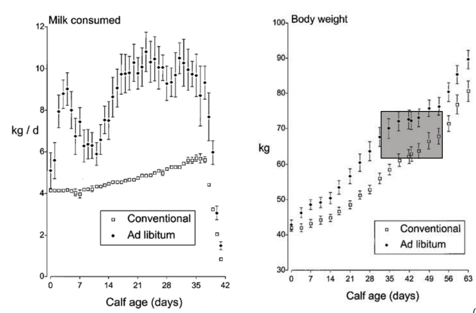


- Lactate-fermenting bacteria exceed adult values then decline
- Protozoa are introduced via contact with mature ruminants

16

17

Weaning Challenges – High Milk



(Jasper and Weary, 2002)

18

Abnormal Gut Development

- Ruminal parakeratosis is common during weaning

(Bush, 1965)

- Ruminal acidosis has been documented however to date, no research has linked it to impairment of gut health

(Laarman et al., 2012)

- Is ruminal acidosis good or bad for the calf?

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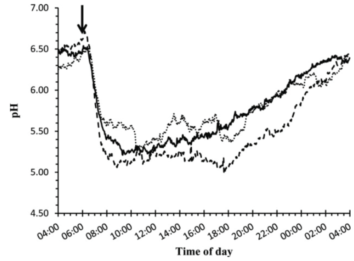
Ruminal pH During Weaning

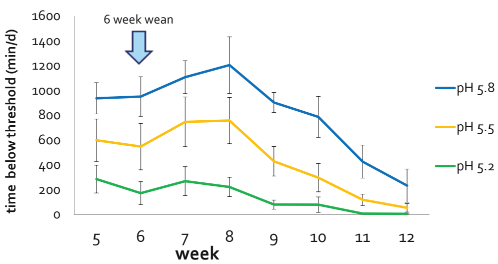


- Composition of pellet did not dictate ruminal pH
- Feeding time and restriction played a larger role

(Laarman et al., 2011)

20

Ruminal pH During Weaning

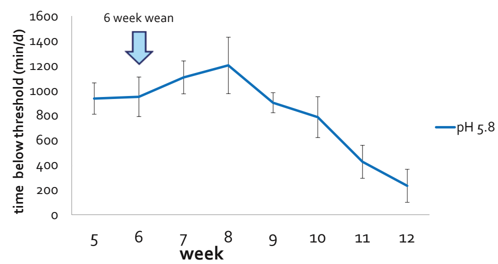


(van Niekerk et al., 2020)

21

Week

Ruminal pH During Weaning

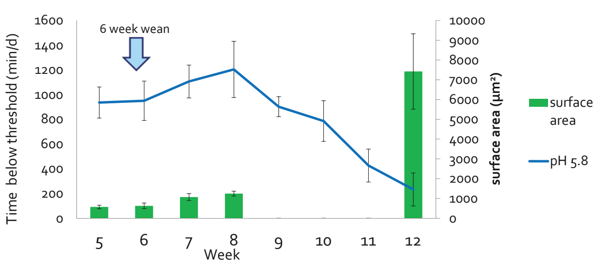


(van Niekerk et al., 2020)

22

Week

Ruminal pH During Weaning

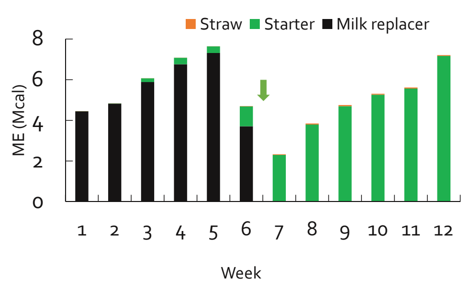


(van Niekerk et al., 2020)

23

Week

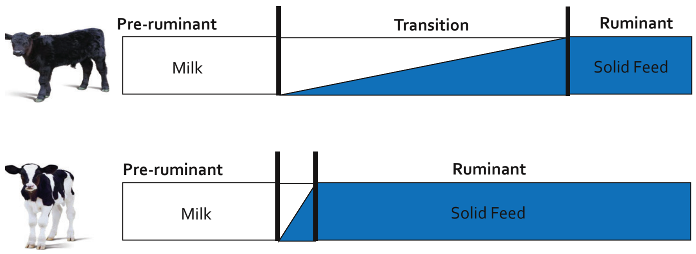
Total Metabolizable Energy



(van Niekerk et al., 2020)

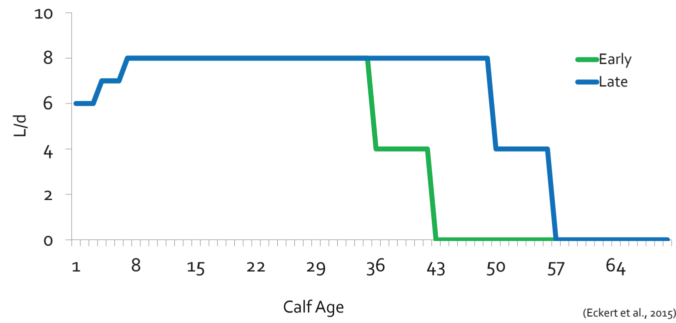
24

Early and Abrupt Weaning



25

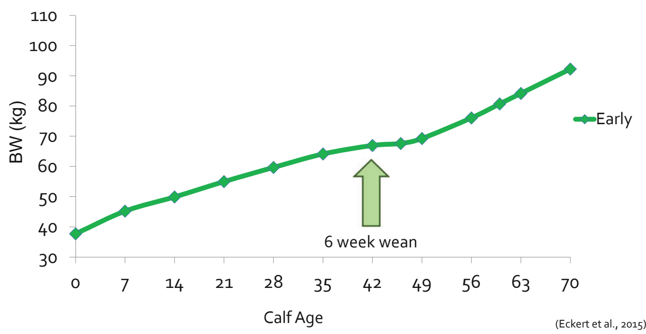
Weaning Age



(Eckert et al., 2015)

26

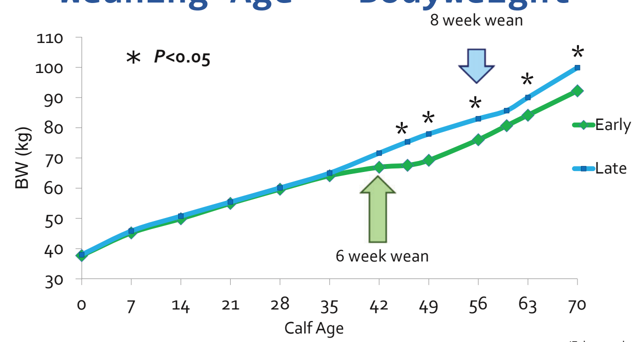
Weaning Age - Bodyweight



(Eckert et al., 2015)

27

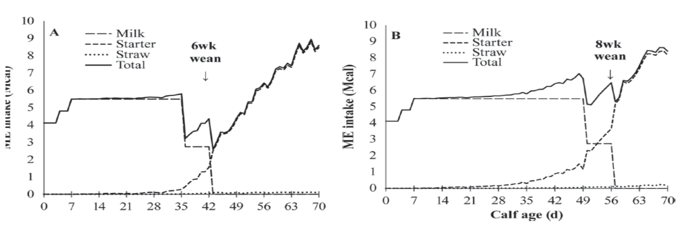
Weaning Age - Bodyweight



(Eckert et al., 2015)

28

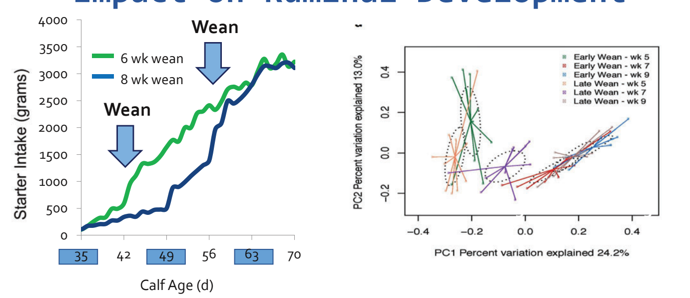
Weaning Age – ME Intake



(Eckert et al., 2015)

29

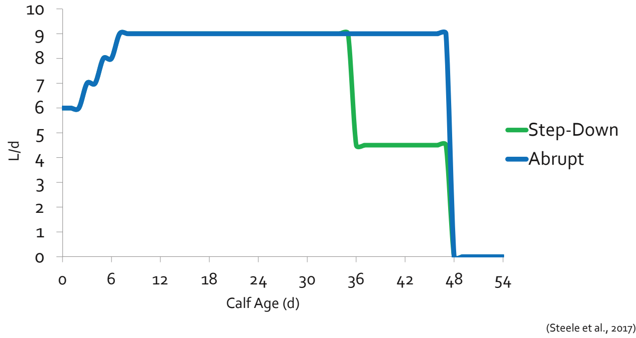
Weaning Strategy – Delayed Weaning Impact on Ruminal Development



(Meale et al., 2016)

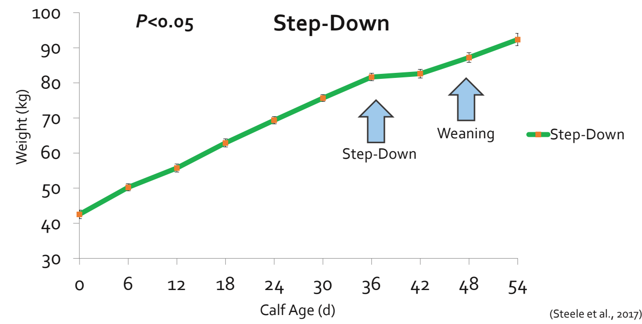
30

Step-Down Weaning



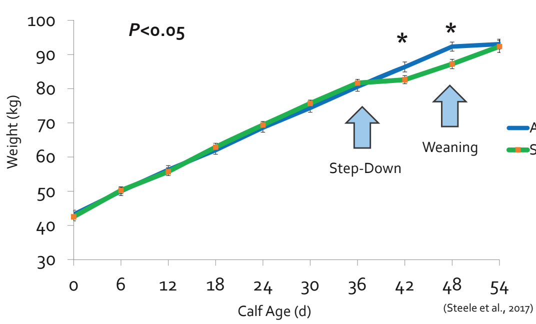
31

Step-Down - Bodyweight



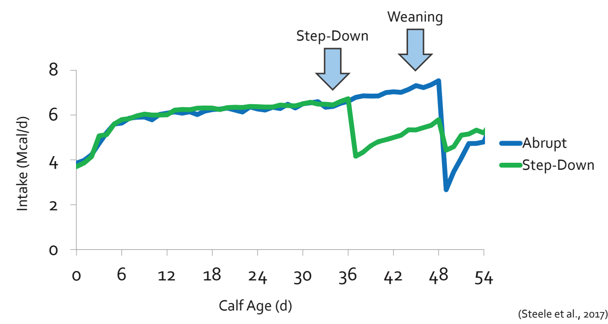
32

Step-Down - Bodyweight



33

Metabolizable Energy Intake



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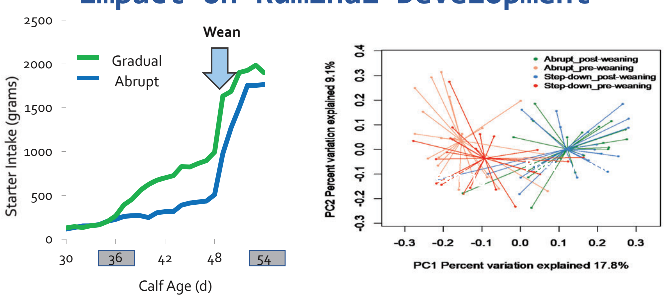
Weaning Strategy – Abrupt Weaning Impact on Ruminal Development



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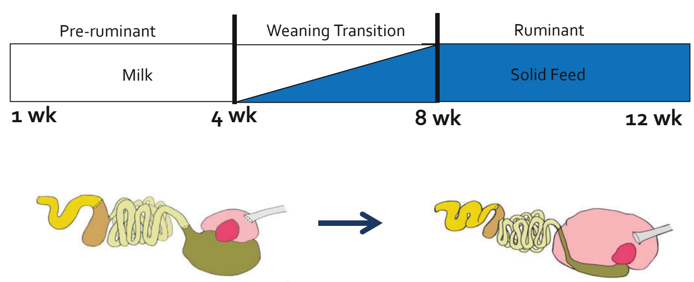
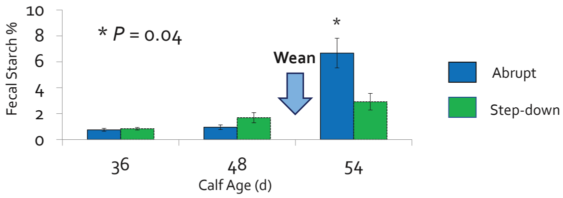
Pre and Post-Weaning



36

Abrupt Weaning Impact on Hindgut

- Fecal microbiota displayed more diversity post-weaning (Meale et al., 2015)



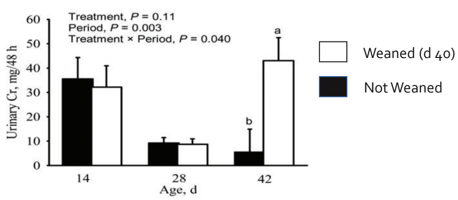
37

Diversity in Fecal Scores

38

Barrier Function at Weaning

Starter feeding in calves decreased the expression of tight junctions (Malmuthuge et al., 2012)



(Wood et al., 2015)

39

Starter chemical composition – somewhat random sampling from 2008 to 2019

	% DM			
Authors	NDF	Sugar	Starch	Sol. Fiber (*cal)
Hill et al., 2008	38.4	5.2	**15.6**	5.7
	15.4	5.1	**43.5**	11.1
Chapman et al., 2016	15	6.1	**40.4**	11.3
Hill et al., 20[illegible]				-
				11.1
Suarez-Men[illegible]				-
				-
Rosenberge[illegible]				-
Dennis et al.				10.3
Quigley et a[illegible]				7.5
Gelsinger et al., 2019	[illegible]	[illegible]	[illegible]	-
	25.3	6.2	**35.3**	3.4
Benetton et al., 2019	18.3	-	**37.3**	-
Hu et al., 2019	14.5	6.0	**43.9**	4.0

Mean starch content : 37.8%

Mean NDF content: 19.2%

40

What about starter composition?

- Why do starters range from 10-50% starch?
- Induces ruminal acidosis an possibly hindgut acidosis
- Should starter composition be tailored for milk feeding program?

Hindgut acidosis?

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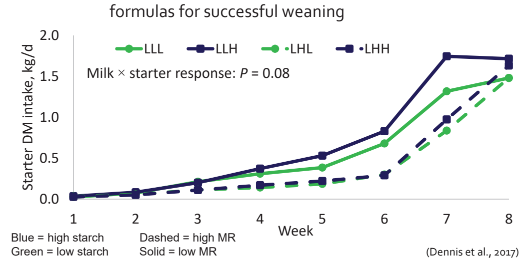
Milk Replacer and Starter Composition

What have we learned in the last decade?

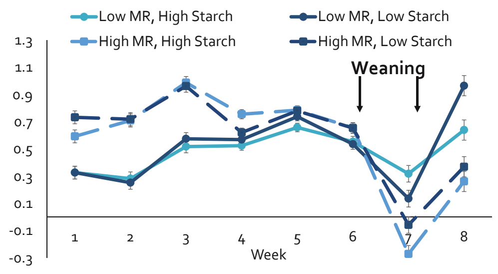
- Higher milk allowances may need different starter formulas for successful weaning



(Dennis et al., 2017)

42

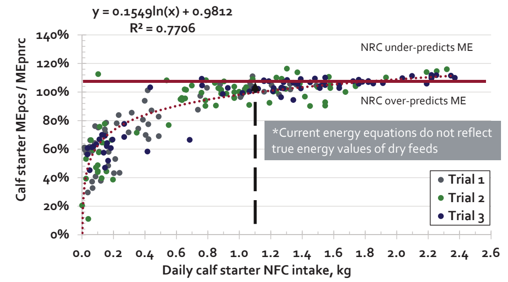
Average Daily Gain (kg/d)



(Yohe et al., 2021)

43

Intake impacts energy value of calf starters



(Quigley et al., 2019)

44

The Future………

Pictures Courtesy of Trouw Nutrition

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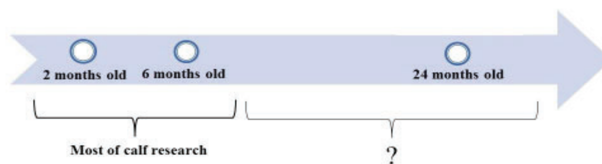
Post-Weaning and Beyond

- An area that has not been studied
- Need to integrate pre and post weaning planes of nutrition with lifetime performance



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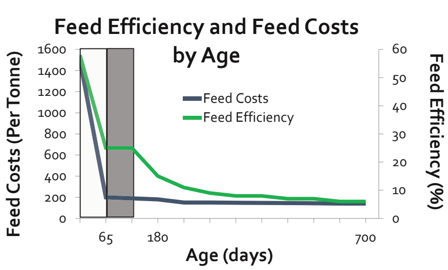
The Investment of Raising Replacements

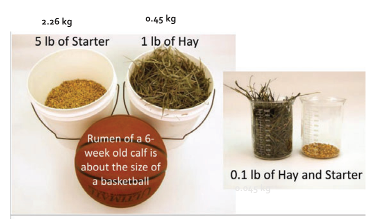


$2,000 investment

(Bach et al., 2013)

47

Are we assuming that calves are consuming more forage than what they are?



48

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Post-Weaning Dry TMR Rations

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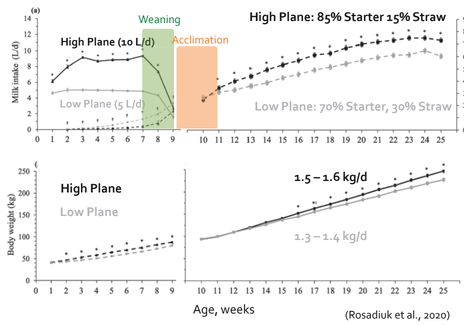
BW and ADG



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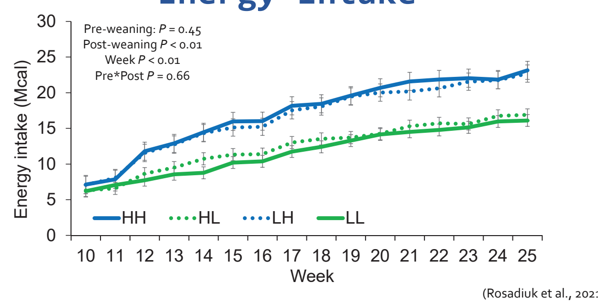
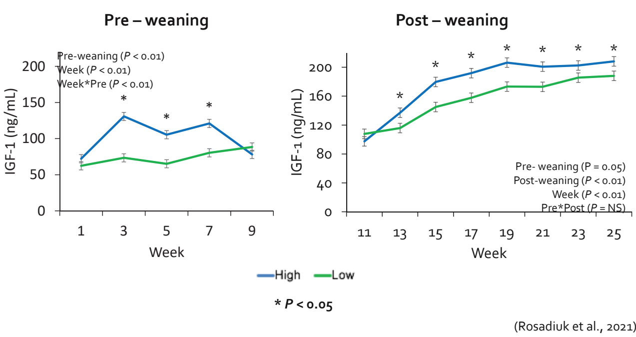
Post-Weaning Metabolizable Energy Intake



52

Growth Factors – IGF-1



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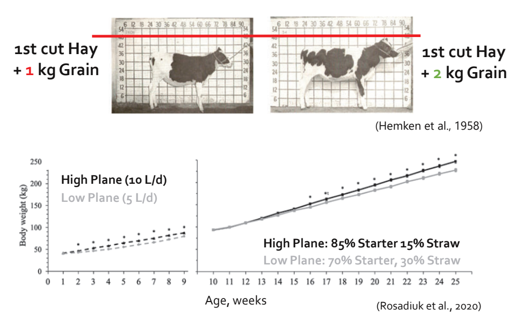
Beyond Concentrate and Forage



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Beyond Concentrate and Forage Feed Chemistry

Growing Heifers

Item	Low	High
Starter/Concentrate		
Chemical composition		
CP (% of DM)	22.4	22.4
Crude fiber (% of DM)	7.6	7.6
Starch (% of DM)	22.3	22.3
ME (Mcal/kg of DM)	2.6	2.6
Straw		
Chemical composition		
CP (% of DM)	4.6	4.6
NDF (% of DM)	71.6	71.6
ME (Mcal/kg of DM)	1.6	1.6
Postweaning phase[2]		
Ingredient (% of DM)		
Concentrate	70.0	85.0
Wheat straw	30.0	15.0
Chemical composition		
CP (% of DM)	21.1	25.0
NDF (% of DM)	46.0	30.1
ME (Mcal/kg of DM)	2.5	2.9

(Adapted from Rosadiuk et al., 2020)

Lactating cows

Item[2]	Corn silage	Alfalfa silage
DM, %	32.3 ± 2.4	41.9 ± 7.6
CP, % of DM	7.8 ± 0.4	17.1 ± 1.6
NH_3-N CPE, % of CP	11.3 ± 0.7	9.9 ± 3.3
Soluble protein, % of CP	54.8 ± 2.8	61.2 ± 6.1
ADICP, % of CP	9.2 ± 0.4	10.5 ± 1.3
NDICP, % of CP	11.6 ± 0.8	15.7 ± 3.1
aNDFom, % of DM	41.3 ± 2.7	44.2 ± 2.2
30-h uNDFom, % of aNDFom	40.8 ± 1.0	50.3 ± 2.5
120-h uNDFom, % of aNDFom	35.9 ± 1.0	44.1 ± 3.1
240-h uNDFom, % of aNDFom	23.9 ± 1.2	40.1 ± 3.5
ADF, % of DM	24.9 ± 1.8	35.4 ± 1.8
Lignin, % of DM	2.8 ± 0.2	7.0 ± 0.6
Sugars, % of DM	1.5 ± 0.2	4.3 ± 1.7
Starch, % of DM	29.4 ± 3.2	2.4 ± 0.8
Ether extract, % of DM	3.1 ± 0.1	3.3 ± 0.2
Ash, % of DM	2.7 ± 0.2	8.8 ± 1.0

(Adapted from Fessenden et al., 2019)

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Keys to Successful Weaning

(Van Niekerk et al., 2021)

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Take Home Messages

- Weaning in dairy calves is one of the largest transformations of the gut in nature
- Milk feeding level has a large impact on weaning stress
- Weaning age and abruptness impact performance on high planes of milk nutrition – after 8 weeks with a two week stepdown
- Weaning is also associated with gut health problems – Leaky hindgut
- Post-weaning nutrition is another under-developed topic- forage inclusion is key more months post-weaning

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Managing Inflammation in Transition Cows

Eduardo Ribeiro
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University of Guelph

Managing Inflammation in Transition Cows

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Four State Dairy Nutrition and Management Conference
Dubuque, IA - June 7, 2023

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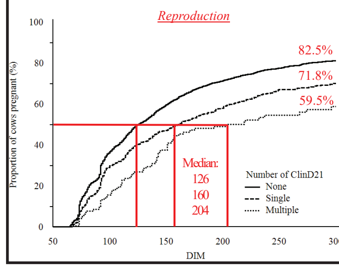
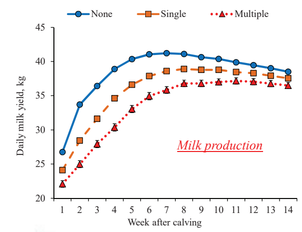
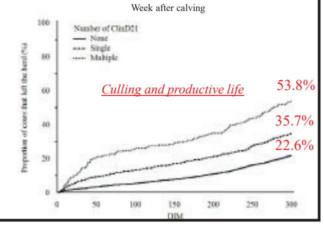
Long-term Consequences of Postpartum Inflammatory Disease

Carvalho et al. 2019 J. Dairy Sci. 102:11701–11717

- n = 5,085 cows classified based on number of ClinD21
  - None – 69.8%
  - Single – 25.7%
  - Multiple – 4.4%





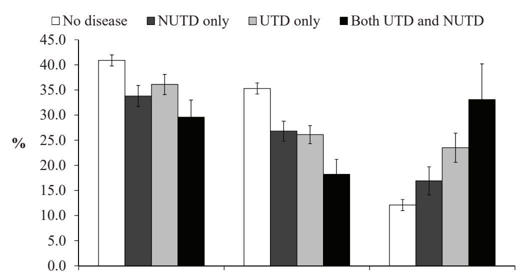


Reproduction – Does the Site of Infection Matter?

Uterine disease (UTD) vs. *Non-uterine disease (NUTD)*

Ribeiro et al. (2016) J. Dairy Sci. 99:2201-2220

Reproduction – Does the Site of Infection Matter?



Ribeiro et al. (2016) J. Dairy Sci. 99:2201-2220

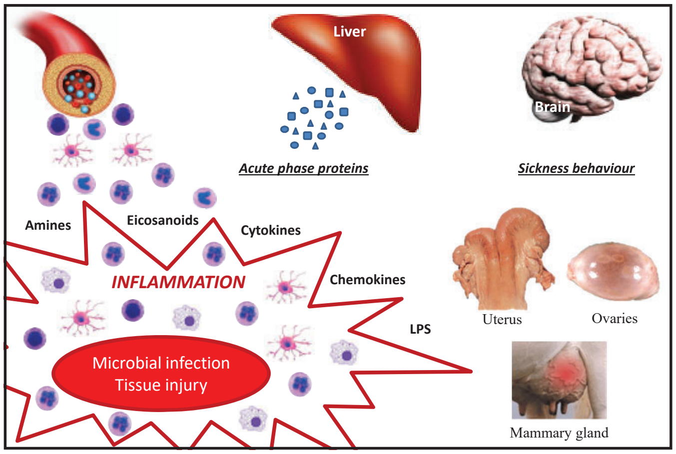
Milk production – Does the Site of Infection Matter?

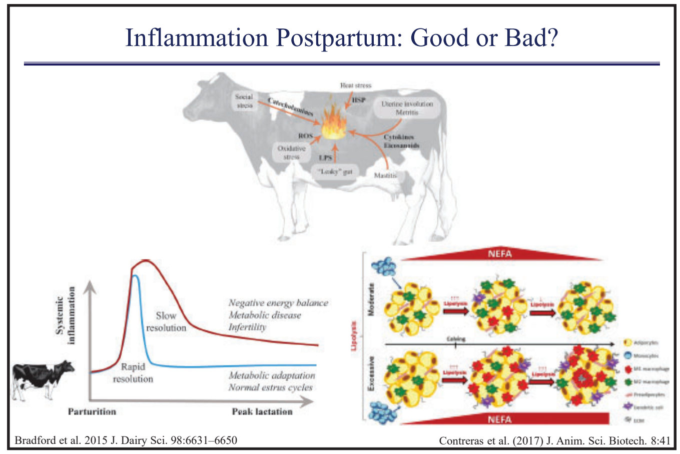
Mastitis (MMD) vs. *Diseases outside the mammary gland (NMMD)*

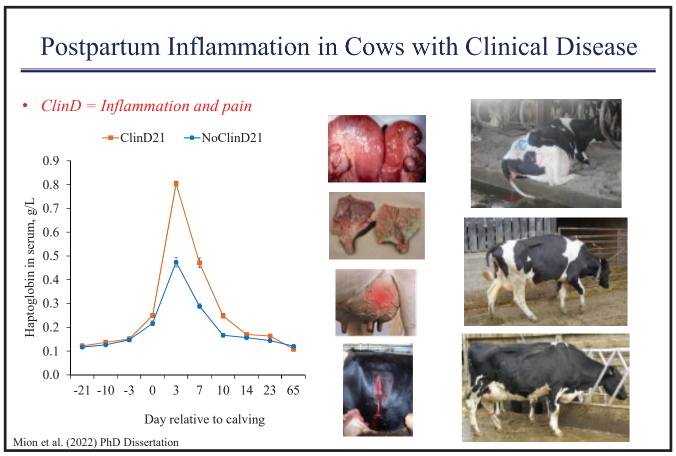
Ribeiro et al. (2016) J. Dairy Sci. 99:2201-2220

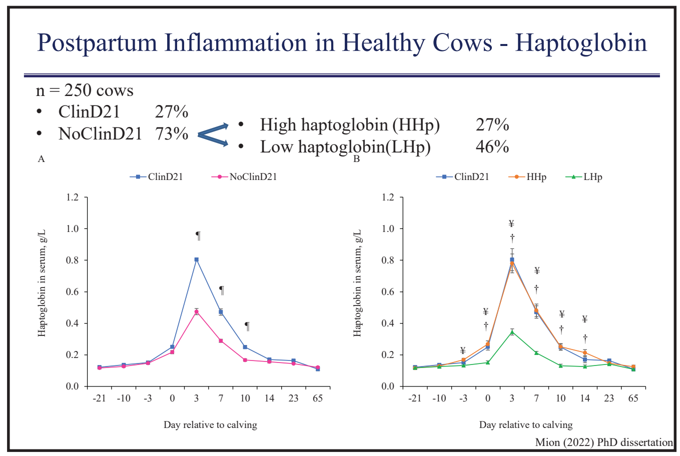
Milk production – Does the Site of Infection Matter?

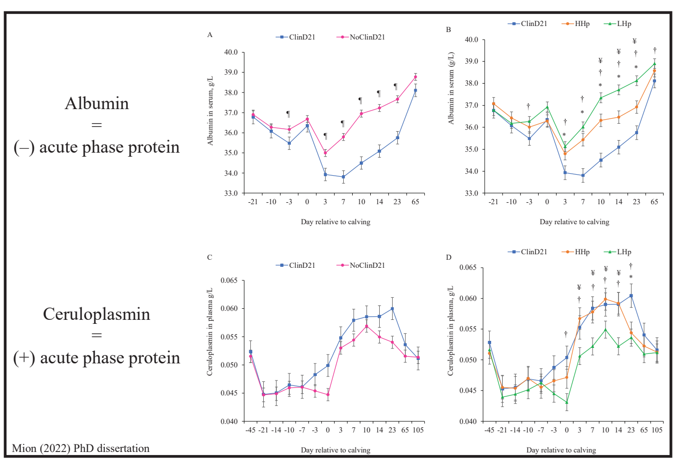
Ribeiro et al. unpublished

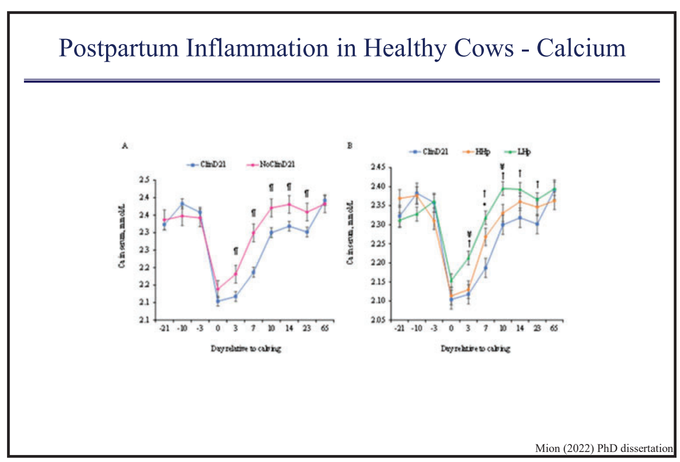

Liver
Brain
Acute phase proteins
Sickness behaviour
Amines
Eicosanoids
Cytokines
Chemokines
INFLAMMATION
LPS
Microbial infection
Tissue injury
Uterus
Ovaries
Mammary gland

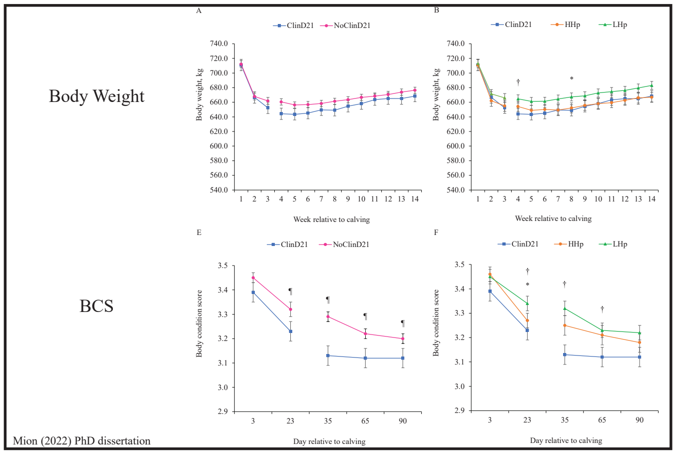

Inflammation Postpartum: Good or Bad?
Systemic inflammation
Slow resolution
Rapid resolution
Negative energy balance
Metabolic disease
Infertility
Metabolic adaptation
Normal estrus cycles
Parturition
Peak lactation
NEFA
Bradford et al. 2015 J. Dairy Sci. 98:6631–6650
Contreras et al. (2017) J. Anim. Sci. Biotech. 8:41

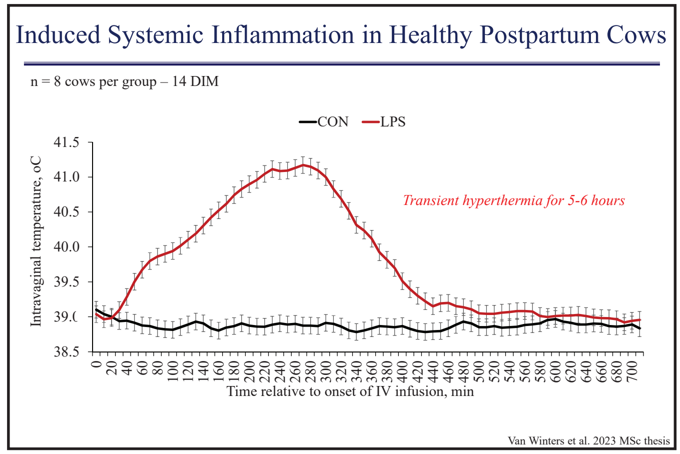

Postpartum Inflammation in Cows with Clinical Disease
• ClinD = Inflammation and pain
ClinD21
NoClinD21
Haptoglobin in serum, g/L
Day relative to calving
Mion et al. (2022) PhD Dissertation

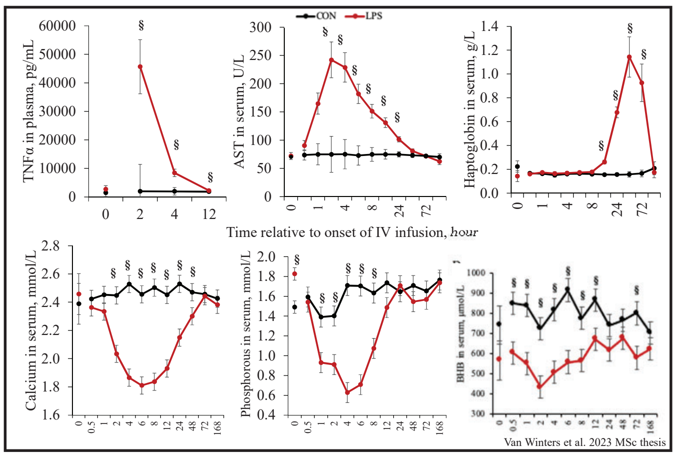

Postpartum Inflammation in Healthy Cows - Haptoglobin
n = 250 cows
• ClinD21 27%
• NoClinD21 73%
• High haptoglobin (HHp) 27%
• Low haptoglobin(LHp) 46%
ClinD21
NoClinD21
HHp
LHp
Haptoglobin in serum, g/L
Day relative to calving
Mion (2022) PhD dissertation

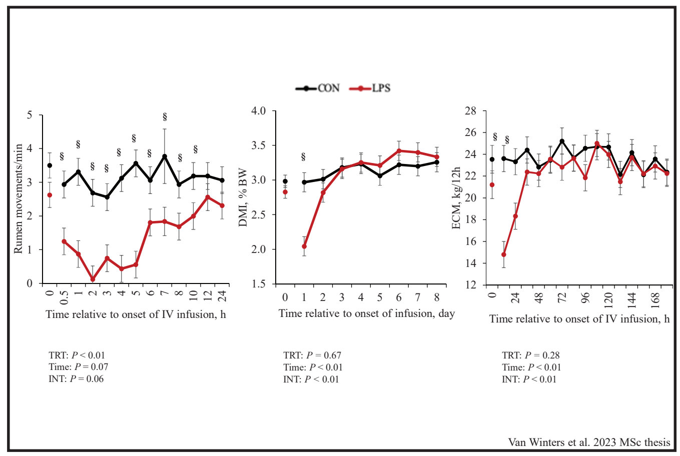

Albumin
=
(–) acute phase protein
Ceruloplasmin
=
(+) acute phase protein
ClinD21
NoClinD21
HHp
LHp
Day relative to calving
Mion (2022) PhD dissertation

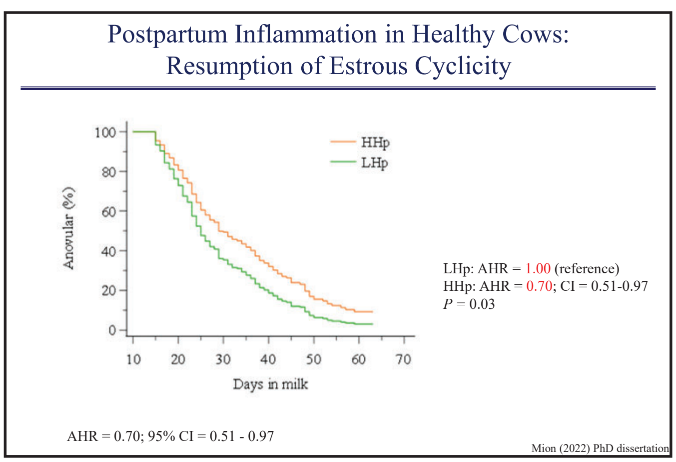

Postpartum Inflammation in Healthy Cows - Calcium
Mion (2022) PhD dissertation

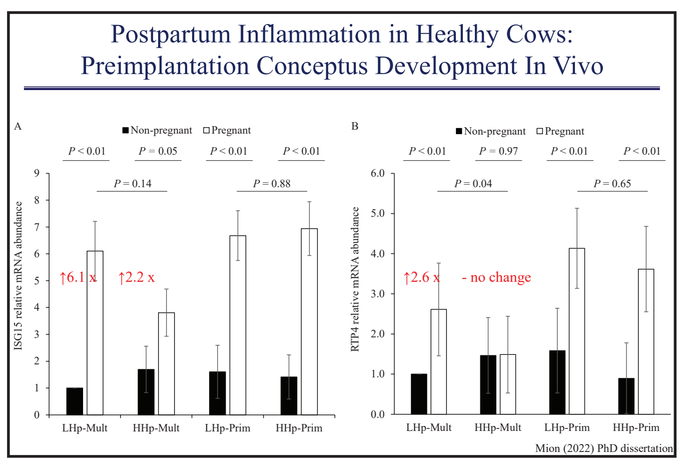

Body Weight
BCS
ClinD21
NoClinD21
HHp
LHp
Body weight, kg
Week relative to calving
Body condition score
Day relative to calving
Mion (2022) PhD dissertation


Induced Systemic Inflammation in Healthy Postpartum Cows
n = 8 cows per group – 14 DIM
CON
LPS
Intravaginal temperature, oC
Transient hyperthermia for 5-6 hours
Time relative to onset of IV infusion, min
Van Winters et al. 2023 MSc thesis

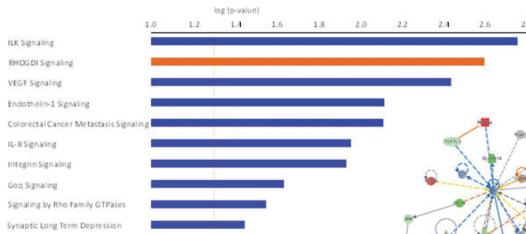

CON
LPS
TNFα in plasma, pg/mL
AST in serum, U/L
Haptoglobin in serum, g/L
Time relative to onset of IV infusion, hour
Calcium in serum, mmol/L
Phosphorous in serum, mmol/L
BHB in serum, µmol/L
Van Winters et al. 2023 MSc thesis

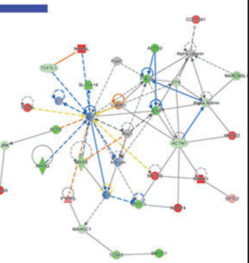

CON
LPS
Rumen movements/min
Time relative to onset of IV infusion, h
TRT: P < 0.01
Time: P = 0.07
INT: P = 0.06
DMI, % BW
Time relative to onset of infusion, day
TRT: P = 0.67
Time: P < 0.01
INT: P < 0.01
ECM, kg/12h
Time relative to onset of IV infusion, h
TRT: P = 0.28
Time: P < 0.01
INT: P < 0.01
Van Winters et al. 2023 MSc thesis


Postpartum Inflammation in Healthy Cows:
Resumption of Estrous Cyclicity
HHp
LHp
Anovular (%)
Days in milk
LHp: AHR = 1.00 (reference)
HHp: AHR = 0.70; CI = 0.51-0.97
P = 0.03
AHR = 0.70; 95% CI = 0.51 - 0.97
Mion (2022) PhD dissertation


Postpartum Inflammation in Healthy Cows:
Preimplantation Conceptus Development In Vivo
Non-pregnant
Pregnant
P < 0.01
P = 0.05
P < 0.01
P < 0.01
P = 0.14
P = 0.88
ISG15 relative mRNA abundance
↑6.1 x
↑2.2 x
LHp-Mult
HHp-Mult
LHp-Prim
HHp-Prim
P < 0.01
P = 0.97
P < 0.01
P < 0.01
P = 0.04
P = 0.65
RTP4 relative mRNA abundance
↑2.6 x
- no change
Mion (2022) PhD dissertation

Postpartum Inflammation in Healthy Cows: Preimplantation Conceptus Cells Biology





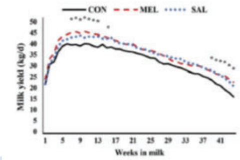
Mion (2022) PhD dissertation

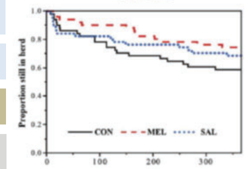
Blanket Postpartum Treatment with Oral NSAD

153 cows, lactation 2+, 1 herd
12-36 h after calving

	CON Control n = 51	SAL Na salicylate n = 51	MEL Meloxicam n = 51
Day 1 bolus:	Placebo	Placebo	675 mg MEL
Day 1 drench:	Water	125 g SAL	Water
Day 2 drench:	Water	125 g SAL	Water
Day 3 drench:	Water	125 g SAL	Water

10,472 vs. 11,205 vs. 11,411 kg





Carpenter et al. (2016) J. Dairy Sci. 99:672–679

Blanket Postpartum Treatment with Oral NSAD

2,653 cows from 20 herds in ON and QC
Immediately after calving:

	CON Untreated control n = 1,644	MOS Meloxicam oral solution (1 mg/kg BW) – single TRT n = 1,009
kg of milk in the first 3 tests	Reference	↑ 0.64 kg/d (±0.29)
Odds of subclinical mastitis in the 1st test	Reference = 1	0.75 (CI: 0.61-0.93)
Risk of culling through 60 DIM	Reference = 1	0.46 (CI: 0.23-0.92)

Shock et al. (2020) PLoSOne 13(12): e0209236

Treatment Protocols: Adding Meloxicam to the Treatment of Clinical Mastitis

- *n = 509 cows diagnosed with clinical mastitis in 61 European herds*

DIM: 0 — 120 — 200 — 300

Diagnosis of mild to moderate clinical mastitis

Cows were assigned to 1 of 2 treatment protocols:

- Control: ATB + placebo (n = 256)
- NSAID: ATB + meloxicam (n = 253)

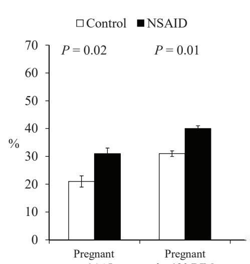
ATB = 1 to 4 intramammary infusion of cephalexin and kanamycin at 24-h intervals

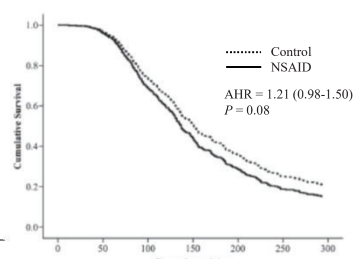
NSAID = single dose of meloxicam (0.5 mg/kg, s.c.)

McDougall et al. (2016) J. Dairy Sci. 99:2026–2042.

Treatment Protocols: Adding Meloxicam to the Treatment of Clinical Mastitis

- *n = 509 cows diagnosed with clinical mastitis in 61 European herds*





Financial benefit = ~$62 CAD

McDougall et al. (2016) J. Dairy Sci. 99:2026–2042.

Treatment Protocols: Adding Meloxicam to the Treatment of Metritis

2,772 cows enrolled

Diagnosis and treatment of metritis:

	Calving	MCK	MCK	MCK	MCK	MCK	MCK
DIM:	0	4	6	8	10	12	14

Cows with diagnosed with metritis were randomly assigned into two treatment groups:

- Ceftiofur (**CEF**)
- Ceftiofur + Meloxicam (**CEFMel**)

Day of TRT: 1 2 3 4 5

Cure? (day 4)

Add TRT if needed

Cows without metritis (**NoMET**)

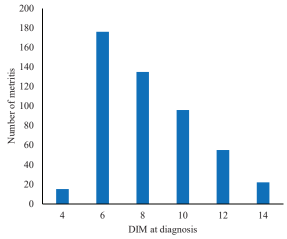
Ceftiofur: 2.2 mg/kg of BW i.m. once daily for 3 days
Meloxicam: 0.5 mg/kg of BW i.m. administered daily for 3 days

Pontes et al. unpublished

Treatment Protocols: Adding Meloxicam to the Treatment of Metritis

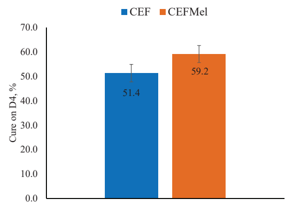
Incidence of metritis:

- 18.8% (501 out of 2772)
  - 251 CEF
  - 250 CEFMel



Cure on D4:

- 54.8% (273 out of 498)



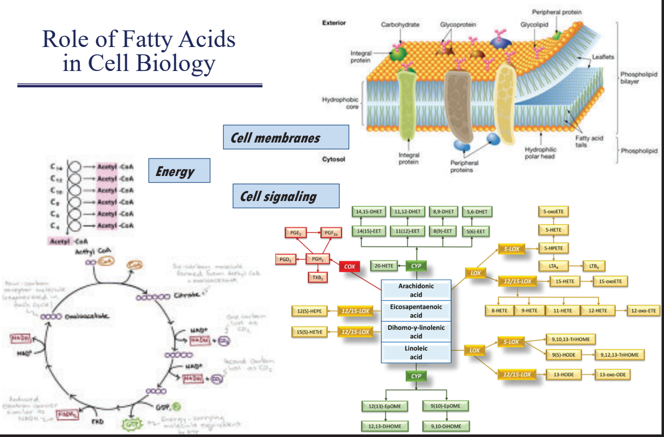
Pontes et al. unpublished

Treatment Protocols: Adding Meloxicam to the Treatment of Metritis

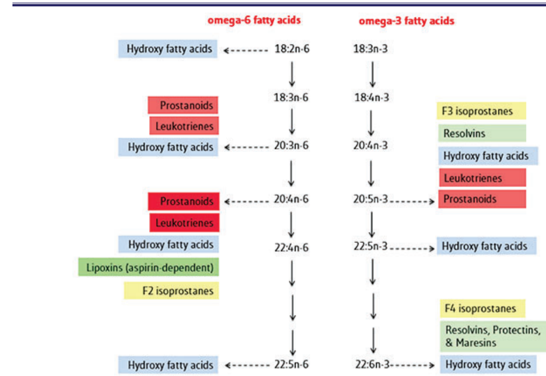
Reproductive performance:

Pontes et al. unpublished

Role of Fatty Acids in Cell Biology



Oxylipins: Bioactive Lipid Mediators From PUFA



Source: http://lpi.oregonstate.edu/mic/other-nutrients/essential-fatty-acids

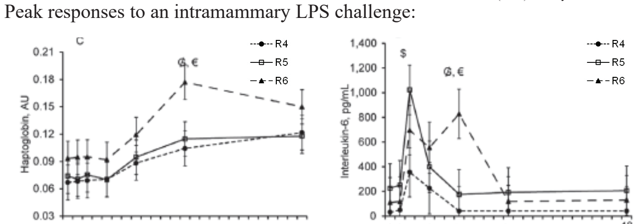
Dietary Ratio of n6 and n3 Fatty Acids

Starting on d 14 postpartum, diets were supplemented with a mixture of Ca salts of fish, safflower, and palm oils (1.4% of DM) to create 3 ratios of n-6 to n-3:

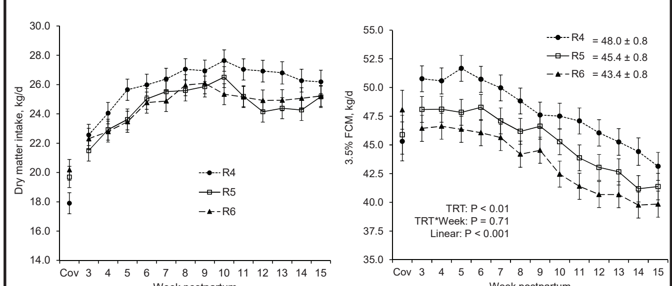
- R6: 6 parts of n-6 to 1 part of n-3 FA
- R5: 5 parts of n-6 to 1 part of n-3 FA
- R4: 4 parts of n-6 to 1 part of n-3 FA

Greco et al. (2015) J. Dairy Sci. 98 :602–617

Peak responses to an intramammary LPS challenge:

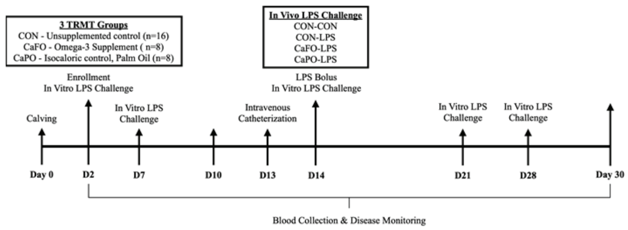


Effect of Dietary n6:n3 Ratio on DMI and FCM



Greco et al. (2015) J. Dairy Sci. 98 :602–617

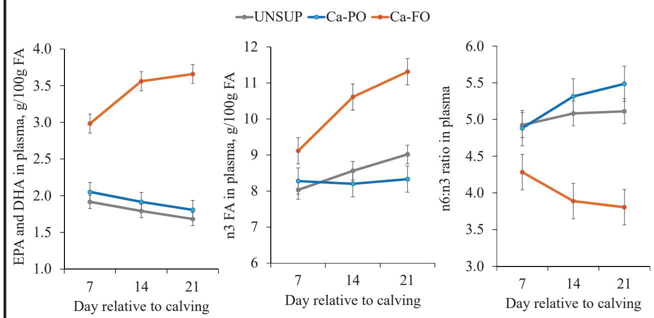
Impact of Omega-3 Fatty Acids on Regulation of Postpartum Inflammation



Van Winters et al. 2023 MSc thesis

Omega-3 Fatty Acids Can Be Enriched in Circulation

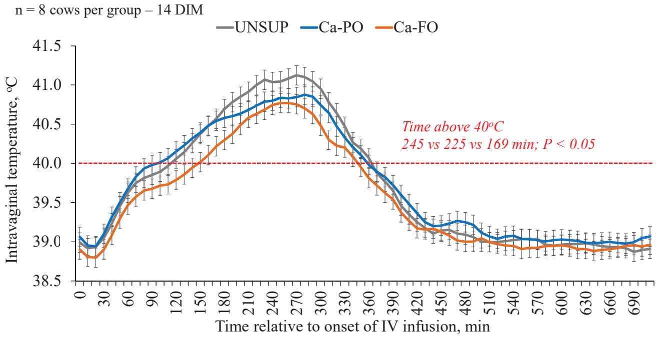
n = 8 cows per group – supplementation started on d 2 – inclusions of 0.8% of DM



Van Winters et al. 2023 MSc thesis

Omega-3 Fatty Acids as Regulators of Inflammation

n = 8 cows per group – 14 DIM



Van Winters et al. 2023 MSc thesis

Take Home Messages

- ClinD limits the cow's ability to manifest her genetic potential to produce milk and to reproduce, and exacerbated inflammation seems to be at least part of the problem;
- Variability in inflammation markers of postpartum cows without ClinD, & the induced inflammation model in healthy postpartum cows demonstrate that inflammation by itself can cause major changes in cow metabolism, behavior, and performance;
- Long-acting NSAIDs (e.g. meloxicam) have been used successfully as part of ClinD treatment protocols or as blanket intervention shortly after calving;
- Polyunsaturated fatty acids are important precursors of lipid mediators, can be enriched in circulation/tissues through the diet, and affect postpartum inflammatory responses.

Acknowledgments

NSERC CRSNG
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Ministry of Agriculture, Food & Rural Affairs
OCE Where Next Happens

Ontario Agri-Food Innovation Alliance
ourofino saúde animal
Rehagro
University of Guelph Food from Thought

Thanks for your attention! eribeiro@uoguelph.ca

Postpartum Ketones: friend or foe?

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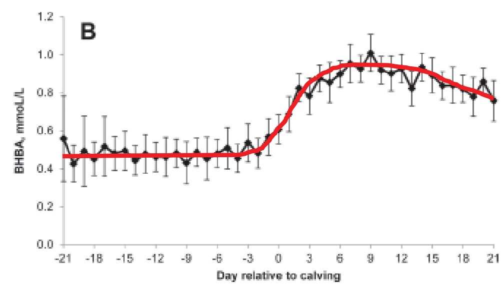
Breakout session room 4: Postpartum ketones: friend or foe?

1

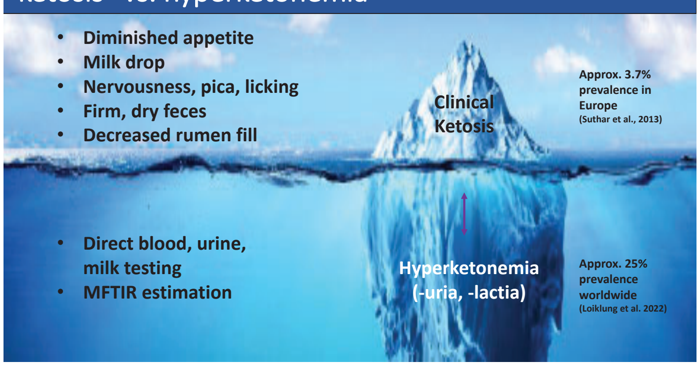
Timing



McCarthy, Mann et al., 2015 n= 269 multiparous Holstein cows, 95% CI shown

2

"ketosis" vs. hyperketonemia



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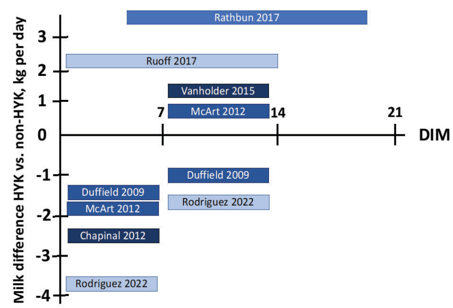
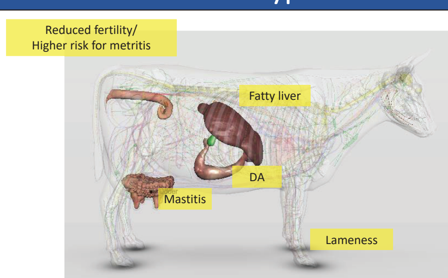
Associated outcomes with hyperketonemia



Difference in kg milk per cow per day between cows diagnosed with hyperketonemia (HYK) and non-hyperketonemic cows based on blood BHB threshold definitions ranging from 1.2 to 1.4 mmol/L at varying days in milk (DIM).
Mann and McArt VCNA, 2023

4

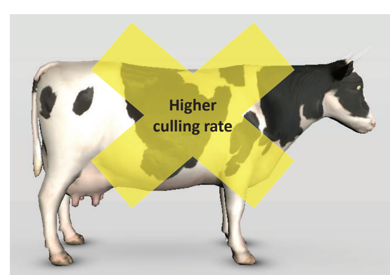
Associated outcomes with hyperketonemia



Suthar et al., 2013, Gohary et al., 2016, McArt et al. 2015, Raboisson et al. 2014

5

Associated outcomes with hyperketonemia



Cost of hyperketonemia varies with analysis and input, but always negative economic effect

Cainzos et al, 2022, Gohary et al., 2016, McArt et al. 2015, Raboisson et al. 2015

6

Associated outcomes – any positive?

Likelihood of culling 30-60 days after surgery is 2.5-3 times greater for cows with BHB < 1.2 mmol/L at time of surgery
(Croushore et al., 2013, Reynen et al., 2015)

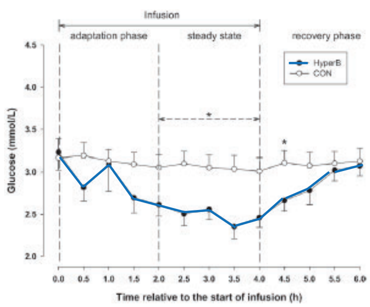
http://www.ldatogglesuture.com/

7

Direct effects of BHB

8

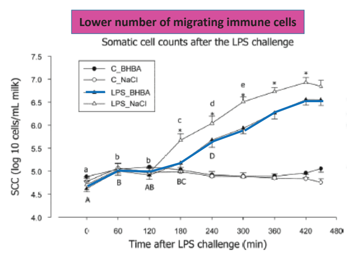
Effects of BHB on postpartum physiology



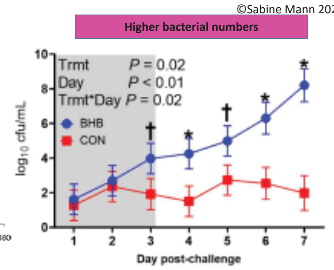
Zarrin et al., 2017. Mean ± SEM plasma glucose concentration in cows with BHB infusion (HyperB, 1.5-2 mmol/L) and on a day without infusion (CON) wk 2 after parturition (n = 8).

9

Effects of BHB on mammary immune response in vivo (late lactation)



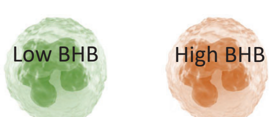
Zarrin et al. 2014. Mean ± SEM somatic cell in milk after the LPS challenge. 28 wks in milk, HyperB n=5, Ctrl n=8



Swartz et al., 2021. LSM ± SE *Strep uberis* milk cfu BHB 1.8 mM for 72 h, n= 6; CON n=6

10

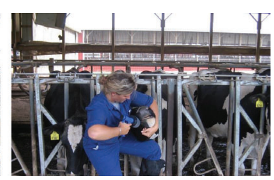
Effects of BHB on immune cells IN VITRO



lymphocyte blastogenesis
neutrophil respiratory burst
killing capacity
neutrophil phagocytosis

…o et al, 1995; Hoeben et al., 1997; Suriyasathaporn et al, 2000; Grinberg et al., 2008

11



Treatment

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Therapeutic vs. control	Dose & route of administration	Length of administration	Blood [BHB]	Disease incidence	Milk yield
Glucose vs. non-treatment	250 g i.v. glucose	3 d	.	N/A	N/A
PG vs. non-treatment	310 g oral PG	3 to 5 d	+	+++	+++
Glucose + PG vs. PG	250 g i.v. glucose + 300 mL oral PG vs. 300 mL oral PG	1 to 3 d (glucose) 3 d (PG)	.	.	.
Glucocorticoids + PG vs. PG	20 mg i.m. dexamethasone + 300 mL oral PG vs. 300 mL oral PG	1 d (dexamethasone) 4 d (PG)	--	.	.
B+C + PG vs. PG	25 mL s.c. B+C + 300 g oral PG vs. 300 g oral PG	3 d (B+C) 3 d PG	+	N/A	+

Summarized overview of evidence-based hyperketonemia treatments to reduce blood β-hydroxybutyrate (BHB) concentrations one week following treatment, reduce post-diagnosis disease incidence, and increase production outcomes. *Mann and McArt VCNA, 2023*

PG = propylene glycol, B+C = butaphosphan + cyanocobalamin

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Study design Mann et al. 2017

©Sabine Mann 2023

Cows 3-9 DIM with BHB ≥ 1.2 mmol/L (n=34)

n = 9 | n = 9 | n = 8 | n = 8

500 mL 50% D-glucose i.v. once daily for 3 d

300 mL PG orally once daily for 3 d

500 mL 50% D-glucose i.v. + 300 mL PG orally once daily for 3 d

untreated control

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BHB concentrations

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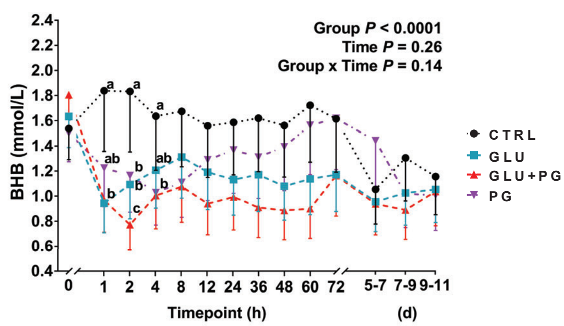

Mann et al., 2017

15

Too much glucose?

©Sabine Mann 2023

Tierärztl Prax 1993; 21: 289–93
F.K. Schattauer Verlagsgesellschaft mbH, Stuttgart – New York

Untersuchungen zur Wirksamkeit intravenös verabreichter hoher Glukosemengen bei der Behandlung der Ketose des Rindes

M. Metzner, W. Hofmann, Ch. Laiblin
Aus der Klinik für Klauentiere, Fortpflanzung und Haltungshygiene der Freien Universität Berlin

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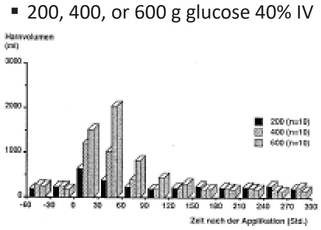
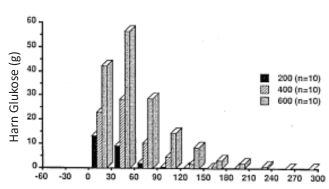
Metzner et al., 1993

©Sabine Mann 2023

- 10 healthy cows
- Cross-over-study
- 200, 400, or 600 g glucose 40% IV





Retained glucose:
173/200 g (87%); 324/400 g (81%); 444/600 g 74%

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Follow-up study (Capel et al. 2021)

©Sabine Mann 2023

- 4 herds in New York State
  - 3X, daily milk weights
  - 1,000-2,100 milking cows
  - 84-88 lbs herd average

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Study design

Cows 3-16 DIM (n= 1,249)

HYK [BHB ≥ 1.2 mmol/L (n=373)]
3 d treatments

no negative control group

n = 121 | n = 125 | n = 127

300 mL PG drench

300 mL PG drench
+
500 mL 50% D-glucose IV
Day 1

300 mL PG Drench
+
500 mL 50% D-glucose IV
Days 1-3

Capel et al., 2021

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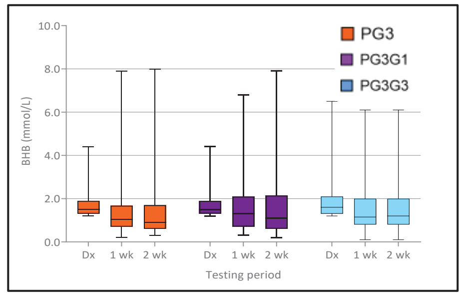
Results



No difference in:

- **Resolution of hyperketonemia**
- **Adverse health events**
- **Daily milk yield over the first 10 weeks of lactation**

Capel et al., 2021

20

Closing toughts

- BHB has both direct effects and is used as a marker of metabolic hemostasis and metabolic stress
- BHB increase is a hallmark of the normal adaptation to lactation
- The relationship between milk production and the level of metabolic challenge indicated by BHB concentrations might not be linear and differs by time of diagnosis
- Focus on the prepartum period and the first days postpartum to reach metabolic stability

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Got Calcium? Why Giving More Isn't Always Better for Postpartum Hypocalcemia

Jessica A. A. McArt, DVM, PhD
Population Medicine & Diagnostic Sciences
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Cornell University, Ithaca NY

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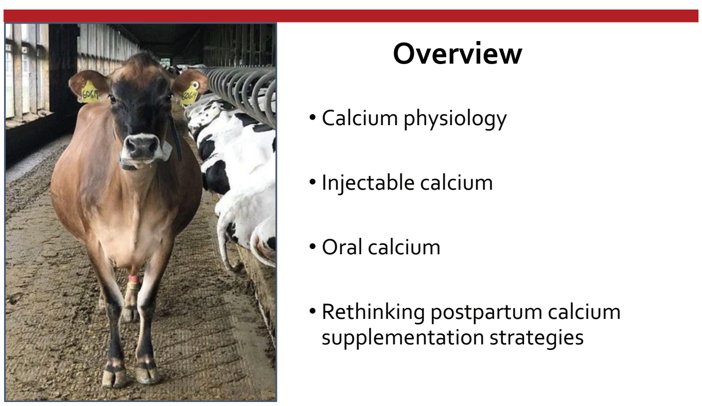

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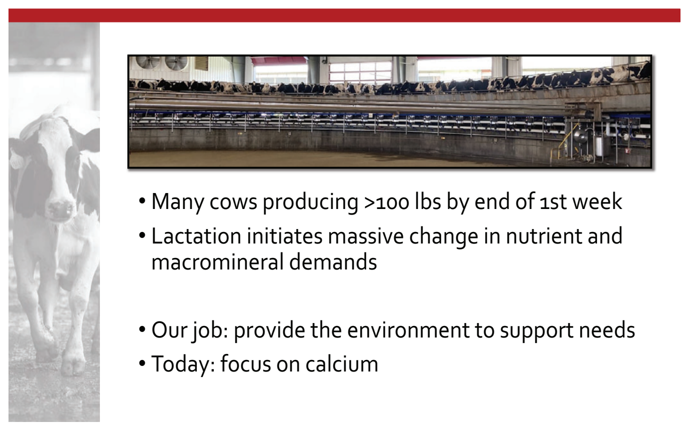

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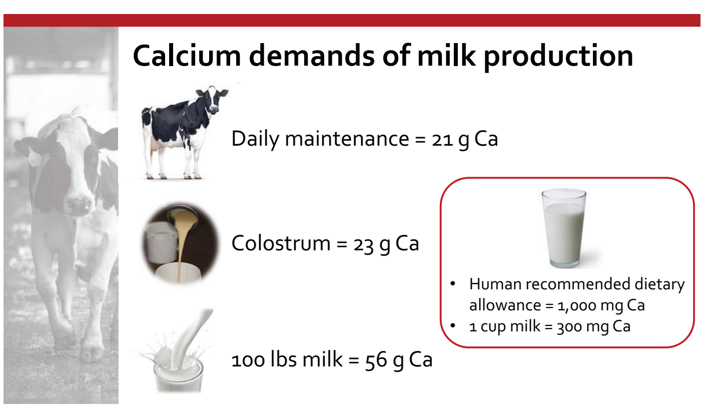

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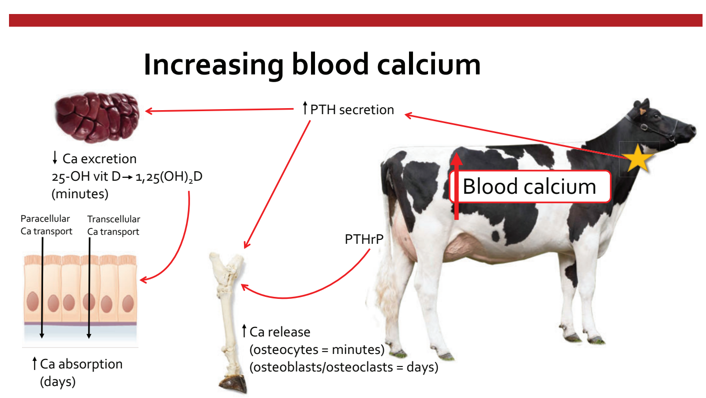

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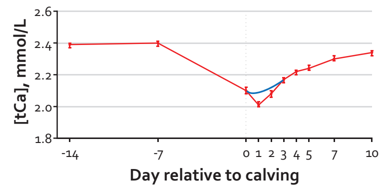
What can we do after calving to prevent hypocalcemia?

7

Postpartum calcium supplementation

- Idea: supply additional calcium to reduce deficit



- Options:
  - Injectable
  - Oral drench, gel, bolus

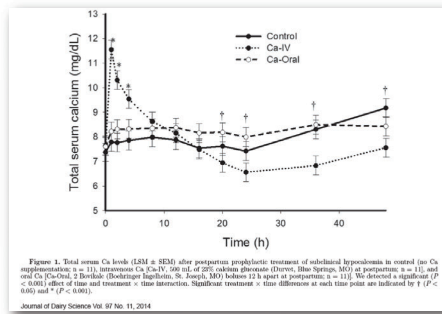
8

Treatment options: injectable calcium

- Administered intravenously or subcutaneously
- Calcium borogluconate 23%
  - ~ 10 g calcium in 500 mL bottle
- Intravenous not recommend for prevention/treatment of subclinical hypocalcemia
- Subcutaneous widely used in dairy industry

9

Intravenous calcium



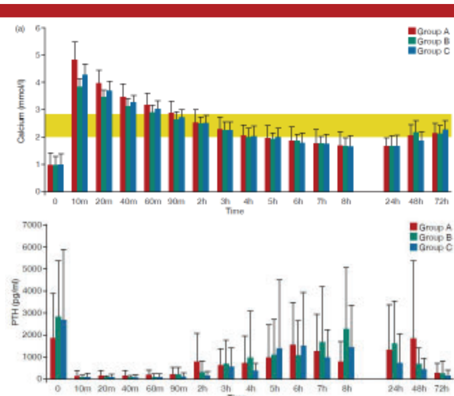
Blanc et al., 2014

10

ntravenous calcium

30 cows

Parturient paresis



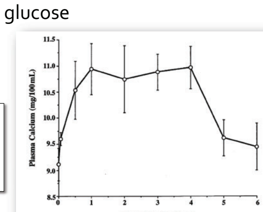
'aun et al., *Vet Rec*, 2009

11

Subcutaneous calcium

- Absorption requires peripheral perfusion
- Can be irritating
  - No more than 1.5 g calcium per site (Oetzel, 2013)
  - Solutions should not contain glucose

Plasma calcium in 6 Jersey cows given 10.5 g Ca as calcium borogluconate subcutaneously (500 mL in 10 sites)
Goff, 1999



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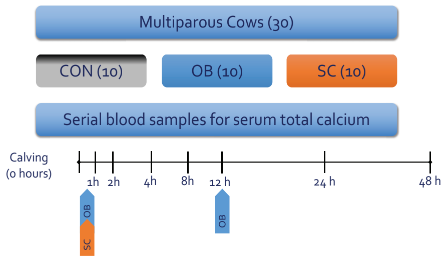
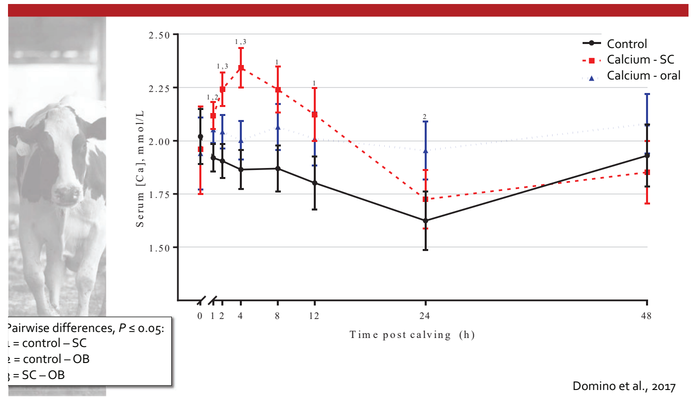
Aim: To observe serum [Ca] during the first 48 h postpartum in cows supplemented with oral or subcutaneous Ca vs. non-supplemented cows



Courtesy of A. R. Domino

Domino et al., 2017

13

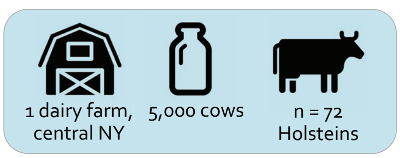


Domino et al., 2017

14

What happened when we looked longer?

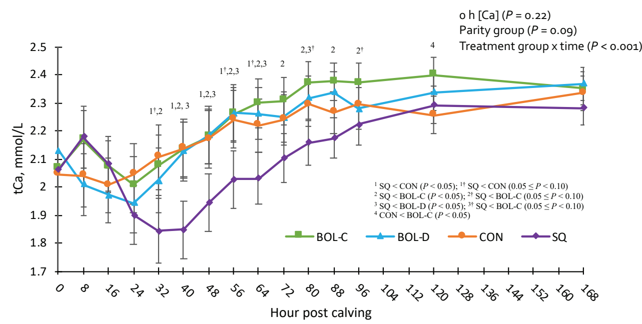
- Enrollment at calving
- Randomized block design
  - **CON**: Control cows, no supplemental Ca
  - **BOL-C**: Conventional oral Ca bolus, 43 g Ca at calving and 24 h
  - **BOL-D**: Delayed oral Ca bolus, 43 g at 48 and 72 h
  - **SQ**: Subcutaneous infusion, 500 mL 23% Ca borogluconate



Courtesy: K. Callero

15

Results: [Ca] across 168 h post enrollment



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Oral calcium

- Administered by drench or bolus
- Effectiveness dependent on calcium source
  - Availability of calcium
  - Efficiency of intestinal absorption
- iCa ~6 mmol/L to achieve passive transport (Goff, 1999)
- Other possible transport mechanisms in rumen

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Oral calcium boluses

- Provide supplemental calcium source in "easy to administer" bolus
- Goal: rapidly and delayed calcium absorption for prolonged increase in blood [Ca]
  - Different types of calcium salts make a difference
  - All calcium boluses are not equal!
- Caution in severely hypocalcemic cows, diminished swallowing reflex

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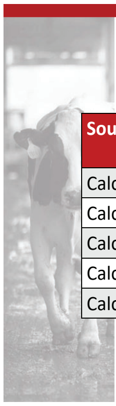

Calcium sources & absorption

Source	Solubility in water[1], g/100 mL @ 20°	Absorption coefficient[2], dairy cattle
Calcium chloride	74.5	0.95
Calcium propionate	26.0	-
Calcium sulfate	0.2	0.70
Calcium carbonate	6.2×10^{-4}	0.75
Calcium hydroxide	0.2	0.55

[1] U.S. National Library of Medicine; www.ncbi.nlm.nih.gov
[2] Nutrient Requirements of Dairy Cattle, 2001

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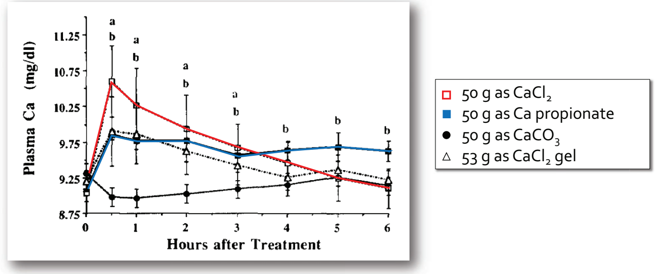
Calcium propionate & calcium carbonate



Goff and Horst, 1993

20

roduct	Manufacturer	Amount of calcium	Calcium sources	Additional items
ovikalc	Boehringer Ingelheim	43 g/bolus	Calcium chloride Calcium sulfate	
eshCAL	mb Nutritional Sciences	46 g/4 boluses	Calcium chloride Calcium sulfate	Yeast extract Vitamin D_3
uadriCal	Bio-Vet	54 to 64 g/3 boluses	Calcium chloride Calcium sulfate Calcium propionate Calcium lactate	Niacin Vitamin D_3
umiLife CAL24	Genex	100 g/2 boluses	Seaweed-derived calcium Calcium chloride Calcium carbonate	Magnesium oxide Vitamin D_3
ansition	MAI Animal Health	22 g/bolus 44 g/bolus	Calcium chloride Calcium carbonate Calcium propionate	Vitamin D_3
iple Calcium	AgriLabs	22 g/bolus 44 g/bolus	Calcium chloride Calcium propionate Calcium carbonate	
traCalc Plus	AgriLabs	44 to 48 g/bolus	Calcium chloride Calcium carbonate Dicalcium phosphate Calcium sulfate	Magnesium oxide Vitamin D_3
MCP Vitall	TechMix	40 to 46 g/2 boluses	Calcium chloride Calcium carbonate	Niacin, magnesium sulfate, yeast + more!

21

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Bolus thoughts:

- Calcium boluses raise blood [Ca]
  - Dose and frequency dependent
  - Likely product dependent
- Real question → *Do calcium boluses affect cow health or production?*
- Answer: it depends.
  - Blanket therapy not beneficial
  - Target groups: high producing cows, older cows, lame cows, cows with difficulty calving

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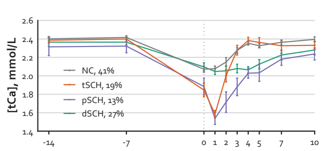
So, should we use boluses?

- Short-term Ca increase has been shown to have beneficial effects for a subgroup of cows.
- Oral calcium supplementation is not always beneficial and sometimes is detrimental, especially to primiparous cows.
- Let's rethink our supplementation strategies to determine which cows benefit from additional calcium and when they need it.



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Postpartum calcium supplementation

- Does calcium supplementation impede welfare for some cows?
- Does type of calcium supplementation matter as far as potential harm?
- By trying to do the right thing, do we interfere with homeostatic mechanisms?
- Use calcium monitoring results to inform postpartum calcium supplementation strategies.

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Summary

- Hypocalcemia is a prevalent, but it is not always bad.
- Evaluate postpartum supplementation strategies
- Dry matter intake is likely better than anything else!

25

Acknowledgements

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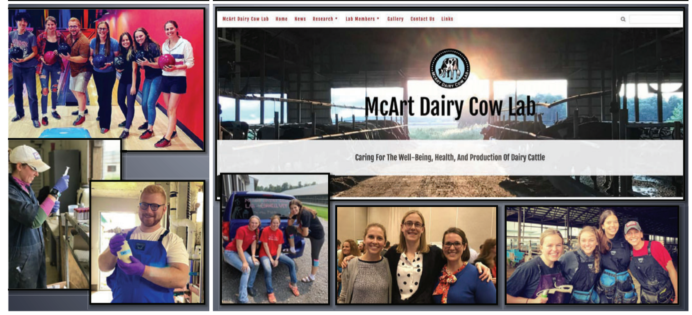
jmcartdvm



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Rumen-protected Lysine: a Lead or Supporting Performer?

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■ Introduction

Methionine (Met) and lysine (Lys) are defined as being most limiting amino acids (AA) for dairy cow diets. These are recommended in amounts of 7.2% of MP for Lys and 2.4% of MP for Met (NRC, 2001). The recommended ration of Lys:Met was originally suggested to be 3.0:1.0 (NRC, 2001). However, more recent findings suggest a ratio closer to 2.8:1.0 may support lactogenesis more effectively (Osorio et al., 2013). This was initially determined due to increased DMI with a greater inclusion of rumen-protected Met in the diet (Zhou et al., 2016b). Additionally, it is also important to note the relationship between energy and AA requirements. Animals have a metabolic flexibility to utilize other carbon containing substrates, such as the carbon backbone of amino acids, when energy intake is low, resulting in an inefficient use of AA as energy (Lobley, 2007). It is recommended to supply 3.03 g of Lys/Mcal of metabolizable energy (ME) and 1.14 g of Met/Mcal of ME to allow for adequate utilization of these AA by dairy cows (Higgs and Van Amburgh, 2016). Deficiencies in these AA is due to a limited and variable concentration in feedstuffs. For instance, Lys concentrations are adequate in blood meal, less in soybean meal, and the least in corn gluten meal and Met concentrations are low in blood meal and soybean meal (Erasmus et al., 1994). Additionally, blood meal appears to be an adequate source of RUP for dairy cows; however, digestibility of Lys in blood meal is dependent on processing methodology. When subjected to heating, digestibility of Lys in blood meal decreases (Stein et al., 2007). Because of these variabilities, rumen protection techniques were developed to ensure adequate delivery of limiting AA to the small intestine of dairy cows. An in-depth discussion of this occurs in a later section. In addition to Lys and Met, histidine (His) has also been identified as a limiting AA for dairy cows (Giallongo et al., 2016). Metabolism of limiting amino acids is important for understanding the negative effects of deficiencies. Methionine is well known for its role in methyl donor physiology. The combination of adenosine triphosphate (ATP) and Met forms S-adenosyl methionine (SAM; Pinotti et al., 2002). S-adenosyl methionine can be utilized as a methyl donor to form a variety of compounds, such as phosphatidylcholine, creatinine, sarcosine, and carnitine. In continuation of the methyl cycle, once SAM donates its methyl group it is converted to adenosine and homocysteine which is then converted to cystathionine (Pinotti et al., 2002). Cystathionine can form other derivatives such as cysteine, taurine, and glutathione (Brosnan and Brosnan, 2006). If homocysteine is not converted to cystathionine, it can be converted back to Met (Pinotti et al., 2002). Glutathione is an antioxidant important in maintaining reactive oxygen species (ROS) concentrations in tissues, which is particularly important during the transition period where there is an increase in ROS due to increased oxidation of fuels (Trevisi et al., 2012; Mailloux et al., 2013). Though Lys is predominately utilized for proteinogenesis, it can be catabolized into carnitine with the addition of the methyl group donation from SAM (Liao et al., 2015). Methylation of Lys, resulting in trimethyllysine occurs in the skeletal muscle (Fischer et al., 2009) and is subsequently transported to the liver for carnitine synthesis. Carnitine is essential for β-oxidation of free fatty acids in the mitochondria (Hoppel, 2003). Carnitine assists in shuttling free fatty acids into the mitochondria via carnitine-acylcarnitine system, particularly carnitine palmitoyltransferase-I (CPT-I) initiating subsequent β-oxidation for energy (Mcgarry and Brown, 1997). This system is upregulated after calving and may assist with oxidation of NEFA in the liver (Carlson et al., 2006). During the transition period, one way to monitor utilization of AA is by blood concentrations at varying time points. As these AA are utilized at a greater extent, concentrations in the blood will decrease. Starting at 21 d prior to calving, blood concentrations of Met and His started to decrease and reached nadir at 10 d after calving; however, they did not return to prepartum levels by 28 d after calving (Zhou et al., 2016a). Interestingly, blood concentrations of Lys decreased from 21 d prior to calving and reached nadir at 1 day after calving; however, concentrations returned to prepartum levels by 7 d after calving. It is possible that this indicates Lys is needed prior to calving predominately, while Met and His are extensively utilized after calving (Zhou et al., 2016a).

■ Dietary AA considerations during the transition period

The transition from gestation to lactation, also known as the periparturient period, is a critical time for dairy cows. This phase is typically defined as 3 wk prior to parturition through 3 wk after parturition (Drackley, 1999). Due to an increase in energy demands, most notably in the first wk following parturition, it is almost impossible to avoid a negative energy balance, resulting in mobilization of body stores (Grummer, 1995). Therefore, the incidence of metabolic disorders increases dramatically (Drackley, 1999). There is also a negative protein balance due to an enhanced demand by the mammary tissues and conceptus growth, which is arguably of greater importance than a negative energy balance (Larsen et al., 2014). Impaired immune and tissue function and decreased proliferation of visceral and liver tissues may occur if duodenal flow of indispensable AA (IAA) is limited during the periparturient period (Connell et al., 1997; Li et al., 2007; Larsen et al., 2014). Notably, Met and Lys are often the most limiting AA in dairy cattle diets (NRC, 2001). Previously, the recommended amount of intestinal supply of Lys and Met was 7.2 and 2.4% of total protein digested in the small intestine, respectively (NRC, 2001). However, expressing IAA requirements as a concentration of the diet can lead to deficiencies of these if DMI is not as high as predicted, which is common during the periparturient period (Vyas and Erdman, 2009). Due to this, amounts of IAA (g/d) is a more accurate unit of measurement. Bell et al. (2000) suggested increasing the amount of MP provided during the prepartum period to 1,000 g/d compared to the previous NRC (2001) recommendation of 742 g/d. However, it is important to note that MP amounts may vary depending on the equation utilized to calculate this value. For example, Bell et al. (2000) postulated that the NRC (2001) formula overestimates the efficiency of AA uptake by the uterus during the prepartum period, thereby underestimating the MP requirement. Inconsistencies in recommendations and expression of IAA content in the diet make it challenging to determine the actual requirement during the periparturient period for dairy cows (Chalupa and Sniffen, 1991).

Milk protein synthesis can be enhanced and mobilization of AA from tissues can be decreased by improving the duodenal flow of IAA (Carder and Weiss, 2017). Removal of Lys across hepatic tissue is limited; therefore, Lys is distributed to other tissues, such as skeletal muscle and the mammary gland (Lapierre et al., 2005). Feeding rumen-protected Lys (RPL) and rumen-protected Met (RPM) during the periparturient period has increased milk and milk protein yields of dairy cows (Xu et al., 1998; Socha et al., 2005; Osorio et al., 2013). It was suggested that the greatest response to intestinally supplied IAA is during early lactation, and likely this response occurs when IAA are fed prepartum. (Overton et al., 1996; Socha et al., 2005). This was validated by a reduced lactational performance when RPL or RPL and RPM were consumed only postpartum compared to when they were consumed prepartum and postpartum, though the physiological mechanism supporting this response has not been verified (Wu et al., 1997; Socha et al., 2005). However, study design with continuous feeding of RPL and RPM throughout the periparturient period make it difficult to decipher prepartum and postpartum effects separately or the effect of prepartum supply on postpartum performance. Though the need for intestinally available Lys in lactating cows has been verified (NRC, 2001), the requirement of intestinally available Lys of the transitioning dairy cow has not been totally explored. Though Lys is present in feedstuffs, Lys is often limiting and variable amounts will reach the intestine for direct supply to the cow. For this reason, RPL is a more consistent means to deliver Lys to the intestine (Chalupa and Sniffen, 1991). Feeding RPL can be utilized to increase lactation performance in dairy cows; however, the effect of feeding RPL during the prepartum and postpartum periods, independently, on cows' performance is not well explored.

■ Reproduction, Nutrition, and Health

Additionally, the negative energy and protein balance around parturition is associated with increased risk of uterine diseases among other metabolic disorders (Velazquez et al., 2019). This is partly a result of impaired endometrial function, as a decrease in the energy supply can alter the inflammatory response and increase the risk of uterine diseases (Sheldon et al., 2017). Thus, in this critical period for the dairy cows' productive life, there might be competing demands for nutrients for lactation and for immune response, including AA (Iseri and Klasing, 2014). Although focusing on the ratio of Lys to Met could be of practical use when formulating diets, it could lead to deficiencies of these AA when actual DMI does not meet the predicted, such as during the transition period (Vyas and Erdman, 2009). Therefore, quantifying the indispensable AA (IAA) is a more accurate approach, and providing these IAA as a ruminal-protected source improves the duodenal flow of AA (Patton, 2010; Robinson, 2010). For instance, reports indicate increased milk yield, milk protein, and DMI upon supplementation of rumen-protected methionine (RPM) and rumen-protected lysine (RPL) on Holstein cows' diets (Xu et al., 1998; Socha et al., 2005; Zhou et al., 2016; Batistel et al., 2017). Additionally, greater MP and Lys intake during the pre-calving period increased DMI postpartum (Girma et al., 2011; Fehlberg et al., 2020).

The reproductive success of dairy cows is associated with multiple factors, such as uterine health, involution and regeneration, and ovarian resumption (Galvao et al., 2004; Chebel et al., 2006; Santos et al., 2009; LeBlanc, 2014; McCoy, 2006). Innate immunity is crucial for the health of the reproductive tract of dairy cows following parturition and is affected by AA supply (Batistel et al., 2018; Zhou et al., 2016). Uterine infection is common in the postpartum period and can have a detrimental effect on ovarian and uterine function (Bromfield and Sheldon, 2013). Therefore, improving immune function and reducing the risk of reproductive tract inflammatory diseases could lead to better reproductive outcomes. Uterine infections can also be detrimental to ovarian resumption, since inflammation can impact the first dominant follicle (DF) growth and function through neuroendocrine mechanisms of inhibition of hypothalamic GnRH release and pituitary LH secretion (Williams et al., 2001). Moreover, there is also evidence of direct localized inflammatory mediators, resulting from uterine bacterial contamination after calving, affecting the ovary by suppressing estradiol secretion and decreasing the growth rate of follicles (Sheldon et al., 2002). Additionally, chronic inflammation can result in the disruption of uterine regeneration processes in the early postpartum period (LeBlanc, 2014; Lucy et al., 2003), which can potentially alter the functional capacity of the uterus (Gray et al., 2001a) and future reproductive efficiency (Gray et al., 2001b). Therefore, ovarian resumption could benefit from modulation of the uterine immune response through nutritional strategies. However, the effects of feeding RPL on the reproductive tract physiology and immune response are still lacking.

Research conducted mainly in monogastric animals provided evidence of the immune system requirements for Lys; for example, Lys consumption by the immune system increased 10-fold in an LPS challenge in poultry (Klasing and Calvert, 1999). Lysine can also play a role in biosynthesis processes, such as the synthesis of acute-phase proteins in response to an increase in circulating cytokines (Iseri and Klasing, 2014) or the synthesis of non-essential amino acids (Lapierre et al., 2009). These processes are pertinent to and activated during the periparturient period when the immune response of the high-producing dairy cow is activated and the animal is under a state of systemic inflammation (Bradford et al., 2015; Pascottini et al., 2020). Though there is limited research in dairy cows relating Lys supply to immune response and inflammatory status, there is evidence of decreased inflammatory response upon supplementation of RPL through the transition period (Fehlberg et al., 2023). The decreased inflammatory response is demonstrated by and increased in negative acute-phase proteins, a decrease in positive acute-phase proteins, and downregulation of interleukin-1β prepartum and interleukin-8 and serum amyloid A3 (Fehlberg et al., 2023).

■ Conclusions

Since mammary gland growth begins during late gestation and continues into early lactation, it is possible that previous approximations of IAA required during the transition period have been underestimated. Prepartum consumption of RPL had the largest effects on postpartum performance and efficiency. This is exemplified by increased ECM and milk fat, protein, lactose, and casein yields and a tendency for increased DMI during the postpartum period of cows that consumed RPL prepartum. Additionally, feeding RPL proved to be an adequate method to increase the concentration of Lys in plasma prepartum; however, this did not occur postpartum. This increase in concentration of Lys in plasma prepartum decreased many other indispensable AA (IAA) and dispensable AA (DAA) when RPL was consumed prepartum, suggesting that Lys was most limiting at this time. Therefore, the increasing concentrations of Lys in the plasma resulted in greater usage of IAA and DAA. Feeding RPL around parturition altered the expression of transcripts involved in inflammatory and immune responses. The downregulation of Toll-like receptor-4 (TLR4), Prostaglandin E synthase 3 (PTGES3), Histone-lysine 9 N-trimethyltransferase (EHMT2), Superoxide dismutase 1 (SOD1); and the upregulation of Apolipoprotein 3 (APOL3), Adenosylhomocisteinase (AHCY), Nuclear factor kappa B1 (NFKB1), Mucin 1 (MUC1), and Mucin 4 (MUC4), in conjunction with the lesser uterine polymorphonuclear neutrophils (PMN) percentage, are indicatives of a potentially less severe inflammatory process by week 4 postpartum (Figure 1). Additionally, a stimulus of cell proliferation is suggested by the tendency of RPL to increase the number of glandular epithelial cells. There was no effect of feeding RPL on the size of the first ovulatory follicle nor days to first ovulation. Increasing intestinal availability of Lys throughout the transition period improved several indicators of uterine health.

■ References

Available upon request.

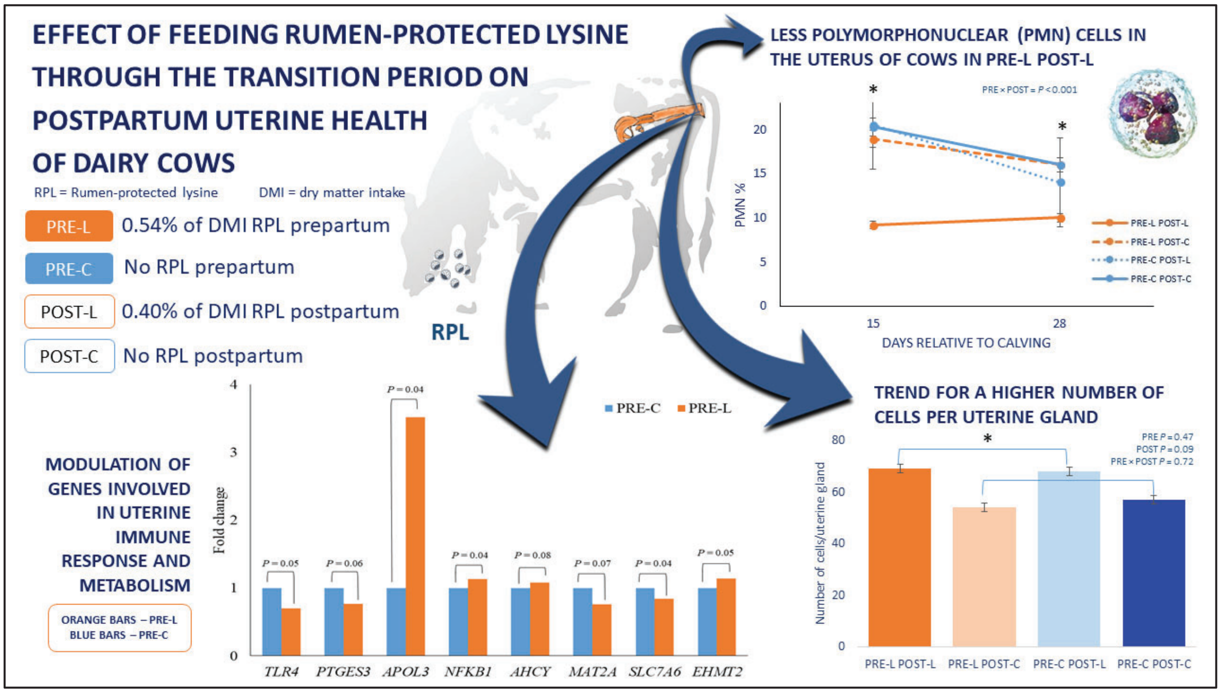


Figure 1. Summary of the effects of rumen-protected lysine on uterine health of dairy cows.

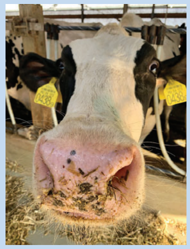
Feeding cows in robotic milking systems

Marcia Endres and Jim Salfer
University of Minnesota

Feeding cows in robotic milking systems

- Four-State Dairy Nutrition and Management Conference

Marcia Endres and Jim Salfer
University of Minnesota



1

Keys to success with robots

Excellent feed management

Survey results

Feed management ranked 1st

Pellet palatability and quality ranked 2nd

Nutritionists that like the challenge of robots

2

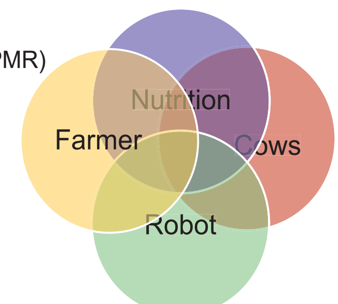
Goal of every feeding program

1. Meet nutritional needs of cows while maintaining cow health
2. Optimizing milk and components
3. Economical
4. Labor efficient and cost-effective feed delivery system

3

Feeding robot dairies is more complicated

- Partial mixed ration (PMR)
- Robot feed
- Feed table settings
- Milking permission settings



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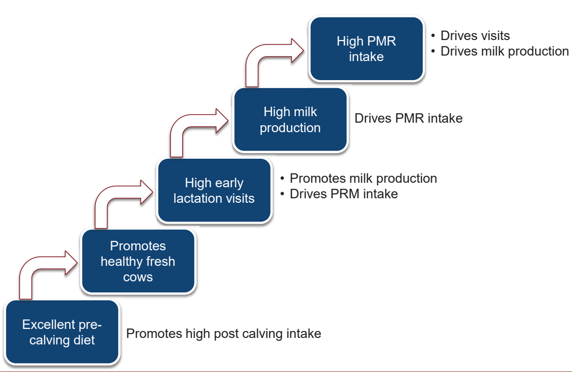

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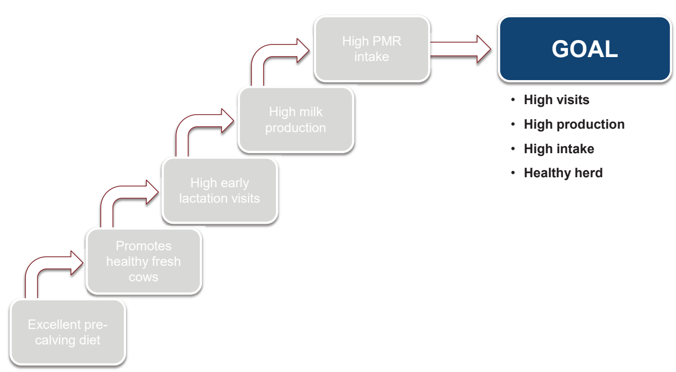

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Recommended feeding management

- **Excellent pre-calving program**
  - 80-90% freestall stocking density
  - 30 inches bunk space per cow
- **Focus on PMR**
  - 80-95% of nutrients are supplied through the PMR
  - That supports high milk production and drives cows to the robot

7

High quality and highly digestible forages encourage cows to be active

- High energy without high starch
- Increased forage rate of passage
- Greater meal frequency
- Cows stay healthy
- Cows are active and feel good

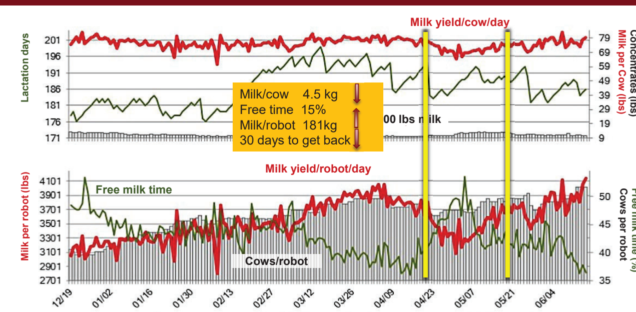
8

Recommended feeding management

- Consistent feed quality/quantity along the bunk
- Monitor forage moisture often and adjust accordingly
- Management that enhances rest and rumination

9

Forage quality/consistency is important



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PMR ration analysis

Crude protein, %	NDF, %	Starch, %	Sugar, %	NDFD, %
16	36.5	18.5	2.5	54.3

Robot pellet analysis

Crude protein, %	NDF, %	Starch, %	Sugar, %	NDFD, %
20.9	22.3	27.7	5.8	61.3

169 Canada Dairy herds samples May to August 2019. Van Soest et al., J. Dairy Sci. Vol. 105, Suppl. 1 2022 p. 261

11

What are the correct feed table settings?

12

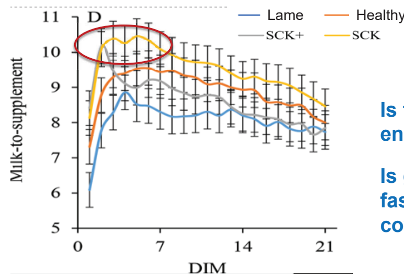
Subclinical ketosis was higher in Canadian robot herds than conventional herds

Multiparous cows on robot farms had a 1.45X higher chance of having ketosis than cows not on robot farms.

Tatone et al, JDS, 2017

13

High producing cows had higher subclinical ketosis for the first week after calving



Is the PMR not high enough in energy?

Is grain not being increased fast enough for high producing cows?

King et al., 2018 J. Dairy Sci 101:10168-10176

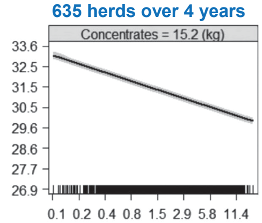
14

Feeding more feed in the robot does not always result in more milk per cow

Flow type	More visits	More milk
Free Flow (5 trials)	1	2
Guided Flow (4 trials)	1	1

Halachmi et al., 2005, Bach et al., 2007 Henricksen et al., 2018, Henrikson et al., 2019, Schwanke et al., 2019, Hare et al., 2018, Menajovsky et al., 2018 Paddick et al., 2019 Haisen et al.,

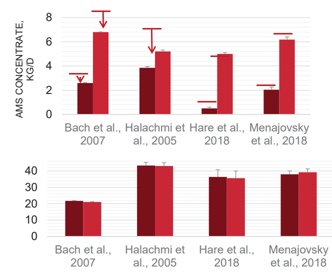
635 herds over 4 years



Tremblay et al, 2016

15

At high feeding levels cows may not consume all robot feed and have lower milk production



Paddick, 2018

16

Robot feeding amounts

Cows eating rates vary

- Maximum eating rate for pellets about 430 grams/minute
- Average eating rate is 200-300 grams/minute
- Do we have to feed pellets?
- Can we feed more precisely with more robot feed?
- How low a rate can we go?
  - Less in guided flow systems

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Feed table management was associated with milk production per cow

- Feed table categorization
  - Intensity = sum of
    - Number of AMS feed options
      - 1, 2, or 3
    - Maximum number of offerings with milk yield levels (up to 12)
    - Maximum number of varying concentrate amounts (up to 12)

Intensity	% of farms
Low (9-12)	44.7
Medium (13-16)	36.8
High (17-21)	18.4

N=38 farms

Gednalske et al., 2021

18

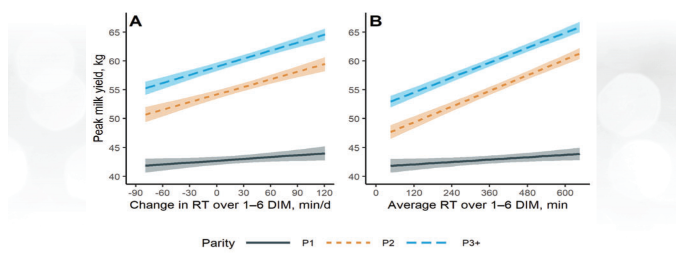
Feed table management was associated with milk production per cow

Feed table intensity	Milk yield per cow
Low	80.9^{b}
Medium	82.5^{b}
High	90.5^{a}

Gednalske et al., 2021

19

Rumination time in the first six days in milk was associated with peak milk yield



Peiter et al., 2021

20

Pre-training heifers can increase early lactation visits

21

Some farms are installing training stalls or pre-fresh concentrate feeder station

22

What's the correct milking access setting?

	1 lactation			2+ lactation		
Maximum Number of Milking	6.0	5.0	2.2	6.0	5.0	2.2
Optimum Expected Yield per Milking	16.0	22.0	24.0	16.0	27.0	27.0
Minimum Number of Milking	5.0	3.3	2.0	5.0	2.7	2.0
	0 DIM	60 DIM	-14d Dry off	0 DIM	40 DIM	-14d Dry off

Example Only

Device Name	Milk Yield last 24hrs	Avg Yield Per Day Last 7 days	Milk Yield To Tank Last 24hrs	Avg Yield To Tank Per Day Last 7 days	Avg. Yield / Milking Last 24h	Milkings Last 24hrs
VMS 1	6778.9	6399.7	6778.9	6388.2	39.9	170
VMS 2	6148.9	5915.7	6148.9	5830.9	41.3	149
VMS 3	6492.4	6131.8	6492.4	6131.8	40.1	162
VMS 4	6871.5	6319.4	6871.5	6255.0	40.4	170

What's the right number?

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Factors related to income over feed cost on 32 Wisconsin AMS farms

	Income over feed cost correlation (r)
Pounds of milk per visit	0.79
PMR dry matter intake	0.38
Total dry matter intake	0.33
PMR starch, % of dry matter	0.28
Robot refusals	-0.38
Pellet cost per ton	-0.26

Hoffman and Ruzic, Hoards 2019

24

Summary

High milk production per cow and robot

- Well balanced diets with high quality forage
- Excellent transition cow program
- High visits early lactation
- High reproductive efficiency
- Excellent cow comfort
- Good foot health
- Low somatic cell count

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Summary

- Labor cost and availability will continue to be a challenge
- Requires excellent management!
- Excellent transition program and high-quality forage
- **Help the robot succeed**
  - Feed and milk access tables
  - The right employees
  - Correct mindset/management
  - Best barn design
  - Robot maintenance/cleanliness
  - Select right kind of cows
- **Whole system approach for best success**
- **Must make the cash flow work!**

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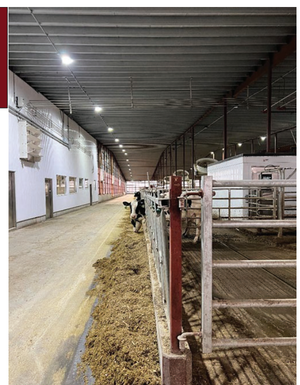
Thank you!



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27

Perspectives from a robot dairy

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Owner/Manager Silver Spirit Farm
Elgin, MN

Perspectives from a robot dairy

Samuel Fessenden, PhD
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1

Silver Spirit Farm – People

- Partnership between Craig and Cathy Reiter, Sam and Brenda Fessenden
  - New robot dairy started in September 2020

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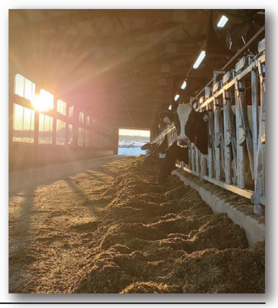
2

Silver Spirit Farm – General overview

- 125 cows on 2 Lely A5 robots
  - All heifers raised on site
- Steers raised from birth to 700 lbs
  - Sexed and beef semen, genomic testing
- 300 acres of tillable ground
  - Corn silage, alfalfa, annual haycrops, rye silage
  - High-moisture and dry corn



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Silver Spirit Farm – Dairy overview

- Current herd performance
  - Milk Fat+Prot: 7.25 lbs/cow, ECM: 107 lbs
  - Milk 96 lbs, 4.21% fat, 3.25% protein. 165k SCC average
  - DIM: 175, 90-100 days open, ~30% pregnancy rate
- Robot stats
  - 435 lbs F+P/robot/day. 5,800 lbs milk/box/d
  - 12-14% free time, 8.4 milk speed (Lely silicone liners)
  - 2.8 milkings, 2.0 refusals
  - Night calls: typically 1/month

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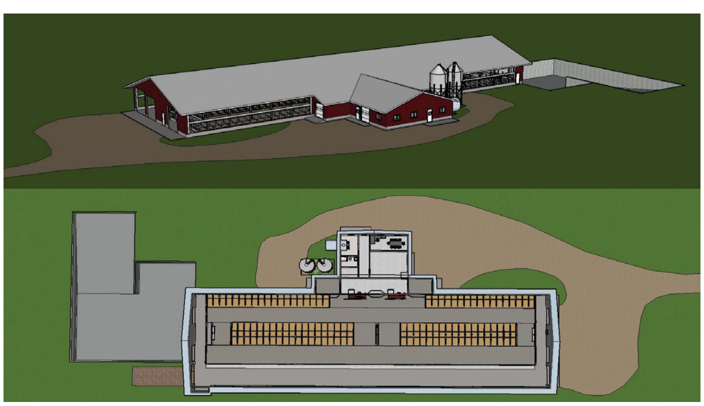

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Barn design take-aways

- Must have:
  - Open space around robots
  - Multiple feeds, commodity feeding system
  - Automatic feed pushing, alley scraper
  - Cattle sorting ability and working area/chute near robots
  - Easy way to do foot bath
- Wish I had:
  - Pre-fresh/calving in same barn
  - Automatic bedding system
  - Scales
- Not all that useful:
  - Liquid feeders

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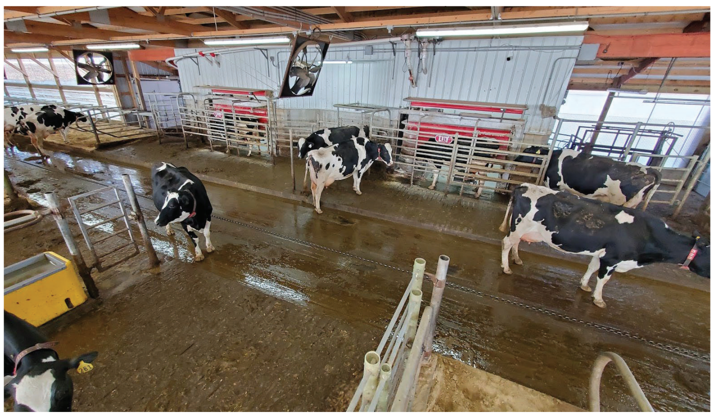

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Most valuable resource: Time

- Capital investment in robots is like paying for a very high-tech parlor PLUS 5-7 years of labor.
  - Con: Paying interest on the labor expense
  - Pro: They show up for work
- Just like a parlor, financial efficiency comes from pushing more milk harvested per unit time.
  - Reduce free time & down time (maintain and clean!)
  - Increase milk/hour (milk speed, attachments)
  - Increase milk/cow (dilution of maintenance, fewer cow touches/cwt)
  - Milk the right cows at the right time! (milk access)

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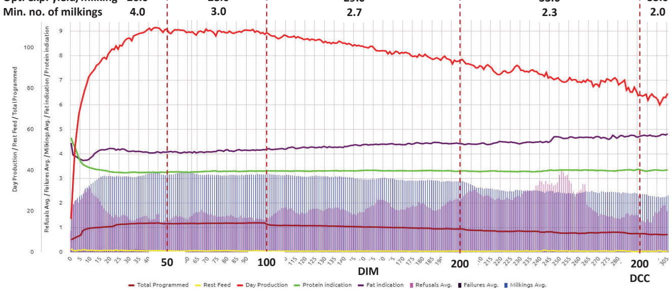
Milk Access

Max no. milkings	5.5	4.9	4.8	3.8	2.5
Opt. exp. yield/milking	26.0	28.0	29.0	33.0	33.0
Min. no. of milkings	4.0	3.0	2.7	2.3	2.0



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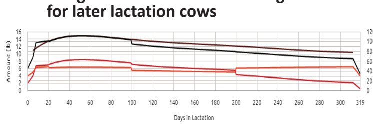
Robot Feed

- Ground dry corn (home-grown)
  - Mixed with some protect AA on-farm
- Gluten pellets (bulk)
- Target 8-12 lbs total robot feed/100lbs milk
  - Start at 40:60 corn:gluten, work up to 70:30 for peak/high cows
  - Bring back down to 20:80 corn:gluten for later lactation cows



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• Photo: S. Fessenden

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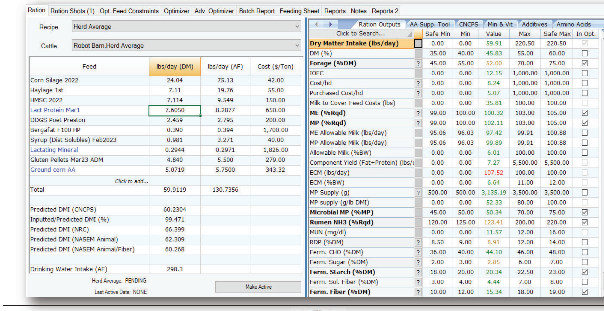
Current ration



Ration | Ration Shots (1) | Opt. Feed Constraints | Optimizer | Adv. Optimizer | Batch Report | Feeding Sheet | Reports | Notes | Reports 2

Recipe: Herd Average

Cattle: Robot Barn.Herd Average

Feed	lbs/day (DM)	lbs/day (AF)	Cost ($/Ton)
Corn Silage 2022	24.04	75.13	42.00
Haylage 1st	7.11	19.76	55.00
HMSC 2022	7.114	9.549	150.00
Lact Protein Mar1	7.6050	8.2877	650.00
DDGS Poet Preston	2.459	2.795	200.00
Bergafat F100 HP	0.390	0.394	1,700.00
Syrup (Dist Solubles) Feb2023	0.981	3.271	40.00
Lactating Mineral	0.2944	0.2971	1,826.00
Gluten Pellets Mar23 ADM	4.840	5.500	279.00
Ground corn AA	5.0719	5.7500	343.32
Click to add...			
Total	59.9119	130.7356	
Predicted DMI (CNCPS)	60.2304		
Inputted/Predicted DMI (%)	99.471		
Predicted DMI (NRC)	66.399		
Predicted DMI (NASEM Animal)	62.309		
Predicted DMI (NASEM Animal/Fiber)	60.268		
Drinking Water Intake (AF)	298.3		

Herd Average: PENDING

Last Active Date: NONE

Make Active

Ration Outputs | AA Supp. Tool | CNCPS | Min & Vit | Additives | Amino Acids

Click to Search...		Safe Min	Min	Value	Max	Safe Max	In Opt.
Dry Matter Intake (lbs/day)		0.00	0.00	59.91	220.50	220.50	☑
DM (%)		35.00	40.00	45.83	55.00	60.00	☐
Forage (%DM)	?	45.00	55.00	52.00	70.00	75.00	☑
IOFC		0.00	0.00	12.15	1,000.00	1,000.00	☐
Cost/hd	?	0.00	0.00	8.24	1,000.00	1,000.00	☐
Purchased Cost/hd	?	0.00	0.00	5.07	1,000.00	1,000.00	☐
Milk to Cover Feed Costs (lbs)		0.00	0.00	35.81	100.00	100.00	
ME (%Rqd)	?	99.00	100.00	100.32	103.00	105.00	☑
MP (%Rqd)	?	99.00	100.00	102.11	103.00	105.00	☑
ME Allowable Milk (lbs/day)		95.06	96.03	97.42	99.91	100.88	☐
MP Allowable Milk (lbs/day)		95.06	96.03	99.89	99.91	100.88	☐
Allowable Milk (%BW)		0.00	0.00	6.01	100.00	100.00	☐
Component Yield (Fat+Protein) (lbs/		0.00	0.00	7.27	5,500.00	5,500.00	
ECM (lbs/day)		0.00	0.00	107.52	100.00	100.00	
ECM (%BW)		0.00	0.00	6.64	11.00	12.00	
MP Supply (g)	?	500.00	500.00	3,135.19	3,500.00	3,500.00	☐
MP supply (g/lb DMI)		0.00	0.00	52.33	80.00	100.00	
Microbial MP (%MP)		45.00	50.00	50.34	70.00	75.00	☑
Rumen NH3 (%Rqd)		120.00	125.00	123.41	200.00	220.00	☑
MUN (mg/dl)		0.00	0.00	11.57	12.00	16.00	
RDP (%DM)	?	8.50	9.00	8.91	12.00	14.00	☐
Ferm. CHO (%DM)	?	36.00	40.00	44.10	46.00	48.00	☐
Ferm. Sugar (%DM)	?	2.00	3.00	2.85	6.00	7.00	☐
Ferm. Starch (%DM)	?	18.00	20.00	20.34	22.50	23.00	☑
Ferm. Sol. Fiber (%DM)	?	3.00	4.00	4.44	7.00	8.00	☐
Ferm. Fiber (%DM)	?	10.00	12.00	15.34	18.00	19.00	☑

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• Data: S. Fessenden

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Feeding/formulation approach:

- Know limits on ground feeds
  - Intake rate ground corn ~250g/min
  - Pelleted feeds ~300-450 g/min
  - Total box time can limit daily intake capacity
- PMR formulation ---not a lot different from TMR-fed herds
  - Focus on rumen-friendly formulation (peNDF, DCAD, fat loads, etc)
- Robot feeds:
  - For the cow: energy density and palatability
  - For the person: flowability, stability
- Robot settings:
  - Make sure max feed rates, amounts etc. are not limiting
  - Look for gaps or large swings in feed tables

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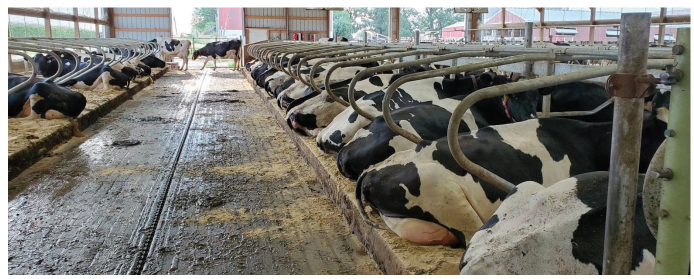
Thank you!



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Keys to Feeding Success in Robotic Milking Systems

JTP Farms
Dorchester, WI

JTP Farms
Jake and Tolea Peissig

1

JTP Farms

Dorchester, WI

475 cow
8-Delaval VMS
2-MFR Lely Vector system

2

Why Robots?

People

Cows

Family

3

4

Quick History

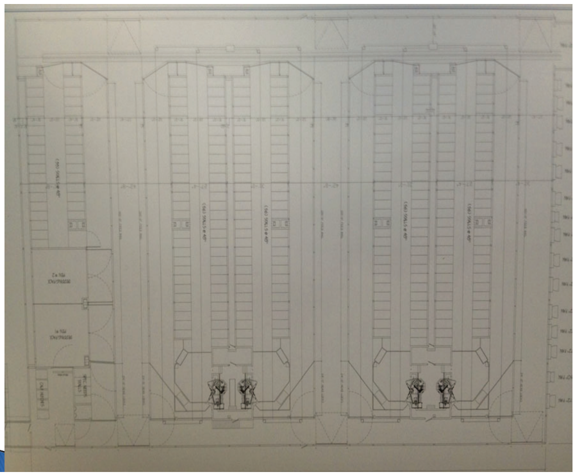
- Jan 2012: 4- Delaval VMS Classics
- 2018 Purchased 80 stall tie-stall
- 2019 stopped keeping calves/Breed Angus
- 2021 2- V300 milking robots July
- 2021 Lely Vector System December
- 2022 2- Delaval Classics

5

Barn Layout and Design

- 56 stall 2 row pens
- Grouping Strategies
  - All mixed groups/what we've learned
- Guided flow/ Smart gates and one ways
  - Less Labor
  - Reduced robot idle time

6



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Training Heifers/New Cows

- Under Crowd
- Harder you try/higher the response
- Heifer Pen?
- In Guided "know the routine"
- Make gate settings to not discourage intakes

9

Current Stats

- 95-97 lbs at tank
- 4.35 fat
- 3.21 protein
- 130 scc
- 181 DIM

10

Feeding Strategies

- Simple From the Start
  - Pellets/gluten
  - Avg 5 lbs per/cow/day
    - 2 lbs per visit

Things we've tried
QLF
Roasted Beans
Crumbles

11

Ration

- 4.5 robot Gluten
- 20 lbs BMR/Conventional Corn Silage
- 13 lbs Fescue/Italian Ryegrass/ alfalfa/clover
- 12 lbs HMC
- 5.6 lbs Protein Mix /Canola/Exceller
- 2 lbs Whey Permeate

12

13

Vector

Benefits
- Reduced shrink/feed waste
- Stimulated cow flow/multiple feedings
- Milk to feed ration increase
- Filling flexibility
- Labor

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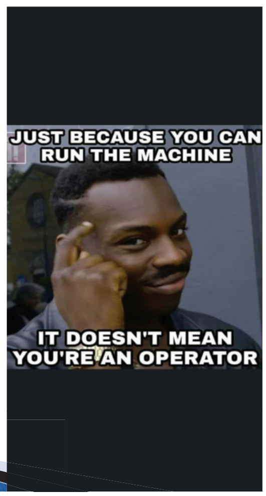

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Vector

- Poor Data
- Limited software
- Inaccuracies
- Not made to be pushed

23

24

New things we are trying

- Double robot pens with more cow Capacity/More milk per freestall
- Rumination/Activity but with AI Technology

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That's all I can Remember
Please ask lots of questions!!

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Amino Acid Balancing Transition Cow Rations - A California Perspective

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■ Introduction

The dairy industry faces the challenge of offering to consumers a high-quality product (i.e.; high protein milk) produced in environmental friendly production systems (Appleby et al., 2003). Dairy farms have been implicated in causing respiratory problems in humans; and surface water and groundwater aquifer contamination because of nitrogen (N) losses (Place and Mitloehner, 2010). It is of special interest to improve milk N use efficiency and reduce urinary urea N excretion to lessen environmental impact. Researchers reported that lower N efficiency could be the result of overfeeding crude protein (CP; Broderick, 2003; Ipharraguerre and Clark, 2005). Therefore, accurate description of both nutrient supply and requirements in the dairy cow need to be a focus of ongoing research as we work to improve the efficiency of nutrient use in high producing cattle and reduce the environmental impact of milk production.

Current diet formulations rely on CP as the metric when evaluating N supply (NRC, 2001); however, the aggregation of all N containing nutrients into one metric creates variability in evaluating animal performance (Ipharraguerre & Clark, 2005). Studies with reductions in dietary CP content have shown positive results (i.e.; no changes in milk yield) and negative results [i.e.; lower milk yield production; (Lee et al., 2012)]. This negative effect could be alleviated by supplementing low CP diets with rumen-protected amino acids (RPAA) such as lysine (LYS) and methionine (MET) (Broderick et al., 2008; Lee et al., 2012). Lysine, along with MET, are considered the most frequently limiting indispensable AA (IAA) in dairy cow diets (NRC, 2001). Nearly all of AA supply can be related with energy when swine diets are formulated (NRC, 2012). Findings from Higgs et al. (2014) indicated that notwithstanding lower levels of CP in the diet, cattle maintained a high level of performance when supplied with adequate rumen N and balanced for IAA. Further investigation alluded to a potential relationship between the supply of digestible IAA and the supply of metabolizable energy (ME) in the diets fed (LaPierre et al., 2019; Lapierre et al., 2020). However, the variation in response when using the aforementioned relationship may be reduced drastically by understanding the use of different ingredients in diets of dairy cows to obtain the ME (i.e.; starch vs. sugar; Cardoso et al., 2020). Additionally, cows fed a prepartum diet with California characteristics may have different results than a typical Midwest diet. The availability of the limiting AA (MET and LYS) in diets during the transition period seems to be of big importance for liver function (LFI) and immune response of these cows (Zhou et al. 2016).

Strategies to improve the reproductive performance of dairy cows include alteration of nutritional status. In other species, dietary supplementation with specific amino acids (AA) (e.g., arginine, glutamine, leucine, glycine, and methionine) had beneficial effects on embryonic and fetal survival and growth through regulation of key signaling and metabolic pathways (Del Curto et al., 2013). Methionine and lysine are the most limiting AA in lactating cows (NRC, 2001), but supplementation of diets with crystalline methionine and lysine has been excluded because free methionine and lysine are quickly and almost totally degraded by the microorganisms in the rumen (NRC, 2001). In contrast, supplementing rumen-protected methionine (RPM) and rumen-protected lysine (RPL) has a positive effect on milk protein synthesis in dairy cows (Ordway, 2009; Osorio et al., 2013). Although the role of methionine in bovine embryonic development is unknown, there is evidence that methionine availability alters the follicular dynamics of the first dominant follicle (Acosta et al., 2017), the transcriptome of bovine preimplantation embryos in vivo (Penagaricano et al., 2013) and the embryonic lipid content (Acosta et al., 2016) which may serve as an energy substrate, improving embryo survivability.

■ Reproduction, Nutrition, and Health

A widespread assumption is that fertility of modern dairy cows is decreasing, particularly for Holstein-Friesen genetics, in part because of unintended consequences of continued selection for high milk production. This assumption has been challenged recently (Leblanc, 2010). There is a wide distribution of reproductive success both within and among herds. For example, within five California herds encompassing 6,396 cows, cows in the lowest quartile for milk yield in the first 90 days postpartum (32.1 kg/day) were less likely to have resumed estrous cycles by 65 days postpartum than cows in quartiles two (39.1 kg/day), three (43.6 kg/day) or four (50.0 kg/day); milk production did not affect risk for pregnancy (Santos et al., 2009). Changes in management systems and inadequacies in management may be more limiting for fertility of modern dairy cows than their genetics per se.

Dairy cows are susceptible to production disorders and diseases during the peripartal period and early lactation, including milk fever, ketosis, fatty liver, retained placenta, displaced abomasum, metritis, mastitis, and lameness (Mulligan et al., 2006; Roche et al., 2013). There is little evidence that milk yield per se contributes to greater disease occurrence. However, peak disease incidence (shortly after parturition) corresponds with the time of greatest negative energy balance (NEB), the peak in blood concentrations of nonesterified fatty acids (NEFA), and the greatest acceleration of milk yield. Peak milk yield occurs several weeks later. Disorders associated with postpartum NEB also are related to impaired reproductive performance, including fatty liver and ketosis (Mcart et al., 2012). Cows that lost > 1 body condition score (BCS) unit (1-5 scale) had greater incidence of metritis, retained placenta, and metabolic disorders (displaced abomasum, milk fever, ketosis) and a longer interval to first breeding than cows that lost < 1 BCS unit during the transition (Kim and Suh, 2003).

Indicators of NEB are highly correlated with lost milk production, increased disease and decreased fertility. However, the extent to which NEB is causative for peripartal health problems rather than just a correlated phenomenon must be examined critically. For example, in transition cows, inflammatory responses may decrease dry matter intake (DMI), cause alterations in metabolism and predispose cows to greater NEB or increased disease (Graugnard et al., 2012 and 2013). Inducing a degree of calculated NEB in mid-lactation cows similar to what periparturient cows often encounter, does not result in marked increases in ketogenesis or other processes associated with peripartal disease (Moyes et al., 2009). Nevertheless, early postpartal increases in NEFA and decreases in glucose concentrations were strongly associated with pregnancy at first insemination in a timed artificial insemination (TAI) program (Garverick et al., 2013). Although concentrations of NEFA and glucose were not different between cows that ovulated or did not before TAI, probability of pregnancy decreased with greater NEFA and increased with greater glucose concentrations at day three postpartum (Garverick et al., 2013). In support of these findings, early occurrence of subclinical ketosis is more likely to decrease milk yield and compromise fertility. Mcart et al. (2012) reported that cows with subclinical ketosis detected between three and seven days after calving were 0.7 times as likely to conceive to first service and 4.5 times more likely to be removed from the herd within the first 30 days in milk (DIM) compared with cows that developed ketosis at eight days or later.

Cows that successfully adapt to lactation and can avoid metabolic or physiological imbalance are able to support both high milk production and successful reproduction while remaining healthy. Decreased fertility in the face of increasing milk production may be attributed to greater severity of postpartal NEB resulting from inadequate transition management or increased rates of disease. Competition for nutrients between the divergent outcomes of early lactation and subsequent pregnancy will delay reproductive function. Because NEB interrupts reproduction in most species, including humans, inappropriate nutritional management may predispose cows to both metabolic disturbances and impaired reproduction. Cows must make "metabolic decisions" about where to direct scarce resources, and in early lactation, nutrients will be directed to milk production rather than to the next pregnancy.

Different nutritional strategies have been proposed to improve reproduction of the dairy cow with no detrimental effect on lactation performance. Feeding high quality forages, controlled-energy diets, or supplemental fat in the diet are some of the most common ways to improve energy intake in cows (Cardoso et al., 2013; Drackley and Cardoso, 2014). Reproduction of dairy cattle may benefit by maximizing DMI during the transition period, and minimizing the incidence of periparturient problems (Cardoso et al., 2013; Drackley and Cardoso, 2014).

■ Dietary Considerations during the transition period

Controlling energy intake during the dry period to near calculated requirements leads to better transition success (Dann et al., 2005 and 2006; Janovick et al., 2011 Graugnard et al., 2012 and 2013). Cows fed even moderate-energy diets (1.50 – 1.60 Mcal NEL/kg DM) will easily consume 40–80% more energy (net energy of lactation; NEL) than required during both far-off and close-up periods (Dann et al., 2005 and 2006). Cows in these studies were all less than 3.5 BCS (1-5 scale) at dry-off and were individually fed a total mixed ration (TMR) based on corn silage, alfalfa silage, and alfalfa hay with some concentrate supplementation. We have no evidence that the extra energy and nutrient intake was beneficial in any way. More importantly, our data indicate that allowing cows to over-consume energy even to this degree may predispose them to health problems during the transition period if they face stressors or challenges that limit DMI (Cardoso et al., 2013).

Prolonged over-consumption of energy during the dry period can decrease post-calving DMI. Over-consuming energy results in negative responses of metabolic indicators, such as higher NEFA and beta-hydroxybutyrate (BHB) in blood and more triacylglycerol (TAG) in the liver after calving (Janovick et al., 2011). Alterations in cellular and gene-level responses in liver (Loor et al., 2006) and adipose tissue (Ji et al., 2012) potentially explain many of the changes at the cow level. Over-consumption of energy during the close-up period increases the enzymatic "machinery" in adipose tissue for TAG mobilization after calving, with transcriptional changes leading to decreased lipogenesis (fat synthesis), increased lipolysis (fat utilization) and decreased ability of insulin to inhibit lipolysis (Ji et al., 2012). Controlling energy intake during the dry period also improved neutrophil function postpartum (Graugnard et al., 2012) and so may lead to better immune function.

Allowing dry cows to consume more energy than required, even if cows do not become noticeably over-conditioned, results in responses that would be typical of overly fat cows. Because energy that cows consume in excess of their requirements must either be dissipated as heat or stored as fat, we speculated that the excess is accumulated preferentially in internal adipose (fat) tissue depots in some cows. Moderate over-consumption of energy by non-lactating cows for 57 days led to greater deposition of fat in abdominal adipose tissues (omental, mesenteric, and perirenal) than in cows fed a high-bulk diet to control energy intake to near requirements (Drackley et al., 2014). The NEFA and signaling molecules released by visceral adipose tissues travel directly to the liver, which may cause fatty liver, subclinical ketosis and secondary problems with liver function.

Data from our studies support field observations that controlled-energy dry cow programs decrease health problems (Beever, 2006). Other research groups (Holtenius et al., 2003; Vickers et al., 2013) have reached similar conclusions about controlling energy intake during the dry period, although not all studies have shown benefits (Winkleman et al., 2008). Application of these principles can be through controlled limit-feeding of moderate energy diets or ad libitum feeding of high-bulk, low-energy rations (Janovick et al., 2011; Ji et al., 2012).

Nutritionally complete diets must be fed and the TMR must be processed appropriately so that cows do not sort the bulkier ingredients. Feeding bulky forage separately from a partial TMR, or improper forage processing will lead to variable intake among cows, with some consuming too much energy and some too little. Underfeeding relative to requirements, where nutrient balance also is likely limiting, leads to increased incidence of retained placenta and metritis (Mulligan et al., 2006). Merely adding a quantity of straw to a diet is not the key principle; rather, the diet must be formulated to limit the intake of energy (approximately 1.3 Mcal NEL/kg DM, to limit intake to about 15 Mcal/day for typical Holstein cows) but meet the requirements for protein, minerals and vitamins. Reports of increased transition health problems or poor reproductive success with "low energy" dry cow diets must be examined carefully to discern whether nutrient intakes were adequate.

Less is known about diet formulation for the immediate postpartum period to optimize transition success and subsequent reproduction. Increased research is needed in this area. Proper dietary formulation during the dry period or close-up period will maintain or enable rumen adaptation to higher grain diets after calving. Failure to do so may compromise early lactation productivity. For example, Silva-del-Rio et al. (2010) attempted to duplicate the dietary strategy of Dann et al. (2006) by feeding either a low-energy far-off diet for five weeks followed by a higher-energy diet for the last three weeks before parturition, or by feeding the higher-energy diet for the entire eight-week dry period. They found that cows fed the higher-energy diet for only three weeks before parturition produced less milk than cows fed the diet for eight weeks (43.8 vs. 48.5 kg/day). However, the far-off dry period diet contained 55.1% alfalfa silage and 38.5% wheat straw but no corn silage. In comparison, the higher-energy dry period diet and the early lactation diet both contained 35% corn silage. Ruminal adaptation likely was insufficient for cows fed the higher energy diet for only three weeks.

A major area of concern in the fresh cow period is the sudden increase in dietary energy density leading to subacute ruminal acidosis (SARA), which can decrease DMI and digestibility of nutrients. Adequate physical form of the diet, derived either from ingredients or mixing strategy, must be present to stimulate ruminal activity and chewing behavior, although good methods to quantify "adequacy" remain elusive. Dietary starch content and fermentability likely interact with forage characteristics and ration physical form. Dann and Nelson (2011) compared three dietary starch contents (primarily from corn starch) in the fresh cow period for cows fed a controlled energy-type ration in the dry period. Milk production was greatest when starch content was moderate (23.2% of DM) or low (21.0% of DM) in the fresh cow diet compared with high (25.5% of DM). If SARA decreases DMI and nutrient availability to the cow, NEFA mobilization and increased ketogenesis may follow. In addition, rapid starch fermentation in the presence of NEFA mobilization leads to bursts of propionate reaching the liver, which may decrease feeding activity and DMI according the hepatic oxidation theory (Allen et al., 2009). A moderate starch content (23-25% of DM) with starch of moderate fermentability (e.g., ground dry corn rather than high-moisture corn or ground barley) along with adequate effective forage fibre may be the best strategy for fresh cows. Recent research also has demonstrated that high grain diets can lead to greater numbers of gram-negative bacteria such as *E. coli* with resulting increases in endotoxin present in the rumen, which may decrease barrier function and inflammatory responses in the cow (Zebeli and Metzler-Zebeli, 2012).

Supplemental fats have been widely investigated as a way to increase dietary energy intake and improve reproduction. A novel strategy is to use polyunsaturated fatty acid (PUFA) supplements to improve reproduction (Silvestre et al., 2011). Cows fed calcium salts of safflower oil from 30 days before to 30 days after calving, followed by calcium salts of fish oil to 160 days postpartum, had greater pregnancy rates and higher milk production. The mechanism is believed to be provision of greater amounts of linoleic acid (omega-6 PUFA) until early postpartum, which improves uterine health, followed by greater amounts of omega-3 PUFA from fish oil to decrease early embryonic loss (Thatcher et al., 2011). The effects of turbulent transitions on reproduction are established early postpartum, likely during the first ten days to two weeks postpartum (Mcart et al., 2012; Garverick et al., 2013). By eight weeks postpartum, > 95% of cows should be at or above energy balance (Sutter and Beever, 2000). Use of targeted prepartum and postpartum strategies may minimize health problems and lessen NEB, and thereby improve subsequent fertility.

■ The Importance of Amino Acids

Some AA are limiting for optimal milk production as evidenced by an increase in milk yield, and milk protein yield, and percentage after supplementation with specific, rumen-protected AA. The first two limiting AA for milk production are considered to be methionine and lysine (NRC, 2001). In addition, many AA can have positive effects on physiological processes that are independent of their effects on synthesis of proteins (Wu, 2013). A summary of the effects of rumen-protected methionine on reproduction of dairy cows are in Figure 1. Fertilization and the first few days of embryo development occur in the oviduct. By about five days after estrus the embryo arrives in the uterine horn. The embryo reaches the blastocyst stage by six to seven days after estrus. The embryo hatches from the zona pellucida by about day nine after estrus and then elongates on days 14–19. The elongating embryo secretes the protein interferon-tau that is essential for rescue of the corpus luteum and continuation of the pregnancy. By day 25–28 the embryo attaches to the caruncles of the uterus and begins to establish a vascular relationship with the dam through the placenta. During all the time prior to embryo attachment, the embryo is free-floating and is dependent upon uterine secretions for energy and the building blocks for development, including AA. Thus, it is critical to understand the changes in AA concentrations in the uterus that accompany these different stages of embryo development.

The lipid profile of oocytes and the early embryo can be influenced by the environment of the cow. Our group ran a trial to determine the effect of supplementing rumen-protected methionine on DNA methylation and lipid accumulation in preimplantation embryos of dairy cows (Acosta et al., 2016). Lactating Holsteins entering their 2nd or greater lactation were randomly assigned to two treatments from 30 ± 2 DIM to 72 ± 2 DIM: control (CON; n = 5, fed a basal diet with a 3.4:1 lysine:methionine) and methionine (MET; n = 5, fed the basal diet plus Smartamine M to a 2.9:1 lysine:methionine). Cows were superovulated (FSH) and embryos were flushed 6.5 days after artificial insemination. Embryos with stage of development four or greater were used for analysis. For lipids, fluorescence intensity of Nile Red staining was compared against a negative control embryo (subtraction of background). Thirty-seven embryos were harvested from cows (MET = 16; CON = 21). Cows receiving MET had greater lipid accumulation (7.3 arbitrary units) compared with cows receiving CON (3.7 arbitrary units). There were no treatment effects on numbers of cells or stage of development. In conclusion, cows supplemented with methionine produced embryos with higher lipid concentration compared with CON cows; this lipid could potentially serve as an important source of energy for the early developing embryo.

The requirements for complete development of bovine embryos have not yet been determined. Current culture conditions allow development of bovine embryos to the blastocyst stage (day 7-8) and even allow hatching of a percentage of embryos (day 9); however, conditions have not been developed in vitro that allow elongation of embryos. The methionine requirement for cultured pre-implantation bovine embryos (day 7-8) was determined in studies from University of Florida (Bonilla et al., 2010). There was a surprisingly low methionine requirement (7 µm) for development of embryos to the blastocyst stage by day seven; however, development to the advanced blastocyst stage by day seven appeared to be optimized at around 21 µm (Bonilla et al., 2010). Thus, the results of these studies indicated that development of morphologically normal bovine embryos did not require elevated methionine concentrations (>21 µm), at least during the first week after fertilization. Stella (2017) reported the plasma concentration of cows fed RPM or not (CON);it seems that cows fed RPM have plasma methionine concentration greater than 20 µm.

Researchers at the University. of Wisconsin (Toledo et al., 2015) conducted a trial with 309 cows (138 primiparous and 171 multiparous) that were blocked by parity and randomly assigned to two treatments: 1) CON: cows fed a ration formulated to deliver 2500 g of metabolizable protein (MP) with 6.9% lysine and 1.9% Met (as a % of MP) and 2) RPM: cows fed a ration formulated to deliver 2500 g of MP with 6.9% lysine and 2.3% Met (as a % of MP). Cows were randomly assigned to three pens with headlocks and fed a single basal TMR twice daily. From 28 to 128 DIM, after the morning milking, cows were headlocked for 30 minutes and the TMR of CON and RPM cows were individually top dressed with 50 g of distillers dried grains (DDG) or a mix of 29 g of DDG and 21 g of Smartamine M), respectively. Following a double Ovsynch protocol, cows were inseminated and pregnancy checked at 28 days (plasma Pregnancy Specific Protein-B concentration), and at 32, 47 and 61 days (ultrasound). Individual milk samples were taken once per month and analyzed for composition. There were no statistical differences in milk production, but milk from RPM cows had a higher protein concentration. Cows fed the methionine enriched diet tended ($P = 0.08$) to have a lower pregnancy loss from 28 to 61 days after AI (16.7 % CON cows vs. 10.0% in RPM cows). Pregnancy losses between days 28 and 61 were not different in the primiparous cows (12.8% CON and 14.6% RPM), however, pregnancy losses were lower ($P = 0.03$) in multiparous cows that received the methionine enriched diet (19.6% CON vs. 6.1% RPM; Toledo et al., 2017).

Perhaps the most detrimental impact of NEB on reproductive performance is delayed return to cyclicity. Dominant follicle (DF) growth and estradiol (E2) production are key factors for a successful conception, and their impairment can be attributed to reduced luteinizing hormone (LH) pulses and decreased circulating insulin and IGF-I concentrations (Komaragiri and Erdman, 1997). Furthermore, immune function is also suppressed during the periparturient period. Negative energy balance and fatty liver syndrome have been shown to impair peripheral blood neutrophil function (Hammon et al., 2006). Acosta et al. (2017) reported that methionine and choline supplementation induced a down regulation of pro-inflammatory genes, possibly indicating lower inflammatory processes in follicular cells of the first DF postpartum.

Additionally, supplementing methionine during the transition period increased 3β-hydroxysteroid dehydrogenase (3b-HSD) expression in the follicular cells of the first DF postpartum. Higher methionine concentrations in the follicular fluid of supplemented cows can potentially affect oocyte quality. Understanding how this may affect reproductive performance in commercial farms needs to be further investigated. Batistel et al. (2017) reported that studies with non-ruminant species argue for the potential relevance of the maternal methionine supply during late gestation in enhancing utero-placental uptake and transport of nutrients. The authors hypothesized that the greater newborn body weight from cows fed RPM compared with CON (42 vs. 44 kg) could have been a direct response to the greater nutrient supply from the feed intake response induced by methionine. The fact that certain AA and glucose induce motor signaling to different degrees is highly suggestive of "nutrient specific" mechanistic responses (Figure 2).

The reproductive success of dairy cows is associated with multiple factors, such as uterine health, involution and regeneration, and ovarian resumption (Galvão et al., 2004; Chebel et al., 2006; McCoy et al., 2006; Santos et al., 2009; LeBlanc, 2014). Innate immunity is crucial for the health of the reproductive tract of dairy cows following parturition and is affected by AA supply (Zhou et al., 2016; Batistel et al., 2017). Research conducted mainly in monogastric animals provided evidence of the immune system requirements for lysine (Lys); for example, Lys consumption by the immune system increased 10-fold in an LPS challenge in poultry (Klasing and Calvert, 1999). Lysine can also play a role in biosynthesis processes, such as the synthesis of acute-phase proteins in response to an increase in circulating cytokines (Iseri and Klasing, 2014) or the synthesis of nonessential AA (Lapierre et al., 2009). These processes are pertinent to and activated during the periparturient period when the immune response of the high-producing dairy cow is activated and the animal is under a state of systemic inflammation (Bradford et al., 2015; Pascottini and LeBlanc, 2020). Though there is limited research in dairy cows relating Lys supply to immune response and inflammatory status, there is evidence of decreased inflammatory response upon supplementation of RPL through the transition period (Fehlberg et al., 2020 and 2023).

Feeding rumen-protected lysine (RPL) around parturition altered the expression of transcripts involved in inflammatory and immune responses. The downregulation of TLR4, PTGES3, SOD1, and EHMT2; and the upregulation of APOL3, NFKB1, MUC1, and MUC4, in conjunction with the lesser uterine PMN percentage, are indicatives of a potentially less severe inflammatory process by week 4 postpartum (Guadagnin et al., 2022). Additionally, a stimulus of cell proliferation is suggested by the tendency of RPL to increase the number of glandular epithelial cells. There was no effect of feeding RPL on the size of the first ovulatory follicle nor days to first ovulation. Increasing intestinal availability of Lys throughout the transition period improved several indicators of uterine health (Guadagnin et al., 2022).

■ Conclusions

Formulation and delivery of appropriate diets that limit total energy intake to requirements but also provide proper intakes of all other nutrients before calving can help lessen the extent of NEB after calving. Effects of such diets on indicators of metabolic health are generally positive, suggesting the potential to lessen effects of periparturient disease on fertility. Dietary supplementation of cows with methionine during the final stages of follicular development and early embryo development, until day seven after breeding, led to lipid accumulation changes in the embryos and resulted in differences in gene expression in the embryo. Methionine supplementation seems to impact the preimplantation embryo in a way that enhances its capacity for survival because there is strong evidence that endogenous lipid reserves serve as an energy substrate. The lower pregnancy losses from cows fed a methionine enriched diets suggest that methionine favors embryo survival, at least in multiparous cows.

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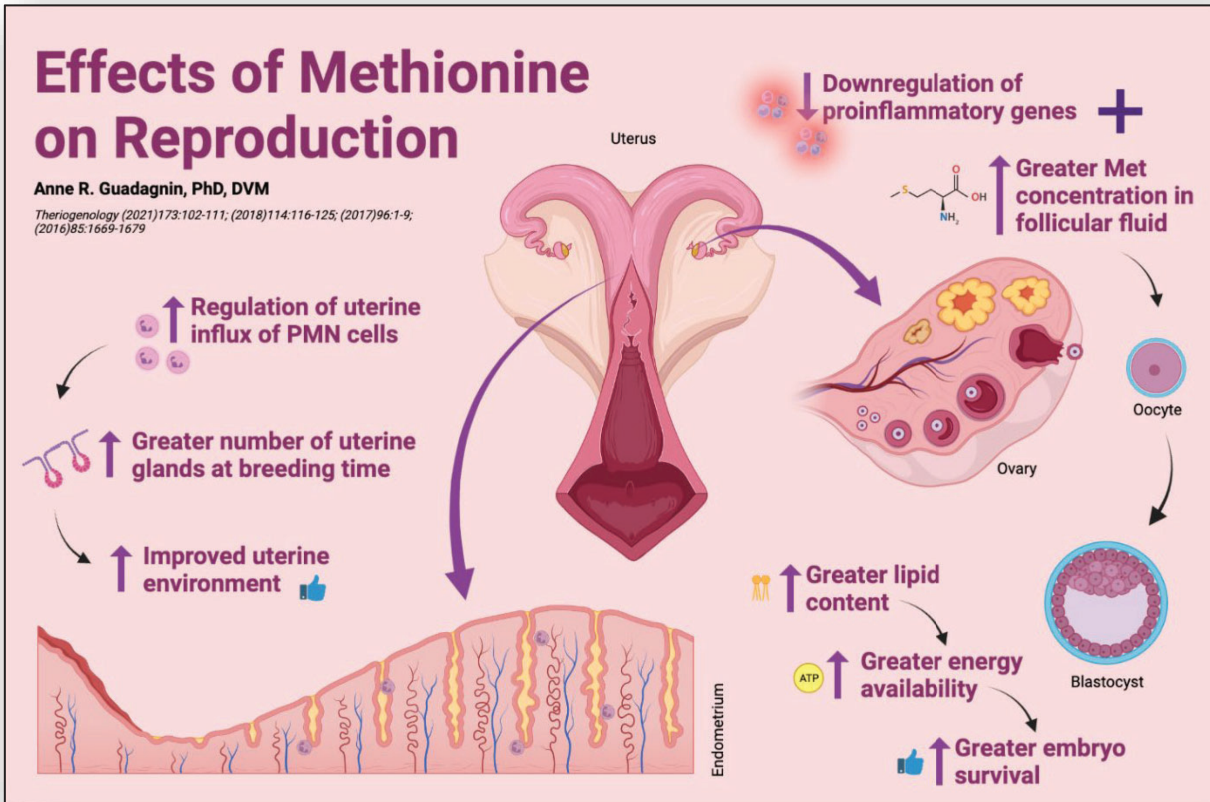


Figure 1. Summary of the effects of rumen-protected methionine on reproduction of dairy cows.

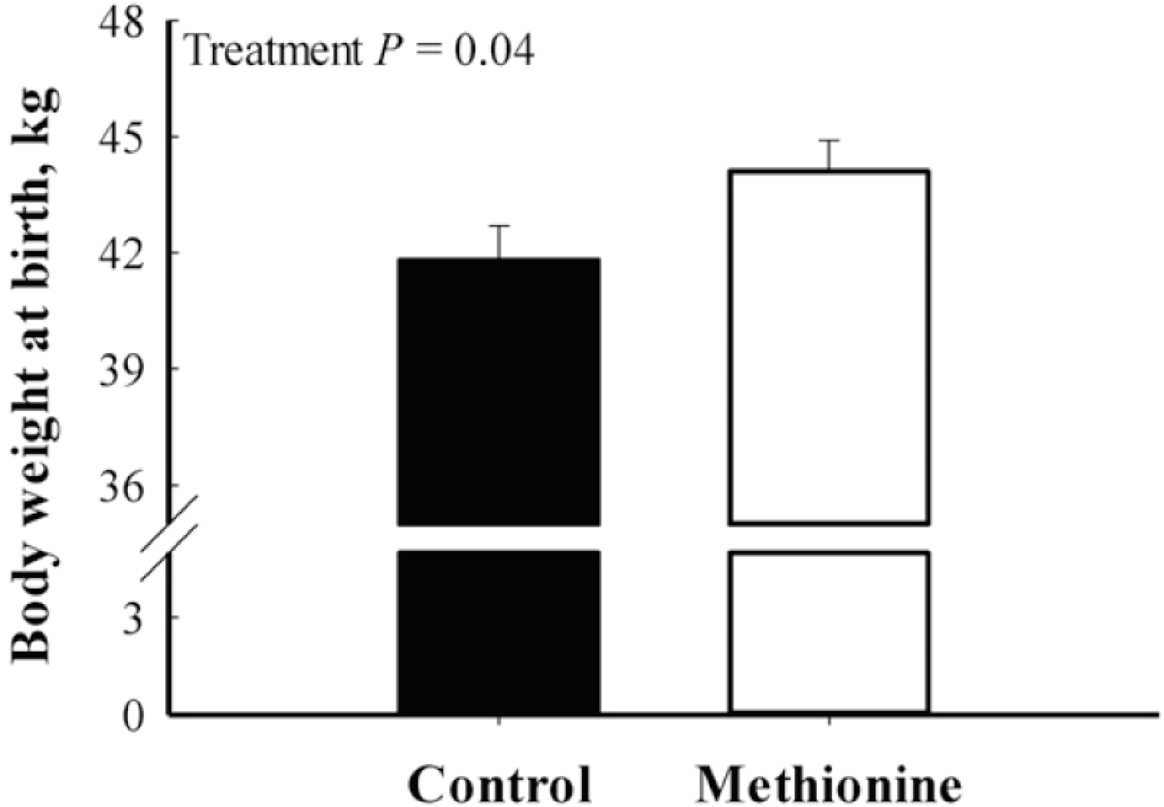


Figure 2. Calf birth body weight (control group, n = 39; methionine group, n = 42) in response to feeding cows a basal control diet or the basal diet plus ethylcellulose rumen-protected methionine (0.9 g/kg dry matter intake) during the last 28 d of pregnancy. Values are means 6 pooled SEMs.

What to Do with Beef on Dairy Calves

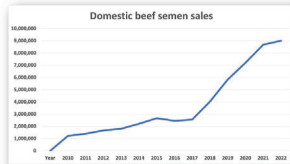
Dr. Gail Carpenter & Taylor Klipp
Iowa State University

What to do with beef on dairy calves

DR. GAIL CARPENTER & TAYLOR KLIPP
IOWA STATE UNIVERSITY

1

Why do we have beef on dairy calves?



Geiger, 2023. "Sales data shows beef on dairy is growing." Hoard's Dairyman.

- Sexed semen + beef semen
  - Bonus: Genomics
  - What place will conventional semen have in tomorrow's dairy industry?
- Strong beef prices in 2023
- 7% of current fed slaughter
  - Projected: 15% by 2026

2

Tell us what you're seeing!

- Why do your dairy clients use beef semen on their operations?

3

Step 0. How long to keep them?

- WET
- WEANED
- FEEDERS
- FINISHED

4

Step 1. Make the right beef on dairy calves

FOR YOUR DAIRY

- Choose the right cows
- Create the right number of heifers

FOR YOUR BEEF

- 3 C's (Sterry): Cost, Conception rate, Calving ease
- Angus?
- Embryos?

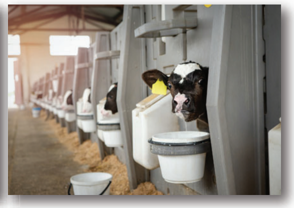
5

Tell us what you're seeing!

- Which cows are getting bred to beef on your clients' dairy herds?
- What criteria do your dairy clients use for selecting beef semen?
- What breed(s) of beef do your dairy clients use?

6

A tale of two industries



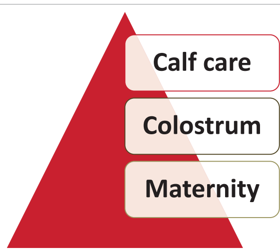
7

What can we learn from beef cows?

- Higher quality colostrum
- Concentrated milk – multiple feedings
- Consistent milk temp, composition
- Weaned
- Exposed to roughage 24/7 (pasture)
- Nurture

8

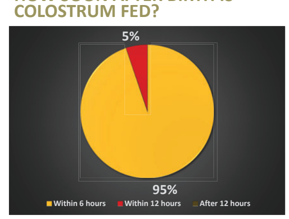
Step 2. Treat beef crosses like assets, not byproducts



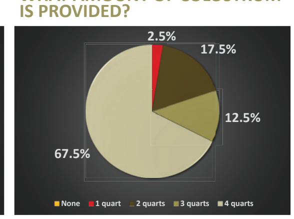
9

2023 Wisconsin survey results

HOW SOON AFTER BIRTH IS COLOSTRUM FED?



WHAT AMOUNT OF COLOSTRUM IS PROVIDED?



n = 40 survey responses

Sterry, 2023. "Beef x Dairy Crossbreeding and Calf Management Practices on Wisconsin Dairy Farms"

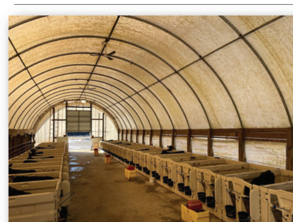
10

Tell us what you're seeing!

- What are your best practices for beef on dairy calves?

11

ISU Research Update



Research
- Pre-weaning strategies
- Receiver diets

Extension
- Survey of feedlot operators
- Online resource library

Early Life Impacts on Beef × Dairy Performance and Assessment of Challenges for Beef × Dairy in Iowa (Carpenter & Schwab)

ADSA: Abstract #88533

12

Pre-weaning methods

- 3 groups of ~40 Angus × Holstein bull calves
  - Source: ISU + commercial dairy
  - 2 of 3 pre-weaning groups completed
- Feeding
  - Milk replacer twice daily
  - 1 of 2 starters fed ad libitum (LO vs. HI starch)
- Measurements
  - Serum proteins at 24-48 hr (Brix)
  - Weights twice weekly

Group 1
- ISU (n=7)
- Commercial (n=32)

Group 2
- ISU (n=7)
- Commercial (n=33)

ADSA: Abstract #88533

13

Pre-weaning starters

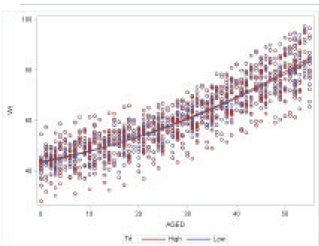
Ingredient (% of DM)	High starch	Low starch
Wheat middlings	21.1	35.6
Dehulled soymeal	29.9	23.0
Fine ground corn	33.9	11.4
Cottonseed hulls	5.0	10.0
Sunflower meal	-	6.0
Cane molasses	4.0	6.0
Soy hulls	1.3	2.5
MinVit mix	4.8	5.6

Nutrient (% of DM)*	High starch	Low starch
Protein	20.4	20.4
Fat	2.4	3.2
Fiber	6.6	11.5
ADF	8.2	14.3
Starch	26.3	15.6

*As balanced, not analyzed

14

Preliminary results



- Starter starch content had limited impact on pre-weaning growth for calves fed high plain of nutrition for milk replacer
- Calves were…
  - Born in a well-managed maternity area
  - Fed high quality colostrum soon after birth
  - Carefully managed and monitored by students, staff, and veterinarians

Treat beef on dairy crosses like assets…NOT BYPRODUCTS!

ADSA: Abstract #88533

15

What are our knowledge gaps?

16

Questions?

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17

Evaluating Corn Silage Nutritive Value for Dairy Cattle - MILK Model Updates

E. Cole Diepersloot, Randy D. Shaver, and Luiz F. Ferraretto
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Evaluating Corn Silage Nutritive Value for Dairy Cattle – MILK model updates

E. Cole Diepersloot, Randy D. Shaver, and Luiz F. Ferraretto

Department of Animal & Dairy Sciences
UNIVERSITY OF WISCONSIN-MADISON

EXTENSION

1

Outline

- Corn Hybrid Selection
- MILK2006
- Updated MILK Index
- Model Comparison

2

Corn Hybrid Selection

- Maximizing corn silage nutritive value can increase productivity and profitability of dairies
- Hybrid selection is important to maximize corn silage nutritive value

3

Corn Hybrid Selection

Nutrient composition of corn silage

Item	CP, % DM	NDF_{om}, % DM	NDFD, % NDF	uNDF, % DM	Starch, % DM	StarchD, % starch	EE, % DM	Ash, % DM
N	271663	274714	277167	268991	276709	221534	263223	262850
Normal Range[1]	6.7-8.6	32.5-42.5	53.0-64.6	7.3-12.7	27.2-40.7	68.6-86.4	2.2-3.4	3.2-5.6

[1]Normal range represents the range of the central 2/3rds of the samples in the data set.

4

Corn Hybrid Selection

Corn hybrid nutrient composition

Item	CP, % DM	NDF_{om}, % DM	NDFD, % NDF	uNDF, % DM	Starch, % DM	StarchD, % starch	EE, % DM	Ash, % DM
Hybrid 1	8.7	39.4	65.1	10.3	32.5	66.3	3.2	2.4
Hybrid 2	6.8	35.8	48.9	12.7	40.6	62.9	3.2	4.5

Which would you choose?

5

Corn Hybrid Selection

- The are multiple variables to consider for hybrid selection
- Producing silage with greater energy content and yield is the ultimate goal

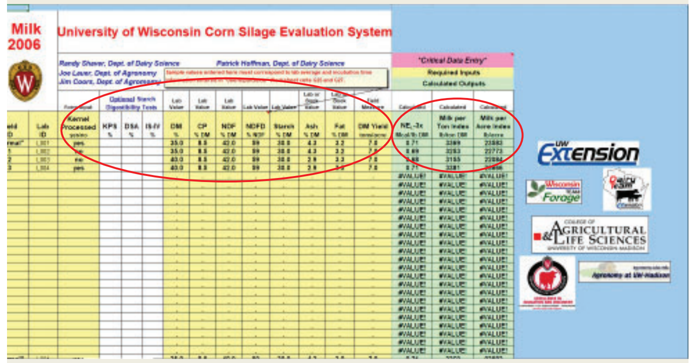
6

MILK2006

- The MILK index was created to select corn hybrids based on predicted energy content and yield
  - Estimates milk yield per ton and acre of corn forage
- The last version released was MILK2006

7

MILK2006



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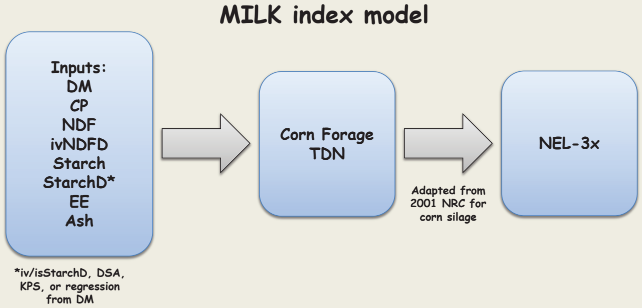
MILK2006

MILK index model



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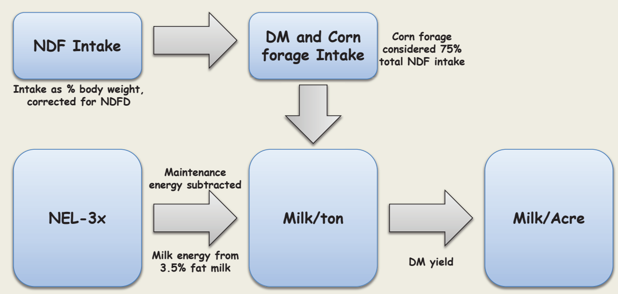
MILK2006



10

MILK2006

Item	CP, % DM	NDF_{om}, % DM	NDFD, % NDF	uNDF, % DM	Starch, % DM	StarchD, % starch	EE, % DM	Ash, % DM
Hybrid 1	8.7	39.4	65.1	10.3	32.5	66.3	3.2	2.4
Hybrid 2	6.8	35.8	48.9	12.7	40.6	62.9	3.2	4.5

Item	Milk/ton
Hybrid 1	2960
Hybrid 2	2905

Data from Cornell University corn hybrid trials courtesy of Joe Lawrence

11

MILK2006

Item	CP, % DM	NDF_{om}, % DM	NDFD, % NDF	uNDF, % DM	Starch, % DM	StarchD, % starch	EE, % DM	Ash, % DM
Hybrid 1	8.7	39.4	65.1	10.3	32.5	66.3	3.2	2.4
Hybrid 2	6.8	35.8	48.9	12.7	40.6	62.9	3.2	4.5

Item	Milk/ton	DM Yield	Milk/acre
Hybrid 1	2960	9.5	28072
Hybrid 2	2905	7.5	20147

Data from Cornell University corn hybrid trials courtesy of Joe Lawrence

12

MILK2006

- MILK2006 uses TDN-based energy equations
- Since its release better equations and predictions have been developed

13

Updated MILK Index

- Goal to update the MILK index model, incorporating new energy equations and predictions.

14

Updated MILK Index

- New energy equations based on NASEM 2021
  - Requires basal diet
    - Energy losses subtracted from diet, not corn forage alone
  - 70% basal diet and 30% corn forage

Item	Alfalfa Silage	HMC	Whole Cotton Seed	Ground Corn	Soy Hulls	Expeller Meal	Canola Meal	Soy-bean Meal	Protected Fat
Inclusion Rate (DM)	28%	12%	7%	21%	6%	10%	9%	2%	1%

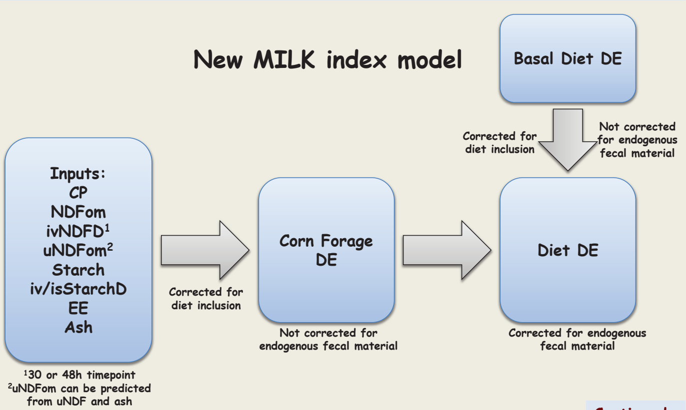
15

Updated MILK Index

- Residual organic matter, total FA, protein digestibility from NASEM 2021.
- Mechanistic models used for starch and NDF digestibility
  - 7h iv/isStarchD estimates kd
  - 30 or 48h ivNDFD estimates kd

16

Updated MILK Index



Continued…

17

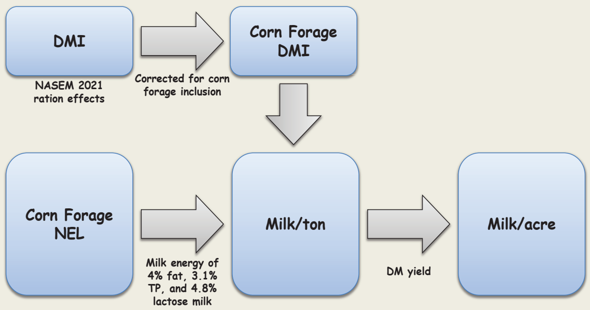
Updated MILK Index

*Corn forage DE/diet DE used to estimate corn forage NEL for this model, not representative of actual NEL contributions of corn forage/silage in a dairy cow diet

Continued…

18

Updated MILK Index



19

Model Comparison

- Milk/ton calculated from the normal range of a large commercial dataset (n = 60,231) of corn silage samples for MILK2006 and updated MILK index

Item	CP, % DM	NDF_{om},[1] % DM	NDFD, % NDF	uNDFom, % DM	Starch, % DM	StarchD, % starch	EE, % DM	Ash, % DM
Average	7.5	37.0	58.5	8.9	34.5	79.4	2.7	4.3
SD	0.48	2.40	3.06	1.19	2.98	5.52	0.41	0.62
Minimum	6.6	32.3	52.0	6.2	26.3	67.3	2.1	3.2
Maximum	8.8	42.6	65.6	11.7	40.7	88.2	3.9	5.6

[1]MILK2006 uses NDF not corrected for ash (38.3% DM ±2.41; Minimum = 32.4; Maximum = 47.7)

20

Model Comparison

Commercial Dataset Outputs

Item	MILK2006 milk/ton	Updated milk/ton
Average	3057	3046
SD	139	95
Minimum	2575	2729
Maximum	3557	3317

21

Questions

ferraretto@wisc.edu
Linkedin.com/in/luiz-ferraretto-7a726731
ferraretto_ruminant_nutrition

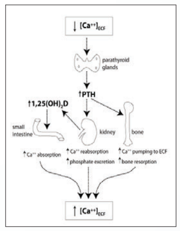
Ferraretto Lab™

22

Calcium Response Technologies (CaRT): New Innovations in Milk Fever Prevention

Pat Hoffman
University of Wisconsin/Dairy Science Solutions, LLC

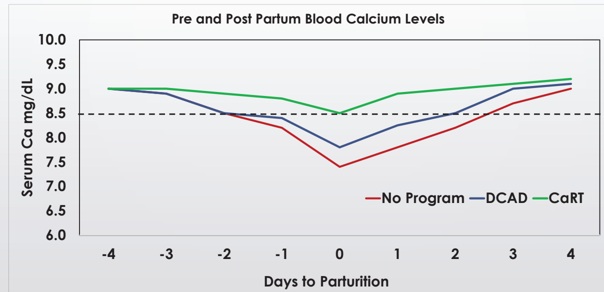
Calcium Response Technologies (CaRT)
New Innovations to Prevent Hypocalcemia in Dairy Cattle



Patrick C Hoffman, Professor Emeritus, University of Wisconsin-Madison

1

Calcium Response Technology (CaRT)



2

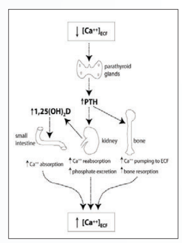
Ca Response Technologies

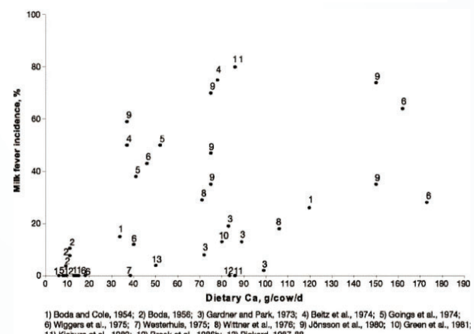
- Dietary Ca Restriction
- Dietary P Restriction
- Zeolite A
- 5-HTP
- Solanum glaucophyllum
- Difructose Anhydride
- Calcidiol 25 (OH) Vit D_3

3

Calcium Restriction

•T Thilsing-Hansen, et al., 2002





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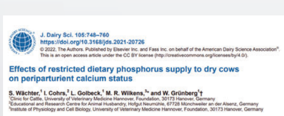
Phosphorus Restriction


J. Dairy Sci. 105:748–760
https://doi.org/10.3168/jds.2021-20726
© 2022, The Authors. Published by Elsevier Inc. and Fass Inc. on behalf of the American Dairy Science Association®. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

Effects of restricted dietary phosphorus supply to dry cows on periparturient calcium status

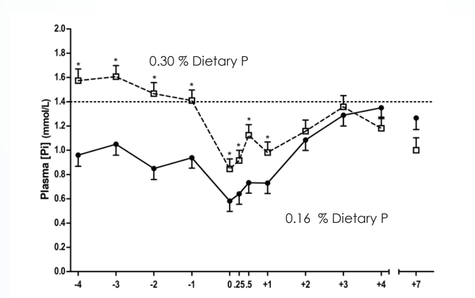
S. Wächter,[1] I. Cohrs,[2] L. Golbeck,[1] M. R. Wilkens,[3]* and W. Grünberg[1]†
[1]Clinic for Cattle, University of Veterinary Medicine Hannover, Foundation, 30173 Hanover, Germany
[2]Educational and Research Centre for Animal Husbandry, Hofgut Neumühle, 67728 Münchweiler an der Alsenz, Germany
[3]Institute of Physiology and Cell Biology, University of Veterinary Medicine Hannover, Foundation, 30173 Hanover, Germany

- 30 prefresh dairy cows
- Fed 0.16 or 0.30 % P
- Controlled feed offerings
- Fed for 28 d prior to calving
- Measurements
  - Blood Ca, P
  - PTH
  - 1-25 (OH_2) Vit D_3
  - Bone mobilization (CrossLaps-CTX)

5

Wachter et.al., JDS-2022

Plasma P



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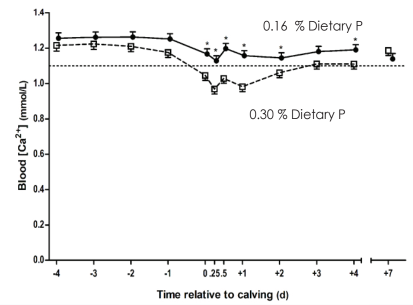
Wachter et.al., JDS-2022

Plasma Ca



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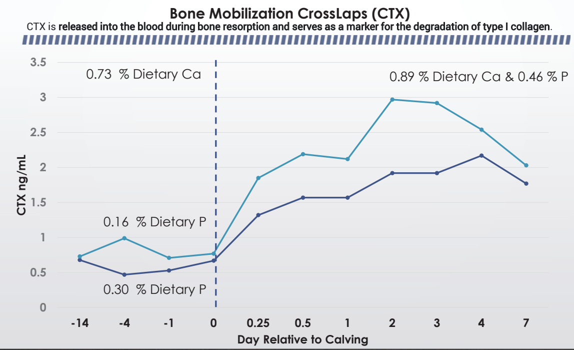


8

Wachter et.al., JDS-2022 (Summary)
Feeding 0.16 % P vs 0.30 % P to prefresh cows…………….

- **Decreased blood P**
- **Increased blood Ca**
- **Increased bone mobilization**
- **PTH did not directly explain differences in bone mobilization**
- **1-25 $(OH_2)D_3$ status appeared to be under the influence of P homeostasis precalving and Ca homeostasis postcalving??**
- **Authors speculated that P homeostasis was under the control of FGF23 (not measured) as opposed to PTH**

9

FGF23 Fibroblast Growth Factor

Produced in bones cells
Identified in the early 2000s
Is a bone derived hormone
Suppresses phosphate reabsorption (kidney)
Modulates kidney Na and P transport
Suppresses enzymes that activate
1-25 $(OH_2)D_3$
Increases when blood P is high
Decreases when blood P is low

10

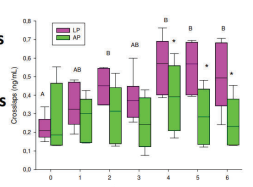
Grunberg et al., 2019

Results

CrossLaps ®

- **Significant increases after 2 weeks of P-depletion**
- **Significantly higher concentrations in LP compared to AP from the 4. week of P-deprivation**

➔ Indication for increased bone resorptive activity with P-deprivation



Different letters: Sampling times differ significantly within treatment
**: Values differ significantly between treatments*

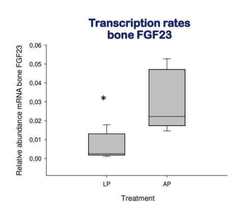
11

Grunberg et al., 2019

Results

Bone FGF23

- **Relative abundance of mRNA of FGF23 in bone is markedly decreased after 6 weeks of dietary P-deprivation**



**: Values differ significantly between treatments*

12

Zeolite A

- Synthetic Zeolite
- Heavily studied sodium aluminium silicate
  - High ion exchange capacity
- Commercially Available to Feed to Dairy Cows
  - To reduce milk fever
  - To reduce subclinical hypocalcemia
- Introduced as a Ca Binder
  - New research = binding of recycling P
- Fed 14-21 d prefresh

13

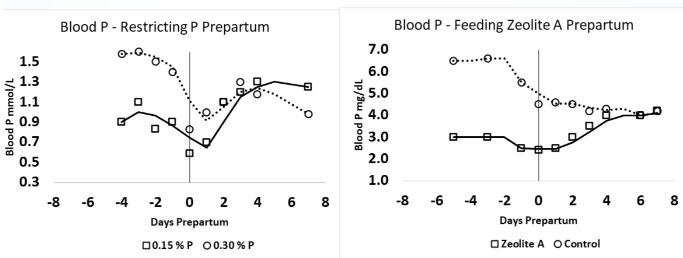
Zeolite A - Kerwin et.al., JDS-2022


J. Dairy Sci. 102
https://doi.org/10.3168/jds.2019-16272
Effects of feeding synthetic zeolite A during the prepartum period on serum mineral concentration, oxidant status, and performance of multiparous Holstein cows
A. L. Kerwin, C. M. Ryan, B. M. Leno, M. Jakobsen, P. Theilgaard, D. M. Barbano, and T. R. Overton

- 55 prefresh Holstein dairy cows
  Fed 0.38 % P or 0.38 % P + Zeolite A
  Ad lib feed offerings
  Fed for 21 d prior to calving
  Measurements
  - Blood Ca, P
  - Clinical Milk Fever
  - Sub-clinical hypocalcemia
  - Milk Production
  - Colostrum Quality

14

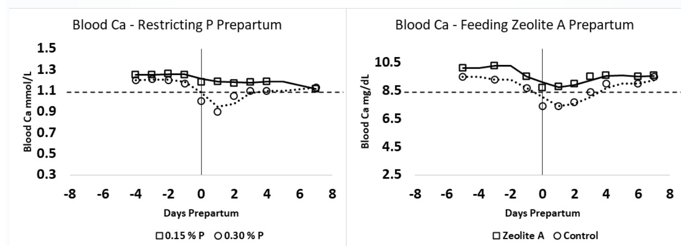
Feeding Zeolite A to Prefresh Cows Mimics Dietary P Restriction



A – Wachter et al., 2022
B – Kerwin et al., 2019

15

Feeding Zeolite A to Prefresh Cows Mimics Dietary P Restriction



A – Wachter et al., 2022
B – Kerwin et al., 2019

16

Determination of effects of feeding DCAD and Zeolite A on transition cows

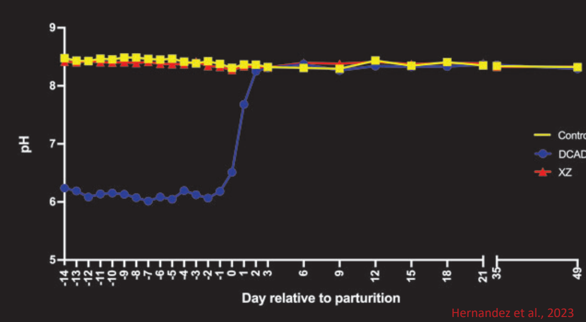
University of Wisconsin – Madison

-120 Cows
- Treatments (Control, DCAD, Zeolite A)

Hernandez et al., 2023

17

Urine pH



Hernandez et al., 2023

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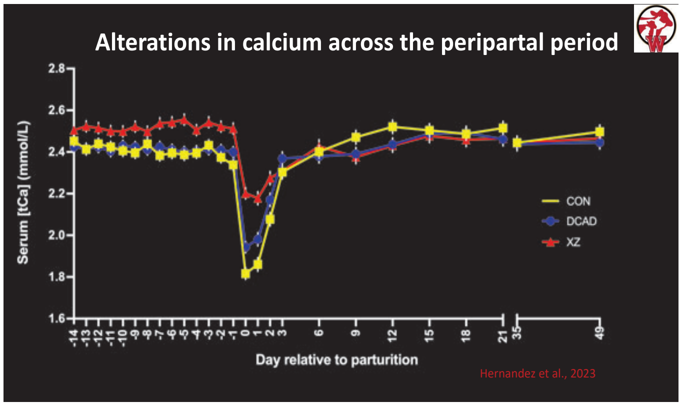

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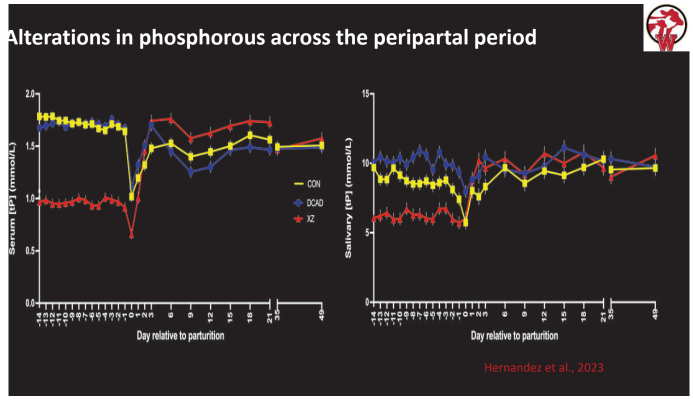

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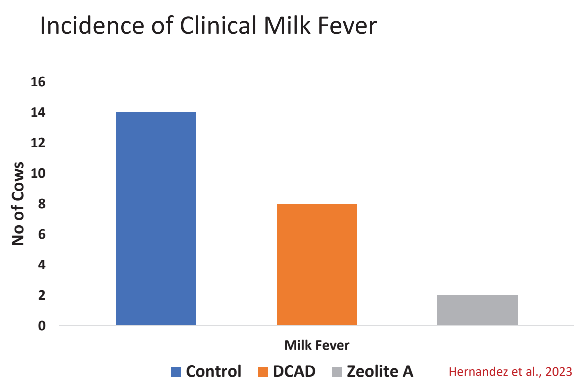

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Review of Zeolite A Feeding Trials

Reference	Treatments	Dietary Ca % DM		Dietary P % DM		Blood Ca Response % of Control	Blood P Response % of Control	Clinical Milk Fever % of Control
		Zeolite	Control	Zeolite	Control	Zeolite vs Control	Zeolite vs Control	Zeolite vs Control
Thilsing-Hansen et al., 2001	Zeolite vs Control	0.64	0.45	0.64	0.45	+ 27 %	NR	- 33 %
Kerwin et al., 2019	Zeolite vs Control	0.65	0.68	0.38	0.39	+ 22 %	- 50 %	0%
Frizzarini et al., 2022	Zeolite vs DCAD	NR	NR	NR	NR	+11 %	-47%	NR
	Zeolite vs Control	NR	NR	NR	NR	+17 %	-49%	NR
Crookenden et al., 2020	Zeolite vs Control	NR	NR	NR	NR	+ 13 %	-73 %	NR
Pallesen et al., 2007	Zeolite vs Control	0.61	0.69	0.61	0.69	+ 33%	- 10 %	- 75 %
	Zeolite vs Control	0.61	0.33	0.61	0.69	+ 57 %	- 72 %	-100 %
Grabherr et al., 2008	Zeolite vs Control	0.42	0.38	0.42	0.38	+ 11 %	- 22 %	NR
Saraiva de Oliveira, 2021	Zeolite vs DCAD	0.57	2.53	0.36	0.43	+ 13 %	- 45 %	-51%
Thilsing-Hansen et a., 2002	Zeolite vs Control	0.60	0.60	0.30	0.30	+12 %	- 36 %	0%
Khachouf et al., 2019	Zeolite vs Control	2.79	2.79	0.80	0.80	+ 8 %	0%	NR

NR = not reported

22

- Research observations
  - Decreased milk fever and hypocalcemia
  - Lower blood P observed
  - Greater blood Ca consistently observed
  - Increases 1-25 (OH2) Vit D but Not PTH?
  - Decreases Salivary P
  - Increases Undigested Fecal Ortho PO4
  - Results are nearly identical to dietary P restriction experiments
  - **Feeding Zeolite A appears to reduce milk fever and hypocalcemia by binding P thereby inducing a dietary P restriction**

23

5-HTP (5-hydroxy-l-tryptophan)

J. Dairy Sci. 100:1580–1587
https://doi.org/10.3168/jds.2016-11638
© American Dairy Science Association®, 2017.

Increased serum serotonin improves parturient calcium homeostasis in dairy cows

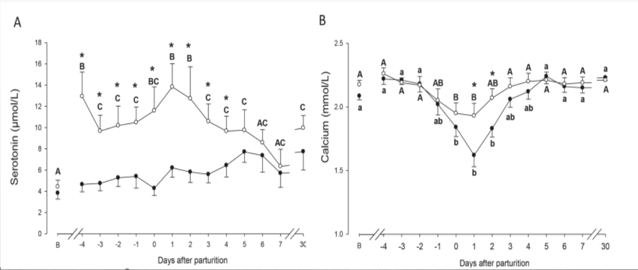
Lorenzo E. Hernández-Castellano,* Laura L. Hernandez,† Samantha Weaver,† and Rupert M. Bruckmaier*[1]
*Veterinary Physiology, Vetsuisse Faculty, University of Bern, CH-3001 Bern, Switzerland
†Department of Dairy Science, University of Wisconsin, Madison 53706

L-tryptophan → 5-hydroxytryptophan (5-HTP)
↓
serotonin
parathyroid hormone-related protein (PTHrP)
Ca (Blood to Milk)
Mammary Ca Demand

- 20 prefresh dairy cows
- **IV Infusion of 1 mg 5-HTP/kg BW**
- 10 days prepartum
- Measurements
  - Blood Ca
  - Serotonin
  - Mg, Glucose
  - Milk Yield

24

5-HTP (IV Infusion of 1 mg 5-HTP/kg BW)



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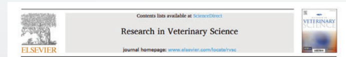
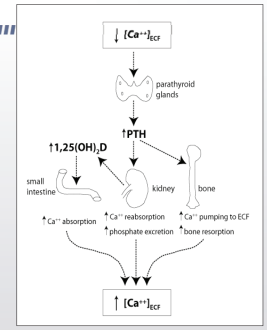
Solanum glaucophyllum

1,25-dihydroxyvitamin D3


Research in Veterinary Science

Pharmacokinetics of 1,25-dihydroxyvitamin D3 glycosides from *Solanum glaucophyllum* extract given in a rumen bolus on blood mineral profiles in dry pregnant dairy cows

M. Meyer-Binzegger, C. Ollagnier, L. Eggerschwiler, K. Bühler, P. Schlegel, M. Meylan



26

Solanum glaucophyllum – Meyer-Binzegger et al., 2022

- Bolus to Dry Cows
- When to give the bolus?

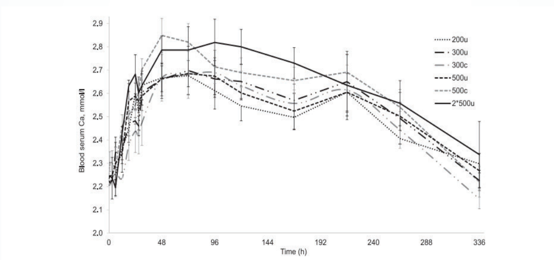


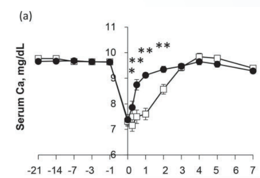
Fig. 2. Pharmacokinetics of calcium in blood serum (least square means ± SE) over time after single oral bolus administration (time effect: $P < 0.001$; treatment effect: $P < 0.001$; time x treatment interaction: $P > 0.10$).

27

- Difructose Anhydride


J. Dairy Sci. 98:8688–8697

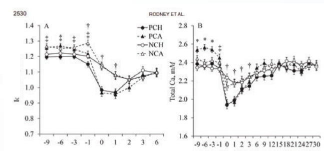
Supplementation with difructose anhydride III promotes passive calcium absorption in the small intestine immediately after calving in dairy cows



- Calcidiol 25 (OH) Vit D_3


J. Dairy Sci. 101:2519–2543

Effects of prepartum dietary cation-anion difference and source of vitamin D in dairy cows: Vitamin D, mineral, and bone metabolism



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Ca Response Technologies - Summary

Technology	CaRT	On-Farm Reality
Dietary Ca Restriction	Yes	Infeasible
Dietary P Restriction	Yes	Difficult to formulate diets low enough in P
Zeolite A	Yes	Commercially available. Induces dietary P restriction – bone mobilization of Ca/P.
5-HTP	Yes	Commercial application in development
Solanum glaucophyllum	Yes	Commercial applications emerging
Difructose Anhydride	No	Increases Ca absorption post-partum
Calcidiol 25 (OH) Vit D_3	No	Improves Vit D status which has other benefits

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Improving Pregnancy Outcomes after IFV Embryo Transfer in Dairy Herds

Dr. Paul Fricke
University of Wisconsin

Improving Pregnancy Outcomes after IVF Embryo Transfer in Dairy Herds

2023 Four-State Dairy Nutrition & Management Conference

Paul M. Fricke

Professor of Dairy Science

Department of Animal & Dairy Sciences, University of Wisconsin-Madison

Extension, University of Wisconsin-Madison

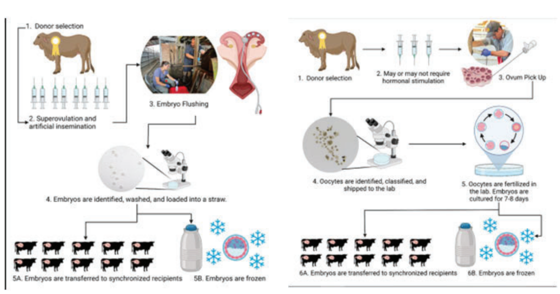
1

Outline

- Background on IVF embryo transfer
- Background on hCG
- **Experiment 1** - Effect of human chorionic gonadotropin (hCG) on pregnancy outcomes in lactating Jersey cows receiving IVF beef embryos after a synchronized estrus versus a synchronized ovulation
- **Experiment 2** - Effect of human chorionic gonadotropin (hCG) on pregnancy outcomes in lactating Jersey cows receiving IVF beef embryos after a synchronized ovulation

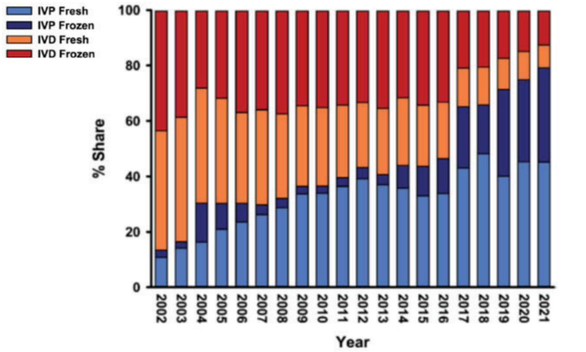
2

IVD	IVP
In-Vivo Derived	In-Vitro Produced



Angela Gonella-Diaza, Assistant Professor at University of Florida, March 2023

3

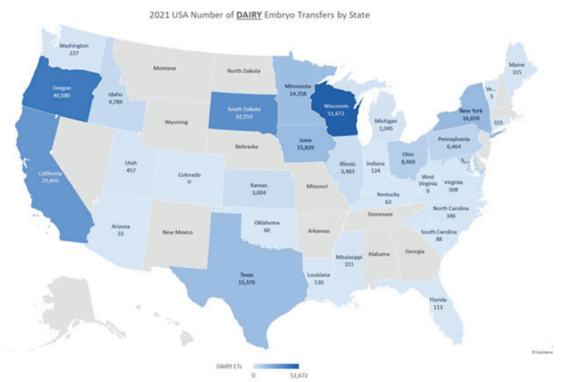


Flourishing business in the world

IETS, 31st annual report, 2022 ET activities during 2021.

4

2022 Annual Report of the AETA Statistical Information Committee



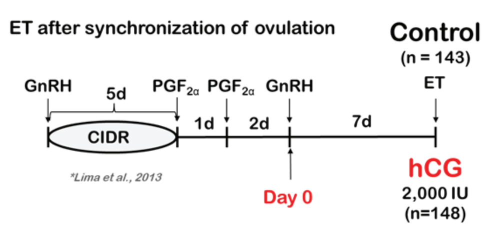
Wisconsin is the leader in Dairy embryo transfers

5

J. Dairy Sci. 102:2593–2606
https://doi.org/10.3168/jds.2018-15588

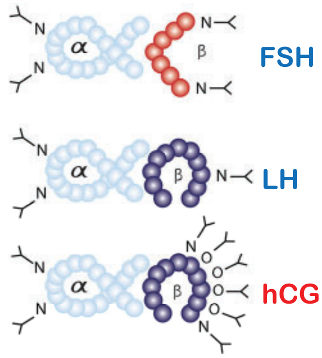
Effect of treatment with human chorionic gonadotropin 7 days after artificial insemination or at the time of embryo transfer on reproductive outcomes in nulliparous Holstein heifers

A. M. Niles, H. P. Fricke, P. D. Carvalho, M. C. Wiltbank, L. L. Hernandez, and P. M. Fricke*
Department of Dairy Science, University of Wisconsin-Madison, Madison 53706



6

Glycoprotein Hormones

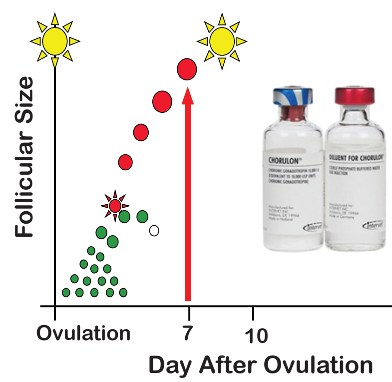


Pituitary gonadotropins

The amino acid sequence homology between hCG and bovine LH is ~80%.
(Pierce and Parsons, 1981)

7

Induction of an accessory CL

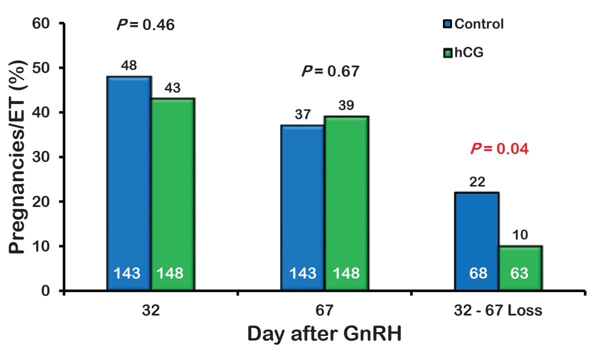


Chorulon - hCG
- Produced by syncytiotrophoblast cells in the placenta
- Involved in maternal recognition of pregnancy and CL maintenance

8

Experiment 2 – ET

Effect of treatment on pregnancy outcomes and pregnancy loss



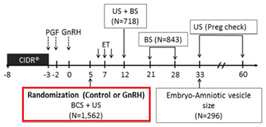
9

Postovulatory treatment with GnRH on day 5 reduces pregnancy loss in recipients receiving an in vitro produced expanded blastocyst

Theriogenology 141 (2020) 202–210

Alvaro Garcia-Guerra [1], Rodrigo V Sala [2], Luciana Carrenho-Sala [2], Giovanni M Baez [3], Jéssica C L Motta [4], Meliton Fosado [2], Juan F Moreno [5], Milo C Wiltbank [6]

Results for IVF Stage 7 embryos (n = 1,562 ± GnRH)



Accessory CL	Pregnancy Loss	P-value
No	27.6%^{a}	0.004
Yes	11.6%^{b}	

10

Effect of hCG at IVF ET on P/ET and pregnancy loss in lactating Holstein recipients synchronized with a Double-Ovsynch protocol for first service

unpublished data

	Control n=400	2,000 IU hCG n=400
P/ET (%)	35	45
Preg Loss (%)	25	22

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Effect of hCG on pregnancy outcomes in lactating Jersey cows receiving IVF beef embryos after a synchronized estrus versus a synchronized ovulation

J. Dairy Sci. 2023 (Abstract #1723W)

N. Hincapie, M. R. Lauber, and P. M. Fricke

ANIMAL & DAIRY SCIENCES
University of Wisconsin-Madison

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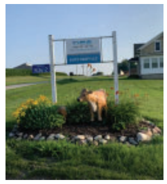
Kutz Dairy, LLC



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Commercial Angus IVF Embryos

Simplot ANIMAL SCIENCES

- Commercial Angus oocytes
- IVF with 1 of 3 Angus sires Selected for calving ease
- Grade 1 Stage 7 embryos
- Frozen for direct transfer

SimVitro HERDFLEX™ SELECT SIRES

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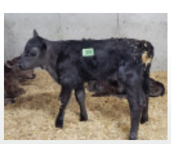
Why Angus embryos in Jerseys?

$10 Jersey Bull

$200 Jersey x Beef



$400 Angus IVF Calf

Beef Embryos in Dairy Cows can be Profitable for Dairies

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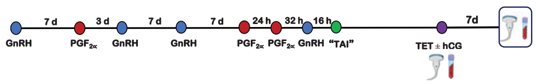
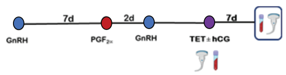
Experimental Design

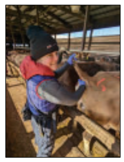
Double-Ovsynch and timed ET

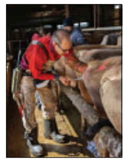


ET after a synchronized estrus

Ovsynch







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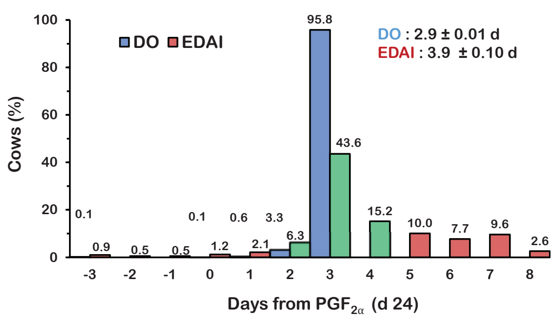
Distribution of Cows Inseminated

From PGF d 24 (0)



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2 X 2 Factorial Design

Main effects of recipient protocol and hCG treatment at IVF ET

N=293	Control	2,500 IU hCG
DO n=156	n=78	n=78
ED+OV n=137	n=67	n=70

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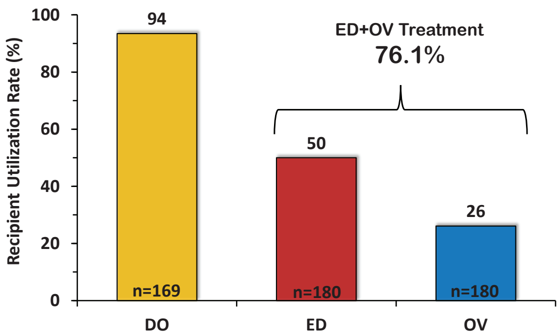
Recipient Utilization Rate



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Partial Budget by Recipient Protocol

Based on recipient utilization

	Treatment		
Cost per pregnancy,US$	DO n=169	ED	OV
		n= 180	
Hormonal Treatments	10.80	6.84	11.32
Detection of Estrus	0	1.89	1.89
Unutilized Recipients	9.68	72.57	72.57
Embryo	50	50	50
Transfer	40	40	40
Non-pregnant Recipients	210.68	306.25	331.75
Veterinarian Pre-checks	4.75	4.75	9.50
Total per pregnancy	325.91	482.3	517.03

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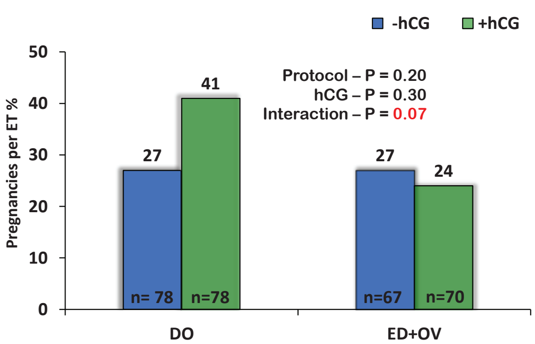
Effect of recipient protocol and hCG on Pregnancies per ET



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Effect of recipient protocol on pregnancy outcomes and pregnancy loss

P/ET	DO		ED		OV	
%	Control	hCG	Control	hCG	Control	hCG
PG32	27	41	32	19	17	33
n=	78	78	44	46	23	24
PG61	25	37	32	19	17	33
n=	78	78	44	46	23	24
PG Loss 32-61	1.3	5.6	0	0	0	0
n=	78	78	44	46	23	24

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Conclusions

1. Recipient utilization rate will be greater for IVF ET after a synchronized ovulation than after a synchronized estrus. ☑
2. IVF ET after a synchronized estrus will yield more P/ET than after a synchronized ovulation. ☒
   - Increased CL size = greater progesterone
3. Treatment with hCG at the time of IVF ET will increase P/ET. ☑

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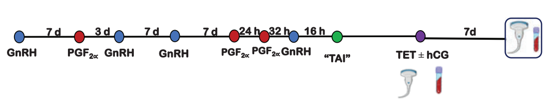
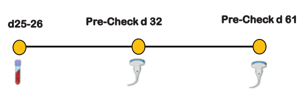
Experiment 2

Double-Ovsynch and timed ET





Thus far, 330 of 420 embryos have been transferred

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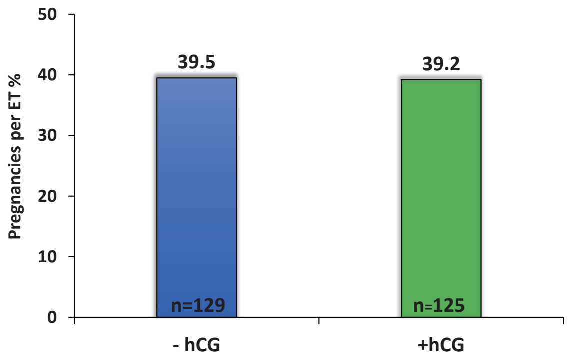

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Data yet to be analyzed

- PAG concentrations at 26 d
  - Effect of hCG on pregnancy loss from 26 to 32 d
- Progesterone concentrations
  - At ET
  - 7 d after ET
  - 26 d
- Ovarian ultrasound
  - At ET
  - 7 d after ET
  - CL volume

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What we have learned thus far…

- Overall, P/ET is ~10 percentage points less than P/AI after Double-Ovsynch
  - TAI to Double-Ovsynch for first AI
  - IVF ET for Resynch cows
- Estrus recipient protocol is not sustainable
  - Recipient utilization was unacceptably low
  - Multiple days of the week for transfers
  - The industry needs more trained ET technicians
- Initially, we have had some high birth-weight Angus calves
  - Donor female genetics

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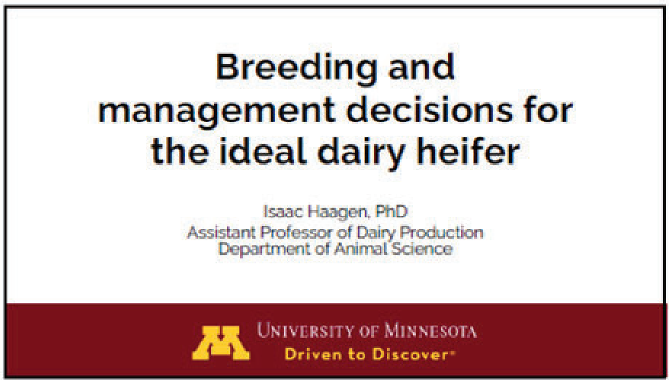
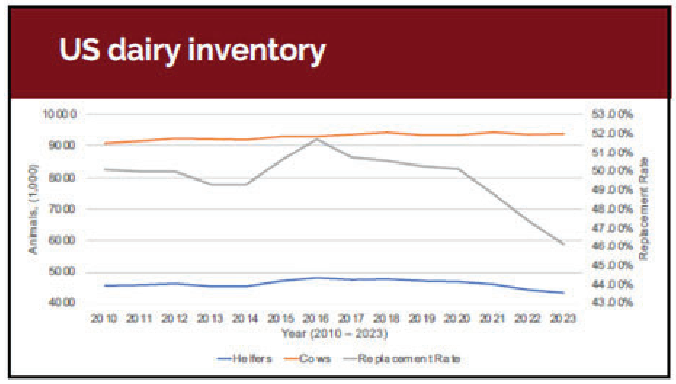
Breeding and Management Opportunities for Creating the Ideal Dairy Heifer

Dr. Isaac Haagen
University of Minnesota



1



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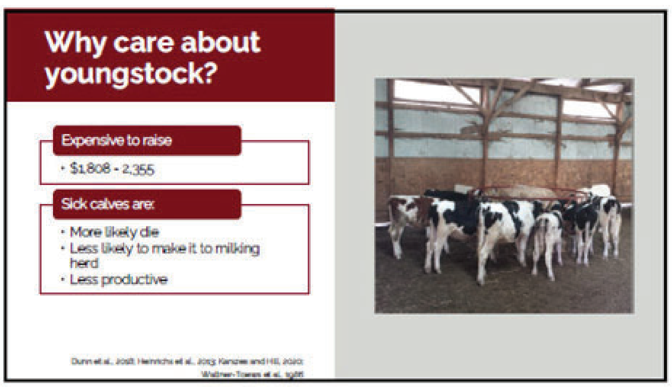

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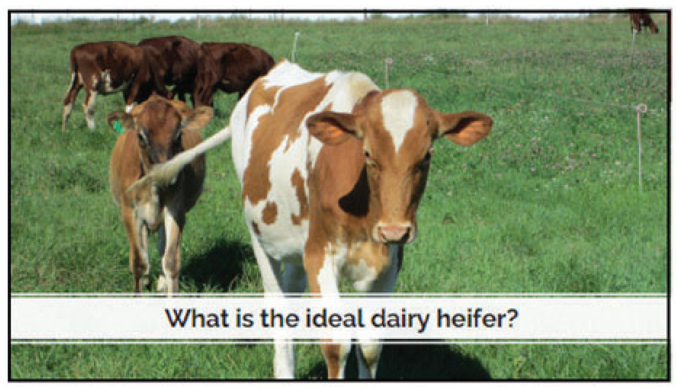

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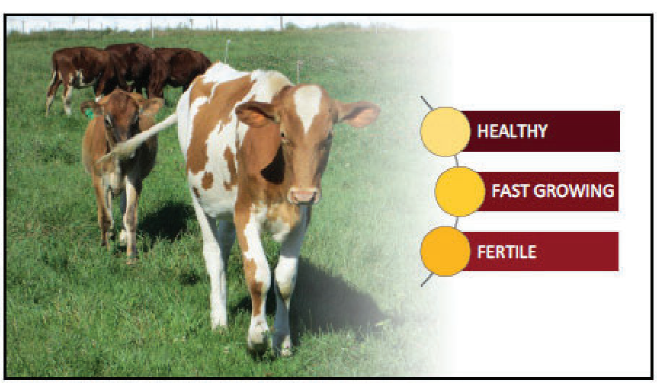

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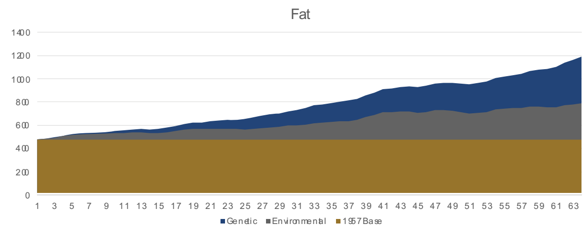
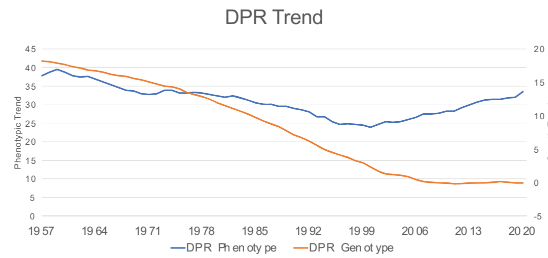
6

Genetics can make a difference



https://webconnect.uscdcb.com/#/summary-stats/genetic-trend

7

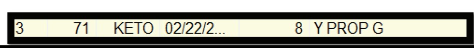


https://webconnect.uscdcb.com/#/summary-stats/genetic-trend

8

Genetic selection of disease traits

- In the US, Zoetis was the first to launch commercial evaluations for cow health traits (2016)
  - Followed by calf health traits
- Official national evaluations from Council on Dairy Cattle Breeding (2018)
  - Milk fever, displaced abomasum, ketosis, mastitis, metritis, and retained placenta



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National genetic selection goals

1971	1976	1994	2000	2003
• Milk yield • Fat yield	• Protein yield	• Productive Life • Somatic Cell Score	• Body size • Udder structure • Feet & Leg structure	• Daughter fertility
2006	**2014**	**2017**	**2018**	**2021**
• Calving Ability	• **Conception rates**	• Cow livability	• Cow Health	• Feed efficiency • **Heifer livability** • **Age at first calving**

https://uscdcb.com/merit-selection/

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Transfer of passive immunity

- 6.2 % of farms measure serum total protein (STP)
  - > 30 % of calves (USDA, 2016)
- Transfer of passive immunity has been associated with:
  - Reduced mortality
  - Improved calf health
  - Increased milk yield and reduced culling?

Burton et al., 1989; DeNise et al., 1989; Donovan et al., 1998; Henderson et al., 2011; Urie et al., 2018

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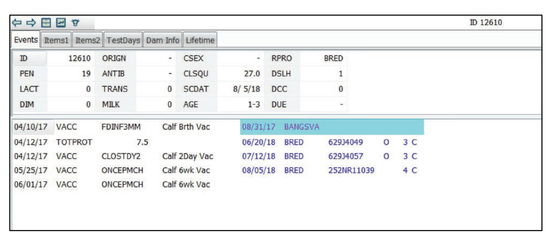
Producers recorded data



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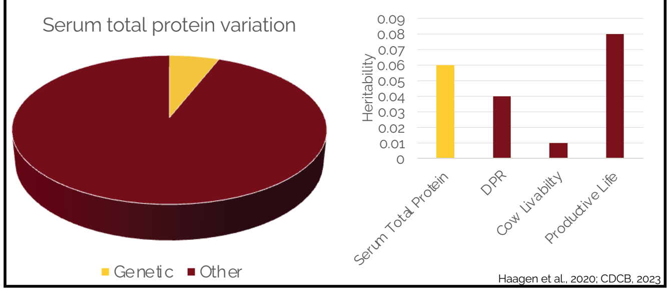
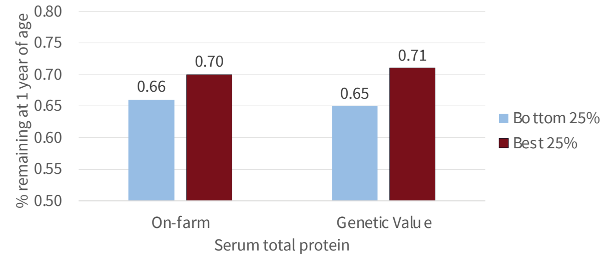
Heritability



Haagen et al., 2020; CDCB, 2023

13

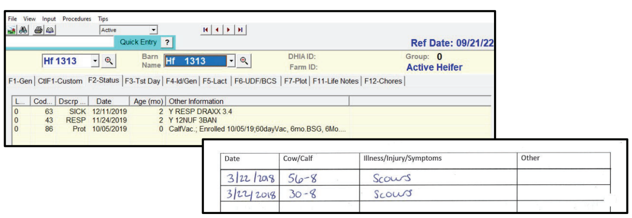
Impact of STP on ability to remain in replacement herd



Haagen et al., 2020

14

Disease resistance



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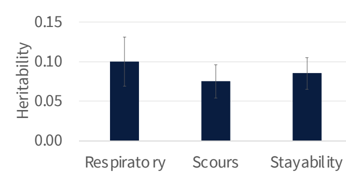
Incidences and heritability estimates for disease resistance

	Respiratory	Scours	Stayability
Incidence (%)	11.5	44.4	75.0



Haagen et al., 2021

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But … no national genetic evaluations

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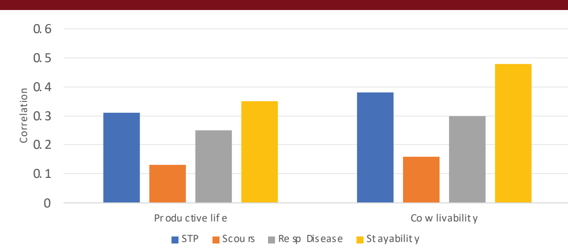
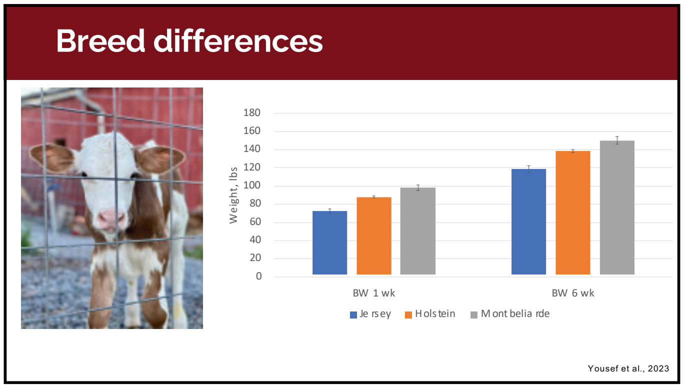
Relationships to other genetic traits



Haagen et al., 2020; 2021

18


Breed differences
180
160
140
120
100
80
60
40
20
0
Weight, lbs
BW 1 wk
BW 6 wk
Jersey
Holstein
Montbeliarde
Yousef et al., 2023

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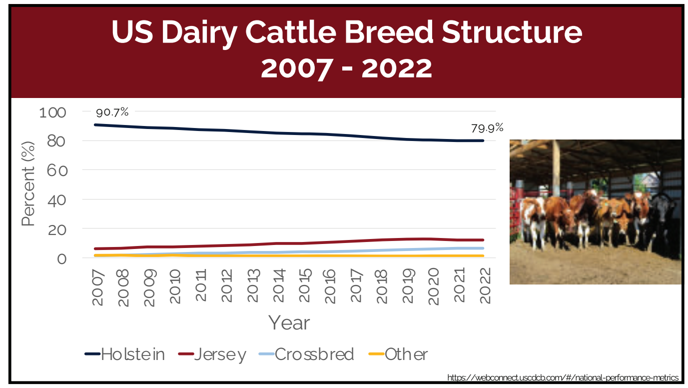
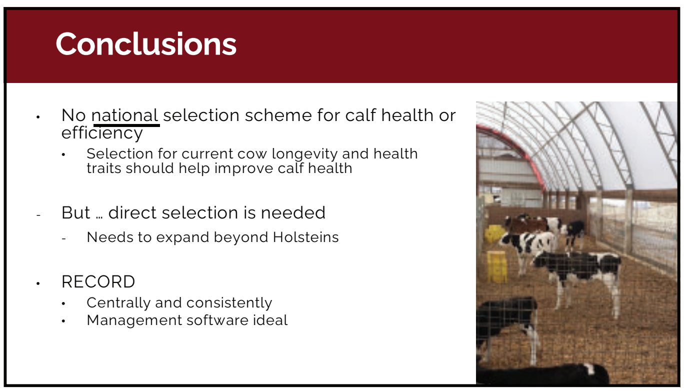

US Dairy Cattle Breed Structure
2007 - 2022
100
80
60
40
20
0
Percent (%)
90.7%
79.9%
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Year
Holstein
Jersey
Crossbred
Other
https://webconnect.uscdcb.com/#/national-performance-metrics

20


Conclusions
No national selection scheme for calf health or efficiency
Selection for current cow longevity and health traits should help improve calf health
But … direct selection is needed
Needs to expand beyond Holsteins
RECORD
Centrally and consistently
Management software ideal

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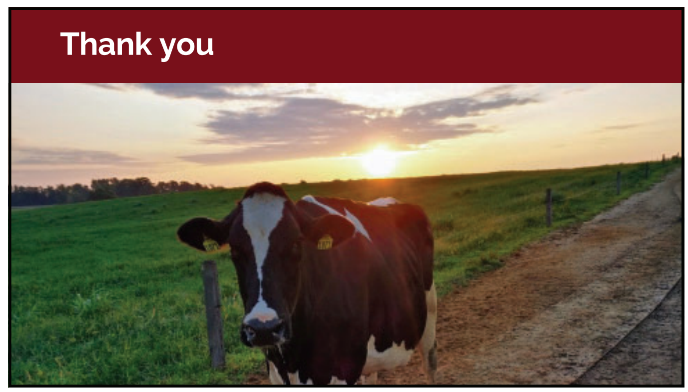
Thank you

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