Four-State Dairy Nutrition and Management Conference

Wednesday, June 10, 2020

Virtual Conference

Cooperative Extension for:
Iowa State University
University of Illinois
University of Minnesota
University of Wisconsin

2020

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All Systems Go! Amino Acid Balancing to Take Cows Farther

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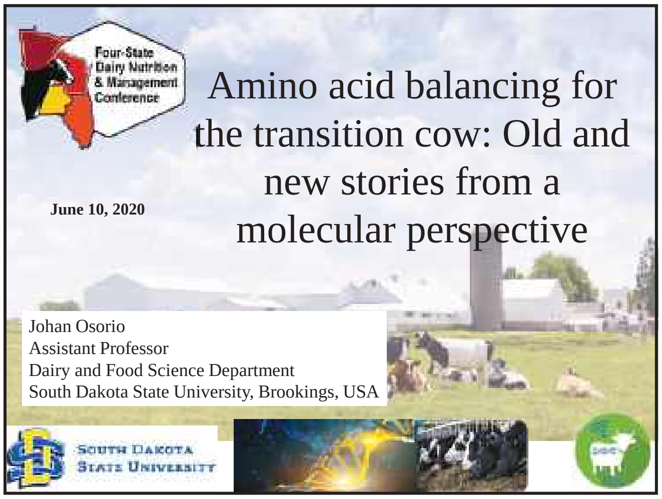
Four-State Dairy Nutrition & Management Conference

Amino Acid Balancing for the Transition Cow: Old and New Stories from a Molecular Perspective

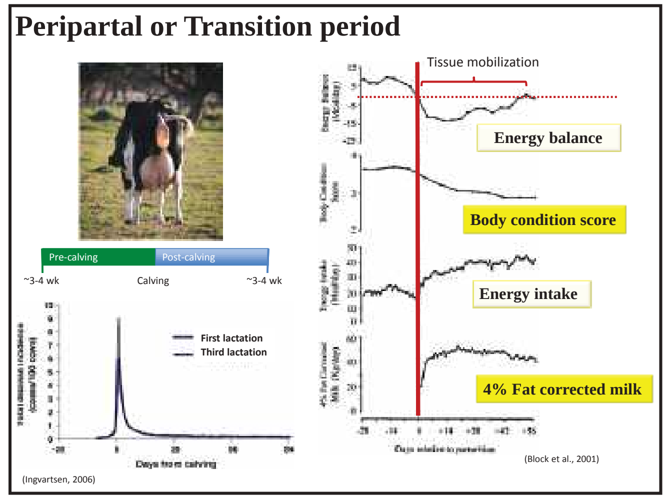
Johan Osorio, Assistant Professor

Dairy and Food Science Department

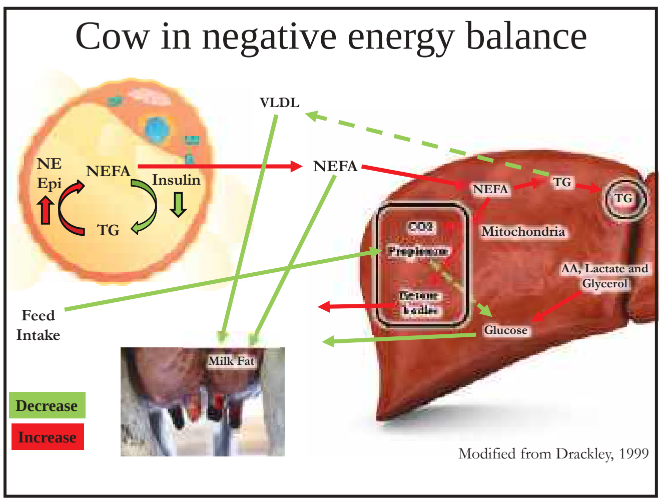
South Dakota State University, Brookings, USA


Four-State Dairy Nutrition & Management Conference
Amino acid balancing for the transition cow: Old and new stories from a molecular perspective
June 10, 2020
Johan Osorio
Assistant Professor
Dairy and Food Science Department
South Dakota State University, Brookings, USA
South Dakota State University

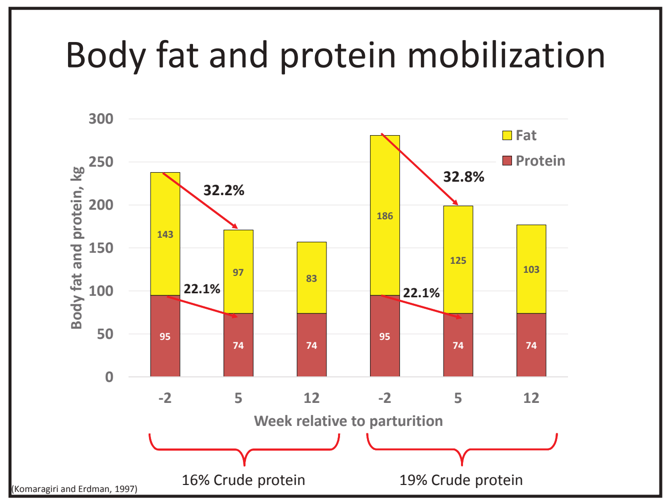
1


Peripartal or Transition period
Pre-calving
Post-calving
~3-4 wk
Calving
~3-4 wk
First lactation
Third lactation
Days from calving
(Ingvartsen, 2006)
Tissue mobilization
Energy balance
Body condition score
Energy intake
4% Fat corrected milk
(Block et al., 2001)

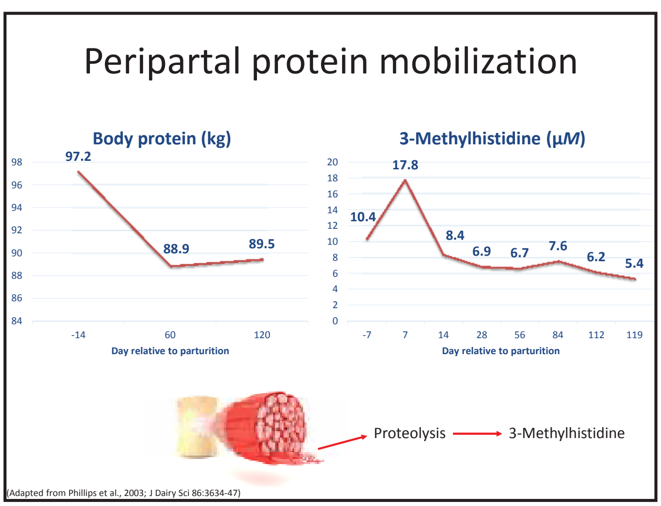
2


Cow in negative energy balance
VLDL
NE
Epi
NEFA
Insulin
TG
NEFA
NEFA
TG
TG
CO2
Propionate
Mitochondria
AA, Lactate and Glycerol
Ketone bodies
Glucose
Feed Intake
Milk Fat
Decrease
Increase
Modified from Drackley, 1999

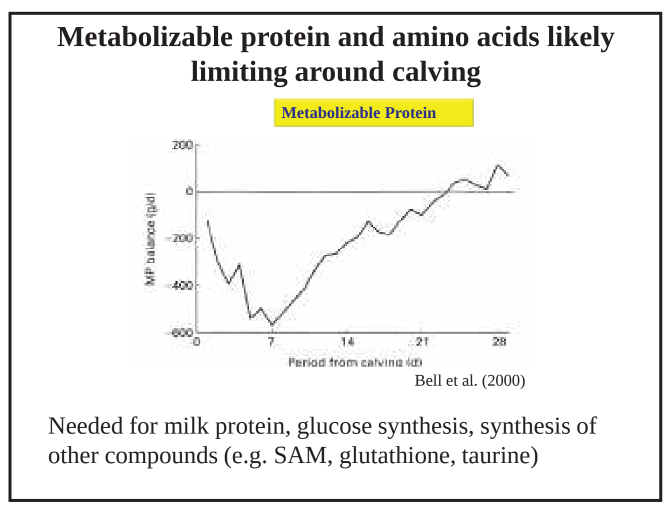
3


Body fat and protein mobilization
Body fat and protein, kg
300
250
200
150
100
50
0
Fat
Protein
143
95
32.2%
22.1%
97
74
83
74
186
95
32.8%
22.1%
125
74
103
74
-2
5
12
-2
5
12
Week relative to parturition
16% Crude protein
19% Crude protein
(Komaragiri and Erdman, 1997)

4

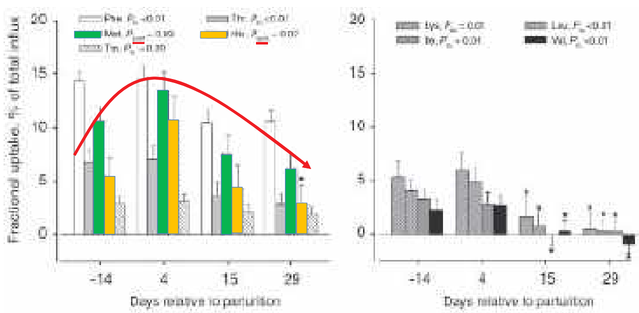

Peripartal protein mobilization
Body protein (kg)
97.2
88.9
89.5
-14
60
120
Day relative to parturition
3-Methylhistidine (μM)
17.8
10.4
8.4
6.9
6.7
7.6
6.2
5.4
-7
7
14
28
56
84
112
119
Day relative to parturition
Proteolysis
3-Methylhistidine
(Adapted from Phillips et al., 2003; J Dairy Sci 86:3634-47)

5


Metabolizable protein and amino acids likely limiting around calving
Metabolizable Protein
MP balance (g/d)
Period from calving (d)
Bell et al. (2000)
Needed for milk protein, glucose synthesis, synthesis of other compounds (e.g. SAM, glutathione, taurine)

6

Net liver uptake of Methionine and Histidine increases after calving



(Larsen and Kristensen, 2013)

Net uptake of Met by liver can be enhanced by supplemental RP-Met……..also prevents decrease in blood Met postpartum (Dalbach et al., 2011)

7

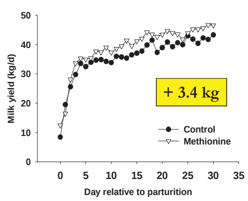
Methionine and the Peripartal Period

Dietary component	Osorio et al., 2013		Zhou et al., 2016		Batistel et al., 2017	
	Control	Met	Control	Met	Control	Met
CP, % of DM	17.4	17.4	17.2	17.3	17.7	17.7
MP supplied (g/d)	1,563	1,840	2,090	2,374	2,425	2,640
MP balance (g/d)	-574	-616	-434	-573	-118	-160
Lys (% of MP)	6.17	6.07	6.33	6.24	6.40	6.38
Met (% of MP)	1.81	2.15	1.79	2.30	1.70	2.24
Lys:Met	3.43:1	2.82:1	3.54:1	2.71:1	3.78:1	2.88:1

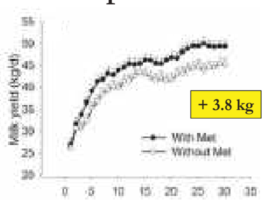
ILLINOIS

8

Methionine and the Peripartal Period



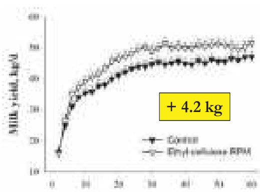
Adapted from Osorio et al., 2013



Adapted from Zhou et al., 2016

Milk Yield

ILLINOIS



Adapted from Batistel et al., 2017

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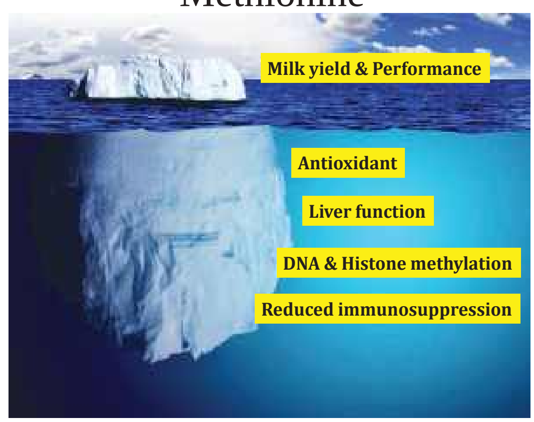
Methionine



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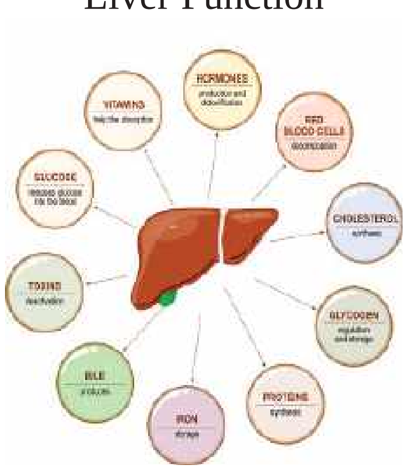
Liver Function



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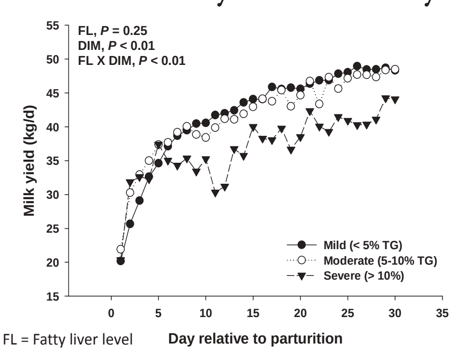
Fatty liver on milk yield



FL = Fatty liver level

Day relative to parturition

n = 100 transition cows

Actual TG mean:

- Mild = 3.3 ± 1.0
- Moderate = 6.5 ± 1.5
- Severe = 11.1 ± 0.9

Actual Milk yield:

- Mild = 41.9 ± 0.84
- Moderate = 41.6 ± 1.5
- Severe = 36.9 ± 2.9

Correlation

- r = -0.2
- P = 0.06

Osorio et al., 2013; Zhou et al., 2016; Bastistel et al., 2017

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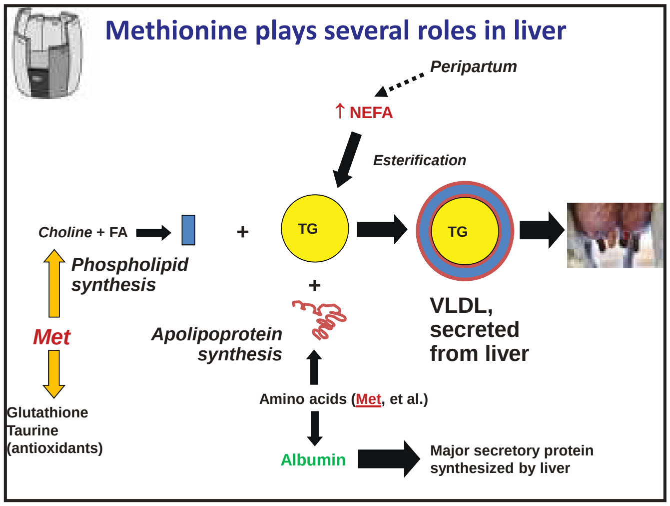

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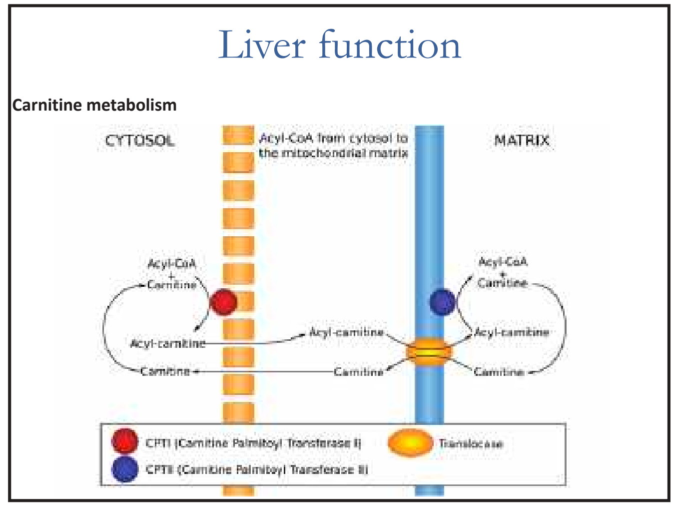

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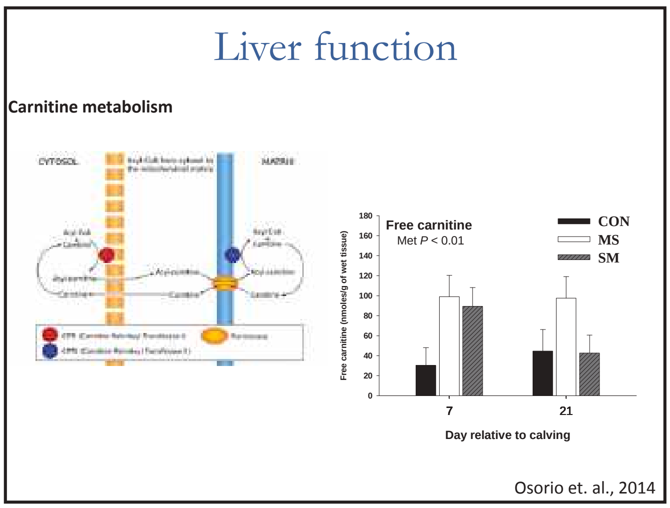

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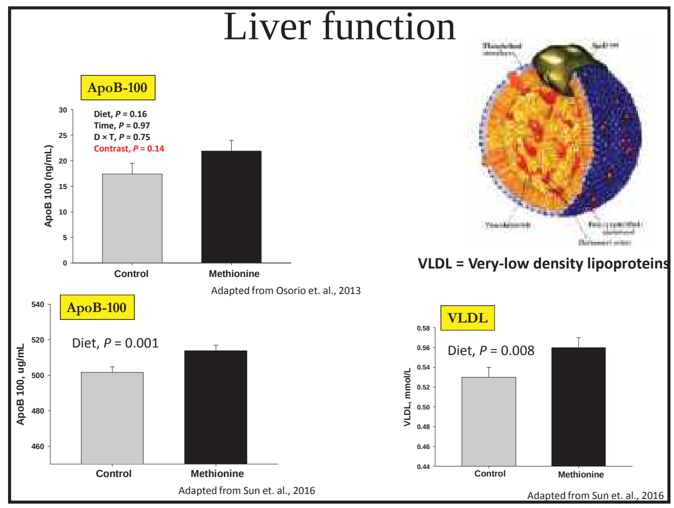

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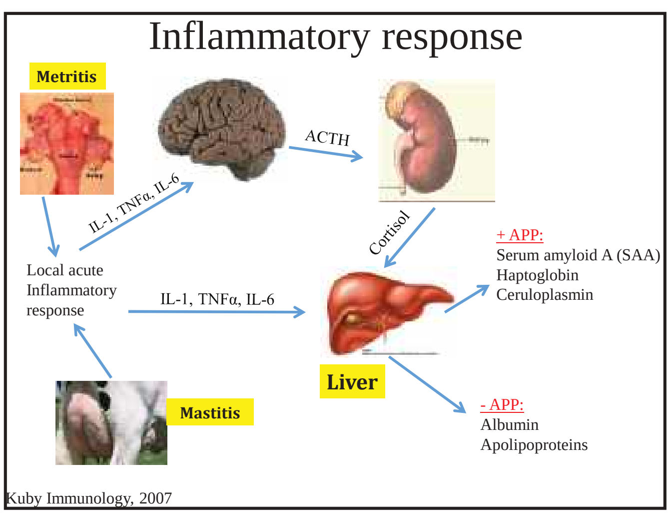

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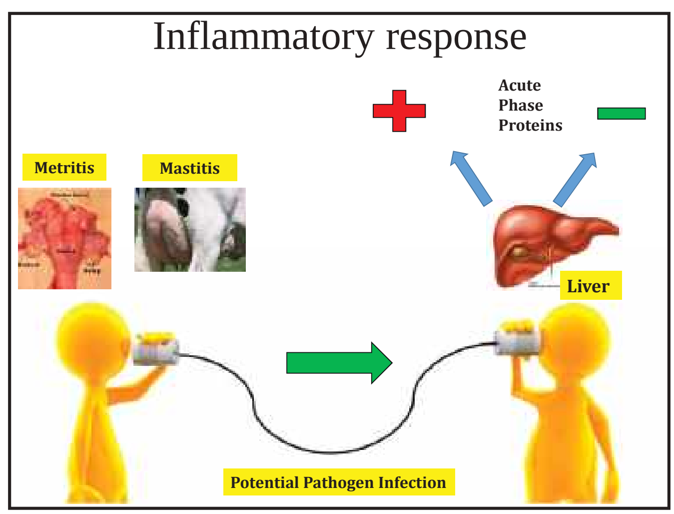

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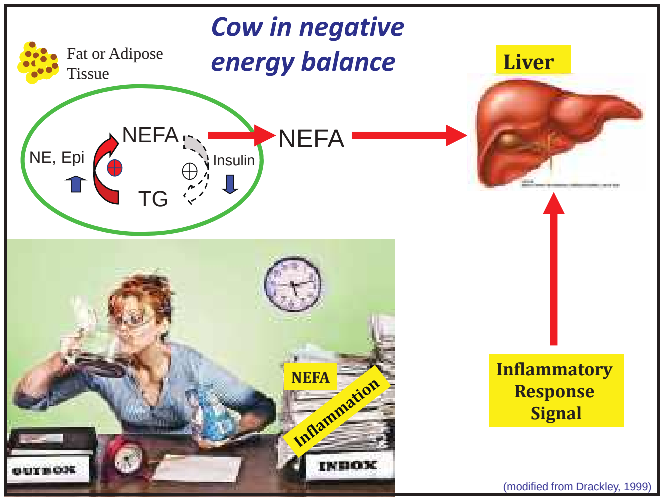

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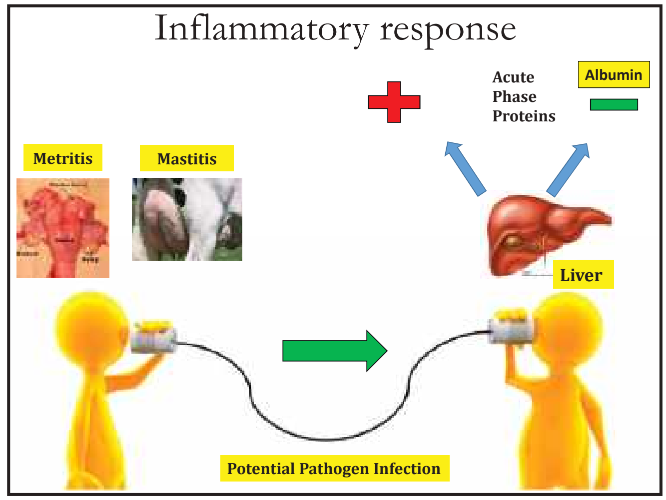

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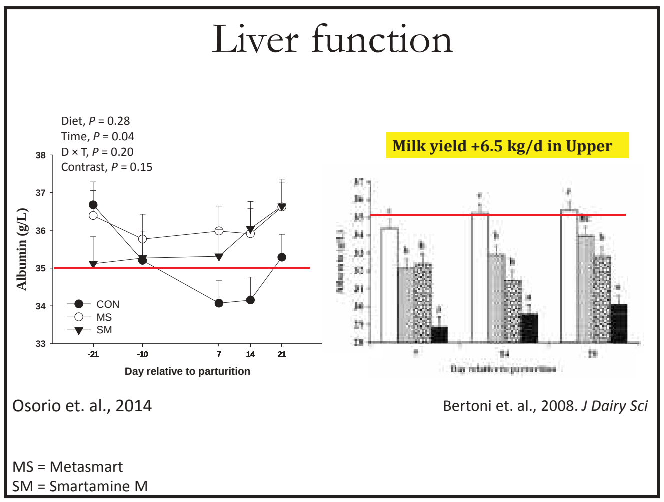

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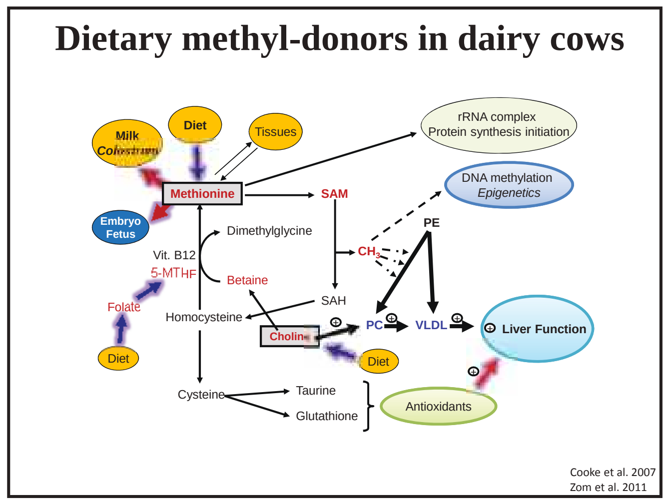

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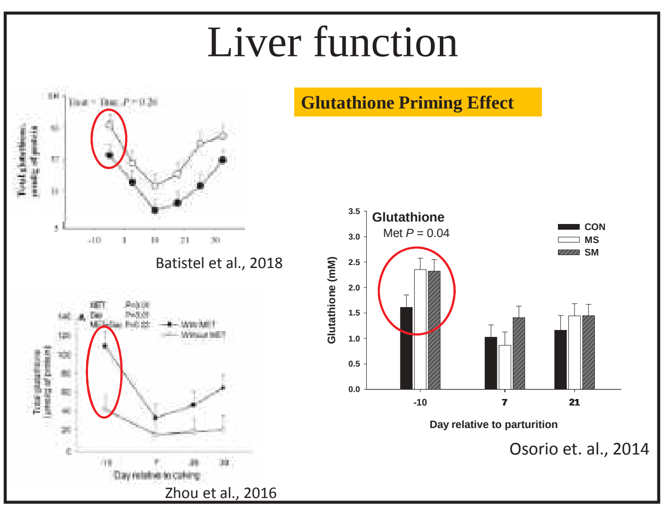

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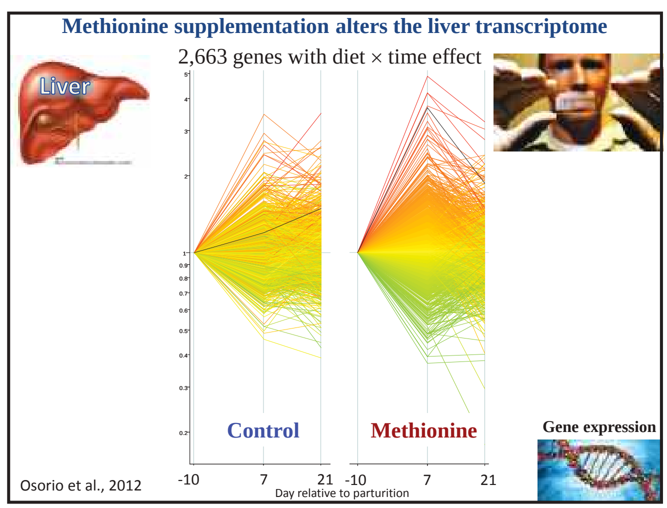

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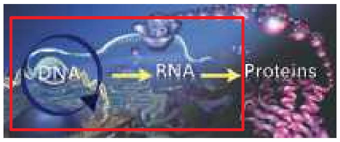
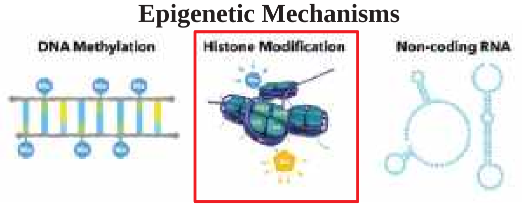
Methionine and Gene Regulation

Central Dogma of Molecular Biology



Epigenetic Mechanisms



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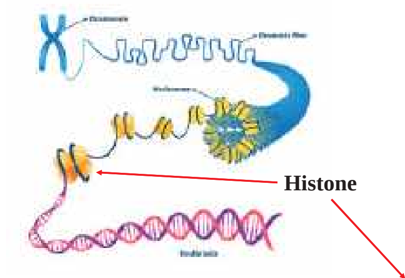
Methionine and Gene Regulation



Active/Open

Histone

Inactive/close

26

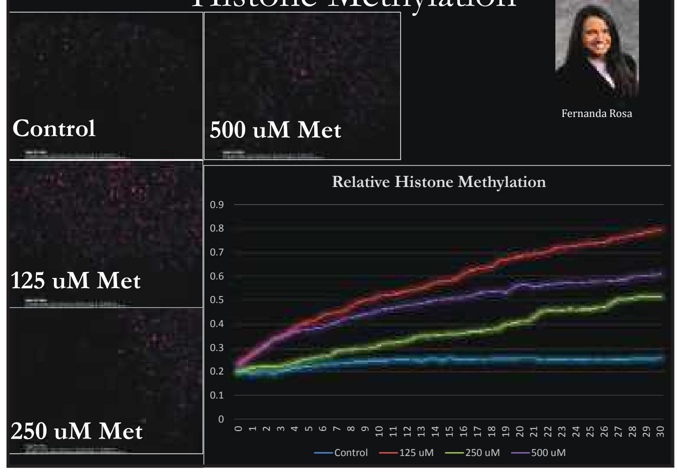
Methionine and Nutrigenomics

Histone Methylation

Tiramisu

27

Histone Methylation



Fernanda Rosa

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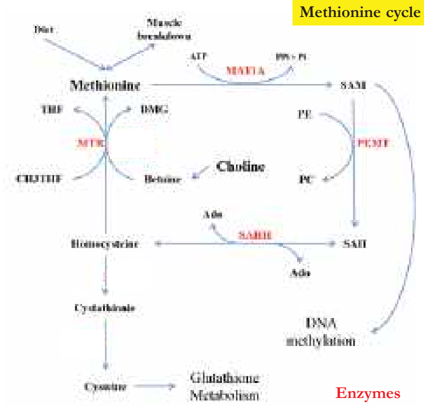
Histone Methylation

Methionine cycle



Enzymes

Fernanda Rosa

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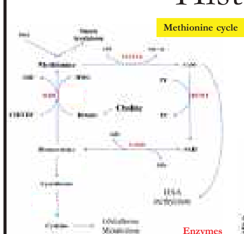
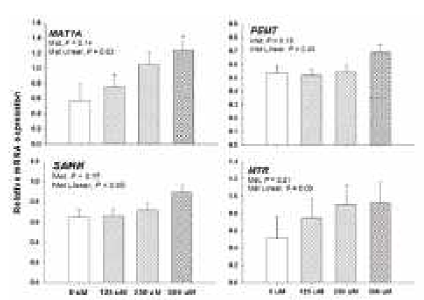
Histone Methylation

Methionine cycle



Enzymes



Fernanda Rosa

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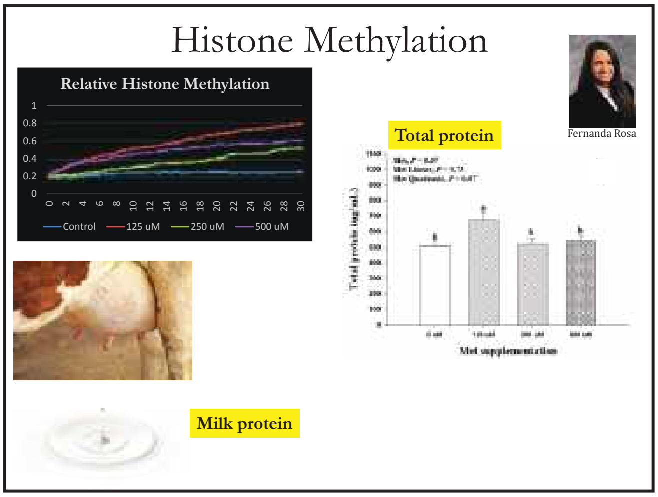
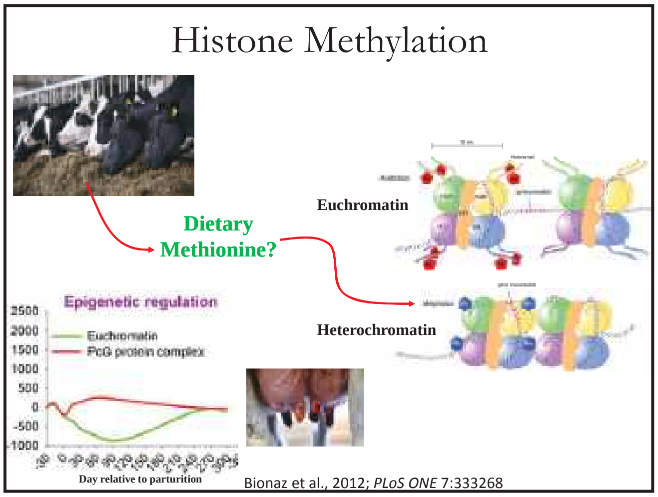
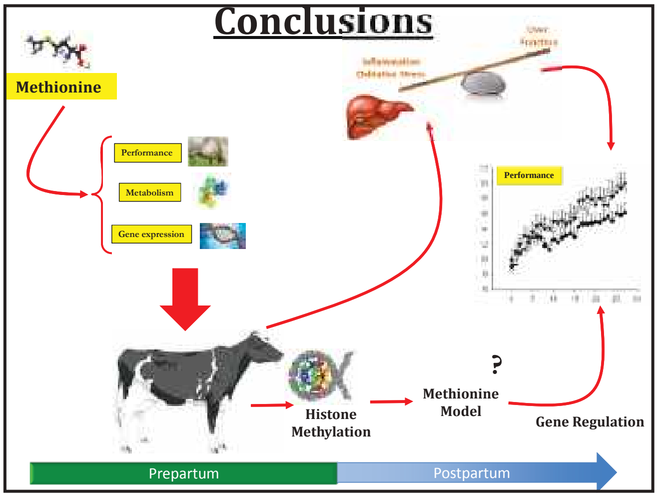

Histone Methylation
Relative Histone Methylation
Control
125 uM
250 uM
500 uM
Total protein
Total protein (ug/mL)
Met supplementation
Fernanda Rosa
Milk protein
31


Histone Methylation
Dietary Methionine?
Euchromatin
Heterochromatin
Epigenetic regulation
Euchromatin
PcG protein complex
Day relative to parturition
Bionaz et al., 2012; PLoS ONE 7:333268
32


Conclusions
Methionine
Performance
Metabolism
Gene expression
Performance
Histone Methylation
Methionine Model
Gene Regulation
Prepartum
Postpartum
33


Thanks!
Johan.Osorio@sdstate.edu
Research
South Dakota State University
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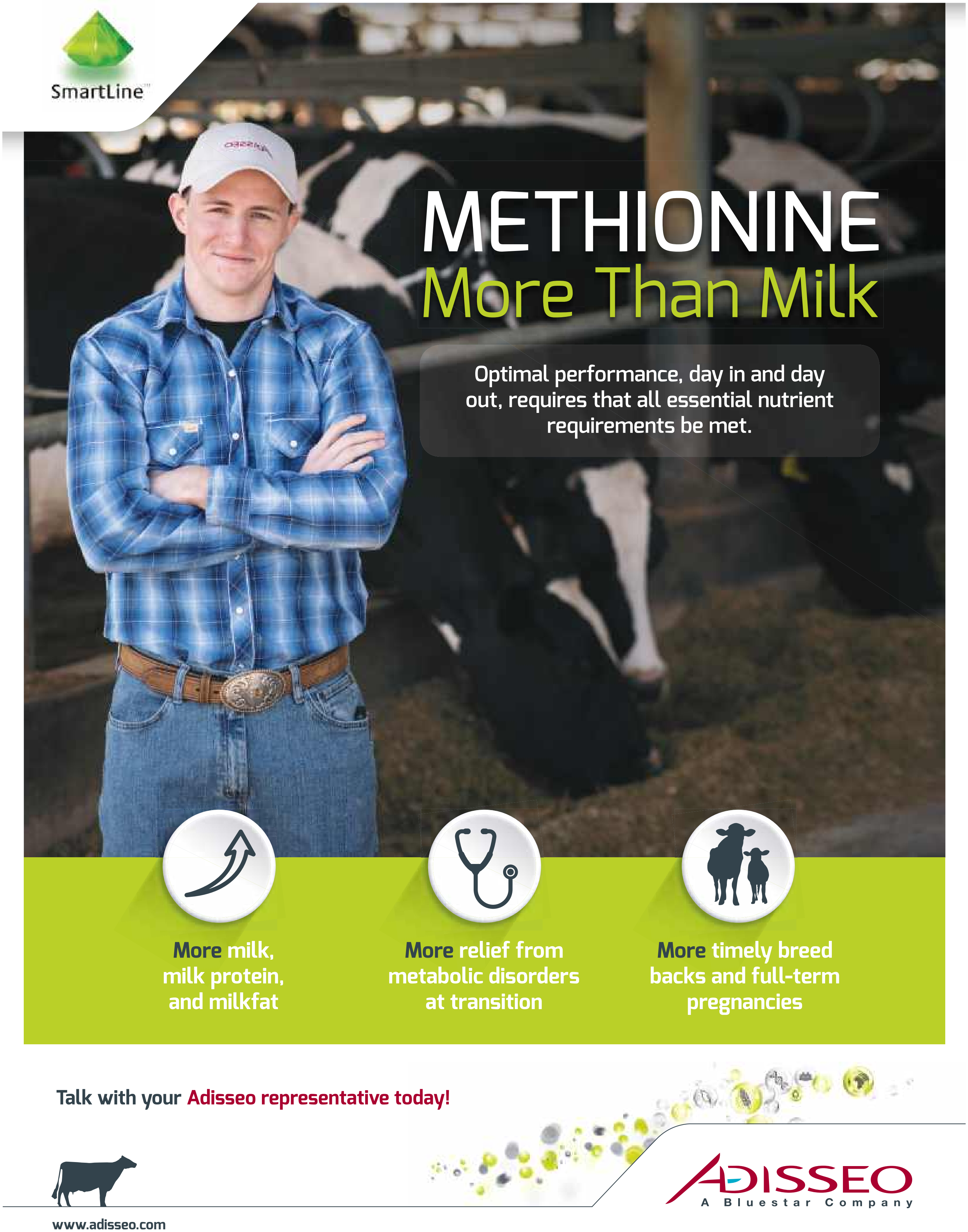
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METHIONINE
More Than Milk
Optimal performance, day in and day out, requires that all essential nutrient requirements be met.
More milk, milk protein, and milkfat
More relief from metabolic disorders at transition
More timely breed backs and full-term pregnancies
Talk with your Adisseo representative today!
ADISSEO
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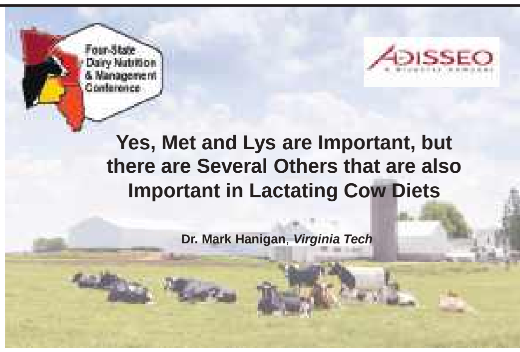
Yes, Met and Lys are Important, but there are Several Others that are also Important in Lactating Cow Diets

Dr. Mark Hanigan
Virginia Tech



Yes, Met and Lys are Important, but there are Several Others that are also Important in Lactating Cow Diets

Dr. Mark Hanigan, *Virginia Tech*

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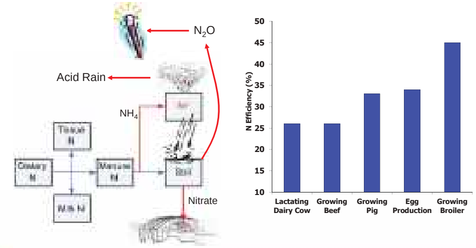
1

N Efficiencies are Low for Ruminants

↑ efficiency = ↑ food/ac and ↓ environmental loading!



Bequette et al., 2003

2

Ohio Dairy Nutrient Values – 5-year Average

Nutrient values derived using Sesame
Buckeye Dairy News: Vol 22, Issue 2 (March, 2020)

Nutrient	Cost/Unit	Daily Supply*	Cost/cow/d
NEL (3X, NRC 2001) MCal	$0.08	35.4 Mcal	$2.83
Metabolizable Protein (NRC) Lbs	$0.43	5.44 lbs	$2.34
Effective NDF (forage NDF) Lbs	$0.14	10.4 lbs	$1.46
Non-effective NDF (Total NDF – Forage NDF) Lbs	-$0.02	7.3 lbs	-$0.15
Total Cost for Energy, Protein and Fiber			$6.48

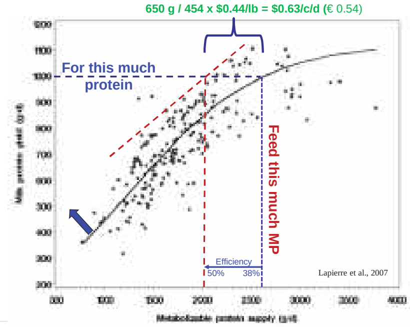
* 1600 lb cow, 80 lbs milk/d, 3.0% protein, 3.5% fat

https://dairy.osu.edu/newsletter/buckeye-dairy-news/volume-22-issue-2/milk-prices-costs-nutrients-margins-and-comparison
Sesame can be licensed and used for local markets

3

Milk Protein vs Metabolizable Protein

650 g / 454 x $0.44/lb = $0.63/c/d (€ 0.54)



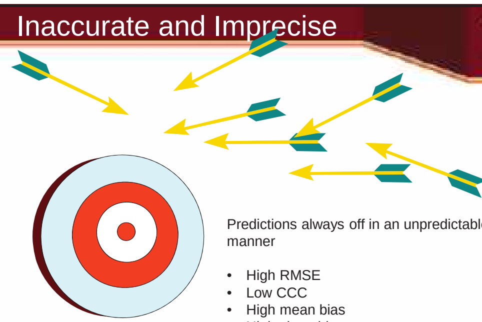
How do we achieve this?

4

Ration Balancer: Behind the User Interface

5

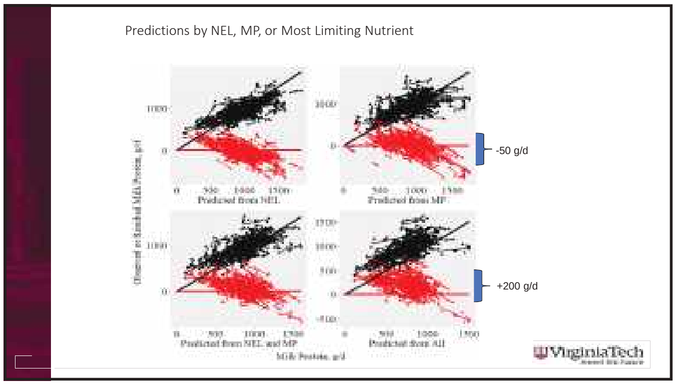
Inaccurate and Imprecise



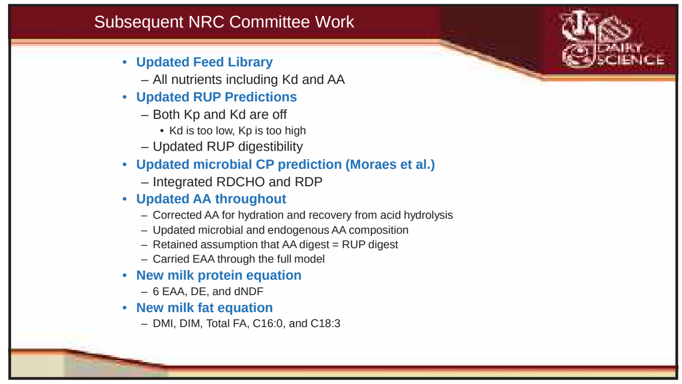
Predictions always off in an unpredictable manner

- High RMSE
- Low CCC
- High mean bias
- High slope bias
- May be useful but difficult calibration
- NRC 2001

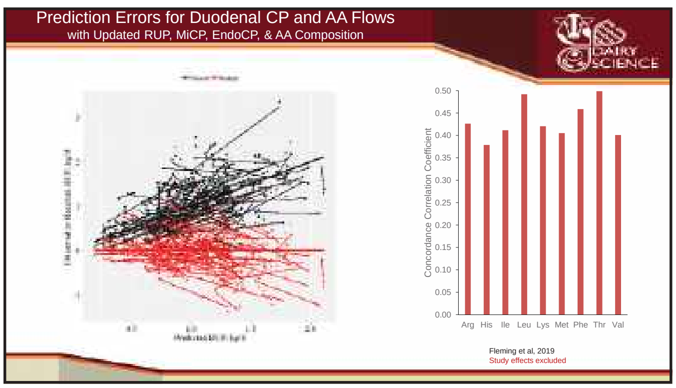
6


Predictions by NEL, MP, or Most Limiting Nutrient
Predicted from NEL
Predicted from MP
Predicted from NEL and MP
Predicted from All
Milk Protein, g/d
-50 g/d
+200 g/d
VirginiaTech

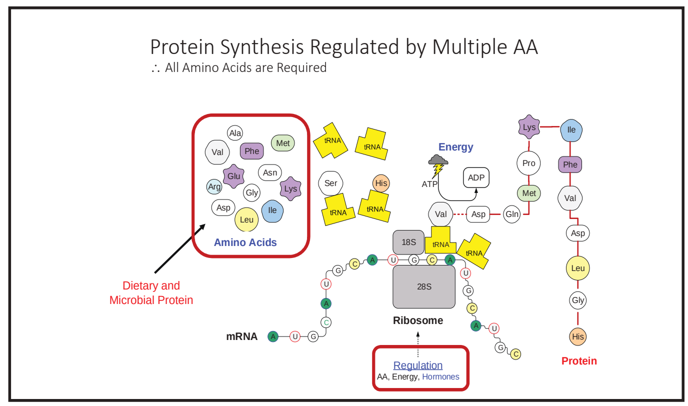
7


Subsequent NRC Committee Work
• Updated Feed Library
– All nutrients including Kd and AA
• Updated RUP Predictions
– Both Kp and Kd are off
• Kd is too low, Kp is too high
– Updated RUP digestibility
• Updated microbial CP prediction (Moraes et al.)
– Integrated RDCHO and RDP
• Updated AA throughout
– Corrected AA for hydration and recovery from acid hydrolysis
– Updated microbial and endogenous AA composition
– Retained assumption that AA digest = RUP digest
– Carried EAA through the full model
• New milk protein equation
– 6 EAA, DE, and dNDF
• New milk fat equation
– DMI, DIM, Total FA, C16:0, and C18:3
DAIRY SCIENCE

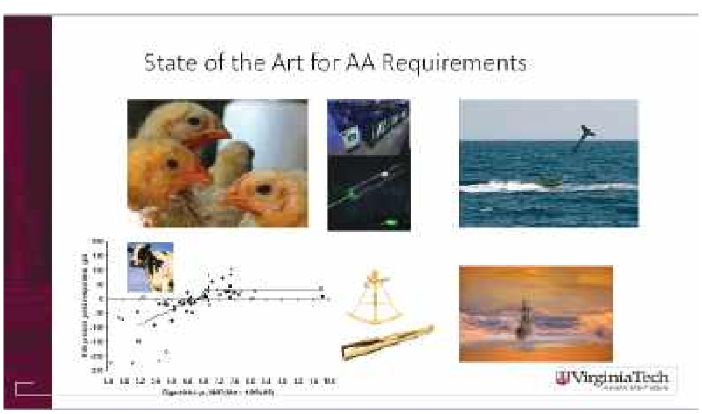
8


Prediction Errors for Duodenal CP and AA Flows
with Updated RUP, MiCP, EndoCP, & AA Composition
DAIRY SCIENCE
Concordance Correlation Coefficient
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Arg His Ile Leu Lys Met Phe Thr Val
Fleming et al, 2019
Study effects excluded

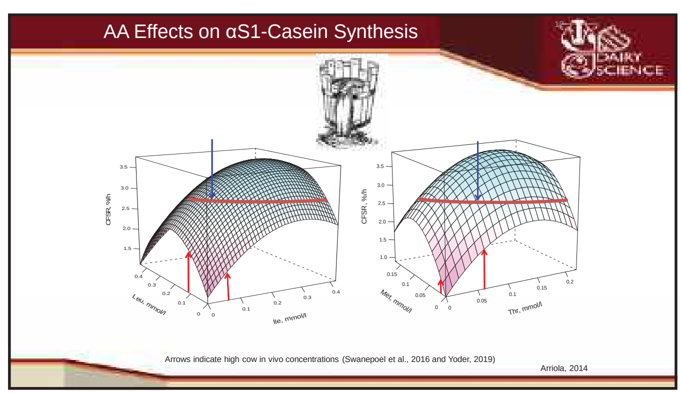
9


Protein Synthesis Regulated by Multiple AA
∴ All Amino Acids are Required
Amino Acids
Dietary and Microbial Protein
Energy
ATP
ADP
tRNA
18S
28S
Ribosome
mRNA
Regulation
AA, Energy, Hormones
Protein

10

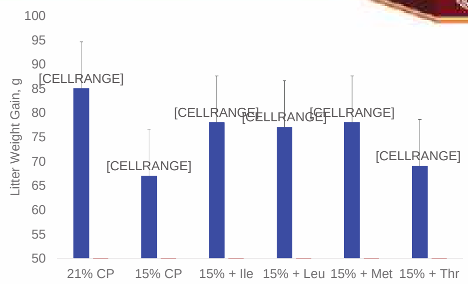

State of the Art for AA Requirements
VirginiaTech

11


AA Effects on αS1-Casein Synthesis
DAIRY SCIENCE
CFSR, %/h
Leu, mmol/l
Ile, mmol/l
Met, mmol/l
Thr, mmol/l
Arrows indicate high cow in vivo concentrations (Swanepoel et al., 2016 and Yoder, 2019)
Arriola, 2014

12

Lactational Responses to Individual Essential AA in Mice



Liu et al., 2017

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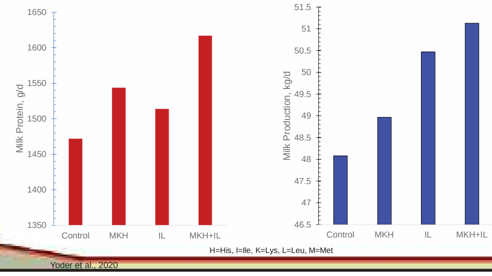
Additive Responses to EAA in Cows

15% CP Diet
38% N Efficiency

	Effect (P-values)		
	MKH	IL	MKH*IL
Milk	0.39	**0.02**	0.89
Milk Protein	**0.002**	**0.02**	0.500



H=His, I=Ile, K=Lys, L=Leu, M=Met

Yoder et al., 2020

14

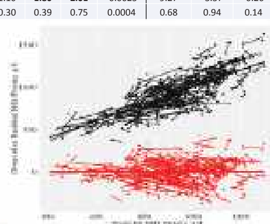
Integrated Milk Protein Predictions from Meta-analysis

$$mPrt = \beta His + \chi Ile + \delta Leu + \varepsilon Lys + \phi Met + \varphi Thr + \lambda DEI + \kappa dNDF + \mu BW + \lambda(\sum EAA^2)$$

Predictors	Intercept	His	Ile	Leu	Lys	Met	Thr	Σ(EAA²)	DEInp	dNDF	BW
	g/d	---- g/g ----							g/mcal	g/%	g/kg
Estimates	6.3	**2.44**	1.05	0.99	1.10	**1.80**	**2.01**	-0.0025	9.27	-3.37	-0.26
SE	102	0.76	0.51	0.29	0.30	0.39	0.75	0.0004	0.68	0.94	0.14

Cross Evaluation Results – 500 Iterations

Variable	Mean	SE
Observed Mean, g/d	924	17
Predicted Mean, g/d	924	13
RMSE	126	7
RMSE, % mean	13.7	0.8
Mean Bias, % MSE	0.7	0.9
Slope Bias, % MSE	2.8	2.4
CCC	0.78	0.03



- Arg significant but variable
- Trp, Phe, and Val → inadequate data

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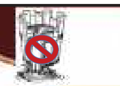
Metabolic Representation



Alternative Facts

Real Facts: A Leaky Barrel

- Leaks define efficiency
- Size of each leak depends on the mix of nutrients
  - AA and Energy Supply
  - AA partitioning to Mammary
  - Mammary responses to AA and energy
- Additive, independent milk protein responses
- **Understanding requires a change in thought!**

16

How Low Can We Go?

Assumptions: 23 kg DMI, MP ~ 0.6 * CP, MP = $0.4375/lb, Milk Prt = $2/lb

	16.5% CP	14.5% CP
MP, g/d	2280	2000
EAA, g/d	1170	1025
Milk Prt, g/d (lb/d)	1080 (2.38)	1064 (2.34)
Abs His, g/d	56	49
Abs Leu, g/d	214	188
Abs Lys, g/d	179	157
Abs Met, g/d	54	47
MP, $/d	$2.20	$1.93
Milk Prt, $/d	$4.76	$4.69
Net, $/d		$0.20

? Is MP cost nonlinear vs reduced dietary CP.

VirginiaTech

17

How Low Can We Go?

$$Milk\ Protein\ (g/d) = 328 - 0.831(DIM) - 62.6(MilkFat\%) + 9.42(DEI) + 4.95(Arg) - 0.021(Arg)^2 + 1.28(His)$$
$$+ 0.687(Ile) + 1.63(Leu) - 0.003(Leu)^2 + 0.393(Lys) + 1.024(Met) - 4.34(Val) + 0.009(Val)^2$$

Assumptions: 23 kg DMI, MP ~ 0.6 * CP, MP = $0.4375/lb, Milk Prt = $2/lb

	16.5% CP	14.5% CP	12.5% CP	12.5% + rpAA
MP, g/d	2280	2000	1725	1885
EAA, g/d	1170	1025	885	1007
Milk Prt, g/d (lb/d)	1080 (2.38)	1064 (2.34)	1042 (2.30)	1114 (2.45)
Abs His, g/d	56	49	42	56 (+14)
Abs Leu, g/d	214	188	162	214 (+52)
Abs Lys, g/d	179	157	135	179 (+44)
Abs Met, g/d	54	47	41	54 (+13)
MP, $/d	$2.20	$1.93	$1.66?	>$1.66?
Milk Prt, $/d	$4.76	$4.69	$4.59	$4.91
Net, $/d		$0.20	$0.36	$0.68

? MP cost is nonlinear vs reduced dietary CP.

VirginiaTech

18

Diet Optimization Using Different Strategies

RP His, Lys, Ile, Leu, Met, and Thr offered

	Least Cost	Maximum IOFC[a]	IOFC + N Penalty[b]	IOFC ↓Milk$[c]	IOFC ↓↓Milk$[d]
Diet Cost, $/d/c	$6.38	$7.72	$7.81	$7.46	$6.80
Milk Value, $/d/c	$14.59	$16.74	$16.18	$12.31	$7.75
Milk Protein, g/d	1110	1286	1210	1262	1189
ME, mcal/kg	2.92	3.01	3.12	3.00	2.98
MP, g/d	2039	3067	2110	2907	2364
Dietary CP, %	14.9	21.8	14.7	20.6	17.1
N Efficiency, %	29.7	23.6	33.0	24.5	27.8
Neutral Detergent Fiber, %	35.7	32.8	34.5	33.4	35.3
Starch, %	26.2	24.1	25.2	24.8	25.9
Fatty Acids, %	2.53	3.17	5.83	2.96	2.77

[a] Milk protein = $4 / lb and milk fat = $2 / lb; assumed high potential production
[b] Excreted N = $4.54 / lb
[c] Milk protein = $3 / lb and milk fat = $1.50 / lb
[d] Milk protein = $2 / lb and milk fat = $1 / lb

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Conclusions

- ✓ Updated feed library
- ✓ Revised RUP and Microbial CP predictions
- ✓ New concepts for milk protein predictions
  - 6 to 8 EAA, DEI, dNDF
  - Marginal responses to individual AA not high
  - AA responses > MP and RPAA input cost
  - Energy supply very important
  - No such thing as a single-limiting AA
- ✓ Milk Protein equations in trial version of NDS
- ✓ AMTS waiting on me
- ✓ NRC out in 2021
- ✓ ☒**Optimize** or ☐**Plug and Chug**?
  - dNDF, dStarch, RDP, dFat, 8 dEAA, 2 dFA, 38 MV, Ingr$, M
  - How much money are you leaving on the table????

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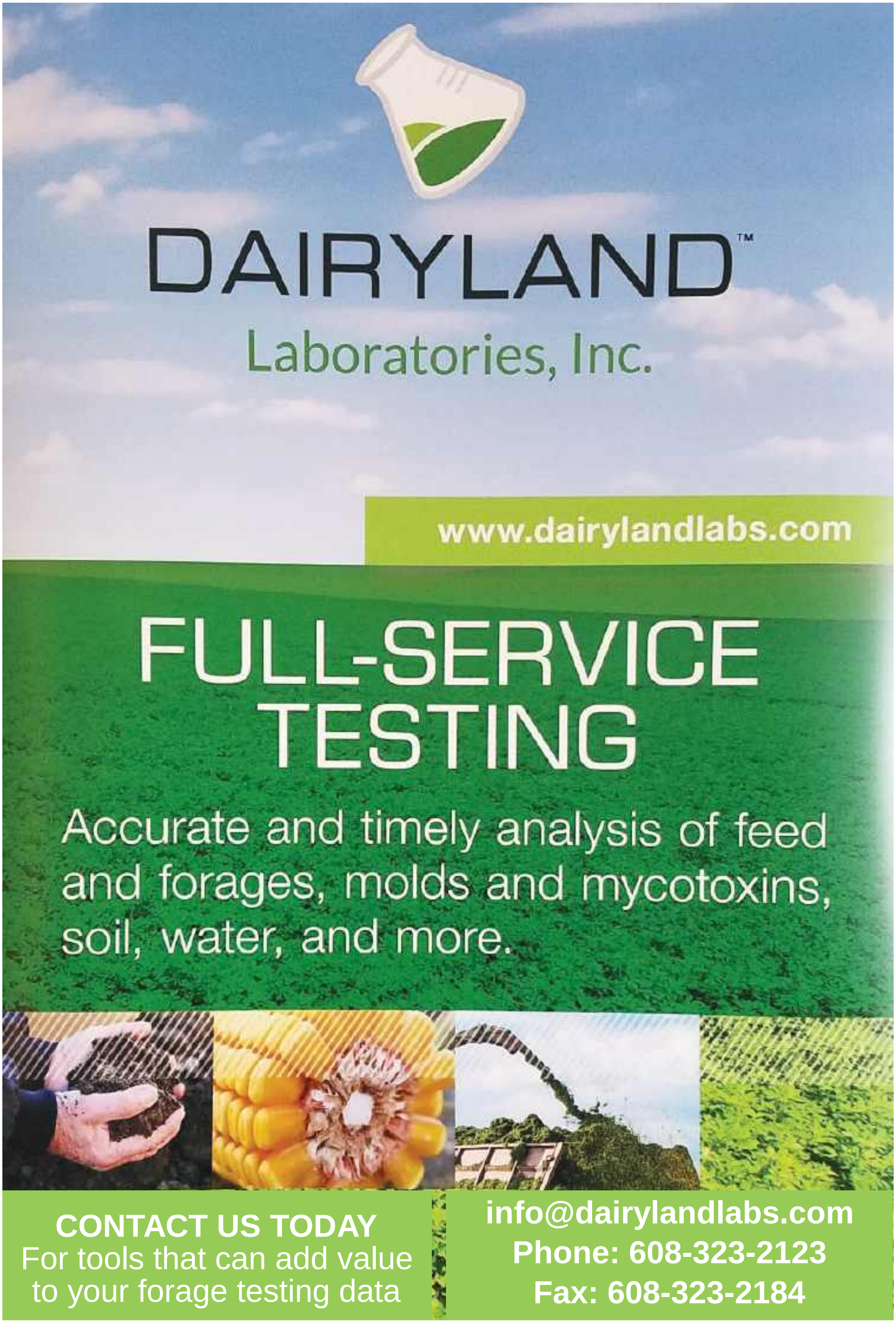
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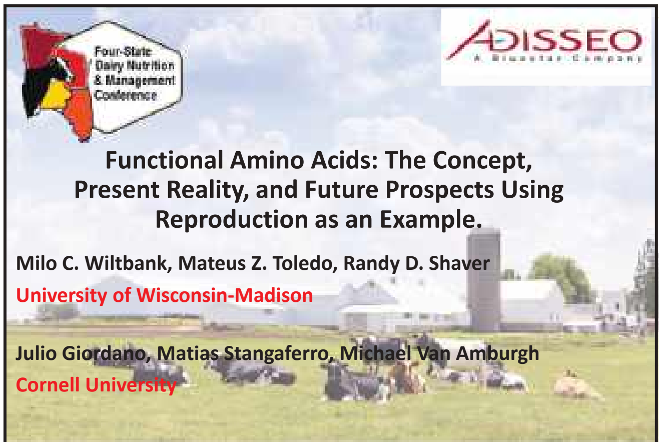
Functional Amino Acids: The Concept, Present Reality, and Future Prospects Using Reproduction as an Example

Milo C. Wiltbank, Mateus Z. Toledo, Randy D. Shaver
University of Wisconsin-Madison

Julio Giordano, Matias Stangaferro, Michael Van Amburgh
Cornell University



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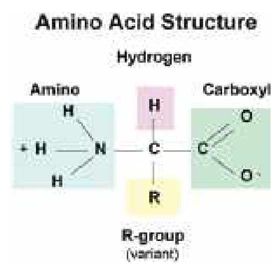
1

AA Nutrition

- Over 700 AA occur in nature, but 20 are incorporated into proteins.
- Amino acids are required nutrients.
- Essential vs. Non Essential.
  - Arg • Ala
  - His • Asp
  - Ile • Asn
  - Leu • Cys
  - Lys • Glu
  - Met • Gln
  - Phe • Gly
  - Thr • Pro
  - Trp • Ser
  - Val • Tyr



Wu, 2010

2

Functions of amino acids

- **Protein Synthesis**
- **Source of energy**
- **"Functional" actions such as:**
  - **Cell signaling (neurotransmitters such as glutamate)**
  - **Regulation of blood flow (NO is made from arginine)**
  - **Regulatory molecules (methionine)**

3

Functional amino acid definition

"There is growing recognition that besides their role as building blocks of proteins and polypeptides, some AA regulate key metabolic pathways that are necessary for maintenance, growth, reproduction, and immunity. They are called functional AA."

Guoyao Wu, 2009. Amino acids: metabolism, functions, and nutrition. Amino Acids 37:1-17.

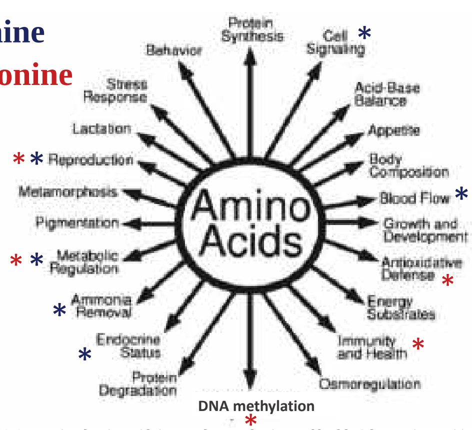
"A growing body of literature leads to a new concept of functional AA, which are defined as those AA that regulate key metabolic pathways to improve health, survival, growth, development, lactation, and reproduction of organisms. Both NEAA and EAA should be considered in the classic "ideal protein" concept or formulation of balanced diets to maximize protein accretion and optimize health in animals and humans."

Guoyao Wu, 2010. Functional amino acids in growth, reproduction, and health. Advances in Nutrition 1:31-37.

4

Functional amino acid definition

Arginine
Methionine



Guoyao Wu, 2010. Functional amino acids in growth, reproduction, and health. Advances in Nutrition 1:31-37.

5

The effect of various AA on reproduction (up to 2017)

AA	Major functions	Number of studies	Species	Year of first publication
Arg	**Synthesis of nitric oxide and polyamines; increased litter size**	**33**	**Pig, sheep, horse, cattle, rats and mouse**	**1996**
Gly	Increased embryonic development in vitro; some ovarian, uterine effects	7	Cattle, pig, mouse, hamster	1990
Gln	Metabolic fuel	5	Pig, sheep, cattle, and mice	1990
Leu	mTOR	2	Rats and mice	2012
Pro	Precursor for polyamines	2	Pig and sheep	2005
Tau	Oxidative balance	2	Cattle and Cat	1998
His	Hemoglobin structure; histamine	-	-	-
Lys	Prevent weight loss	7	Pig and cattle	1991
Met	**Methylation of DNA, synthesis of choline, antioxidant**	**8**	**Cattle and rats**	**1989**

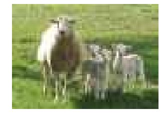
6

Reproductive effects of Arg feeding in pigs

Study	Period	% Arg	Litter Size	Birth Weight
Mateo et al 2007	Days 30-114	0.83%	Increase 2.0	Increase 24%
Cambell 2009	Days 14-28	1%	Increase 1.0	Increase 6.4%
De Blasio et al. 2009	Days 17-33	1%	Increase 1.2	Not Determined
Berrard & Bee 2010	Days 14-28	0.87%	Increase 3.7	Increase 32%
Li et al., 2011	Days 14-25	0.4%	Increase 2.2	No Effect
Li et al., 2011	Day 0-25	0.8%	Decrease 3.1	Decrease 34%
Gao et al., 2012	Days 22-114	0.8%	Increase 1.1	Increase 11%
Nuntapaitoon et al. 2018	Days 20-80	0.8%	Increased 2.1	Increased 23%
14 Total Studies			10+; 2-; 2NE	9+; 2-; 2NE

7

Reproductive effects of Arg feeding in ruminants?



Study	Period	Arg Treatment	Lambs born	Birth/weaning Weight
Lassala et al. 2011 – Sheep with multiple fetuses	100-121	i.v. infusion 3X/d 345 ug	Decrease 23% born dead	Birth: Increase 23%
Crane et al. 2016	0-14	i.v. once daily of 30 mg/kg BW	No effect	Weaning: 6.1 % increase in litter weight
Luther et al. 2009	0-15	i.v. once daily 27 mg/kg of BW	46 % more lambs	Birth: No effect

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Functional amino acids: The concept, present reality, and future prospects using reproduction as an example: Arginine

Concept: When higher amounts of Arg are fed, effects on reproduction and immune function will be observed.

Present Reality: Feeding Arg increases uterine blood flow and improves reproduction in litter-bearing species. No studies have been done on reproduction in dairy cattle. Large, controlled studies are needed.

Future Prospects: An effective rumen-protected Arg is needed. Perhaps feeding N-carbomylglutamate will work. Effects on pregnancy loss and stillbirth seem possibly economically-important endpoints.

9

Potential Arg effects on reproduction in dairy cows

Pregnancy loss in single and twin pregnancies in cool vs. warm temperatures in lactating dairy cows

Singletons	Preg Loss	n	*P*-value
Cool	4.6%	37/805	
Warm	12.7%	64/505	
Total	**7.7%**	**1,310**	**< 0.0001**

Twins	Preg Loss	n	*P*-value
Cool	17.6%	16/91	
Warm	53.7%	22/41	
Total	**28.8**	**132**	**< 0.0001**

Lopez-Gatius et al., 2004

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Percentage of stillbirth

Reference	Country	# Herds	# Calves	% Stillbirth
Overton and Dhuyvetter, 2020	USA	50	120,500	5.7
Mahnani et al., 2017	Iran	10	53,265	4.2
Vieira Neto et al., 2017	USA	2	8,095	9.8
Kayano et al., 2016	Japan	5,172	1,281,737	7.7
Lombard et al., 2007	USA	3	7,788	8.2
Meyer et al., 2001	USA	≈ 2,821	666,341	7.0
Total	-	**8,058**	**2,137,726**	**7.3**

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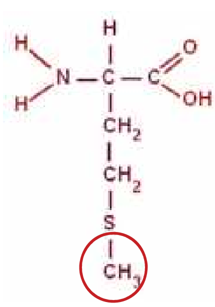
Methionine



- **Most common "start" signal for protein initiation**
- **Can be a rate-limiting amino acid in dairy cattle**

One-Carbon Pathway:

- **DNA methylation**
- **Synthesis of other compounds (choline, creatine, polyamines)**
- **Antioxidant balance**

Brosnan et al., 2007; Zanton et al., 2014

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Functional amino acids: The concept, present reality, and future prospects using reproduction as an example: Methionine

Concept: Increased Met is needed for optimal milk production but feeding higher amounts of Met may improve reproduction and health traits.

Present Reality:

Future Prospects:

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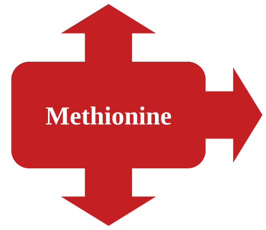
Methionine

⬆**Milk protein production**
(Vyas and Erdman, 2009; Patton, 2010; Zanton et al., 2014)



⬆**Health**
(Osorio et al., 2014; Zhou et al., 2015)

Reproduction?

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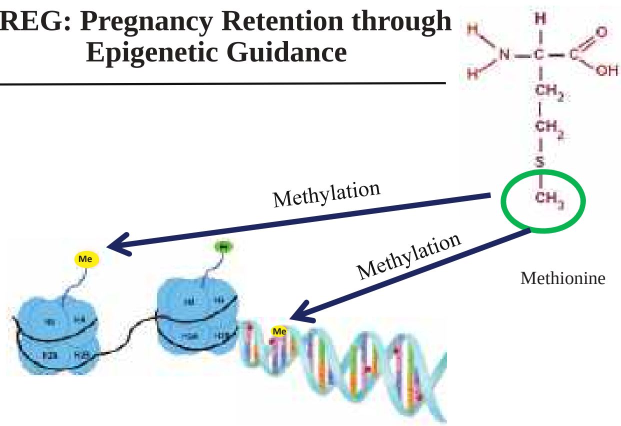
PREG: Pregnancy Retention through Epigenetic Guidance



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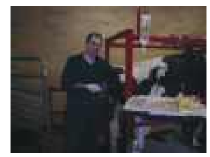
Effect of dietary methionine supplementation in early lactation dairy cows:
I - Lactation performance & II - Embryo quality

Souza, Carvalho, Dresch, Vieira, Hackbart, Luichini, Bertics, Betzold, Wiltbank & Shaver



- Holstein cows (n=72)
- Dry period:
  - Housed in a single pen & fed same basal diet
- From calving to 70 DIM:
  - Individual tie-stalls and milked twice daily
- At calving, cows blocked by parity & calving date randomly assigned to two treatments differing in content methionine:
  - **MET**, formulated to deliver 2875g MP with **6.8 Lys %MP** & **2.43 Met %MP** (fed 26 g/d Smartamine M)
  - **CON**, formulated to deliver 2875g MP with **6.8 Lys %MP** & **1.89 Met %MP**

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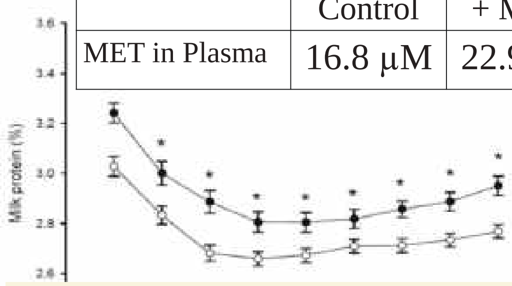
PROTEIN%

	Control	+ MET
MET in Plasma	16.8 µM	22.9µM



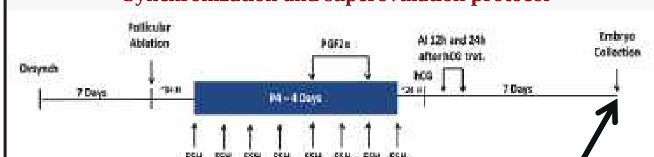
- Supplemental dietary rumen-protected methionine increased plasma methionine concentrations and milk protein concentration & milk protein yield.

17

Effect of dietary methionine supplementation in early lactation dairy cows:
I - Lactation performance & II - Embryo quality

Souza, Carvalho, Dresch, Vieira, Hackbart, Luichini, Bertics, Betzold, Wiltbank & Shaver

Synchronization and superovulation protocol



Flushed Embryos

Embryo Morphology – All embryos (> 500)
RNA-Sequencing - Grade I Embryos
(n = 8 cows/treatment group)

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Embryos of superovulated cows fed MET or CON

Total 571 embryos/oocytes; n=	MET 35	CON 37	*P*-value
CL number	17.0 ± 1.3	17.7 ± 1.5	*0.90*
% Fertilized ova	74.7 ± 5.6	82.2 ± 3.8	*0.27*
% Transferable embryos	56.3 ± 6.5	62.5 ± 6.0	*0.49*
% Degenerate embryos	18.5 ± 4.6	19.7 ± 4.7	*0.83*

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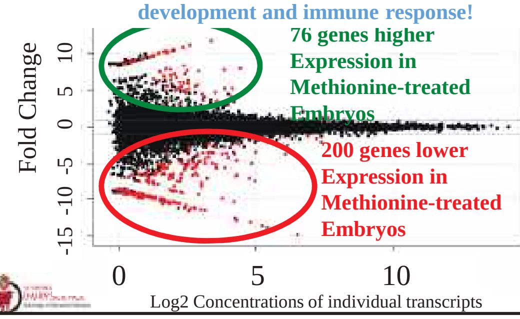
PLOS | ONE

Effect of Maternal Methionine Supplementation on the Transcriptome of Bovine Preimplantation Embryos

Francisco Peñagaricano[1], Alex H. Souza[2], Paulo D. Carvalho[2], Ashley M. Driver[1], Rocio Gambra[1], Jenna Kropp[1], Katherine S. Hackbart[2], Daniel Luchini[3], Randy D. Shaver[2], Milo C. Wiltbank[2]*, Hasan Khatib[1]*

Several of the most significant genes are related to embryonic development and immune response!



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Present Reality based on RNA-Seq trial:

- Methionine has functional effects on embryos
- Methionine supplementation of the dam changes gene expression in the embryo (Epigenetics).
- Most genes are down-regulated by methionine supplementation.

Gene Expression Is Different

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PLOS | ONE

RESEARCH ARTICLE

Effect of feeding rumen-protected methionine on productive and reproductive performance of dairy cows

Mateus Z. Toledo[1], Giovanni M. Baez[1¤a], Alvaro Garcia-Guerra[1,2¤b], Nelson E. Lobos[1], Jerry N. Guenther[1], Eduardo Trevisol[1], Daniel Luchini[3], Randy D. Shaver[1], Milo C. Wiltbank[1,2]*

1 Department of Dairy Science, University of Wisconsin-Madison, Madison, Wisconsin, Unites States of America, 2 Endocrinology and Reproductive Physiology Program, University of Wisconsin-Madison, Madison, WI, United States of America, 3 Adisseo USA Inc., Alpharetta, Georgia, Unites States of America

DEPARTMENT OF DAIRY SCIENCE University of Wisconsin-Madison

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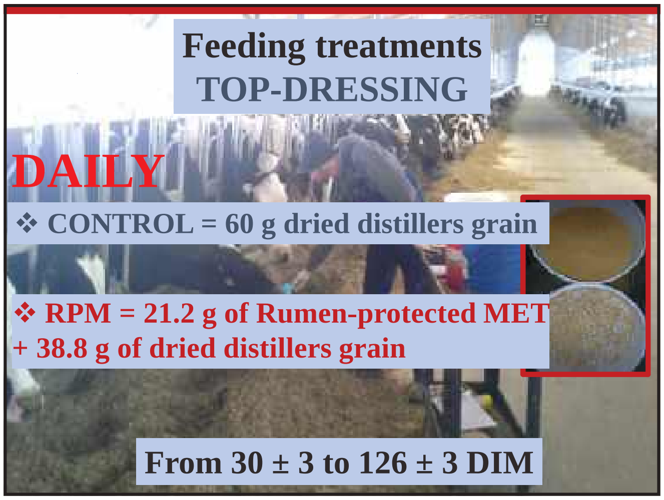

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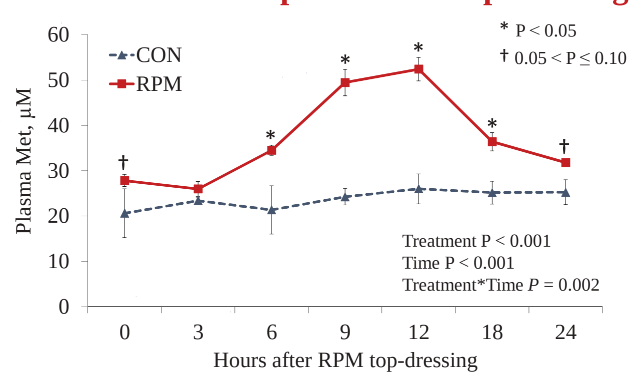
Plasma methionine profile after top-dressing



CON=2 pools, RPM=3 pools (n=4 cows each pool, total 20 cows)

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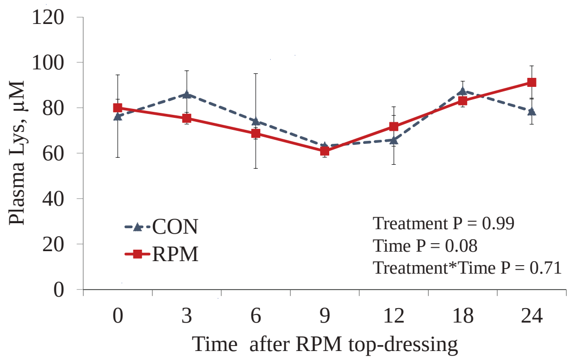
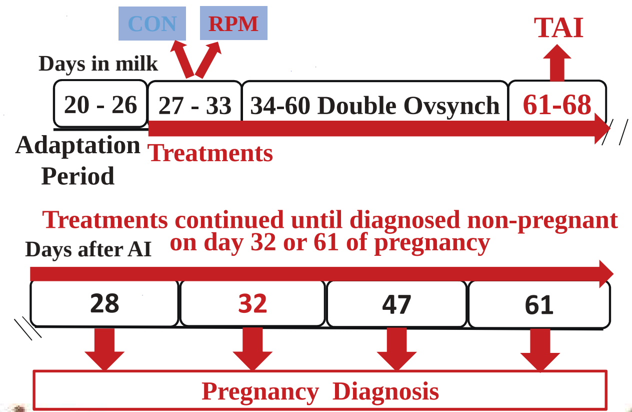
Plasma Lys



CON=2 pools, RPM=3 pools (n=4 cows each pool, total 20 cows)

25

Experimental design timeline



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Double-Ovsynch

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					GnRH	
					PGF	
	GnRH					
	GnRH					
	PGF	PGF	GnRH	TAI		

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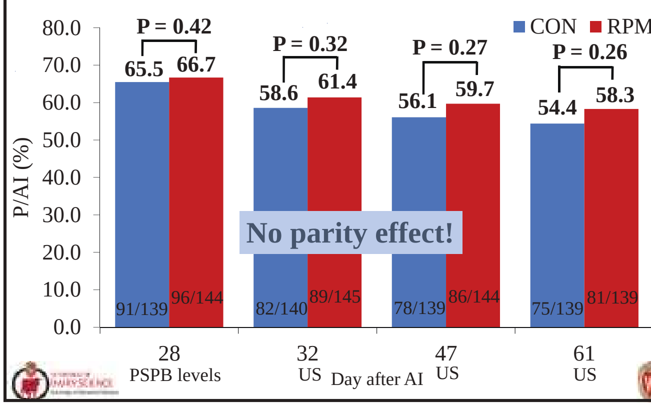
MZT2

Fertility of synchronized cows (92.2%) Pregnancy/AI (P/AI)



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Embryo size

- **Measurements – Software, Image J** (National Institutes of Health, Bethesda, MD)
- **Recorded for 15 seconds and the ideal position and orientation of the conceptus was selected**
- **2 independent people analyzed the videos**

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Mateus Z. Toledo

Methionine & Embryo Size

Trt & Parity	n	Amnionic Vesicle (mm^3)	Crown-Rump Length (mm)	Abdominal Diam. (mm)
Pri-Con	36	**617.1**	**10.5**	**5.6**
Pri-RPM	38	**596.0**	**10.9**	**5.7**
P-Value		*0.67*	*0.21*	*0.53*
Mul-Con	37	**479.4**	**10.6**	**5.3**
Mul-RPM	45	**593.9**	**11.0**	**5.9**
P-Value		*0.04*	*0.22*	*0.01*

Multiparous Cows supplemented with RP-Methionine had larger embryos.

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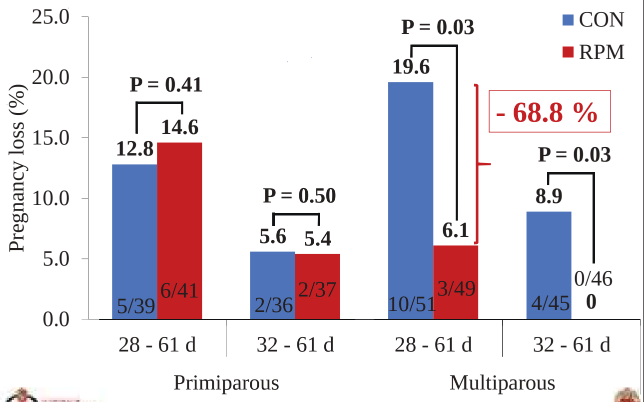
Pregnancy loss by parity



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Conclusions from Methionine Supplementation Trials.

- Methionine supplementation of the dam:
  - ↑ Size of embryo (+22%) in multiparous cows
  - ↓ Pregnancy loss (19.6 vs. 6.1%) in multi cows

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Feeding Rumen-Protected Methionine Pre- and Postpartum in Dairy Cows: Impact on Health, Productive and Reproductive Performance

M.Z.Toledo*, M.Stangaferro*, R.S.Gennari, P. L. J. Monteiro Jr., R.V. Barletta, C. A. Gamarra, A.B. Prata, J. Dorea, D. Luchini, M.M. Perez, M. Masello, R. Wijma, M.E. Van Amburgh, R.D. Shaver , J.O. Giordano, and M.C. Wiltbank

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Hypotheses

- We hypothesized that feeding RPM pre- and postpartum incorporated into TMR from -21 d until 147 DIM would:
  - **Increase plasma Met and milk protein production**
  - **Improve overall health**
  - **Enhance embryo development**
  - **Improve reproductive efficiency**

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Experimental Design

- 470 multiparous Holstein cows
  - **Cornell University Ruminant Center (CU; n = 235)**
  - **Emmons Blaine Dairy Research Center (UW; n = 235)**
- Housed in replicated pens:

	UW	CU	n cows
Close-up	4	2	10
Lactation	6	12	16

CON = 9 MET = 9

- Cows were enrolled between 3 and 4 weeks before calving
- Randomly assigned to either a control **(CON; no Smartamine M)** or treatment diet **(MET; 12 g (Pre) and 27 g (Post) Smartamine M)**

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Methionine Crew Acknowledgments

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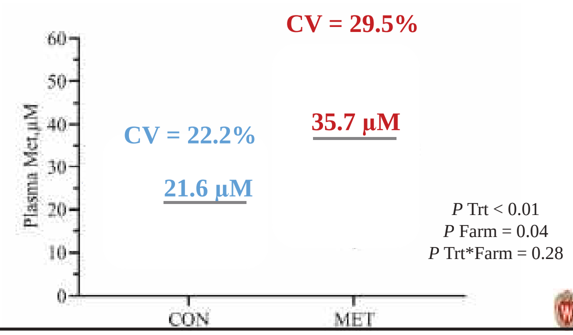
Does feeding RPM increase plasma Met?

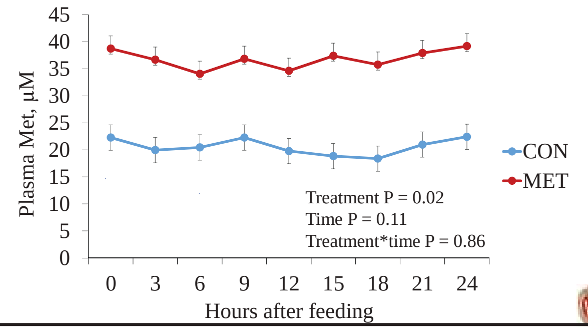
- Blood samples collected from 72 cows [0 – 3 h after feeding (UW=24; CU= 48) only; 80 DIM] and individually analyzed for free AA by LC-MS



37

Does plasma Met vary during the day?

- Blood samples collected from 16 cows (UW only; 60-85 DIM) every 3 h and analyzed for free AA by LC-MS



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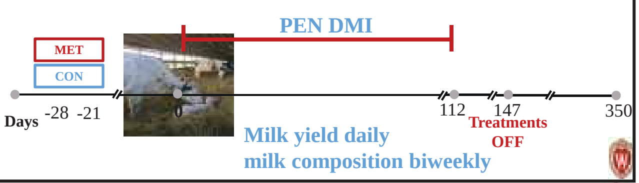
Outline

- Background
  - Amino acids (AA) nutrition in dairy cattle
  - Met importance and functions
  - Studies feeding Met during pre- and postpartum and evaluating health and productive performance?
- **Does feeding RPM pre- and postpartum improve:**
  - Production?, Health?, Reproduction?, HealthXReproduction?



39

Lactation performance: 0-112 DIM

	CON	MET	Trt	Farm
DMI, Kg/d	28.0	27.9	0.96	< 0.01
Milk yield, Kg/d	49.2	48.7	0.36	0.61

Time P : < 0.001; No interaction Trt x time and Trt x farm

40

Productive performance: 0-112 DIM

	CON	MET	Trt	Farm
DMI, Kg/d	28.0	27.9	0.96	< 0.01
Milk yield, Kg/d	49.2	48.7	0.36	0.61
Fat, %	3.77	3.87	0.03	0.04
Fat, kg	1.83	1.86	0.36	0.11
Protein, %	2.95	3.07	< 0.01	0.17
Protein, kg/d	1.43	1.48	0.02	0.04
Lactose, %	4.88	4.86	0.22	< 0.01
Lactose, kg/d	2.41	2.37	0.32	0.34

0.11 % units of milk fat

0.12 % units of milk protein

40 g of milk protein yield

Time P : < 0.001; No interaction Trt x time and Trt x farm

41

Productive performance: 16 weeks

	CON	MET	Trt	Farm
DMI, Kg/d	28.0	27.9	0.96	< 0.01
Milk yield, Kg/d	49.2	48.7	0.36	0.61
Fat, %	3.77	3.87	0.03	0.04
Fat, kg	1.83	1.86	0.36	0.11
Protein, %	2.95	3.07	< 0.01	0.17
Protein, kg/d	1.43	1.48	0.02	0.04
Lactose, %	4.88	4.86	0.22	< 0.01
Lactose, kg/d	2.41	2.37	0.32	0.34
SCC x 10^3, cells/ml	76.3	68.5	0.45	< 0.01
MUN, mg/dl	10.3	10.5	0.44	< 0.01
Milk:DMI	1.79	1.79	0.96	< 0.01
Efficiency of N use	0.306	0.320	0.04	< 0.01

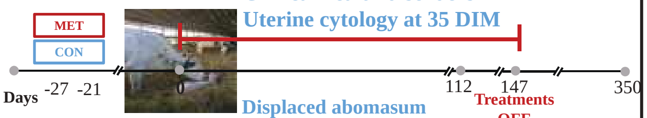
Time P : < 0.001; No interaction Trt x time and Trt x farm

42

Outline

Clinical health disorders

Uterine cytology at 35 DIM



Displaced abomasum

ketosis – urine sticks, BHB ≥ moderate

Retained placenta – Lack of expulsion in 24 h

Mastitis

Respiratory problems

Lameness

- Prevalence of health disorders?

43

Proportion of health disorders

	CON	RPM		P-value	
Number of health disorders	Proportion, % (n)		SEM	Trt	Farm
None	49.4 (117)	48.7 (114)	2.8	0.86	0.63
Single	28.3 (67)	30.4 (71)	3.0	0.61	0.69
Multiple	22.3 (53)	20.6 (48)	2.7	0.65	0.93
Type of health disorder					
Displaced abomasum	2.9 (8)	3.3 (8)	1.1	0.81	0.12
Ketosis	13.9 (33)	9.9 (23)	2.1	0.18	0.58
Mastitis	20.9 (49)	17.4 (41)	3.0	0.40	0.40
Retained placenta	7.8 (19)	9.7 (23)	2.0	0.48	0.11
Respiratory problems	11.3 (27)	11.5 (28)	2.3	0.95	0.16
Lameness	5.0 (15)	3.9 (12)	1.7	0.62	0.01

All Trt*Farm interaction $P > 0.10$, except lameness and cytological endometritis.
Multiple health disorders includes cytological endometritis.
Cytological endometritis: cows with ≥ 10 % in the uterine smear at 35 DIM. There was no trt effect (P = 0.94) on percentage of PMN.

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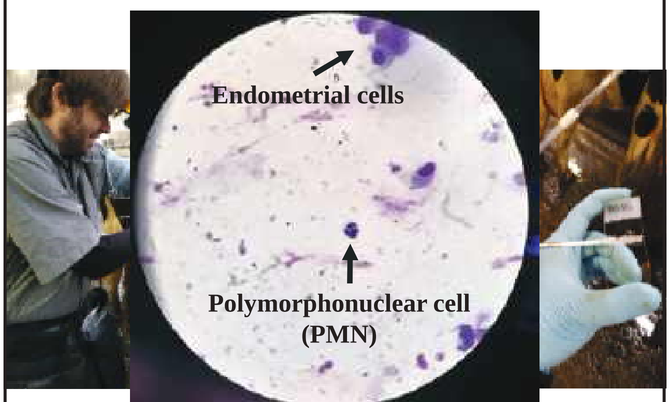
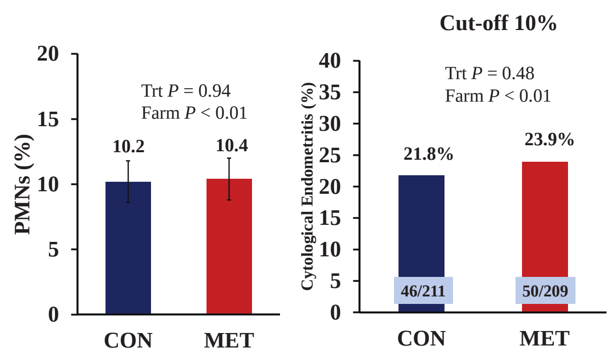
Uterine Health



45

Uterine Health on Day 35 after calving



46

The Effect of Feeding Met on Health

Author	Health
Griel et al.	not evaluated
Overton et al.	not evaluated
Xu et al.	Blood TG levels
Phillips et al.	Body protein mobilization
Piepenbrink et al.	NS
Socha et al.	NS
Johnson-VanWieringen et al.	not evaluated
Ordway et al.	not evaluated
Preynat et al.	NS
Preynat et al.	NS
Osorio et al. I, II	Ketosis, immune response, liver function, oxidative stress
Zhou et al. I, II	Ketosis, RP, liver function, immune response
Batistel et al. I, II	NEFA, liver function, immune response, oxidative stress

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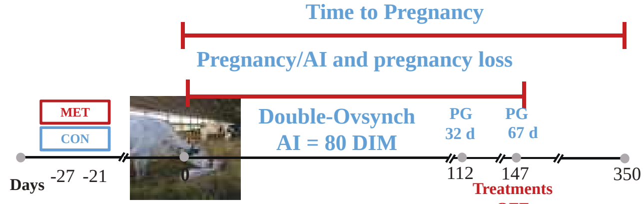
Outline

Culling

Time to Pregnancy

Pregnancy/AI and pregnancy loss



Embryo Development

- Reproductive performance and herd exit dynamics?

48

Pregnancies per AI and pregnancy loss
Synchronized cows (84%)

P/AI	CON	MET	*P*-value
Day 25 (based on PSPB)	**63.9%** (115/180)	**64.4%** (112/174)	0.45
Day 29 (based on PSPB)	**60.6%** (109/180)	**62.6%** (109/174)	0.34
Day 32 (based on TUS)	**53.9%** (97/180)	**55.2%** (96/174)	0.41
Day 67 (based on TUS)	**48.0%** (86/179)	**51.2%** (89/174)	0.29

49

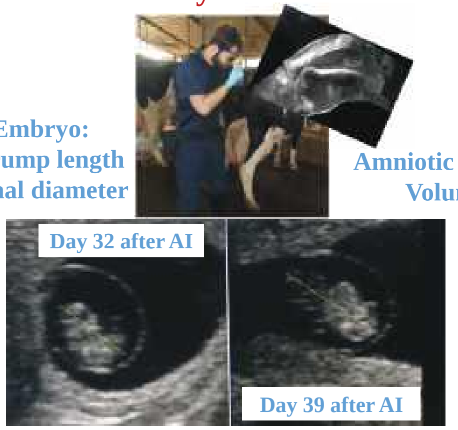
Pregnancies per AI and pregnancy loss

Pregnancy loss	CON	MET	*P*-value
Day 25 - 29	**5.2%** (6/115)	**2.7%** (3/112)	0.17
Day 29 - 32	**11.0%** (12/109)	**11.9%** (13/109)	0.43
Day 25 - 67	**24.6%** (28/114)	**20.5%** (23/112)	0.24
Day 32 - 67	**10.4%** (10/96)	**7.3%** (7/96)	0.23

50

Embryonic Size

Embryo:
Crown-rump length
Abdominal diameter



Amniotic vesicle:
Volume

51

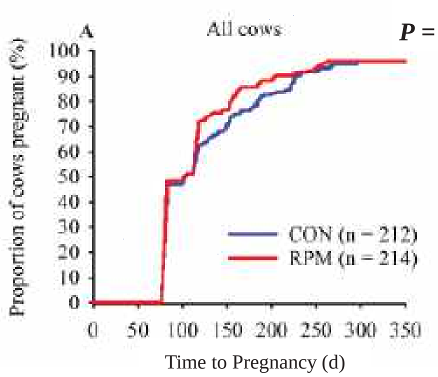
Embryonic Size

	Day 32		Day 39		
	CON	MET	CON	MET	*P* Trt
Amniotic vesicle volume (mm^3)	559.8	527.8	3,282.3	3,079.5	0.16
Crown-rump length (mm)	10.8	10.7	18.2	17.9	0.42
Abdominal diameter (mm)	5.7	5.6	9.5	9.4	0.23

*Interaction treatment by time P > 0.10

52

Time to pregnancy



Hazard Ratio: 1.14

***P* = 0.20**

CON (n = 212)

Median: 130 d

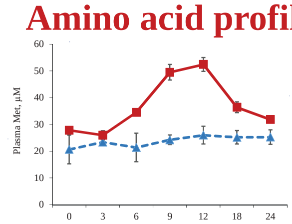
MET (n = 214)

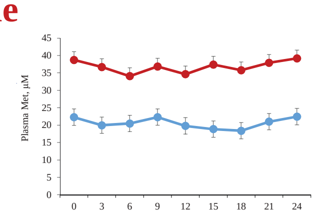
Median: 119 d

53

Differences between studies?

Amino acid profile

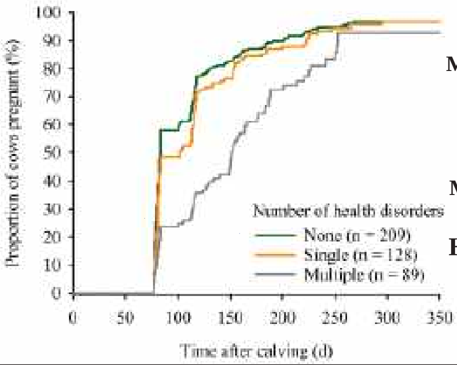




Environment (Stress, overcrowding)

54

Health disorders and time to pregnancy



None — Median: 83 d

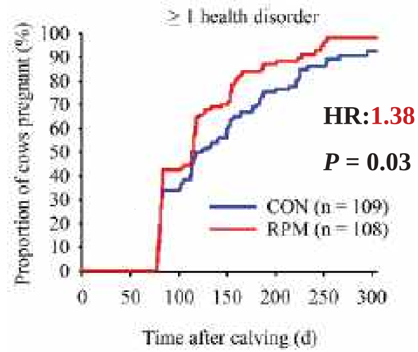
CON / MET — HR:1.05 *P* = 0.71

Multiple — Median: 151 d

HR:2.11 *P* < 0.01

55

Cows with at least one health disorders and time to pregnancy



HR:1.38

P = 0.03

CON — Median: 148 d

MET — Median: 125 d

56

Productive Performance by Health Status Category

Item	None CON	None RPM	Single CON	Single RPM	Multiple CON	Multiple RPM	Trt *P*-value None	Trt *P*-value Single	Trt *P*-value Multiple
n	103	106	62	66	47	42			
Milk yield, kg/d	50.3	49.4	50.1	49.7	48.6	48.9	0.20	0.62	0.73
ECM, kg/d	50.5	50.8	50.1	50.8	48.1	49.4	0.73	0.47	0.20
NE_L in milk, Mcal/d	35.9	36.1	35.5	36.0	33.9	35.0	0.73	0.46	0.17
Milk components yield, kg/d									
Fat	1.86	1.88	1.85	1.88	1.76	1.82	0.53	0.44	0.28
Protein	**1.46**	**1.49**	**1.43**	**1.48**	**1.36**	**1.44**	**0.12**	**0.07**	**0.01**
Lactose	2.48	2.41	2.45	2.41	2.36	2.38	0.12	0.50	0.69
Milk composition									
Fat, %	3.74	3.86	3.72	3.82	3.68	3.75	0.10	0.21	0.51
Protein, %	**2.93**	**3.06**	**2.89**	**3.01**	**2.84**	**2.96**	**< 0.01**	**< 0.01**	**< 0.01**
Lactose, %	4.92	4.89	4.87	4.86	4.84	4.85	0.13	0.45	0.87
MUN, mg/dl	10.4	10.8	10.2	10.4	10.1	10.1	0.18	0.67	0.99
SCC x 10^3, cells/ml	77.5	65.8	96.5	105.6	182.6	132.4	0.34	0.64	0.18

↑ 80 g of milk protein

Feeding RPM seems to improve functional properties of cows that suffer diseases (production, reproduction, herd exit).

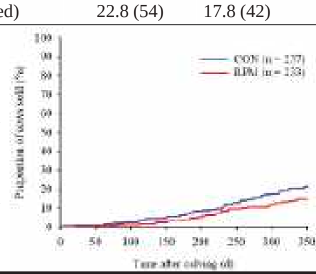
57

Herd Exit Dynamics
Cows that were sold during lactation (350 DIM)

Item	CON Proportion, % (n)	RPM Proportion, % (n)	SEM	*P*-value Trt	*P*-value Farm
Sold	**20.6 (49)**	**13.4 (32)**	**2.6**	**0.06**	**0.14**
Died	6.6 (5)	7.1 (10)	1.5	0.85	< 0.01
Left (Sold + Died)	22.8 (54)	17.8 (42)	2.3	0.13	0.91

CON — Mean: 310 d

MET — Mean: 315 d



67% (54/81)

Had one or more health disorders

HR:1.53 *P* = 0.06

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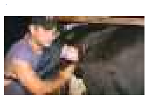
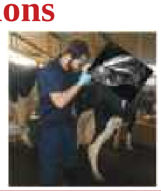
Summary & Conclusions

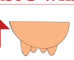
Pre- and postpartum RPM

MET CON





Dry Period (last 3 wks) | Early Post-partum (3 wks) | Pre-AI (1 wk) | First two months of Pregnancy



Improved lactation performance:
Milk protein % and yield, and milk fat %

No effects on health disorders, embryo development and 1st service P/AI and pregnancy loss

May reduce time to pregnancy, particularly in cows with at least one health disorder, and appears to decrease likelihood of cows being sold.

59

Functional amino acids: The concept, present reality, and future prospects using reproduction as an example: Methionine

Concept: Increased Met is needed for optimal milk production but feeding higher amounts of Met may improve reproduction and health traits.

Present Reality: There are physiologic effects of Met: Change in gene expression in embryo when dam is fed Met. Reduced pregnancy loss in multiparous with Met feeding. Improved reproductive efficiency with Met for unhealthy cows.

Large, randomized, controlled studies are needed to determine effects of functional amino acids on economically important traits of dairy cattle.

60

Future Prospects: **Amounts and timing of RPM feeding still needs to be optimized.**

Rumen-protected methionine – Need more data on reproductive efficiency and health effects under field conditions (stress, overcrowding, diseases).

Changing amino acids in uterine histotroph and during pregnancy may improve reproduction.

Effect of decreased or maintained amino acid concentrations during the transition period on health and reproduction.

61

Association of Amino acids profile during pre- and postpartum with health disorders, productive and reproductive performance

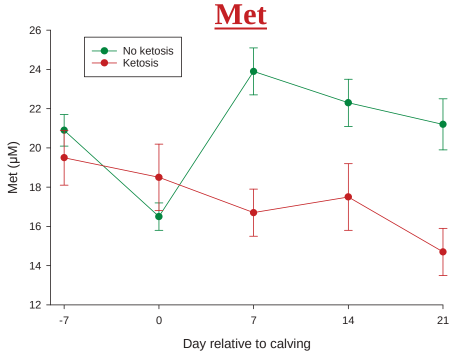
Mateus Z. Toledo, Pedro Monteiro Jr., Rodrigo Gennari, João Dorea, Daniel Luchini, Randy Shaver and Milo Wiltbank

Preliminary data
44 cows (20 %)

Loading…

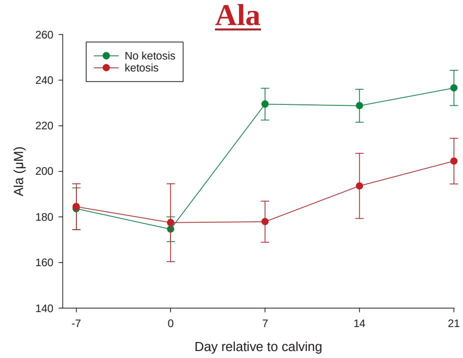
62

Met



63

Ala



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Four State Pre-Conference

Thank you for your attention!
Questions?

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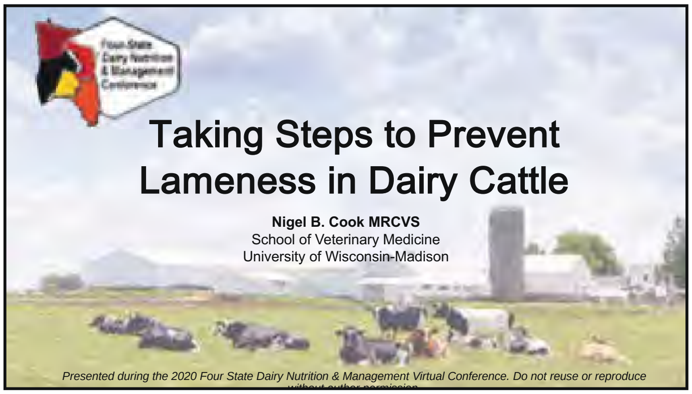
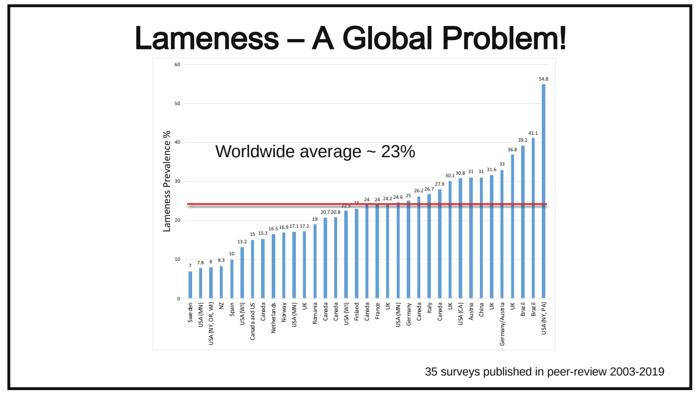
Four-State Dairy Nutrition & Management Conference

Taking Steps to Prevent Lameness in Dairy Cattle

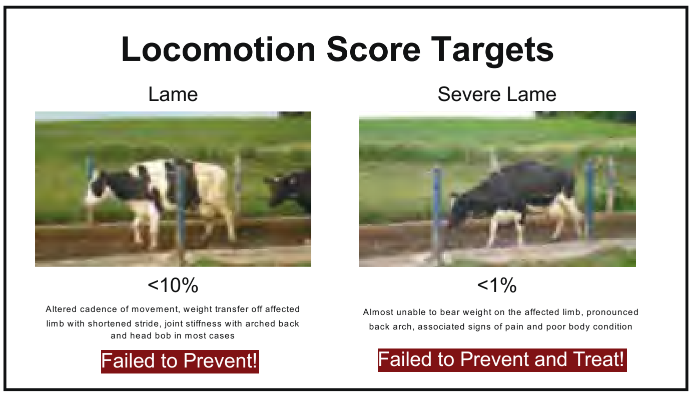
Nigel B. Cook MRCVS
School of Veterinary Medicine
University of Wisconsin-Madison


Four-State Dairy Nutrition & Management Conference
Taking Steps to Prevent Lameness in Dairy Cattle
Nigel B. Cook MRCVS
School of Veterinary Medicine
University of Wisconsin-Madison
Presented during the 2020 Four State Dairy Nutrition & Management Virtual Conference. Do not reuse or reproduce

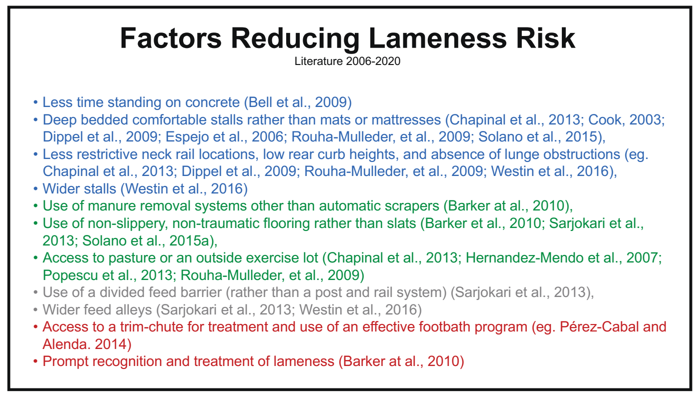
1


Lameness – A Global Problem!
Lameness Prevalence %
Worldwide average ~ 23%
35 surveys published in peer-review 2003-2019

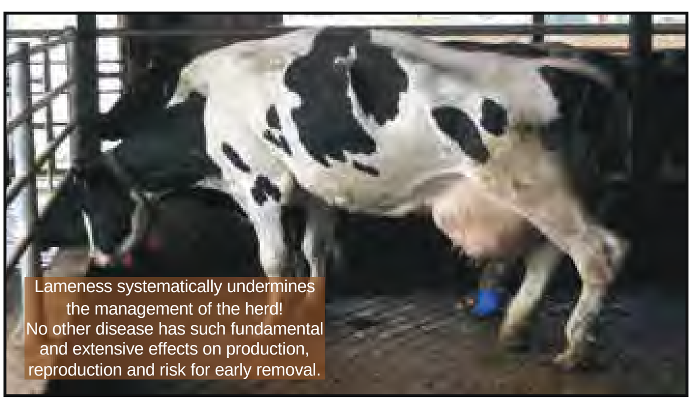
2


Locomotion Score Targets
Lame
Severe Lame
<10%
Altered cadence of movement, weight transfer off affected limb with shortened stride, joint stiffness with arched back and head bob in most cases
Failed to Prevent!
<1%
Almost unable to bear weight on the affected limb, pronounced back arch, associated signs of pain and poor body condition
Failed to Prevent and Treat!

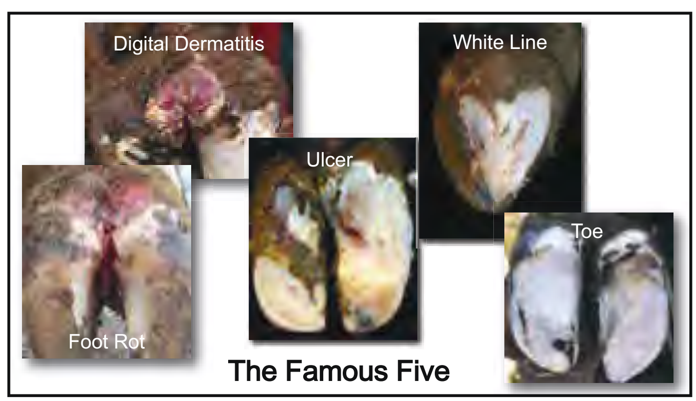
3


Factors Reducing Lameness Risk
Literature 2006-2020
• Less time standing on concrete (Bell et al., 2009)
• Deep bedded comfortable stalls rather than mats or mattresses (Chapinal et al., 2013; Cook, 2003; Dippel et al., 2009; Espejo et al., 2006; Rouha-Mulleder, et al., 2009; Solano et al., 2015),
• Less restrictive neck rail locations, low rear curb heights, and absence of lunge obstructions (eg. Chapinal et al., 2013; Dippel et al., 2009; Rouha-Mulleder, et al., 2009; Westin et al., 2016),
• Wider stalls (Westin et al., 2016)
• Use of manure removal systems other than automatic scrapers (Barker at al., 2010),
• Use of non-slippery, non-traumatic flooring rather than slats (Barker et al., 2010; Sarjokari et al., 2013; Solano et al., 2015a),
• Access to pasture or an outside exercise lot (Chapinal et al., 2013; Hernandez-Mendo et al., 2007; Popescu et al., 2013; Rouha-Mulleder, et al., 2009)
• Use of a divided feed barrier (rather than a post and rail system) (Sarjokari et al., 2013),
• Wider feed alleys (Sarjokari et al., 2013; Westin et al., 2016)
• Access to a trim-chute for treatment and use of an effective footbath program (eg. Pérez-Cabal and Alenda. 2014)
• Prompt recognition and treatment of lameness (Barker at al., 2010)

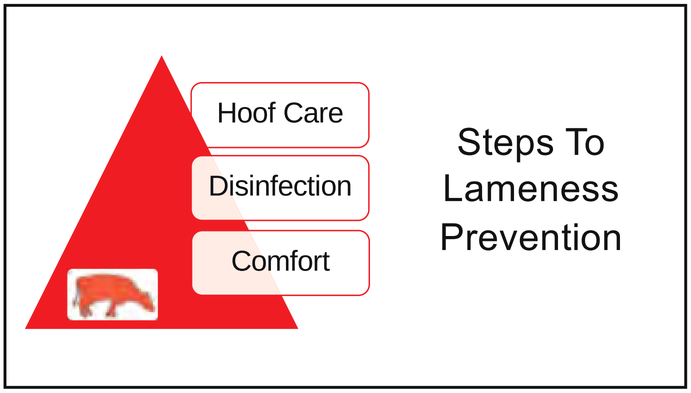
4


Lameness systematically undermines the management of the herd!
No other disease has such fundamental and extensive effects on production, reproduction and risk for early removal.

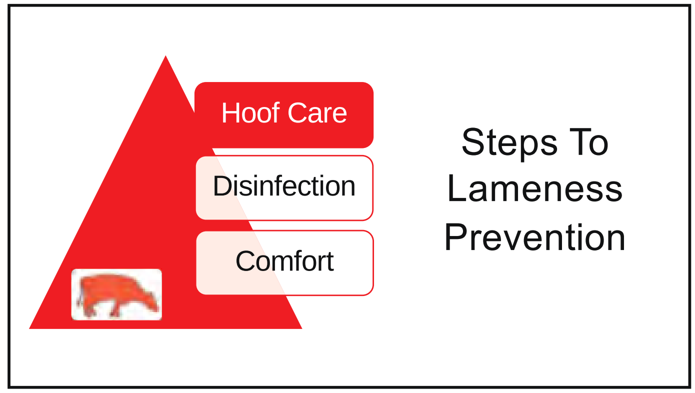
5


Digital Dermatitis
White Line
Ulcer
Toe
Foot Rot
The Famous Five

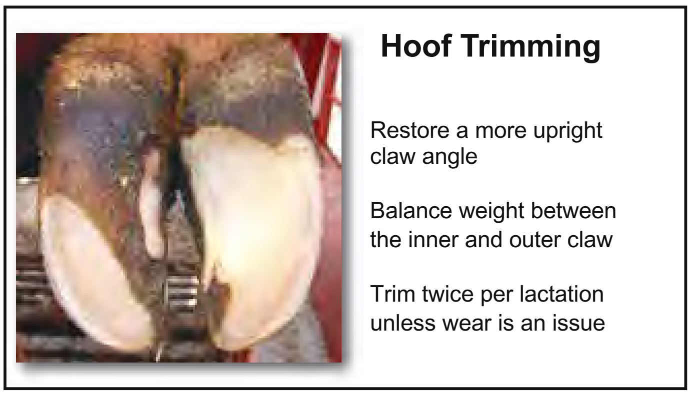
6


Hoof Care
Disinfection
Comfort
Steps To Lameness Prevention

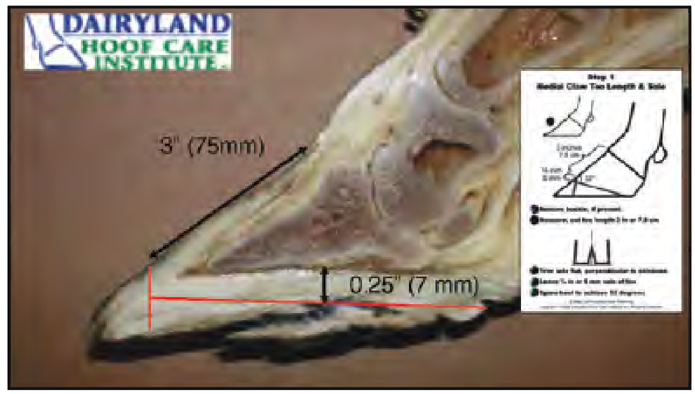
7


Hoof Care
Disinfection
Comfort
Steps To Lameness Prevention

8


Hoof Trimming
Restore a more upright claw angle
Balance weight between the inner and outer claw
Trim twice per lactation unless wear is an issue

9


DAIRYLAND HOOF CARE INSTITUTE
3" (75mm)
0.25" (7 mm)

10


Avoid Doing Harm!

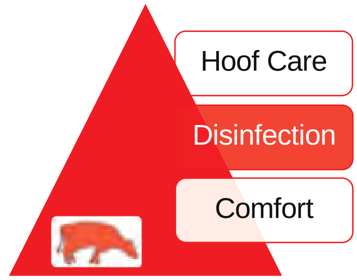
11


Provide Facilities and Equipment

12

Easy access to a chute for individual cow attention is essential in an AMS unit

13



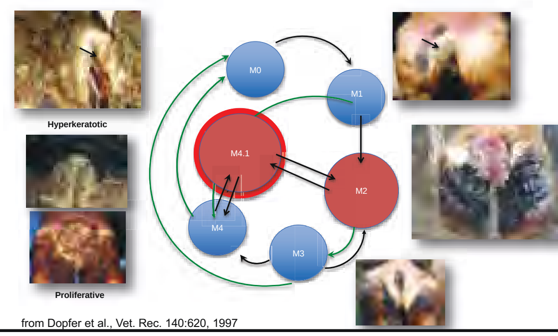
Steps To Lameness Prevention

14

Foot Rot (Phlegmon)

15

Digital Dermatitis Dynamics



from Dopfer et al., Vet. Rec. 140:620, 1997

16

- Hygiene (Rodriguez-Lainz et al. PVM 28:117, 1996)
- Genetics (Schopke et al., JDS 98:1-11, 2015)
- Nutrition (Gomez et al. JDS 97:6211, 2014)
- Infectious agents – *Treponeme spp* (Gomez et al. JDS 95:1821, 2012)

17

DD occurrence during the first lactation by DD experience during the rearing period

	DD during the rearing period		
	No DD (Type I)	1 DD case (Type II)	>1 DD case (Type III)
% First Lactation Heifers Suffering a DD event	13.7	45.6*	67.6*

18

Treatment vs Disinfection

ACUTE ACTIVE M2

Treat these topically

CHRONIC INACTIVE M4

Footbath these

19

The Ideal Footbath – 2-3 immersions per foot

Cook et al., Vet J. 193, 669-673, 2012

20

Do Longer footbaths improve efficacy?

(Logue et al., Vet. J. 193:664, 2012)

- 3 herds with 7' (2.2m) long baths and 3 herds with 14' (4.4m) long baths
- Tested 5% CuSO4 and a test product in split bath design BID for 3d per week, for 15 wks

Reduction in DD lesion Score Effect	OR (95% CI)	P-Value
5% copper sulfate v test product	1.6 (1.14-2.32)	<0.01
Longer footbath v shorter footbath	3.38 (2.07-5.18)	<0.001
Parity	1.13 (1.02-1.25)	<0.05

21

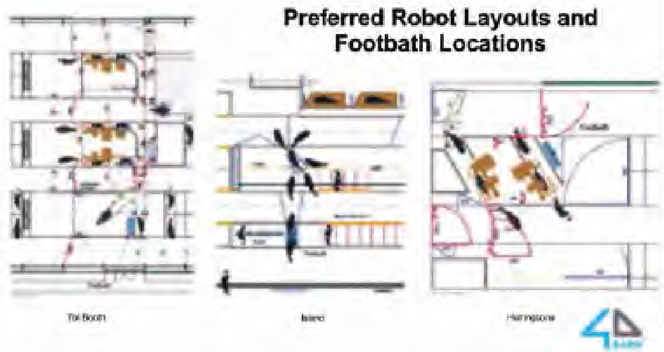
Footbath Best Management Practice

- Use a well-designed footbath with adjacent mixing facility
- Footbath 4 milkings per week and adapt based on outcome to achieve a minimum frequency to maintain control
- Use an antibacterial with evidence of efficacy against DD and footrot
    - No higher than 5% CuSO4 and monitor soil copper levels
    - No higher than 4% formalin and avoid in cold weather
    - Use of acidifier to pH no lower than 3.0
- Use the bath as long as it is effective ~ 150-300+ cow passes
- Don't forget to include all life stages of the cow!

22

23

Preferred Robot Layouts and Footbath Locations



24

Steps To Lameness Prevention

25

Sole Hemorrhage and Ulcer

26

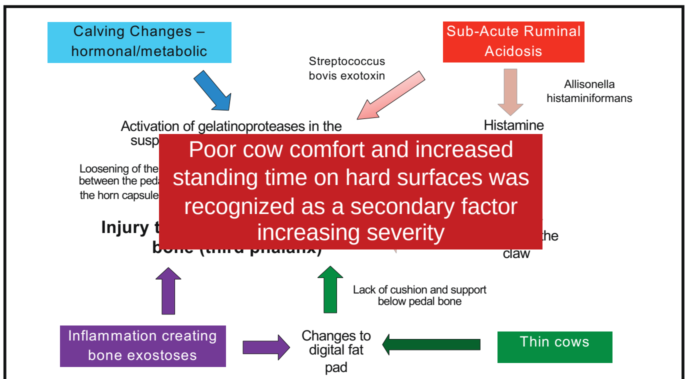
The primary lesion is an injury to the corium of the sole beneath the pedal bone (third phalanx)

The big question is why?

27

Sole hemorrhage and ulcer formation

28



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It is now becoming increasingly probable that standing up alone could be the primary cause of claw horn disruption pathogenesis … not just a secondary factor

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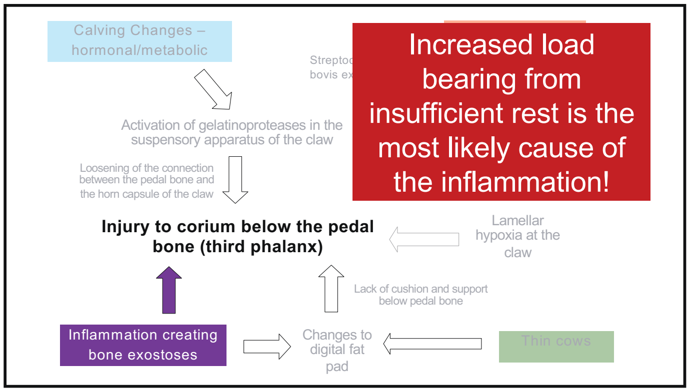

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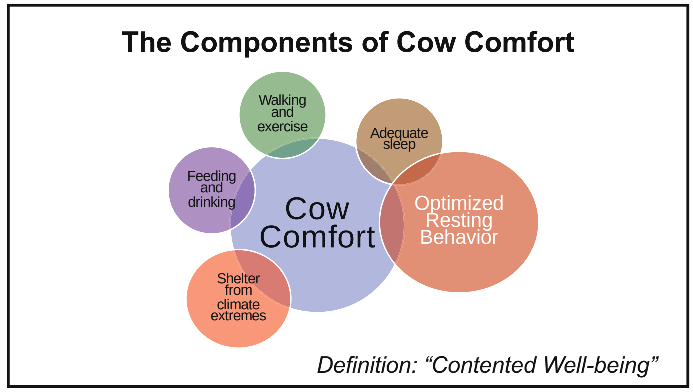

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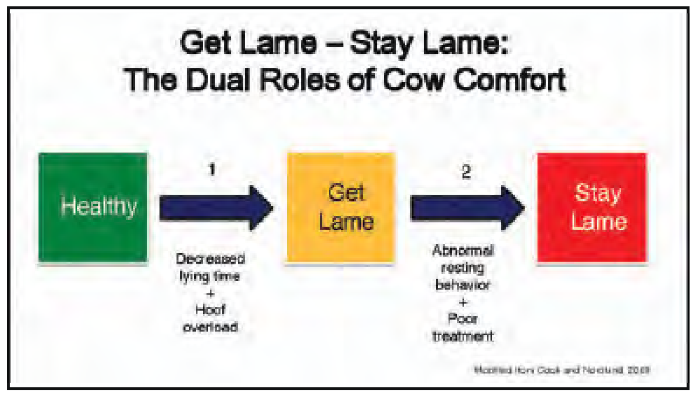

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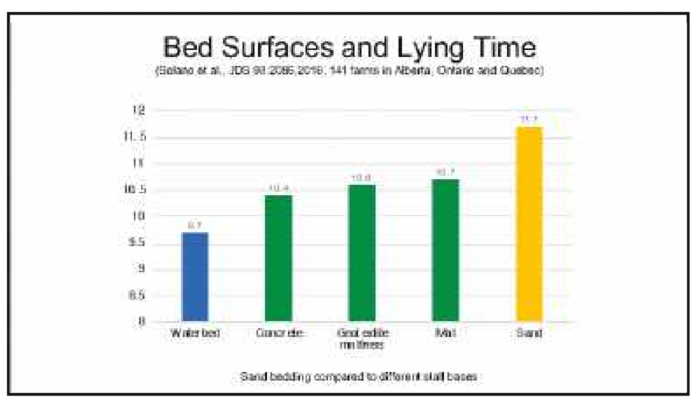

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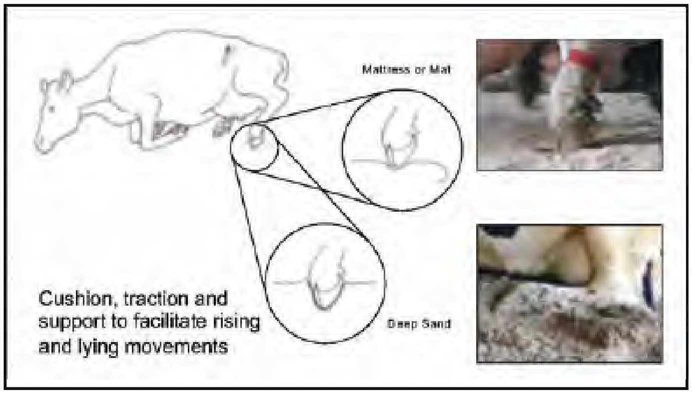

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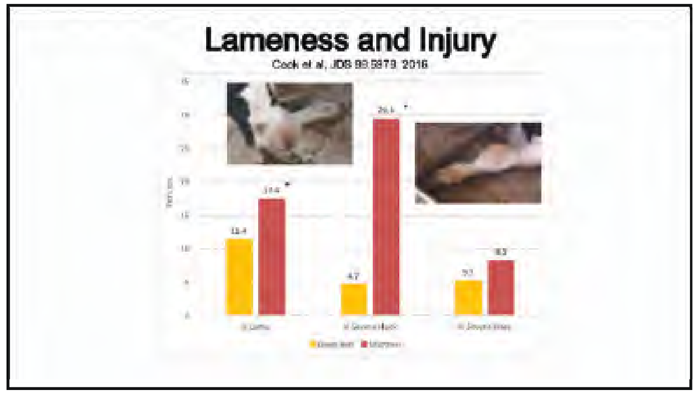

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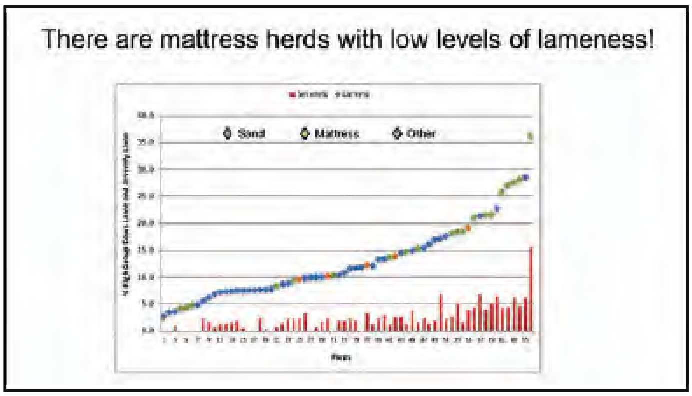

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Mattress Herds and Lameness

- Equal pressure for new cases of lameness between mattress and sand herds
- Impact of sand is on reducing the chronicity of lameness!
- Mattress herd owners must:
  - Have excellent stall design
  - Identify new cases of lameness and treat effectively
  - Allow lame cows to recover on a bedded pack
  - Control infectious causes of lameness through effective footbathing
  - Use sufficient bedding to reduce hock injury .....

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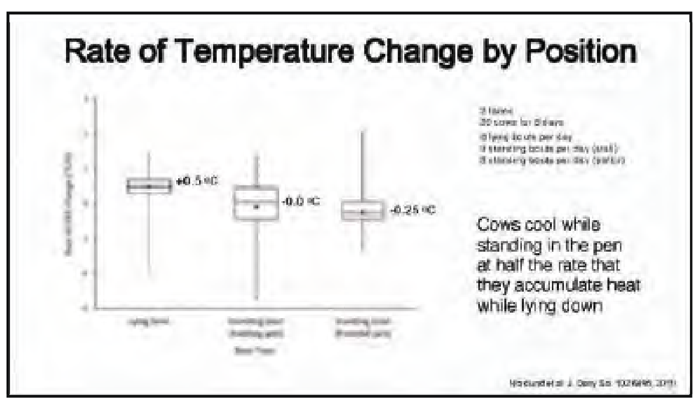

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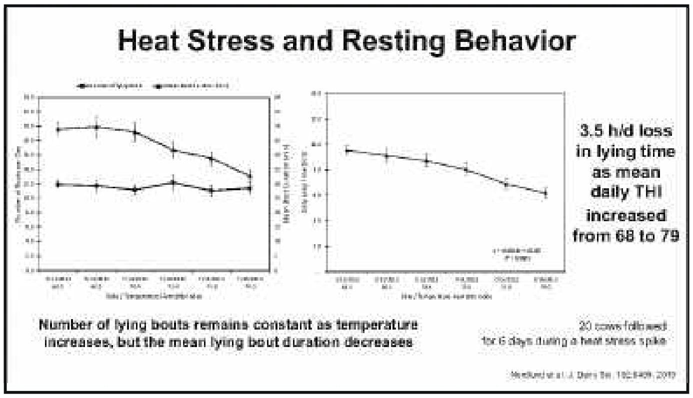

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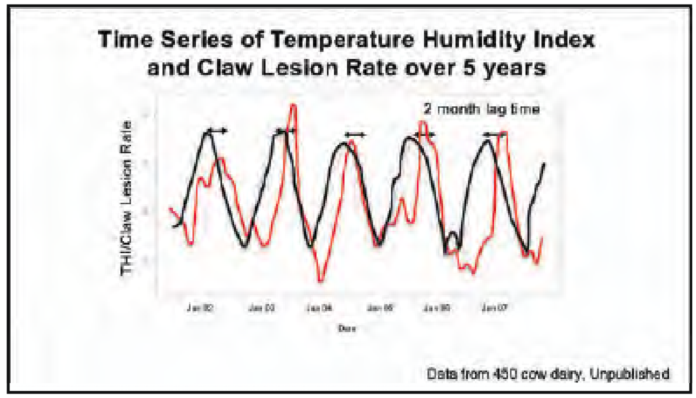

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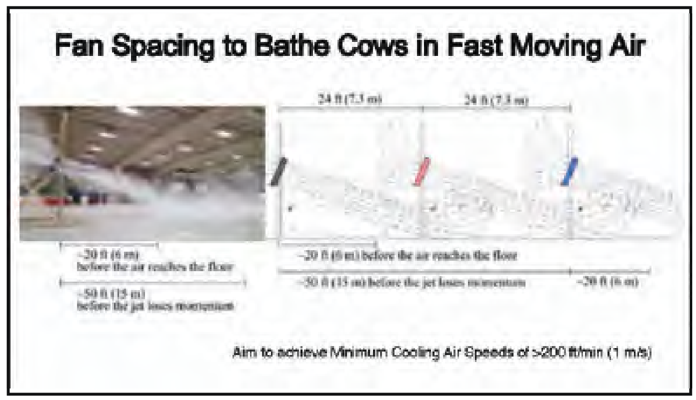

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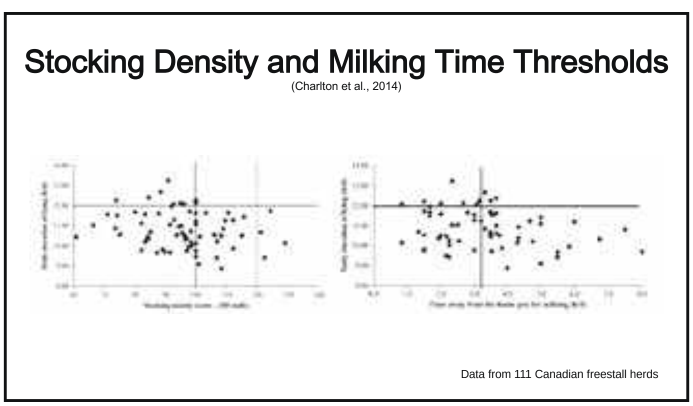

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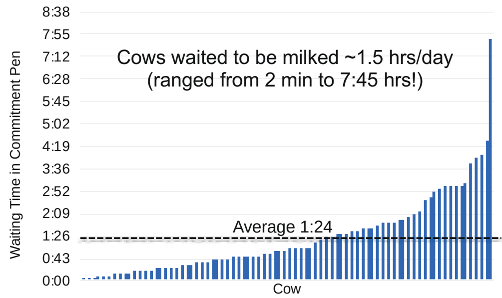
48

Daily waiting time to be milked in a guided-flow AMS



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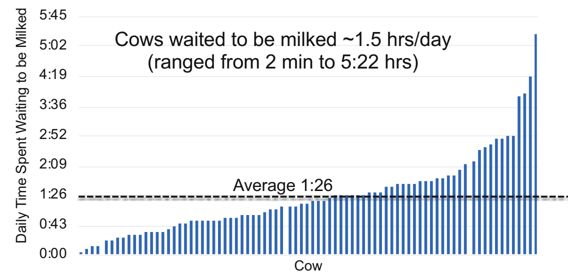
Daily waiting time to be milked in a free-flow AMS



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Surveys of Resting Behavior (453 Farms)

Study	Number of Cows	Number of herds	Mean herd lying time (h/d)	Mean number of lying bouts per d	Mean daily lying bout duration (h/bout)	Days recorded	Recording type
Ito et al., 2009	2,033	43	11.0	9.0	1.5	5	HOBO
Gomez and Cook, 2010	205	16	11.9	12.9	1.2	1-2	VIDEO
Thomsen et al., 2012	1,340	42	10.5	NR	1.2	2	ICETAG
Yunta et al., 2012	NR	10	12.0	9.8	1.4	10	HOBO
Deming et al., 2013	NR	13	10.8	9.3	1.3	4	HOBO
Charlton et al., 2014	NR	111	10.6	10.5	1.2	4	HOBO
Solano et al., 2016[2]	5,135	81	10.3	10.5	1.0	4	HOBO
		40	11.0	10.0	1.1	4	HOBO
		20	11.2	9.2	1.2	4	HOBO
King et al., 2016	1,230	41	11.5	9.3	1.3	6	HOBO
Westin et al., 2016	1,418	36	11.4	9.5	1.2	4	HOBO/ICETAG
Mean			11.1	10.0	1.2		

52

An Achievable Target for Rest

- Based upon:
  - Healthy, non-lame cows
  - Deep bedded comfortable freestalls
  - TMR fed
  - >21 h/d in the pen
  - 1 cow per stall
  - Favorable resting area microenvironment
- Aim for mean lying times of 11.5 to 12.5 h/d, with mean lying bout durations of 1.2 h

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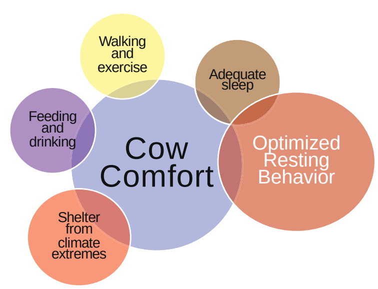
The Components of Cow Comfort



Definition: "Contented Well-being"

54

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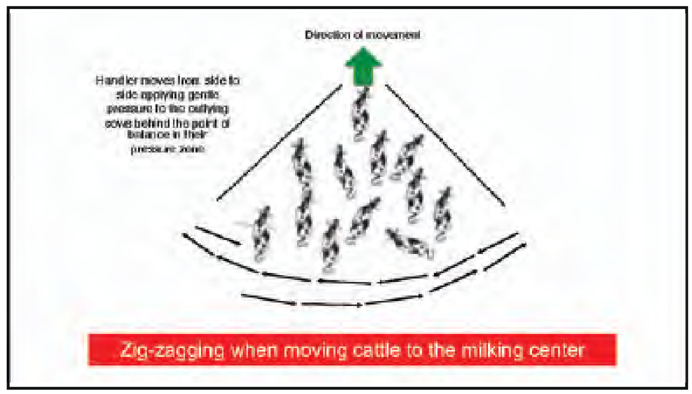

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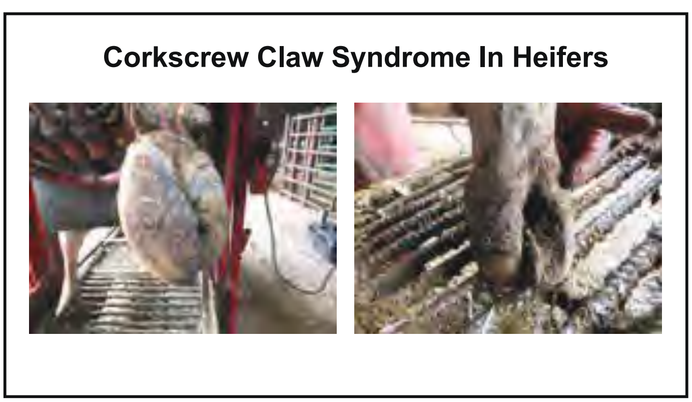

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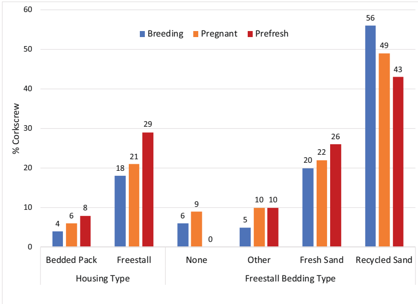
Type of Heifer Housing and Bedding



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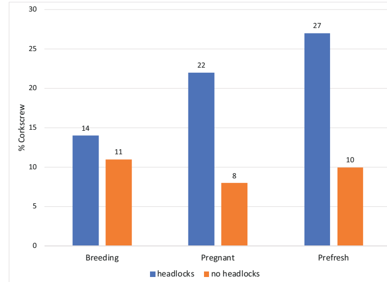
Use of Feed Bunk Headlocks



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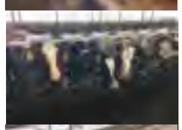
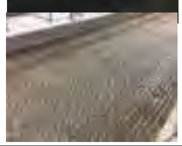
Pressure at the bunk





Creates hoof growth/wear issues during heifer development

69

Heifer Housing Recommendations (Different from Cows!)

1. Bedded pack housing preferred where possible up to at least breeding age
2. Deep bed freestalls with organic bedding vs sand (avoid recycled sand!)
3. Mix slant bar and headlock feed bunks – reduce headlock exposure
4. Improve the design of flooring finishes to suit heifers – mini-grooves?
5. Provide outdoor access – feeding/pasture

70

Can we have high milk production and low levels of lameness?

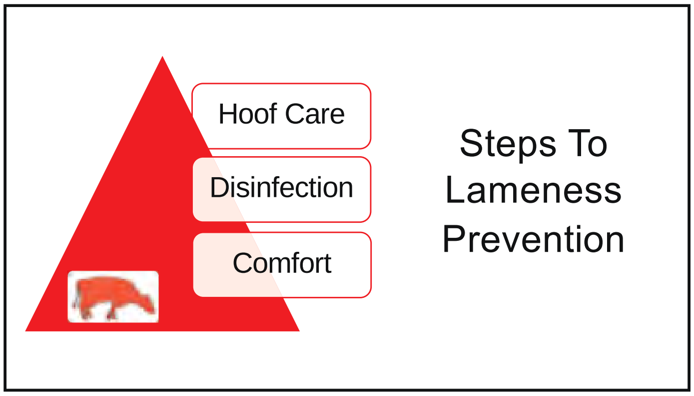
71

Select Housing and Management Characteristics of High Milk Production (90lb 41 kg) Herd Groups (n=44) with Lameness Prevalence of 13%

Management Characteristic	% Herds or Mean
Deep loose bedded stalls (sand)	70
Headlocks at the feedbunk	70
Solid floor (vs slats)	97
Manual manure removal from alleys (vs scraper)	69
Rubber freestall alley flooring	3
Fans over resting area	96
Feedline soakers in the pen	79
Trim cows feet at least once per lactation	83
Footbath frequency (mean times per week)	4.5

From Brotzman et al., 2015, Cook et al, JDS 99:5879, 2016

72


Hoof Care
Disinfection
Comfort
Steps To Lameness Prevention

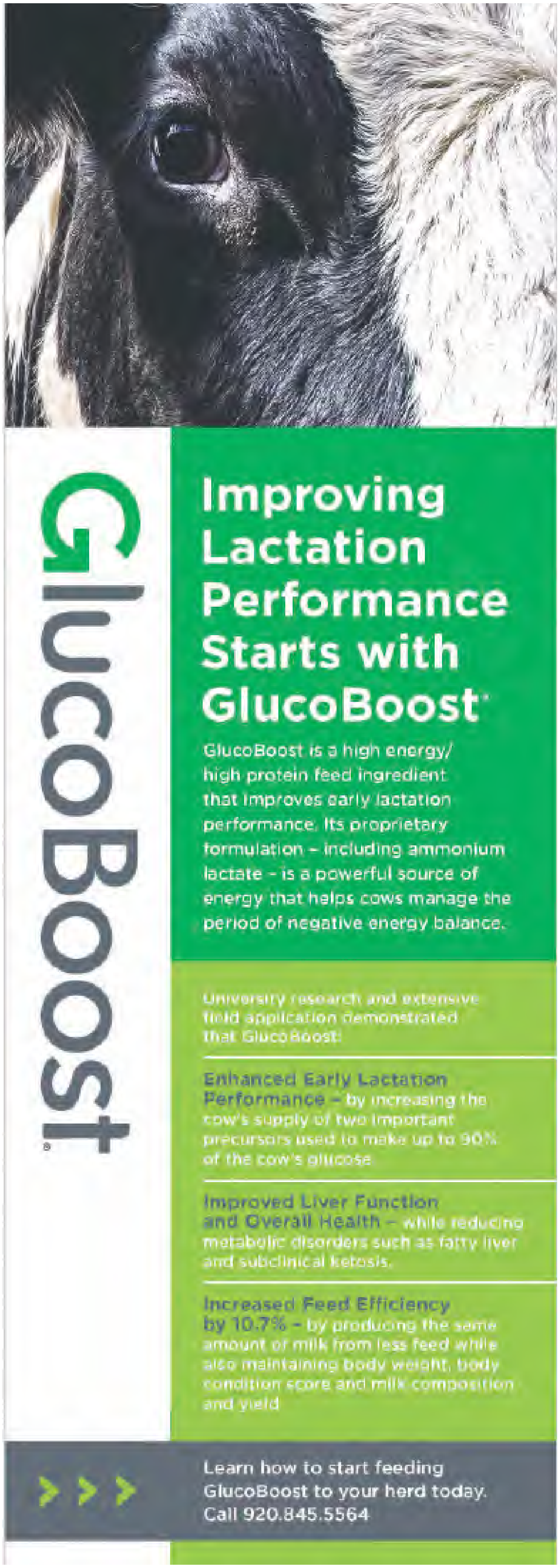
73


Dairyland Initiative
Sponsors
Mission
Saputo
Program
ZINPRO
DAIRYLAND HOOF CARE INSTITUTE
Workshop
Artex
McLanahan
Kestrel

74


DairylandInitiative
Dairyland Initiative
www.thedairylandinitiative.vetmed.wisc.edu
Thank you!

75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Improving Lactation Performance Starts with GlucoBoost®
GlucoBoost is a high energy/ high protein feed ingredient that improves early lactation performance. Its proprietary formulation – including ammonium lactate – is a powerful source of energy that helps cows manage the period of negative energy balance.
University research and extensive field application demonstrated that GlucoBoost:
Enhanced Early Lactation Performance – by increasing the cow's supply of two important precursors used to make up to 90% of the cow's glucose.
Improved Liver Function and Overall Health – while reducing metabolic disorders such as fatty liver and subclinical ketosis.
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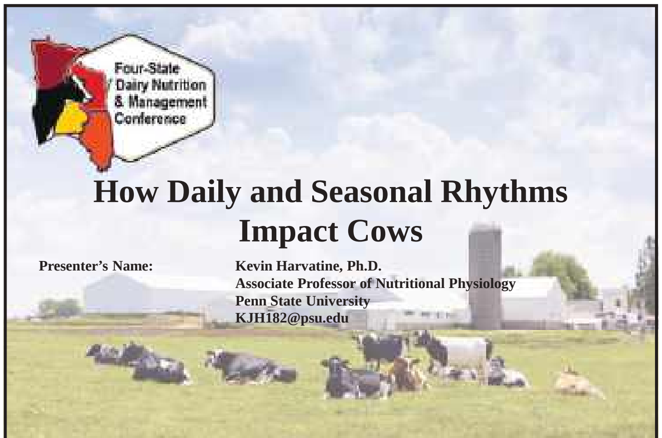
How Daily and Seasonal Rhythms Impact Cows

Kevin Harvatine, Ph.D.
Associate Professor of Nutritional Physiology
Penn State University
KJH182@psu.edu



How Daily and Seasonal Rhythms Impact Cows

Presenter's Name: Kevin Harvatine, Ph.D.
Associate Professor of Nutritional Physiology
Penn State University
KJH182@psu.edu

1

Milk fat and protein are affected by many factors

Nutritional Factors

Decreased by milk fat depression
- Unsaturated fat
- Fermentability
- Acidosis
- Feeding strategies
- Ionophores

Increase by additional substrate
- Acetate from forages
- Fat supplement
    - Palmitic acid

Milk fat

Non-nutritional Factors

Genetics

Season

Time of day

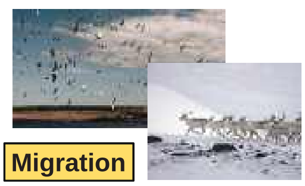
Stage of lactation

Parity

Milk protein also impacted by diet and other similar non-nutritional factors

2

Seasonal rhythms coordinate physiology (metabolism) with the environment: Amazing examples in nature!



Migration

Hibernation

Seasonal Breeding in Sheep

3

Daily rhythms coordinate metabolism with changes across the day

Most processes in the body follow a 24 h cycle
- Activity and Alertness
- Nutrient Metabolism
- **Milk Synthesis**
- **Intake**

Why??
Allows the animal to anticipate changes and adapt before they occur

4

Key Principles

- **There is a seasonal pattern of milk composition and yield driven by day length and change in day length**
- **There is a daily (circadian) pattern of intake that has a major impact on the rumen and there is a daily pattern of milk synthesis**
- **Considering seasonal and daily patterns provide additional avenues to optimize milk production and profitability**

5

How does the cow know what time of year and day it is?

Environmental Cues
Light/Dark

Master Clock (SCN- Brain)

Other Environmental Cues e.g. Feeding Times

Peripheral Clocks

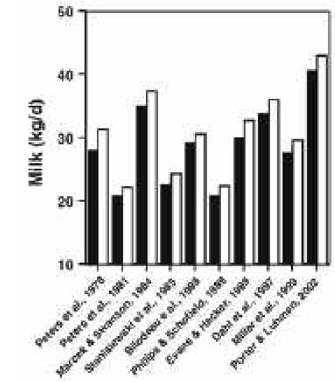
- **Main environmental cues:**
  - Light/Dark
  - Feeding Times
  - Milking Time?
- **A breakdown in the system creates jetlag!**
- **A disconnection between lighting and timing can cause metabolic issues in humans and rodents**

- Example is night shift work in humans

Asher, Schibler 2011

6

We know “Photoperiod” has a large impact on milk yield



Dahl and Petitclerc., 2003

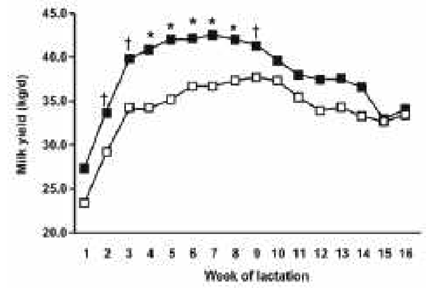
Constant 16 to 18 h vs. 8 to 10 h light

- ~5 to 10% increase in milk yield and no change in milk composition
- Additional effect of short days in dry period
- Eliminated by constant light

-Basic mechanism of photoperiod is through same signaling as circadian rhythms

7

Short photoperiod during dry period increases milk yield in the next lactation!



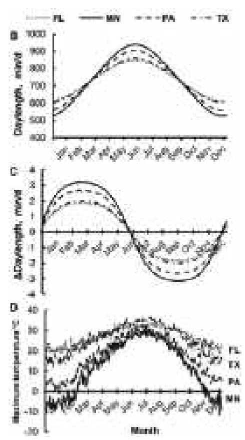
Auchtung et al., 2005

- **Spring calving cows would normally be dry during short days**
- **Likely driven by increased mammary development so more milk secreting cells**

8

Seasonal rhythms are common in many animals

- **Patterns that repeat every year**
- **Mostly driven by**
  - **- day length**
  - **- lengthening/shortening days**
  - **- change in day length**
- **Regulated through the same molecular system as circadian rhythms**

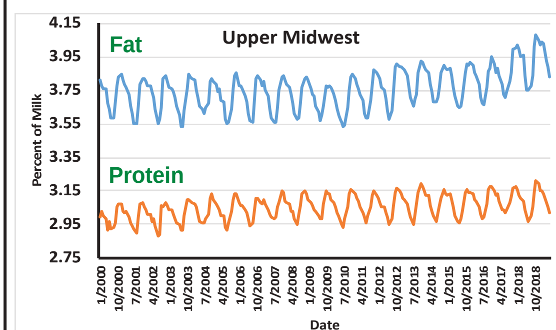


Some Amazing Examples in Biology

9

Seasonal Pattern of Milk Fat & Protein:

Upper Midwest US Milk Market



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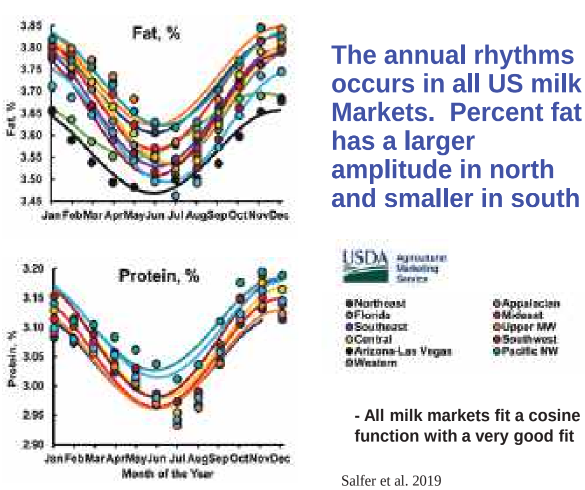


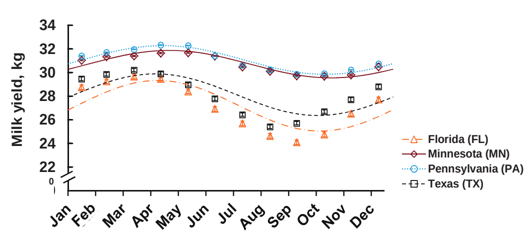
The annual rhythms occurs in all US milk Markets. Percent fat has a larger amplitude in north and smaller in south

- **All milk markets fit a cosine function with a very good fit**

Salfer et al. 2019

11

There is also an annual rhythm to milk yield: Data from PA, MN, FL, and TX

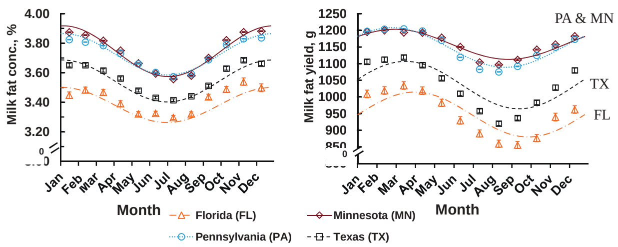


State	Range, lb	Acrophase
MN	5.3^a	Apr 22
PA	5.3^b	Apr 15
TX	7.9^c	April 7
FL	9.2^d	April 9

Salfer et al. 2020

12

Milk fat percent peaks at end of year, but milk fat yield peaks in March and differ by region



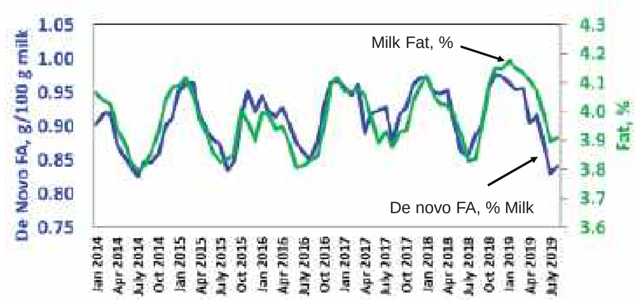
State	Range, %	Peak
PA	0.28	Jan 4
MN	0.34	Jan 5
TX	0.28	Jan 3
FL	0.24	Jan 2

State	Range, lb	Peak
PA	0.26	Feb 23
MN	0.20	Feb 27
TX	0.31	March 13
FL	0.29	March 31

Salfer et al. 2020

13

Most of the seasonal variation in milk fat is due to de novo synthesis <16 C FA (40 herds)



40 St. Albans Coop herds

Dann 2019 PSU Dairy Nutr. Workshop

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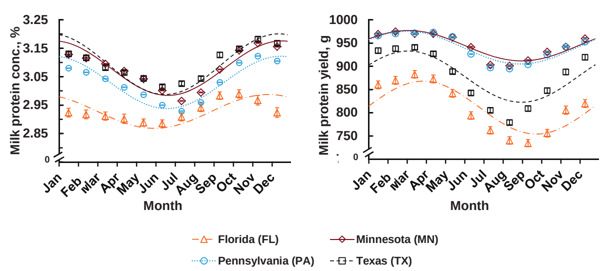
There is an annual pattern to milk protein!

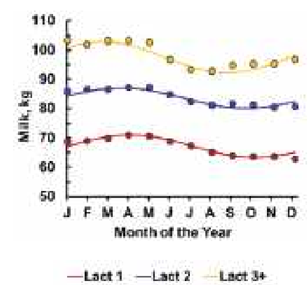


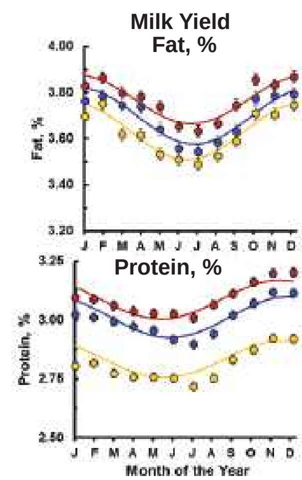
State	Range, %	Peak
PA	0.18	Dec. 21
MN	0.20	Dec. 22
TX	0.22	Dec. 17
FL	0.12	Dec. 1

State	Peak
MN	Feb 24[a]
PA	Mar 2[b]
TX	Mar 6[c]
FL	Mar 19[d]

15

The seasonal pattern is consistent by parity





16

What does heat stress do to milk yield and composition?

Reference	MY, kg	Fat, %	Prot, %
Rungruang et al. 2014	-3.4	0.20	-0.10
Baumgard et al. 2011	-6.2	0.28	-0.12
Zimbelman et al. 2010	-0.1	-0.17	0.13
Wheelock et al. 2010	-9.6	0.60	-0.27
Rhoads et al. 2009	-10.6	0.34	-0.13
Schwartz et al. 2009	-10.1	0.06	-0.22

- Generally a decrease in milk yield and milk protein percent and an increase in fat percent

17

What do I think is going on?

Two seasonal time-keepers:

- **Milk composition is driven by lengthening and shortening days and aligns with the solstice**
- **Milk yield is driven by rate of change in day length and aligns with the equinox**

Constant long days appears to be setting physiology of the spring equinox (increased milk yield and no change in composition)

- No data on how to manage out of this. Managing photoperiod probably best chance

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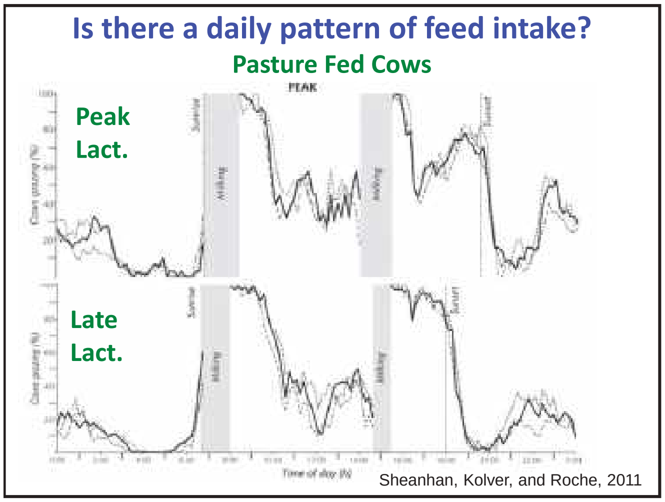

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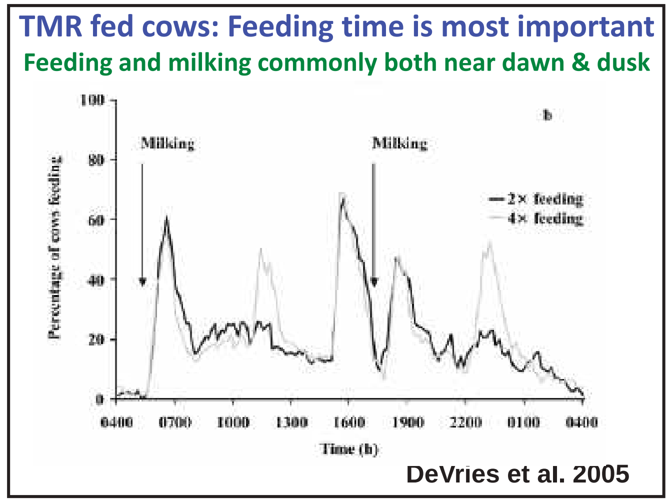

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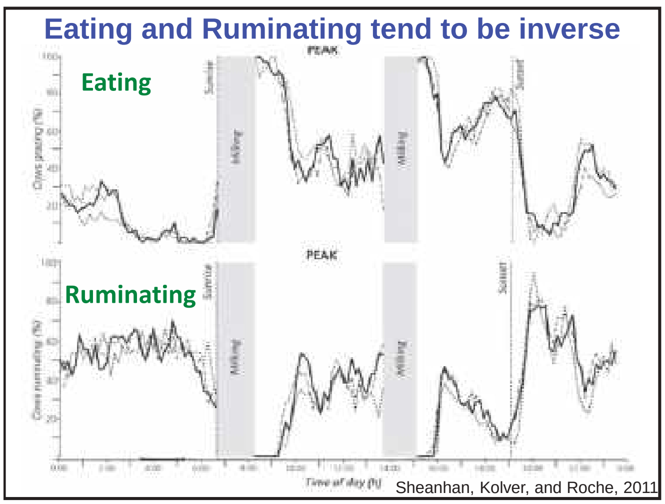

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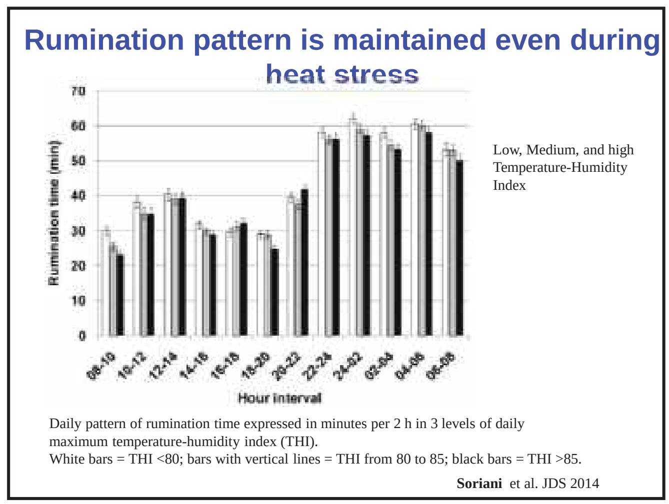

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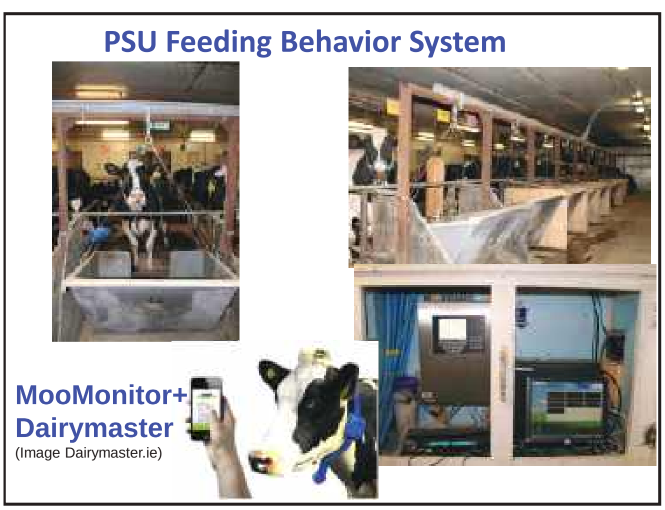

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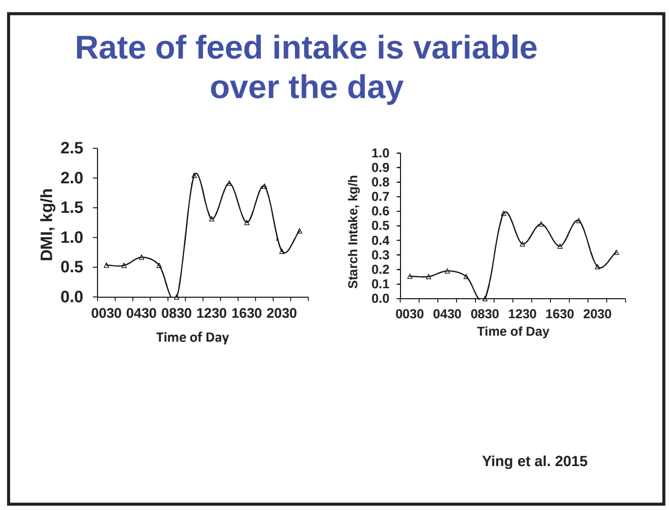


24

What is the impact of the daily pattern of intake?

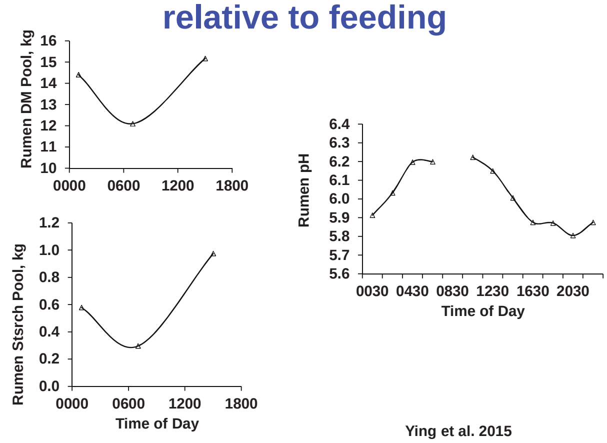
Intake =
Entrance of fermentable feed into the rumen for microbes to digest

Fermentable feed =
Synthesis of VFA's (acids) & microbial protein

VFA's =
Acid load for rumen
Nutrient supply for cow

25

What is in the rumen changes relative to feeding



Ying et al. 2015

26

How flexible is the daily pattern of feed intake?

- **Feeding stimulates intake, but what is the impact of feeding time**
- **Fed TMR:**
  - **1x/d at 0830 h (AM)**
  - **1x/d at 2030h (PM)**
  - **2x/d at 0830 and 2030 h (AMPM)**

27

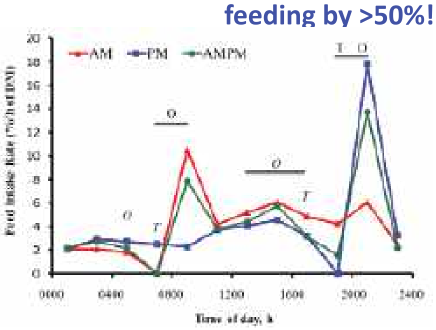
AM vs PM feeding had no effect of DMI or milk production

	Treatment Means				*P*-value		
						-----Contrasts-----	
Item	AM	PM	AMPM	SE	Trt	AM vs. PM	AM vs. AMPM
Yield, lbs/d							
Milk	110.0	111.1	111.8	5.7	**0.69**	**0.59**	**0.40**
Milk fat	3.78	3.78	3.85	0.09	**0.84**	**0.99**	**0.62**
Milk protein	3.26	3.28	3.30	0.13	**0.77**	**0.78**	**0.48**
Milk composition, %							
Fat	3.51	3.49	3.48	0.15	**0.90**	**0.83**	**0.66**
Protein	2.97	2.95	2.96	0.07	**0.80**	**0.52**	**0.69**
DMI, lbs/d	71.7	69.1	70.2	2.0	**0.40**	**0.18**	**0.44**
Feed Efficiency	1.54	1.58	1.57	0.05	**0.43**	**0.21**	**0.37**

- **Also no difference in milk FA profile**

28

Evening feed delivery increased feed intake after feeding by >50%!



➢ ANOVA

Effect	*P*-value
Treatment	0.78
Time	<0.01
Treatment x Time	<0.01

➢ Circadian Parameters

Treatment	Phase/h	Amplitude	*P*-value
AM	1654	2.0	<0.01
PM	1638*	0.6*	<0.01
AMPM	1448*	1.1*	<0.01

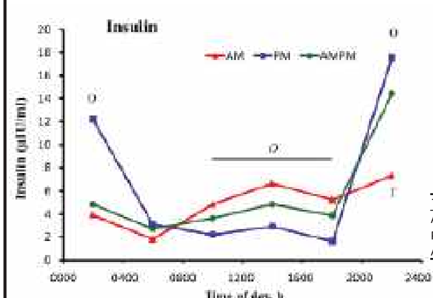
*Significantly ($P < 0.05$) different from AM

❖AM vs.PM (^{O} = $P < 0.01$, and ^{o} = $P < 0.05$); AM vs. AMPM (^{T} $P < 0.01$, and ^{T} $P < 0.05$)

- Conditional meals were larger at the evening feeding
- Modestly higher intake rate in the early afternoon for **AM**

29

Increase intake in the evening spikes insulin



➢ ANOVA

Effect	*P*-value
Treatment	0.76
Time	<0.01
Treatment x Time	<0.01

➢ Circadian Parameters

Treatment	Phase/h	Amplitude	*P*-value
AM	1844	1.8	0.07
PM	0031*	8.3*	<0.01
AMPM	2220*	4.8*	<0.01

*Significantly ($P < 0.05$) different from AM

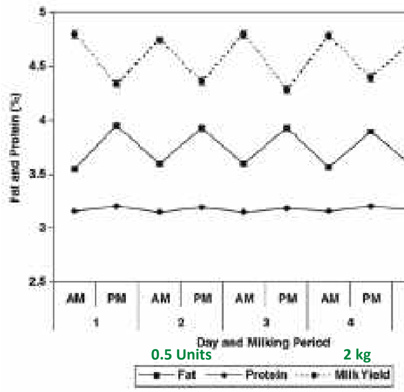
❖AM vs.PM (^{O} = $P < 0.01$, and ^{o} = $P < 0.05$); AM vs. AMPM (^{T} $P < 0.01$, and ^{T} $P < 0.05$)

- Fresh feed delivery at night resulted in greater insulin secretion
- Morning feeding moderately increased insulin in the early afternoon

30

Milk synthesis is variable over the day

2x Milked Herds

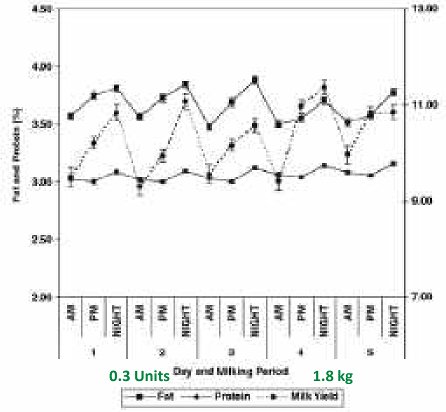


Quist et al. 2008

31

Milk yield is variable over the day

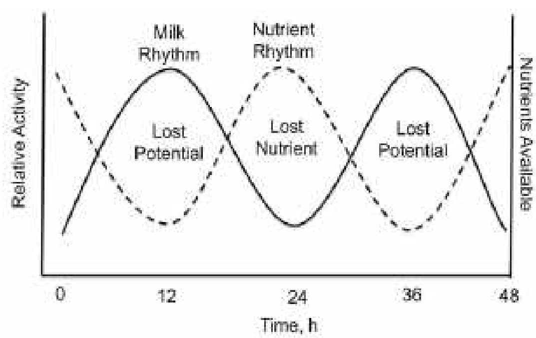
3x Milked Herds



Quist et al. 2008

32

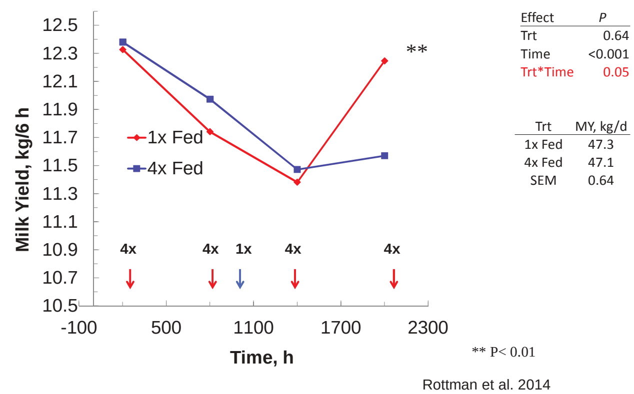
Theoretical de-synchronization of intake and mammary metabolism



First test: Fed cows 1x/d or 4x/d in equal feedings

33

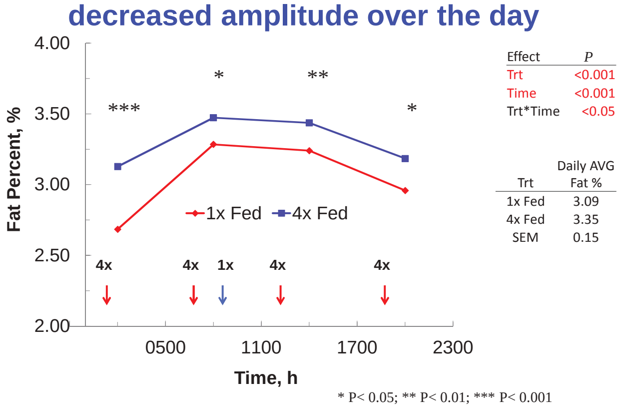
Feeding cows 1x/d vs 4x/d changed milk yield over the day at one milking



Rottman et al. 2014

34

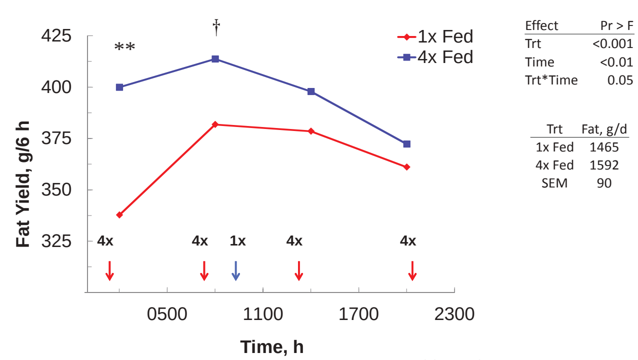
Feeding 4x/d increased milk fat and decreased amplitude over the day



Rottman et al. 2014

35

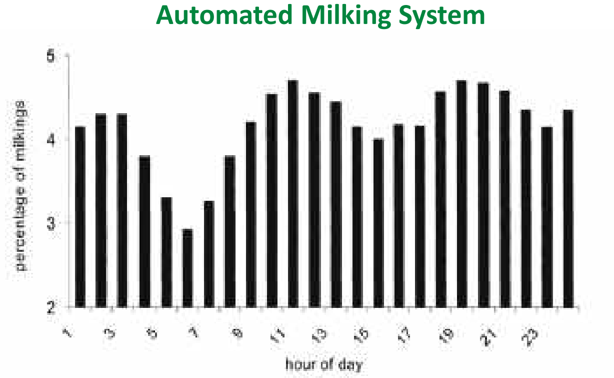
Rhythm of milk fat yield also modified by 4x feeding



Rottman et al. 2014

36

When do cows prefer to be milked??
Automated Milking System



Hogeveen et al., 2001

37

How Can We Use This Information??

Think not just about the diet we are feeding, but how we are feeding it and how the cows are eating it!

We need to watch the cows and see what they are doing!

38

1st… Think of the rumen

- **Can we stabilize the amount of fermentable feed entering the rumen over the day?**
  - **Take out some of the slugs and fill in during some of the low points**

39

How do we do this?

- Feed delivery is a strong signal for feeding which can be used to increase intake during low intake periods of the day
- Make sure feed is available when return from parlor………, but
  - Delivery of feed 2-3 h before or after milking may spread intake more across the day??

40

What else can we do?

- **Feeding different diets across the day might also work**
  - **Feed same ration to entire herd in morning**
  - **Return to “top-off” high groups**

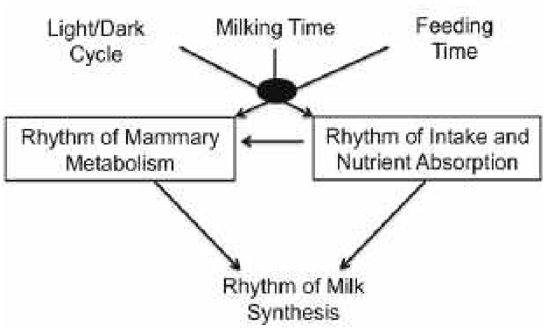
41

Interesting Call From the Field

- One pen of cows on a large farm consistently 0.3 to 0.5 units lower in milk fat than peer pen in another barn fed same diet
- Moved fifteen cows from the pen to another pen and they increased milk fat
- Normal MFD troubleshooting turned up no clues
- Cows being fed later in the day (11:30 AM)
- Switched milking and feeding order so feed delivered earlier and before milking.
- Milk fat increased equal to peer pen

42

Must Consider Multiple Factors That Have an Impact on Behavior



43

Key Principles

- There is a daily (circadian) pattern of intake that has a major impact on the rumen
- There is a daily pattern of milk synthesis
- We need to manage the daily pattern of intake and our best tools for this are through feeding and milking schedules
- Don't be afraid to feed multiple diets per day, but be careful with late afternoon and evening feedings (early morning may be safer)

44

Lab Members:

Cesar Matamoros, Beckie Bomberger, Alanna Staffin, Reilly Pierce, Ahmed Elzennary, and Rachel Walker.

Previous Lab Members:

Chengmin Li, Elle Andreen, Dr. Isaac Salfer, Dr. Daniel Rico, Dr. Michel Baldin, L. Whitney Rottman, Mutian Niu, Dr. Natalie Urrutia, Richie Shepardson, Andrew Clark, Dr. Liying Ma, Elaine Brown, and Jackie Ying

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

Disclosures

K.J. Harvatine's research in the past 10 years were partially supported by the Agriculture and Food Research Initiative Competitive Grant No. 2010-65206-20723, 2015-67015-23358, 2016-68008-25025, and 2018-06991 from the USDA National Institute of Food and Agriculture [PI Harvatine], USDA Special Grant 2009-34281-20116 [PI Harvatine], Berg-Schmidt, Elanco Animal Health, BASF, Novus International, PA Soybean Board, Phode Laboratories, Kemin International, Milk Specialties Global, Adisseo, Micronutrients Inc., Organix Recylcing, Insta-Pro Intl., and Penn State University. Harvatine has consulted for Milk Specialties Global, a manufacturer of prilled saturated fat supplements and Micronutrients Inc. as a member of their science advisory boards. Harvatine has also received speaking honorariums from Elanco Animal Health, Novus International, Cargill, Virtus Nutrition, Chr Hansen, NDS, Nutreco, Mycogen, and Milk Specialties Global in the past three years.

Thank You

45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*The increased rate of fiber digestion, extent of digestion and crude protein data was developed from replicated research and on-farm testing. During the 2015 growing season at West Salem, WI and Woodland, CA, the following commercial dormant, semi-dormant and non-dormant alfalfa varieties were compared head-to-head with Alforex varieties with Hi-Gest alfalfa technology for rate of digestion, extent of digestion and percent crude protein: America's Alfalfa Brand AmeriStand 427TQ; Croplan Brands LegenDairy XHD and Artesia Sunrise; Fertizona Brand Fertilac; S&W Seed Brands SW6330, SW7410 and SW10; and W-L Brands WL 319HQ and WL 354HQ. Also, during the 2015 growing season, 32 on-farm Alforex varieties with Hi-Gest alfalfa technology hay and silage samples were submitted to Rock River Laboratory, Inc., for forage analysis. The results for rate of digestion, extent of digestion and percent crude protein were averaged and compared to the 60-day and four-year running averages for alfalfa in the Rock River database which included approximately 1,700 alfalfa hay and 3,800 silage 60-day test results and 23,000 hay and 62,000 silage tests results in the four-year average.
**Crude protein=60-day running averages and uNDF240=four-year running average
[1]Combs, D. 2015. Relationship of NDF digestibility to animal performance. Tri-State Dairy Nutrition Conference, 101-112. Retrieved from https://pdfs.semanticscholar.org/5350/f0a2cb916e74edf5f69cdb73f091e1c8280b.pdf.
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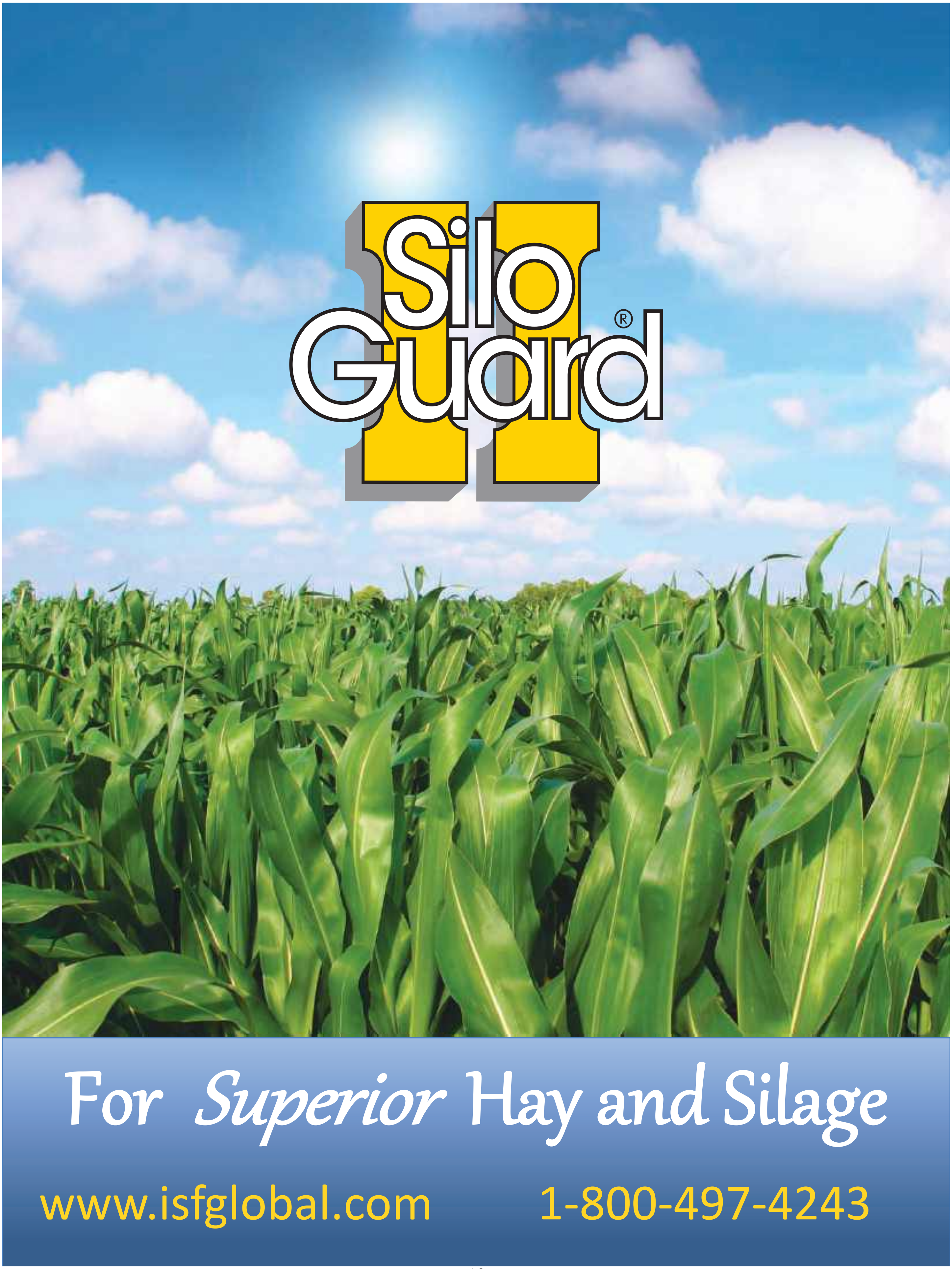
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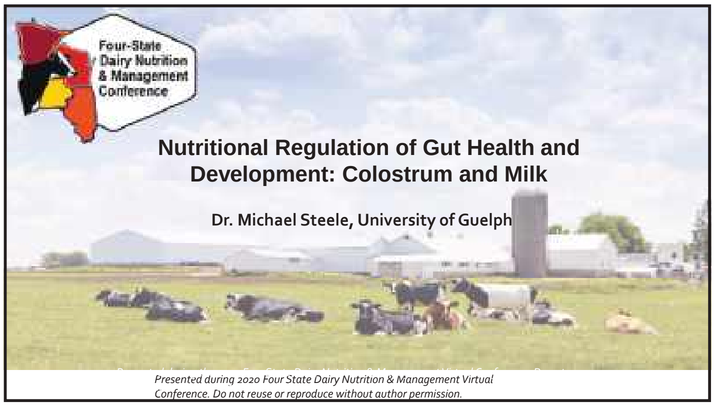
Nutritional Regulation of Gut Health and Development: Colostrum and Milk

Dr. Michael Steele
University of Guelph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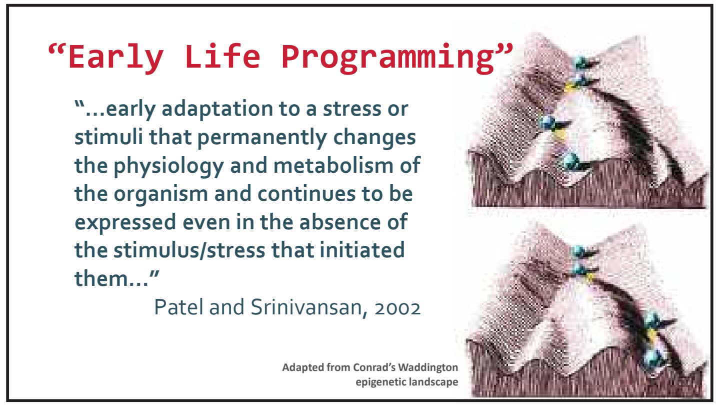
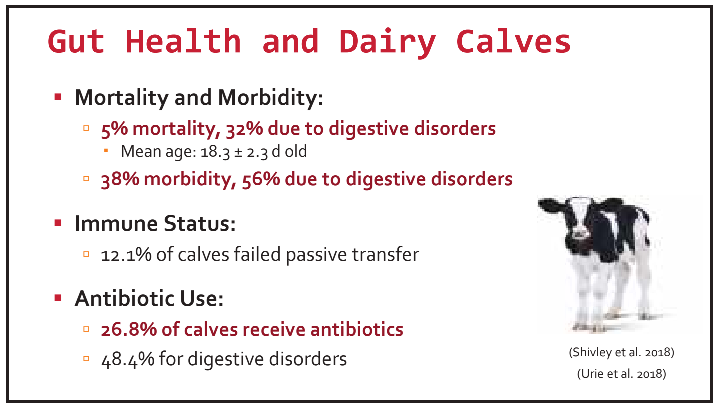
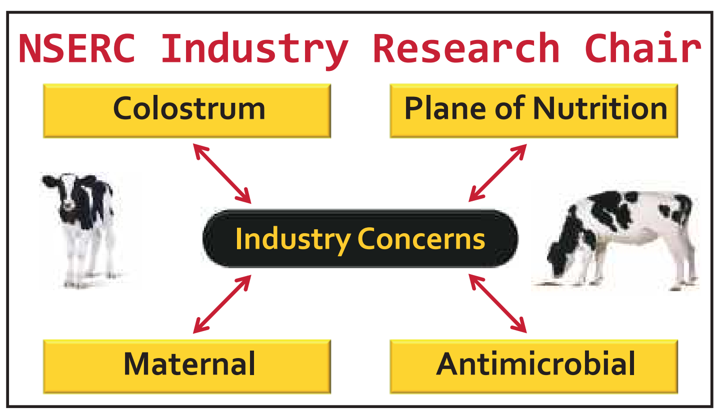
1


"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
3


Gut Health and Dairy Calves
Mortality and Morbidity:
5% mortality, 32% due to digestive disorders
Mean age: 18.3 ± 2.3 d old
38% morbidity, 56% due to digestive disorders
Immune Status:
12.1% of calves failed passive transfer
Antibiotic Use:
26.8% of calves receive antibiotics
48.4% for digestive disorders
(Shivley et al. 2018)
(Urie et al. 2018)
4

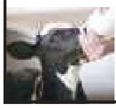

5


NSERC Industry Research Chair
Colostrum
Plane of Nutrition
Industry Concerns
Maternal
Antimicrobial
6

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

7

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

8

Colostrum –Is it all the same?

	Colostrum Types		
	Fresh	Pasteurized	Dried
Pros	• Tailored for the calf • All bioactive molecules and cells	• Can assess 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

9

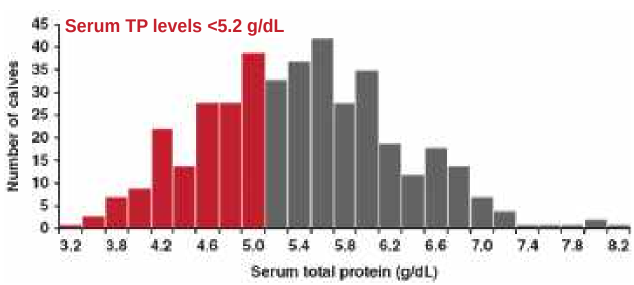
Evaluating colostrum absorption in calves

5.0 – 5.2 g/dl
Serum total protein = 5.0 – 5.2 g/dl ~
Serum IgG >10mg/ml

Brix refractometer is a good start but has limitations

10

Failure of Passive Transfer

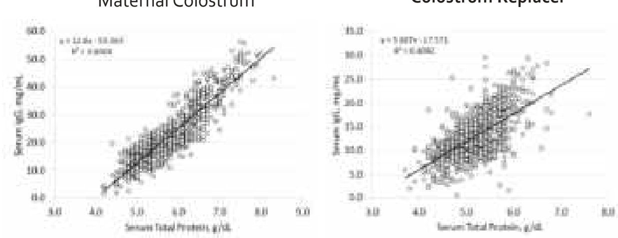


Trotz-Williams, 2008

11

But is it accurate for all neonatal programs?

Maternal Colostrum | Colostrum Replacer



(Lopez et al., in review)

12

What's in colostrum?

Immunoglobulins	>100:1	immune function
Lactoferrin	>15:1	local immunity effect in gut
IGF-I	80:1	
IGF-II	20:1	
Epidermal growth factor	2:1	
Insulin	100:1	local gut effects
Interleukines	> 100:1	
Relaxin	19:1	reproductive development
Prolactin		little data
TGFα and TGFβ	> 100:1	
Leptin		hypotahlamic pituitary axis
Leucocytes		immune function

Slide Courtesy of Dr. VanAmburgh

13

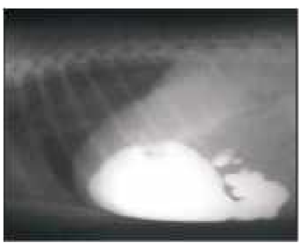
Components of Colostrum Management

Successful
Colostrum Feeding

14

Colostrum Feeding Method

Bottle

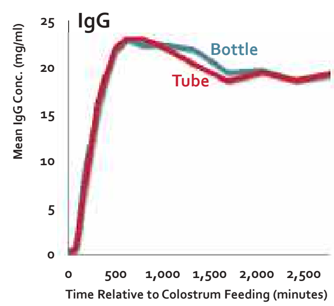


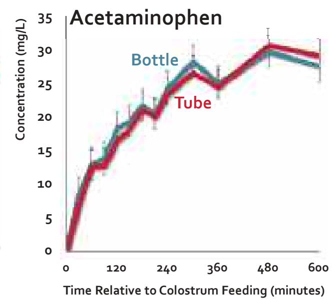
Tube

Sharifi et al., 2009

15

Colostrum Feeding Method

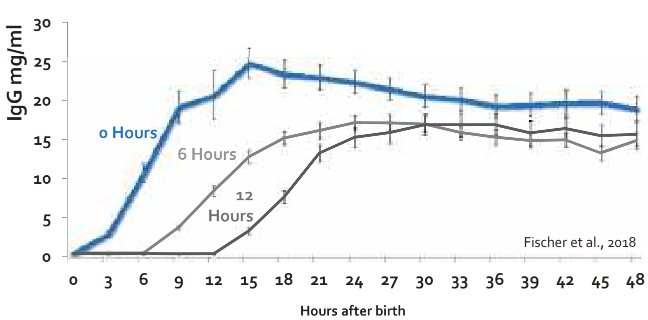




Desjardins-Morrissette et al., 2018

16

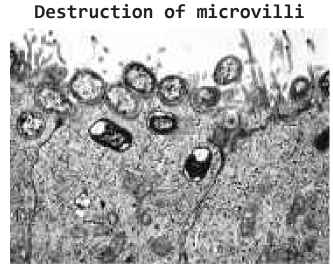
Delayed Colostrum Feeding



Fischer et al., 2018

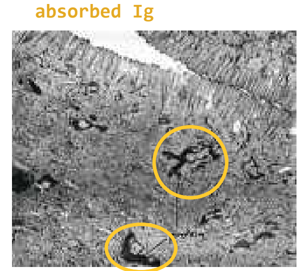
17

E. Coli entering intestine epithelial cell Destruction of microvilli



Colostrum deprived calf

Dark areas represent absorbed Ig

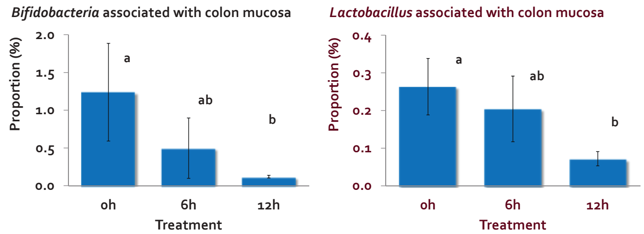


Colostrum fed calf

Slide Courtesy of Dr. James

18

Delayed Colostrum Feeding



Delaying the first colostrum meal may delay the colonization of beneficial bacteria to the calf intestine

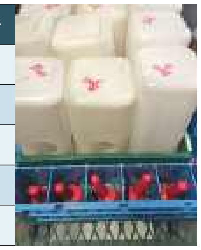
Fischer et al., 2018

19

Bacterial Contamination of Colostrum

Cut point is bacterial count < 100,000 cfu/ml

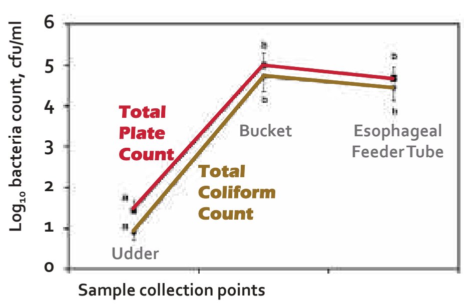
Total Bacterial Count	% of Samples[12]
< 100,000	54.8
100,000 - 300,000	12.1
300,000 - 500,000	6.3
500,000 - 1,000,000	9.9
>1,000,000	16.9



Morill, 2012

20

Cleanliness of colostrum handling equipment

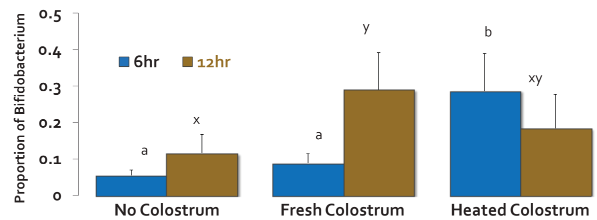


Mean $\log_{10}$ total plate count and mean $\log_{10}$ total coliform count for colostrum samples collected from the udder, milking bucket and esophageal feeder tube within bacteria type group.

Stewart et al., 2005

21

Heat Treatment of Colostrum

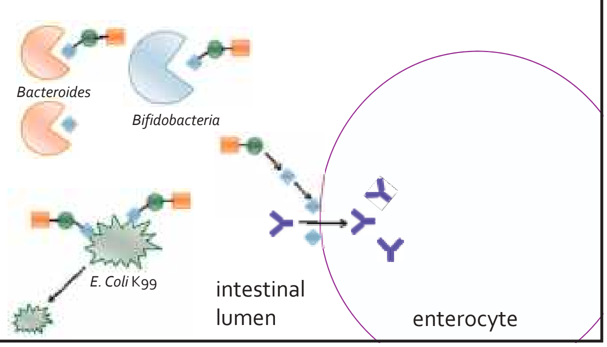


Heat-treated colostrum increases *Bifidobacterium* and reduced the colonization of *E. coli* in the small intestine

Malmuthuge et al., 2015

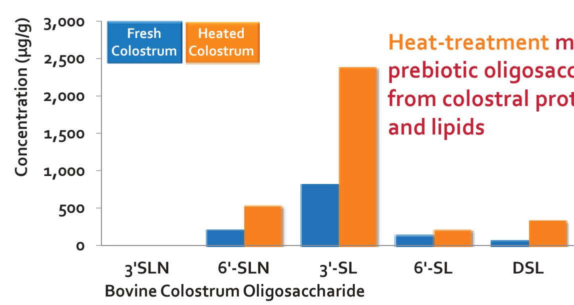
22

Colostrum Oligosaccharides



23

Heat Treatment of Colostrum

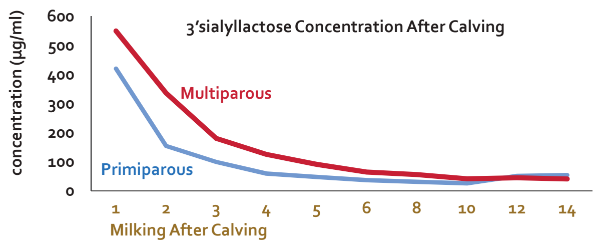


Heat-treatment may cleave prebiotic oligosaccharides from colostral proteins and lipids

Fischer et al., 2018

24

Oligosaccharides – Transition

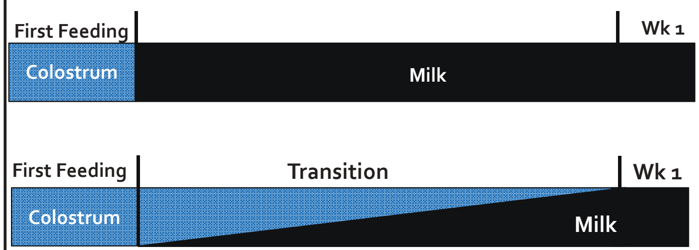


Bovine colostrum oligosaccharides (bCOs) produced in higher concentrations immediately after parturition

Fischer et al., 2020

25

From Colostrum to Milk



26

From Colostrum to Milk

	Unit	Colostrum Milking 1	2	3	4	5	Mature Milk
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

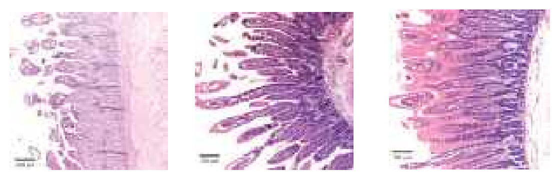
Conneely et al., 2014

27

From Colostrum to Milk

- All calves fed one meal of colostrum followed by:
  - Milk
  - 50% milk/ 50% colostrum (Transition)
  - Colostrum

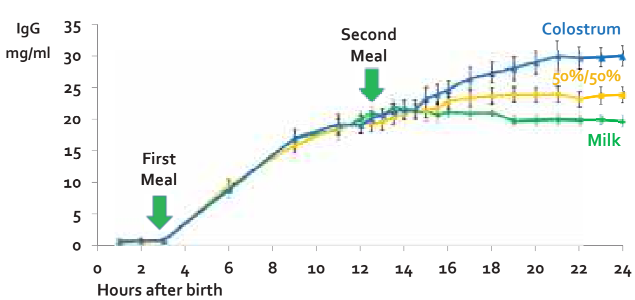
Pyo et al., 2020



Milk | 50%/50% | Colostrum

28

From Colostrum to Milk

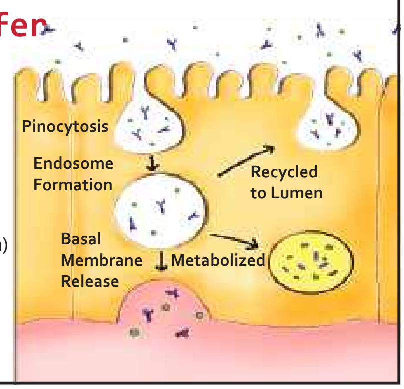


Hare et al., in review

29

Passive Transfer

- Trancytosis of immunoglobulins
  Jochims et al., 1997
- Receptor mediated and highly regulated
  - Trancytosis (to blood)
  - Recycling (back to lumen)
  - Metabolism (endosome)
- Regulation of these pathways in calves is unclear



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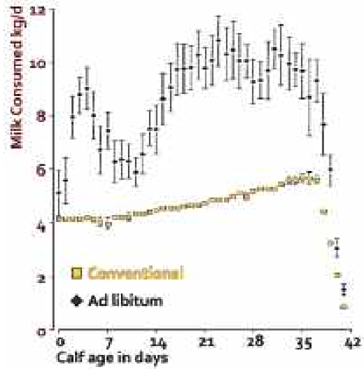
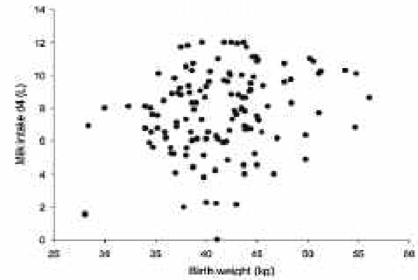
Normal Pre-Weaning Milk Intake



Jasper and Weary, 2002

31

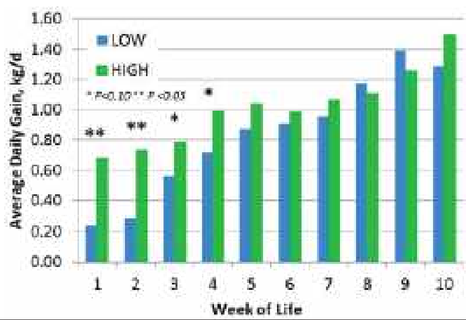
Normal Pre-Weaning Milk Intake



de Passille et al., 2016

32

5 (Low) vs 10L (High)



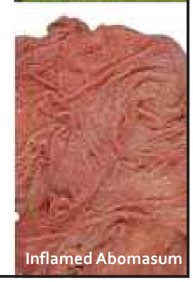
Haisan et al., 2018

33

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

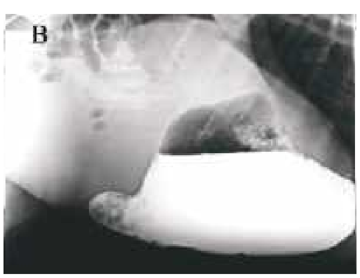
Berends et al., 2012; 2015



34

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

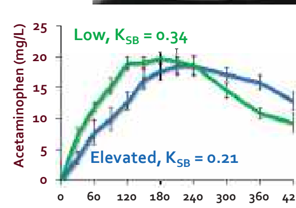
35

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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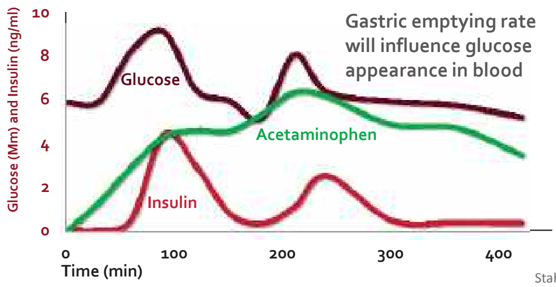
Gastric Emptying and Glucose-Insulin Dynamics



Gastric emptying rate will influence glucose appearance in blood

Stahel et al., 2016

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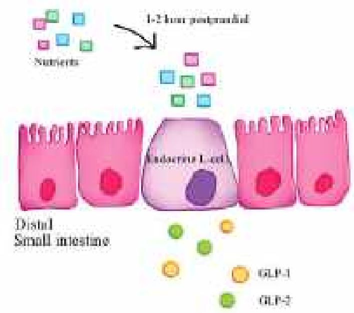
Gut Hormones



- ↓ Gastric motility
- ↓ Gut Permeability
- ↑ Proliferation
- ↑ Blood flow
- ↑ Nutrient absorption

38

Best innovation in calf feeding in recent years:

3-L and 4-L nursing bottles!

Allows us to design feeding system to meet calf requirements.

39

Should intake be the same?

Slide Courtesy of Dr. VanAmburgh

40

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

Milk Replacer/Milk Dry Matter Required (kg/d)

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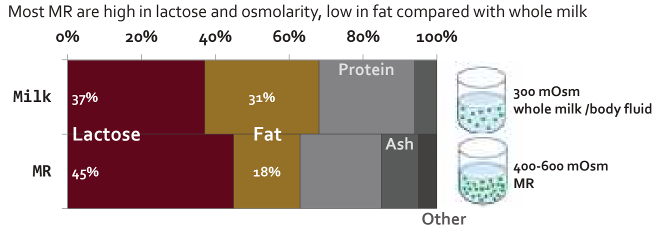
Milk Replacer vs Whole Milk

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



Hypertonic MR increases gut permeability

Wilms et al., 2019

Higher lactose results in increased gastric emptying and lower glucose tolerance in the first week of life

Welboren et al., in review

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Take Home Messages

- There are still some basic concepts in calf biology and nutrition that we do not understand
- No difference between tube vs. bottle feeding colostrum for passive transfer
- Delaying colostrum by six hours can impact passive transfer and gut microbiology
- Pasteurizing colostrum may help to improve calf gut health if managed properly

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Take Home Messages

- An abrupt transition from colostrum to milk can compromise gut development
- Calves can consume large quantities of milk in early life when starter intake is depressed
- 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

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Take Home Messages

- Some milk replacers are too high in lactose which may comprise calf health
- Using high quality ingredients and feeding consistency is key to promote gut health

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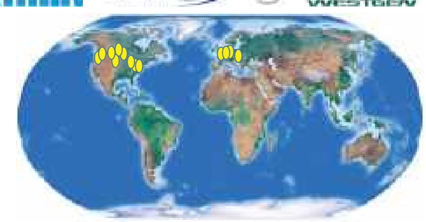
Industry Collaborators



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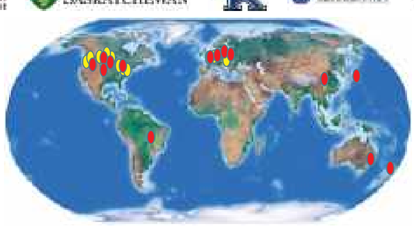
Academic Collaborators



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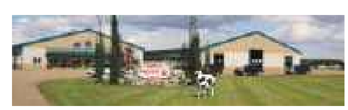
Colostrum and Milk Collaborators

- SCCL
- Alberta Milk
- Trouw Nutrition
- Alberta Agriculture
- NSERC
- Breevliet Ltd.



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Thanks
to my Team
Alberta, 2017
Guelph, 2019

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DAIRY
at GUELPH
Mike Steele
masteele@uoguelph.ca

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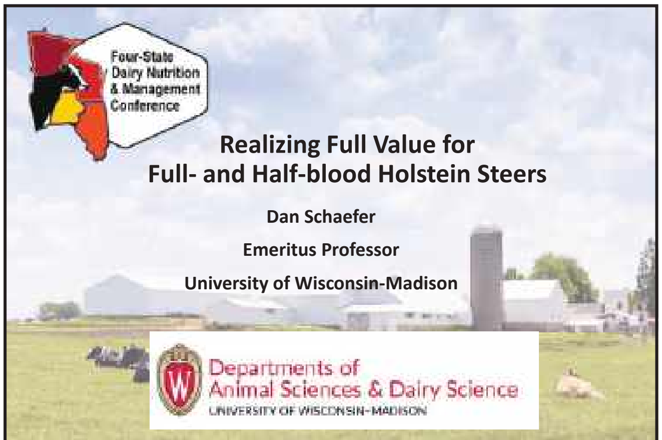
Realizing Full Value for Full- and Half-blood Holstein Steers

Dan Schaefer

Emeritus Professor

University of Wisconsin-Madison



Realizing Full Value for Full- and Half-blood Holstein Steers

Four-State Dairy Nutrition & Management Conference

Dan Schaefer
Emeritus Professor
University of Wisconsin-Madison

Departments of Animal Sciences & Dairy Science
UNIVERSITY OF WISCONSIN-MADISON

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1

Outline

- Finishing Holstein steers
  - Management principles
  - Nutrition principles
- Characteristics of Holstein steers
  - Beef yield and quality
  - Attributes and limitations
- Dairy x native crossbred steers
  - Growth and nutrition principles

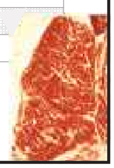
2

2

Significance of Holstein steers to U.S. beef production?

Assumptions	
Calving interval	13.1 months
Dairy calf component of U.S. calf crop	26%
Heifer component of dairy calf crop	53%
Dairy calf death loss	8.1%
Dairy feeder cattle deaths and realizers	3.77%
Holstein component of dairy cow herd	86%
Fed Holstein carcasses, USDA Prime	12.9%[1]
Results of Calculations	
Holstein steer component of fed steer & heifer supply	13.8%
Holstein steer component of USDA Prime carcasses	33%

[1] Native carcasses, 2.1% Prime (2016)



3

The Ideal Holstein Steer

"Really ideal type of steer. Live weight 1415 lbs, dressed yield estimate 61.5%, Y3, High Choice, Muscle score 1-2. The ideal kind of steer that is desired by both the dairy steer harvesters and native cattle packers alike."

Ron Mayer – JBS Packerland

4

Holstein Steer Packing Plants

- JBS – Green Bay, WI; Plainwell, MI; Tolleson, AZ; Omaha, NE; Grand Island, NE
- Cargill – Wyalusing, PA; Fresno, CA; Schuyler, NE
- American Foods Group – Green Bay, WI

5

5

Target for Marketing

- Only two competing Holstein steer harvesters in Upper Midwest
  - JBS
    - Prefers calf-fed steers up to 1550 lbs
  - American Foods Group
    - Prefers 1400 lbs and heavier
- Target finished weight for Holstein steers is 1400-1550 lbs for competitive bidding
  - 840-930 lb carcass
    - Discounts to cow beef price for stags, Standards (silage-fed), and dark cutters

6

Special Considerations for the Holstein Bull Calf

- Feed colostrum to bull calves as it is fed to heifer calves
- Purchase calves with colostrum feeding as a stipulation
- Castration
  - Stags: expensive to re-castrate, or steep carcass discounts
  - Simple math – count to two and then the job is done!
- Dehorn to prevent bruising

7

Weaning and Post-weaning

- Colostrum shortage, milk replacer, and housing environment are challenges to calf respiratory health
- Age at weaning? Typically, 7-8 wks.
  - "Wean early (28 to 42 d) and promote feed DM intake to take advantage of the efficient growth by young calf." – Hugh Chester-Jones, Univ. Minn.
- Growth target for the nursery phase is to double initial BW by 56 d of age with hip height growth of 4 inches or more
- Provide a high energy diet (60 Mcal NEg/cwt DM) with 18% crude protein

8

Grower Phase – Role for Forages?

- A grower phase is not needed for Holstein steers.
- Pastures, silage or hay can be included for middle weight (400-750 lb) steers to accommodate cropping system.
- Subsequently, reduce forage component to achieve $\geq$62 Mcal NEg/cwt DM

9

Short Transition to Finisher Phase

Conditions at a Midwest feedlot into which 300 lb Holstein steers were received. Upon arrival, the steers started at 56 Mcal NEg/cwt DM and were gradually incremented to 62 Mcal NEg/cwt DM. (Below Farms, Waseca, MN)

10

Finisher Phase

- Start them on finishing diet ($\geq$ 62 Mcal NEg/cwt DM) by 750 lbs
- Holstein steers need high-energy diets so they will finish at 1400-1450 lbs

11

Net Energy$_{gain}$ (NEg) Concentrations in Feedlot Diets

Equivalencies between corn silage:high-moisture corn ratios and net energy for gain concentrations[1, 2].

Corn silage	Corn, high-moisture	Net Energy$_{gain}$
Proportion (%)	Proportion (%)	Mcal/lb
10	60	0.65
15	55	0.64
20	50	0.63
25	45	0.61
30	40	0.60
40	30	0.57
50	20	0.54

[1] Based on diet DM formula as follows: corn silage proportion; high-moisture corn proportion; modified wet distillers grain with solubles, 25%; and supplement, 5%.
[2] NEg values for diet ingredients (NASEM, 2016) were corn silage, 0.44 Mcal/lb; high-moisture corn grain, 0.71 Mcal/lb; and modified wet corn distillers grain with solubles, 0.74 Mcal/lb. Supplement was considered to be only minerals, vitamins and additives with zero NEg value.

12

Consistency of Holstein Steer Population

- Breed has an inbreeding coefficient of 6-7%
- Implications of this genetic homogeneity are both positive and negative.
- The following closeout results display consistency.

13

Commercial Diets Self-fed (as-fed basis)

Ingredient	Diet 1	Diet 2
Corn, cracked, %	67	65
Corn gluten feed, pelleted %	12	-
Distillers grain, %	15	30
Balancer pellets, %	6	5

No inclusion of Tylan, Optaflexx, molasses, probiotics or other non-nutritional additives. No forage/roughage provided, except corn stalk bedding.

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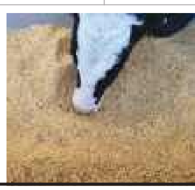
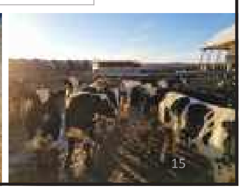
Summary across 25 Closeouts

Variable	Overall Ave
Head, Ave	346 (n=25)
Initial wt, lb	487
Harvest wt, lb	1437
Duration, d	321
DMI, lb/hd*d	**20.5**
ADG, lb/hd*d	**2.95**
DMI/ADG	**6.97**
Grade	**80+% Choice & Prime**





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Closeouts 1-5 with Self-feeders

	Group							
	1	2	3	4	5	**Mean**	S.dev.	**C.V.**
Head, n	294	390	114	360	534	**338**		
Implants[a]	E+FO	E+IS	E+FO	E+FO	E+FO			
Housing	Bedded Confine ment	Outside lots with sheds	Outside lots with sheds	Outside lots with sheds	Outside lots with sheds			
Begin wt, lb	565	593	594	610	541	**581**	27.4	**4.7%**
Kill wt, lb	1461	1458	1426	1440	1442	**1445**	14.3	**1.0%**
Duration, d	323.5	293	305	307	315	**309**	11	**3.7%**
DMI, lb/hd*d	20.7	21.0	21.8	20.9	21.0	**21.1**	0.4	**2.0%**
ADG, lb/hd*d	2.77	2.95	2.73	2.7	2.86	**2.80**	0.10	**3.7%**
DMI/ADG	7.48	7.11	8.00	7.76	7.34	**7.54**	0.35	**4.6%**
Death & Culls, %	4.85	2.74	5.0	2.7	2.9	**3.64**	1.18	**32%**
Choice & Prime, %	-	78.33	81.25	79.75	80.01	**79.84**	1.20	**1.5%**

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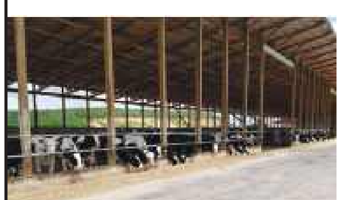
Consistent Holstein Steer Performance

- Note the consistency of DMI, ADG, DMI/ADG (feed conversion efficiency) and Choice/Prime percentage.
- Dead and culled steers are a greater percentage than one would expect from similar native steers, and this is probably due to early calfhood mgmt and inbreeding.

17

Aim for Dry, Draft-free Housing



Holstein steers are <u>more tolerant of elevated temperatures, but less tolerant of freezing temperatures</u> than native steers, which may be because of their thinner hide and diminished subcutaneous fat cover. Insulation provided by dry bedding is essential in cold conditions. (Ramthun Farms, West Bend, WI)

18

Yield Characteristics of Holstein Steer Carcasses

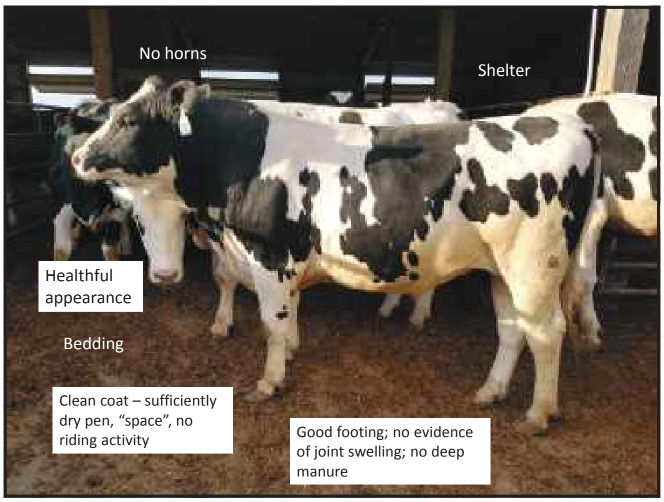
- Lower dressing percentage than native carcasses
  - Due to increased proportion of gut, reduced muscling score, less subcutaneous fat, increased liver size, increased proportion of abdominal fat
  - However, hide as proportion of body weight is less
- Lower muscle:bone ratio
  - Loin muscle of the Holstein is stretched over a longer skeleton, resulting in a smaller REA (Nour et al., 1981)

19

Quality of Holstein Beef

- Holstein steers have had higher marbling scores than the U.S. native fed cattle population
  - In recent years, there is less difference due to marked improvement in marbling scores within native population
- Holstein loin has greater drip loss but responds to vitamin E supplementation, if there is a large differential
- No breed difference in taste panel or tenderness attributes for Holstein vs Angus

20

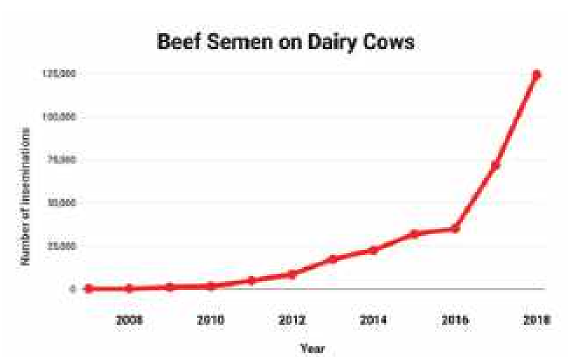


21

Finished Holstein Steer

Body wt	1388 lb
Dress	58.6%
Carcass	814 lb
Fat thickness	0.28 in
Loin muscle area	12.2 in^2
Kidney, pelvic, heart fat	3.0%
USDA Yield Grade	3.0
USDA Maturity	A
USDA Marbling	Modest[20]
USDA Quality Grade	Choice

22



Source: Agsource; Paul Fricke

23

What are the goals for half-blood dairy steers?

- Note the difference in frame size.

24

Beef Sire Selection for Dairy Matings

- Aim for more than simply a black calf
  - If it won't qualify for Certified Angus Beef, it's just a black Holstein or black Jersey
    - No reason to value greater than Holstein or Jersey bull calf
- F1 generation needs to meet CAB standards

Denise Schwab, Iowa State,
Extension Beef Specialist

25

Certified Angus Beef
(as stds apply to dairy-beef crossbreds)

- Predominantly (51%) solid black hair coat or AngusSource® genetic verification
- Modest or higher marbling (average and high Choice and Prime)
- Superior muscling (restricts influence of dairy cattle)
- 10- to 16-square-inch ribeye area
- 1,050-pound hot carcass weight or less

https://www.certifiedangusbeef.com/brand/specs.php

26

Traits of Importance

- Marbling
  - Highly heritable
- Muscling (muscle:bone ratio)
  - Medium to high heritability
- Respiratory health
- Hybrid vigor
  - Not a consideration for marbling or muscling
  - Possibly a benefit for respiratory health

27

Beef Sire Selection Criteria for Holstein Matings

- Black hair coat – homozygous
- Polled – homozygous
- Frame size – 5 to 5.5 (on a scale of 1-9)
- Muscling – ribeye area in top 20% of breed; emphasize muscle to bone ratio
- Marbling – top 20% of breed
- Calving ease direct – top 50% of breed
- Conception rate – not known; beef = Holstein; sorted < non-sorted
- An index designed for these matings?

28

Beef Sire Selection Criteria for Jersey Matings

- Black hair coat – homozygous
- Polled – homozygous
- **Frame size – 6 to 6.5** (on a scale of 1-9)
- Muscling – ribeye area in top 20% of breed; emphasize muscle to bone ratio
- Marbling – top 20% of breed
- Calving ease direct – top 50% of breed
- Conception rate – not known; sorted < non-sorted
- There is no existing index designed for these matings

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Cattle Performance Estimates

Enterprise	ADG lb/d	Feed:Gain	Days on Feed
Holstein, birth to 400	2.0	3.5	150
Dairy x beef, birth to 400	2.0	3.5	150
Holstein 400- 1450	2.9	7.2	362
Dairy x beef 400-1400	3.2	6.9	312

There are no publicly available reports of half-blood Holstein steer feedlot performance.

30

Finishing Programs[1]

	Holstein	Half-Holstein	Native
Diet NEg (Mcal/cwt DM)	62-65	62-65	62-65
Start finishing by ____, lb	750	850	950
Harvest-ready, lb	1450	1375	1300
Daily gain, lb/day	2.9	3.2	3.5
Days to finish	240	165	100

[1] Assumes anabolic implant inserted as follows:
Holstein – Revalor XS (200 days)
Half-Holstein – Revalor S (last 100 days)
Native – Revalor S (last 100 days)

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Nutritional Recommendations

Nutrient	Growing	Finishing
	%, DM basis	
Crude protein	14	13
Calcium	0.65	
Phosphorus	0.30	
Potassium	0.60	
Sulfur	0.15-0.40	
Magnesium	0.10	
Salt	0.25	
Trace mineral pmx	0.05	
Vitamins	IU/lb DM	
A	1,000	
D	125	
E	15	

32

Trace Mineral Premix[1,2]

Mineral	NRC Recomm.	TM Premix	Premix/Recomm.
	mg/kg	mg/kg	
Ca		230,000	
Fe	50	10,000	200
Mn	20	40,000	2,000
Zn	30	60,000	2,000
Co	0.15	300	2,000
Cu	10	20,000	2,000
I	0.5	1,000	2,000
Se	0.1	200	2,000

[1] Based on NASEM (2016)
[2] Add TM Premix as 0.05% of diet DM

33

Early Results are Encouraging

Black-coated, half-dairy crossbred heifers harvested in early January 2020 weighed 1250 lbs and dressed 61.3 % with 18% Prime and 77% Choice.

Note variation in frame size.

She's not pretty, but she's finished.

34

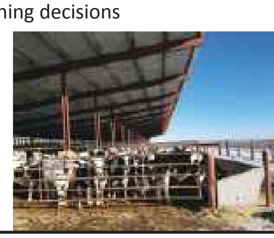
Summary

- Holstein steers have deficiencies
  - Respiratory health, growth rate, feed conversion, dressing percentage
  - Market understands these deficiencies and knows how to value them
  - Despite deficiencies, growth, carcass yield and quality are consistent
  - Supply of these cattle numbers hundreds of thousands
  - Mature market
- For Holstein x beef bull calf, easiest profit is realized by selling the 100-lb calf.
  - This market will become more discriminating as finishers and packers gain experience with these bull calves.
  - Immature market

35

Market Comments

- The cash/auction market for feeder and finished cattle is not offering a profit incentive.
- The profit incentive is available for large volume forward contracts involving finished (and probably feeder) cattle.
  - Allows for better control of variability via mating, sorting and finishing decisions



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Interpretation

- Market for Holstein bull calves will persist as long as there is a
  - market demand
  - packer(s) with a market for Holstein beef
  - packer profit in the carcass cut-out value
- When the supply of Holstein bull calves shrinks relative to market demand,
  - market will induce more Holstein beef production
    - price incentive for forward-contracted Holstein steers & heifers
    - price incentive for newborn Holstein bull and heifer calves

37

Take Home Message

- Health, growth, cost of production, and carcass value of Holstein steers have become consistently predictable.
- Much will need to be learned about dairy x native crossbreds so that the price premium in these commodity calves can be preserved.

38

Alltech®

ON-FARM SUPPORT

Helping your dairy save time and money.

Our team of Elite Dairy Advisors serve as a new tool for nutritionists, producers and laborers. Specializing in Herd Analytics, Forage Quality, Cow Comfort, and Talent Development we work with you to troubleshoot problems, set customized goals and help lay a foundation for your dairy to save time and money.

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Alltech®

The Commercial Science Behind Purebred Holstein Beef

Bill Munns
Head of Sales & Supply Chain
JBS Regional Beef

Four-State Dairy Nutrition & Management Conference

The Commercial Science Behind Purebred Holstein Beef

Bill Munns
Head of Sales & Supply Chain, JBS Regional Beef

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1

JBS BEEF PLANTS

2

B2B MARKETING APPROACH

PURBRED **FED HOLSTEINS**

- Holstein steers represent 20% of total US fed cattle harvested Approximately 100K head/week*
- 32% of industry USDA Prime is Holstein*
- Grain-fed from an early age
- Consistent genetic base delivers uniform carcass weights, primal confirmation, meat quality, tenderness & flavor

HOLSTEIN **PERFORMANCE**

- Above average USDA quality grade – 10-12% Prime, 72-75% Choice
- Delivers a more flavorful & tender eating experience consumers prefer
- Over 90% Yield Grade 1, 2 & 3
- Superior saleable yields deliver a retail gross margin advantage

PROVEN **PROGRAMS**

- Only young A Maturity cattle qualify into JBS Graded Holstein Brands
- No dark cutters allowed in JBS Programs
- Various programs available across USDA Prime, Choice & Select

ELITE PRIME SHOWCASE

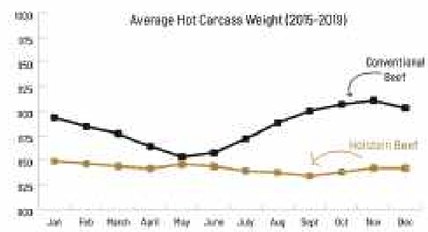
*National Beef Quality Audit, 2016.

3

HOLSTEIN BEEF

CARCASS WEIGHTS

- Holsteins sustainability offer consistent sizing throughout each year, YOY

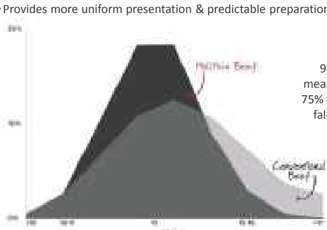


4

HOLSTEIN BEEF

EXCEPTIONALLY **CONSISTENT PRIMALS**

- Smaller, lower weight middle meats allow for thicker steaks while maintaining portion size
- Provides more uniform presentation & predictable preparation



98% of Holstein ribeyes measure 10-16 in^2, while only 75% conventional beef ribeyes fall within the same range

5

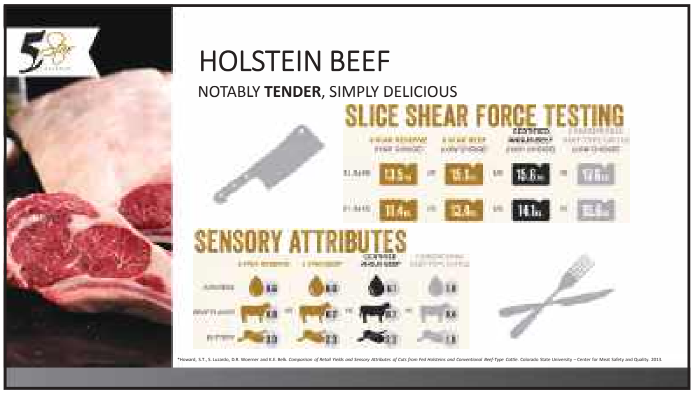
HOLSTEIN BEEF

INCREMENTAL MARGIN DELIVERED	50¢ STRIP LOIN	21¢ INSIDE ROUND	12¢ EYE OF ROUND
76¢ SHORT LOIN	50¢ TENDERLOIN	17¢ 1/4" TOP SIRLOIN	20¢ CLOD
45¢ LIP-ON RIBEYE	22¢ BOTTOM ROUND FLAT	23¢ KNUCKLE	7¢ CHUCK ROLL

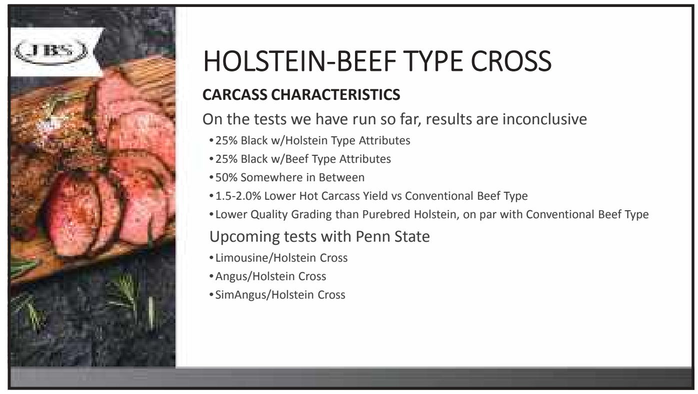
In a study* conducted by Colorado State University, beef from Fed Holstein cattle (5 Star beef) was compared to products from Conventional Beef-Type Cattle, and key yield differences were identified.

*Howard, S.T., S. Luzardo, D.R. Woerner and K.E. Belk. *Comparison of Retail Yields and Sensory Attributes of Cuts from Fed Holsteins and Conventional Beef-Type Cattle*. Colorado State University – Center for Meat Safety and Quality. 2013 & 2018.

6


HOLSTEIN BEEF
NOTABLY TENDER, SIMPLY DELICIOUS
SLICE SHEAR FORCE TESTING
SENSORY ATTRIBUTES
*Howard, S.T., S. Luzardo, D.R. Woerner and K.E. Belk. Comparison of Retail Yields and Sensory Attributes of Cuts from Fed Holsteins and Conventional Beef-Type Cattle. Colorado State University – Center for Meat Safety and Quality. 2013.

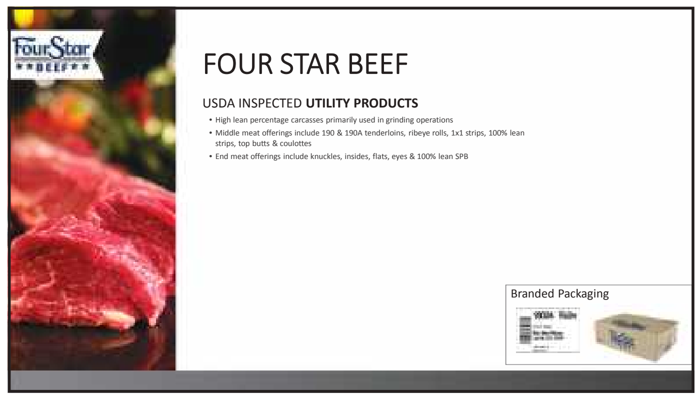
7


JBS
HOLSTEIN-BEEF TYPE CROSS
CARCASS CHARACTERISTICS
On the tests we have run so far, results are inconclusive
• 25% Black w/Holstein Type Attributes
• 25% Black w/Beef Type Attributes
• 50% Somewhere in Between
• 1.5-2.0% Lower Hot Carcass Yield vs Conventional Beef Type
• Lower Quality Grading than Purebred Holstein, on par with Conventional Beef Type
Upcoming tests with Penn State
• Limousine/Holstein Cross
• Angus/Holstein Cross
• SimAngus/Holstein Cross

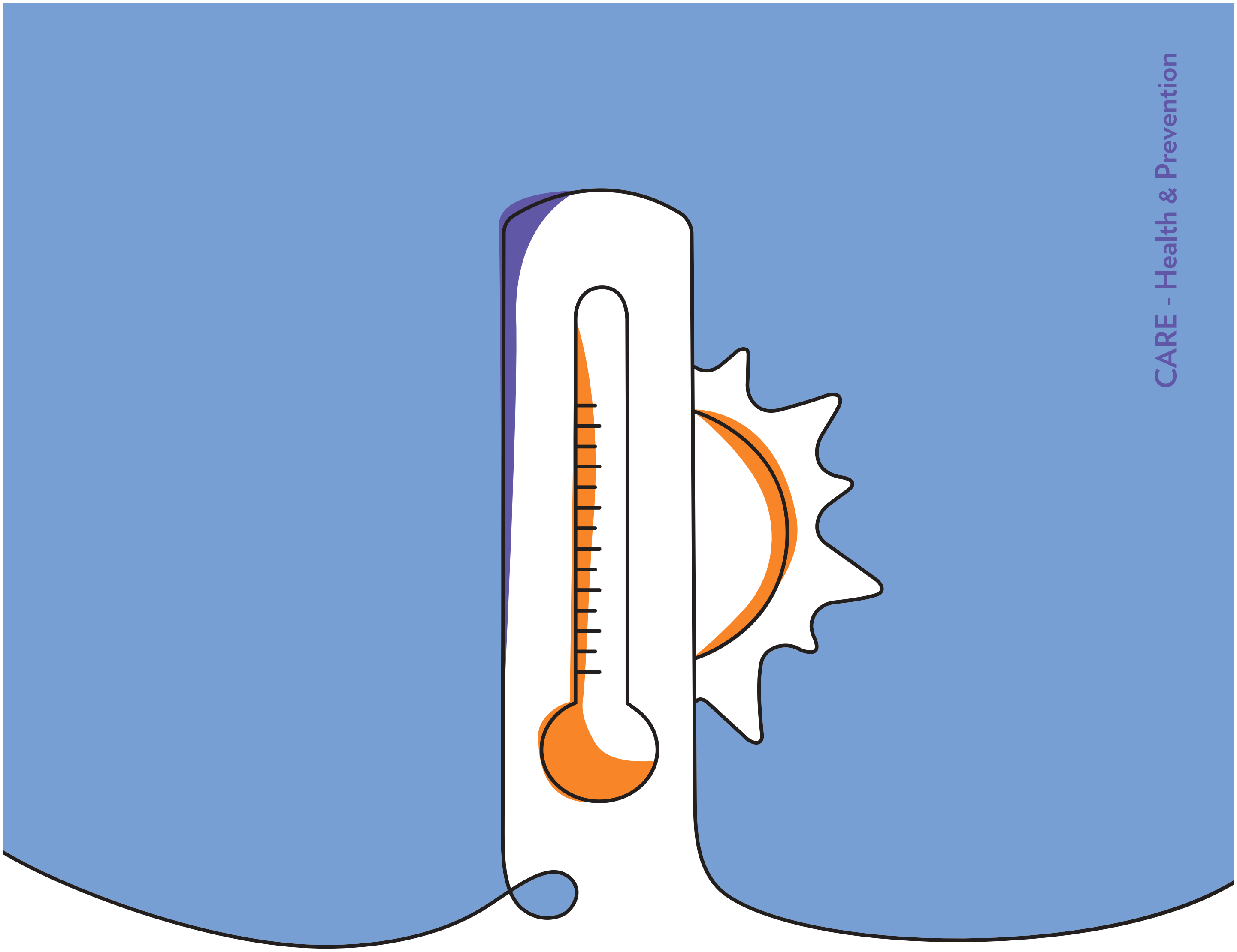
8


Farms
CLEAR RIVER FARMS
USDA INSPECTED UNGRADED BEEF
• Minimum marbling requirement SL00 – equivalent to USDA Select/Higher
• Lean & fat color specification to ensure premium visual appearance (6 or better on Japanese Color Chart)
• No dark cutters, no yellow fat allowed
• Minimum carcass weight & ribeye area size to ensure product sizing & consistency – 600 lbs & 1.2 in2 per 100 lbs
• Comprehensive offering of Ungraded >30 products
• Carcasses not meeting these specifications are offered as Four Star
• Produced in all 5 JBS Regional plants
Branded Packaging

9


Four Star BEEF
FOUR STAR BEEF
USDA INSPECTED UTILITY PRODUCTS
• High lean percentage carcasses primarily used in grinding operations
• Middle meat offerings include 190 & 190A tenderloins, ribeye rolls, 1x1 strips, 100% lean strips, top butts & coulottes
• End meat offerings include knuckles, insides, flats, eyes & 100% lean SPB
Branded Packaging

10


CARE - Health & Prevention

Four-State Dairy Nutrition & Management Conference

CA Data Driven Approach to Sourcing Profit Focused Beef Bulls for Holstein Based Dairy Industry

Chip Kemp
International Genetic Solutions
American Simmental Association

1

Transforming
FRUSTRATION
to *Leverage*!

2

3

What is IGS International Genetic Solutions?

- Collaboration of numerous associations and industry groups.
- Largest Beef Genetic Evaluation on the planet. (**~20,000,000 head**)
- Only Mega, Multi-Breed Evaluation in existence.
- Allows for direct comparison of cattle - regardless of breed type.
- No Breed bias.
- Most Importantly for this conversation…
  Allows for genetic awareness of largest population in the beef business…
  The Crossbred Terminal Beef Calf!

4

IGS is a tech company

- Data-driven tools to empower serious producers and the industry
- The key – take billions of data points, remove the noise, and make genetic tools to add value.
  - EPDs and Indexes on any breed of cattle
  - EPDs and Indexes on commercial, crossbred cattle
  - IGS Feeder Profit Calculator
- Significant growth in non-IGS seedstock types
- Tremendous growth in commercial clients

Feeder Profit CALCULATOR

5

A little background…

6

A simple look at semen sales numbers…

Excluding import numbers which are small and export numbers that don't directly impact US beef market.

7

Combined Dairy Domestic Sales & Custom

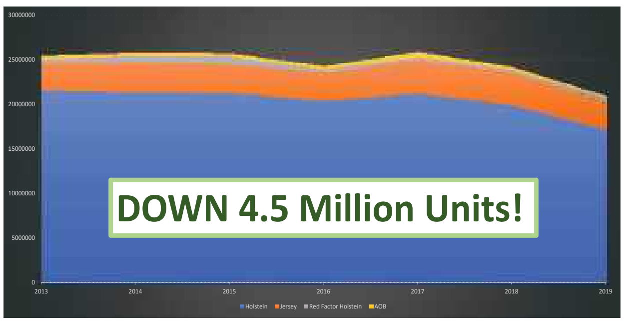
Total Dairy Semen (NAAB)

	2013	2014	2015	2016	2017	2018	2019	% Change
Holstein	21645443	21421445	21346838	20474167	21287608	19976218	17162554	-20.7105
Jersey	3048823	3333879	3243907	3072640	3703766	3630467	3074001	0.825827
Red Factor	416175	703441	782435	390038	343857	314176	500270	20.20664
AOB	401464	392582	391764	390462	609260	306804	262544	-34.6034
TOTAL	25511905	25851347	25764944	24327307	25944491	24227665	20999369	-17.688

NOTE: Dairy industry down 4,512,536 unit of semen.

8

Combined Dairy Domestic Sales & Custom



9

Combined Beef Domestic Sales & Custom

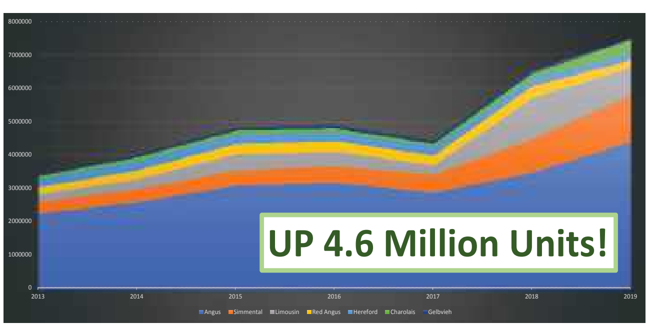
Total Beef Semen (Sales & Custom)

	2013	2014	2015	2016	2017	2018	2019	% Change
Angus	2241974	2595931	3090752	3180929	2881182	3489149	4411231	96.75656
Simmental	356369	386278	450136	493057	537386	996978	1412403	296.3316
Limousin	229878	299106	483099	434565	279856	1238743	807181	251.1345
Red Angus	207734	266282	308861	316277	291410	347441	228691	10.08838
Hereford	246881	271536	296837	274465	258375	249125	236462	-4.22025
Charolais	89880	119202	111198	103386	99619	136891	364647	305.7043
Gelbvieh	66091	78724	84933	98394	79792	110185	51484	-22.1013
AOB	932400	895105	889525	735164	810837	1142369	1438536	54.28314
TOTAL	4371207	4912164	5715341	5636237	5238457	7710881	8950635	104.7635

NOTE: Only three breeds beat the average % change.
NOTE: Beef semen units up 4,579,428.

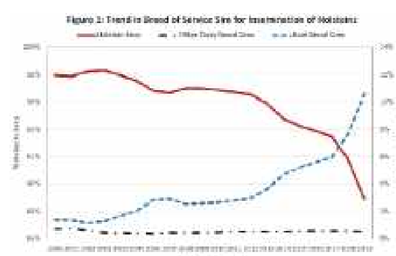
10

Combined Beef Domestic Sales & Custom



11

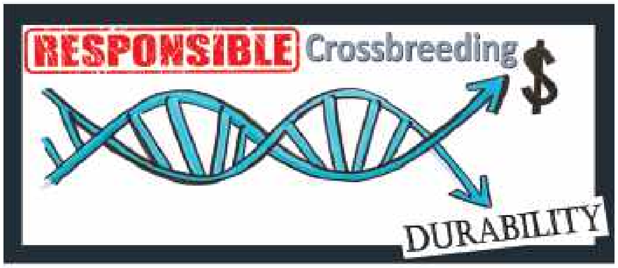
Beef on Dairy



Canadian Dairy Network

12

WHY?



13

All the while…

- Despite struggles dairy cow numbers are growing (albeit slightly).
- USDA numbers show steady year over year increase. 9 million.
- 50% or more of beef semen presently goes into dairies.
- No clear increase in beef semen usage in beef business.
- ~ 3 units of semen/dairy cow/pregnancy.

14

Beef breeds used in the beef x dairy model

Angus

- Large Supply
- Marbling Genetics
- High Growth

- Less REA
- High BF
- Large Frame Size

15

Beef breeds used in the beef x dairy model

Charolais

- High REA
- High Growth
- High Retail Yield

- Less Marbling
- Large Frame Size
- Calf Color is Limiting

16

Beef breeds used in the beef x dairy model

Limousin & LimFlex

- High REA
- High Cutability
- Moderate Growth/Size

- Lower Marbling
- Lower Growth
- Particularly Popular for Jersey

17

Beef breeds used in the beef x dairy model

Simmental & SimAngus

- High REA & Cutability
- Moderate Size & Mod/High Growth
- More Marbling than LM or CH

- Have to avoid excessive white mark

18

Semen purchase
What are the producer's expectations

- Get them bred
- Fairly priced relative to the ROI
- Convenient, consistent, reliable quality and service
- Add more profit to the bottom line of the enterprise
- Outperform semen company competitors

19

Reality – we've set the bar way too low.

Most have grown to accept:

- Cheap
- Easy
- Fertility

We can do more!

Dollars, convenience, and fertility are crucial. BUT, shouldn't that be a given??

You are buying semen to breed a cow after all.

Where is the value add?

20

Adding a Profit Center to Dairy Business

- The BeefXDairy calf has become relatively commonplace.
- Too frequently, the beef sire has been a **byproduct** of other enterprises.
- This has resulted in some added value…
- However, also **wide variability in the true profit potential of BD calf**.
- Thus, buyers are still skeptical. This restrains their spend.
- **Data is needed** to provide decision support to ensure most profit focused BeefxDairy cross that is available.
- Need ongoing data feedback to refine and improve the model.

21

Precision Agriculture – *or lack there of*

- Beef on Dairy = "Vague on Vague"
- There is a distinct difference in the "beef" between Holstein & Jersey.
- First, we need to determine what is necessary to fit your cow base.
- Secondly, we have to be honest about what best complements.
- Excessive carcass length is a significant concern in Holsteins.
- Jerseys have greater marbling capacity than Holsteins.
- Calving ease, muscle conformation, dressing percent are problems in both.
- Two different approaches.
- The bulls appropriate in one may not be ideal for the other.

22

Without data-driven tools we aren't deciding
We are **Guessing!**

Let's study the
Beef X Holstein model…

23

Step 1

- Late 2017/Early 2018
- IGS was asked to assist a group trying to solve the dilemma of identifying the appropriate Beef sire for Holstein operations.
- Group included:
  - Major packer (who provided carcass metrics)
  - Feedlots heavily vested in dairy cattle
  - Dairy Operators
  - Seedstock Producer
  - Various association group personnel
- Agreement that most important phenotypes were: MB, REA, Size/Growth, CE.

24

I digress…

- **Marbling**
  - **Economic import of intramuscular fat**

$28.15 Choice/Select Spread.

That is over $250 difference on 900 lb carcass!

25

I digress…

- Marbling
  - Economic import of intramuscular fat
  - **Jersey vs. Holstein**

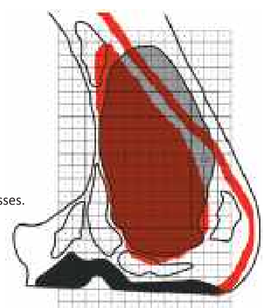
Jersey carcasses have an advantage of 20 degrees of marbling over Holstein carcasses.
Dr. Bob Weaber, KSU
NALF & IGS data

26

I digress…

- Marbling
  - Economic import of intramuscular fat
  - Jersey vs. Holstein
- **REA**
  - **Very Important**
  - **Not so much**

Holstein carcasses have 2/3 of inch advantage over Jersey carcasses.
Dr. Bob Weaber, KSU
NALF & IGS data

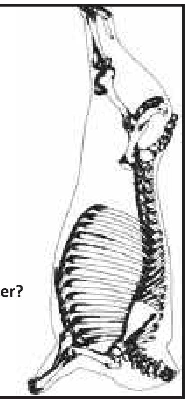


27

I digress…

- Marbling
  - Economic import of intramuscular fat
  - Jersey vs. Holstein
- REA
  - Very Important
  - Not so much
- **Size/Growth**
  - **AKA – carcass length. Not traditionally a concern in beef.**
  - **Jersey vs. Holstein. How does this impact or limit cattle feeder?**

The cattle feeder's success/failure and confidence in the product <u>is the key to the success and viability</u> of "Beef on Diary" efforts.



28

I digress…

- Marbling
  - Economic import of intramuscular fat
  - Jersey vs. Holstein
- REA
  - Very Important
  - Not so much
- Size/Growth
  - AKA – carcass length. Not traditionally a concern in beef.
  - Jersey vs. Holstein. How does this impact or limit cattle feeder?
- **CE**
  - **Dystocia**
  - **Production impact**

29

Step 1

- Late 2017/Early 2018
- IGS was asked to assist a group trying to solve the dilemma of identifying the appropriate Beef sire for Holstein operations.
- Group included:
  - Major packer (who provided carcass metrics)
  - Feedlots heavily vested in dairy cattle
  - Dairy Operators
  - Seedstock Producer
  - Various association group personnel
- Agreement that most important phenotypes were: MB, REA, Size/Growth, CE.
- Queried the entire IGS database to provide a view of what breed types fit.

30

And the answer was clear…

31

Step 2

- May 2018
- Massive change to the beef landscape.
- IGS Multi-Breed Genetic Evaluation *powered by BOLT*
- Allowed for better incorporation of genomic knowledge through single-step.
- Maintain (and enhanced) the multi-breed component of IGS.
- Revisited the Beef on Dairy question.
- Same Answer was delivered…

IGS Multi-breed Genetic Evaluation powered by BOLT

32

The Answer

- Searched IGS database (and the second largest beef database) for sires in:
  - Top 25% REA, MARB, CE, Mid level YW & CW
- Results:
- 3.125% were straight British
- 6.25% were straight Continental
- 90.6% were Composite bulls that were a mix of British & Continental

- Of the list of Composite Bulls – 89.7% were SimAngus.
- So roughly 80% of all bulls that populated were SimAngus.

33

Trait	Simmental Rank vs Major Continental Breeds	Angus/Red Angus Rank vs Major British Breeds
Marbling Score	First	Second
Carcass Weight	First	First
Lbs of Retail Product	Second	First
Weight Gain/Feed Efficiency	First	Second
Weaning Weight	Second	First
Post Weaning Gain	Second	Second
Shear Force	First	First

Across-breed EPD Table, GPE Report 22, MARC, USDA

34

So where is the BEEF – with Holstein?

- Clearly Continental based cattle are seen as the growth opportunity in the beef on Holstein sector.
- The data is clear that no singular breed type ideally fills this void.
- The data is also clear that composites are most appropriate.
- On the composite front, SimAngus are the largest group that genetically complement Holstein terminal genetics. But, definitely not the only group.

35

But…

Limitations exist to a threshold approach.
We need something more sophisticated.

36

Indexing is the way to go!

Beef on Holstein Index

Starting with largest population – SimAngus.

37

Starts with the…

IGS International Genetic Solutions™

Feeder Profit CALCULATOR™

38

IGS Feeder Profit Calculator
-Highlights

- Highlights known sires & management approach *(wean & vac)*
- Capitalize on cow herd genetic awareness
- Leverages power of largest database in industry
- USDA MARC & IGS data for breed differences
- Robust science team
- **No cost to producers!** ***HOW?***

IGS International Genetic Solutions

39

The How…

- The SimAngus x Holstein (SAxH) index uses the IGS Feeder Profit Calculator™, the industry leader in feeder cattle evaluation, as the foundation for this effort.
- The results from the FPC are then adjusted for the unique economic situations relevant to Holstein cattle, namely, the need for added calving ease, muscle conformation, grading ability and sensitivity to carcass length.

40

Using the FPC as foundation for the SAxH Index

- All homozygous polled & homozygous black 3/8 to 3/4 SimAngus bulls.
- FPC ran on a Holstein cow base with high health calves.
- Provided a profit prediction from all of those potential matings.
- Then added curvilinear adjustments to the FPC results for:
  - REA
  - Body Length
  - Calving Ease
- Utilized two separate curvilinear approaches.
- Sires had to be within top 1000 for both approaches to be considered.

41

HOLSim AMERICAN BEEF

HOLSim Objectives…

- To provide additional revenue to dairy producers through the production of value-added terminal calves.
- To offer new marketing avenues for progressive beef seedstock operations.
- To offer a consistent supply of high-quality calves better situated to capture market premiums.

AND MORE INDEXING WORK TO COME!

42

Interesting side note…

- Bulls that populate on the HOLSim index (e.g. look more appropriate in a Beef on Holstein model) tend to be high indexing bulls on a Whole Life Cycle index (All Purpose Index).
- Given the homogeneity of the traditional beef business, one could make a very sound argument that high API bulls are what is actually needed by overwhelming percent of beef operations. Along with strengths of responsible crossbreeding and heterosis.
- Semen companies could have the bulls that can "do both". Be a data appropriate match for Holstein genetics and add profit to their British based beef audience.

43

Opportunities associated with BeefXDairy Model

- Consistency of product
- Relatively known and consistent production costs
- Less impacted by land prices than traditional beef model
- Adoption of traceability and data tracking methodologies.
- Ability to choose strictly for terminally minded traits. No concern for maternal merit – clarity of genetic selection.
- R&D feedback loop and novel traits (fertility).

44

Key difference to the SimAngus X Holstein model

It takes advantage of the Premiums and Discounts presently built into the beef business.

Does not require building a complicated Rube Goldberg machine to add profit. It places these carcasses squarely at the center of the beef industry. Not on the periphery!

Simply build better cattle and then retain ownership.

45

Want a better understanding?
Want to maximize your return?

Become a cattle feeder!

46

Courage to consider the new

- The right kind of partners
- Profit-minded genetics
- The right kind of marketing
- The right kind of tools

47

48

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QUALITY & SAFETY: IT'S ALL BY DESIGN.

Kemin knows chromium.

Our commitment to chromium promises to provide you with a high-quality, safe and efficacious product to help your animals reach their optimal performance while boosting your bottom line.

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Four-State Dairy Nutrition & Management Conference

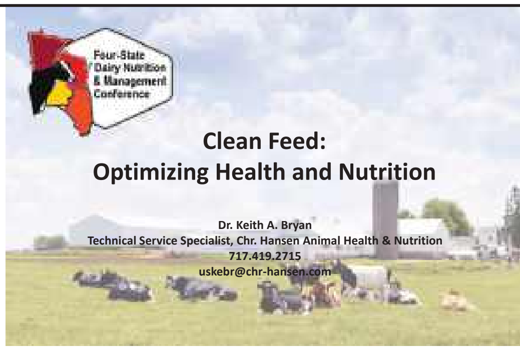
Clean Feed: Optimizing Health and Nutrition

Dr. Keith A. Bryan

Technical Service Specialist, Chr. Hansen Animal Health & Nutrition

717.419.2715

uskebr@chr-hansen.com



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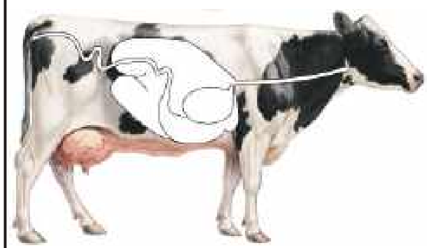
1

We don't feed the cow…we feed her microbiota!



- Complex symbiotic microbial ecosystem
- Continuous replenishment and perturbation
- Pathogenic & Non-pathogenic organisms within the same *Genus*
- Silage: Inherent vs. Contamination
- Mitigation strategies

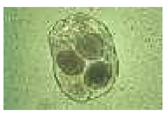
2

CHR HANSEN *Improving food & health*

2

The rumen microbial ecosystem (microbiota)

Bacteria
10e10 – 10e11 bacteria/g rumen contents
>200 species
Strictly anaerobic
Specialist activities in feed breakdown

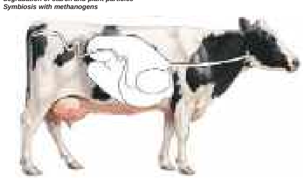


Protozoa
Eukaryotes, 10e4 – 10e6 cells/ml
50% biomass
Bacterial predation, N recycling and degradation of starch and plant particles
Symbiosis with methanogens

Fungi
8-10% of the microbial biomass
High cellulolytic activity
Role in plant cell wall weakening

Archaea
Methanogens
10e8 – 10e11 cells/ml
Live in symbiotic relationship with H donating microbes

Mycoplasmas
Represent between 0.1- 1% of the total bacterial population.
No distinguishable cell wall. Parasitic.
Can affect ruminal fibre breakdown.



Phage
10e11 – 10e12 viral particles/ml
Bacterial turnover and cell lysis

CHR HANSEN *Improving food & health*

3

4

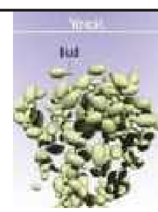
Typical Epiphytic Populations on Plants Prior to Ensiling

Group	Population (cfu/g)	Population (log cfu/g)
Total aerobic bacteria	> 10,000,000	> 7
Lactic acid bacteria	10 - 1,000,000	1 - 6
Enterobacteria	1,000 – 1,000,000	3 - 6
Yeast & yeast-like fungi	1,000 – 100,000	3 - 5
Molds	1,000 – 10,000	3 – 4
Clostridia (spores)	100 – 1,000	2 – 3
Bacilli (spores)	100 – 1,000	2 – 3
Acetic acid bacteria	100 – 1,000	2 – 3
Propionic acid bacteria	10 – 100	1 - 2

5

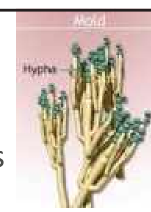
CHR HANSEN *Improving food & health*

5



Fungi

Yeasts — Molds



Single cell — Multicellular filaments (hyphae)

Desirable	Undesirable	Desirable	Undesirable
Saccharomyces cerevisiae	*Candida albicans*	*Aspergillus oryzae*	*Aspergillus flavus*
Pichia jadinii	*Candida tropicalis*	*Aspergillus niger*	*Aspergillus fumigatus*

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Molds and mycotoxins of concern

Pre and post-harvest		Post-harvest
		
Fusarium	*Aspergillus*	*Penicillium*
Deoxynivalenol (DON) Nivalenol T-2 toxin HT-2 Fumonisin B1, B2, B3 Zearalenone (ZEA)	Aflatoxin B1, B2, G1, G2 Ochratoxin A Patulin	Ochratoxin A Citrinin Cyclopianzonic acid Patulin Roquefortine C Mycophenolic acid

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Listeria monocytogenes

- Facultative anaerobe, Gram +
  - Soil
  - Silage
  - Surface water
  - Vegetation
  - Feces (human and animal)
- Severe systemic infections (Listeriosis)
- Prevalence:
  - Oxygen, high pH
    - Poor compaction
    - Air ingress
    - Relatively high pH
- Human health concern

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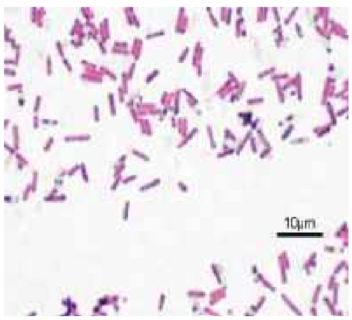
Bacillus spp.

- Aerobic (facultative anaerobe), spore-formers
  - Soil
  - Silage (soil contamination)
  - Other feeds
  - Bedding material
- Bacilli:
  - *B. subtilis, B. licheniformis, B. pumilus, B. coagulans, B. sphaericus, B. cereus*
- Prevalence:
  - Oxygen, high pH
    - Poor compaction
    - Air ingress
    - Relatively high pH (>4.6)
- Human health concern (food-borne pathogen)



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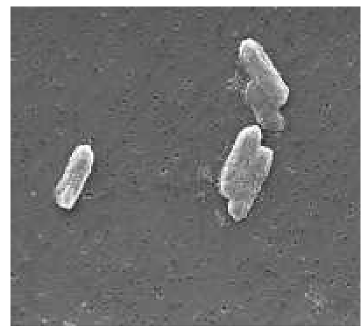
Enterobacteriaceae (*E. coli*)

- Facultative anaerobe, Gram -
  - Ubiquitous
- Silage
  - Epiphytic microflora of crops
- Varying degrees of pathogenicity
  - Commensal
  - STEC: *E. coli* O157:H7
    - Other serogroups: O26, O103, O111 & O145
- Prevalence:
  - Oxygen, high pH
    - Poor compaction
    - Air ingress
    - Relatively high pH (>5.0)
- Human health concern (food-borne pathogen)



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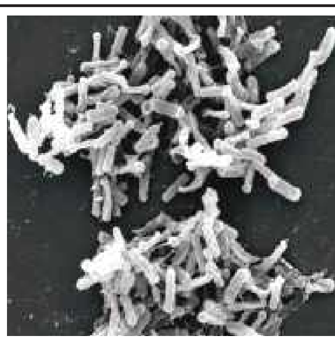
Clostridium

- Obligate anaerobe, Gram +, spore-formers
  - Ubiquitous
  - Soil
  - Silage
  - Feces (animal)
- Clostridium:
  - *C. butyricum, C. tyrobutyricum, C. beijerinckii, C. sporogenes, C. botulinum, C. tetani, C. difficile, C. perfringens*
- Prevalence:
  - Wet, high pH
    - High moisture (>65%)
    - High water activity (0.952-0.971)
    - Relatively high pH (>4.5)
- Human health concern (food-borne pathogen)



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Pathogen Load in Silage: Inherent vs. Contamination

- Human health concern (food-borne pathogens)
- Found in soil, silage, feces and bedding material
- Prevalence in silage: Oxygen & High pH
- Some spoilage microorganisms are pathogenic, some are not!
  - Contamination:
    - Soil
    - Fecal

- **"Hygiene" – silage, feed → TMR**

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Mitigation Strategies

- Proper silage making and feed-out practices:
- **Compaction**
  - Min. AF or bulk density: 48-50 lbs./ft^3
  - Min. DM density: 17 lbs./ft^3
  - Align packing tractor weight and forage delivery rate
- **Inoculant**
  - Science-based, research-proven inoculant
  - Drives pH below 4.5 within 3 days of ensiling
  - Maximizes aerobic stability at feed-out
- **Minimize air ingress at feed-out**
  - Leading edge of top-layer/face
  - Smooth face (rake or rotary de-facer)

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Compaction (Packing)

- Match delivery rate to packing tractor weight to exceed **'the rule of 800'.** (Packing tractor weight = 800 * tons of forage delivered/hour).
- Thin layers (**~4" thick**) spread and packed in a progressive wedge configuration will facilitate achievement of higher density bunkers and piles.
- For bunker silos, **alternate dumping**, push-up and packing from left side-to-right side and vice-versa for uniform layer thickness, optimal packing weight and time, and overall efficiency.
- Also, alternate dumping, push-up and packing will reduce the likelihood of 'crowned' or 'cupped' filling and the resulting variations in DM density across the face of the bunker. **The ideal packing tractor speed is 1.5-2.5 mph**. Do not turn around on the pile. Make sure one set of wheels comes off the pile when changing direction in order to minimize loss of traction.

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Compaction (Packing)

- In order to store more feed in the same area (volume) of storage, increase DM packing density! **Increasing DM packing density from 16 to 18 lbs. DM/cu. ft. increases storage capacity by 12.5%.** If you routinely store 6,000 tons of DM, you could now store 6,750 tons of DM in the same area, or an additional 2,140 tons as fed at 35% DM.
- **Packing is complete when every square foot of top layer has tire tracks; having been run-over twice, and is smooth!** There is no advantage to more than 30 minutes of packing after the final load has been spread.
- ***Bottom line: The most skilled tractor operator should be in the 'push' tractor. The people operating the 'push' and 'pack' tractors could be the most valuable (and often most overlooked) team members in the entire process! Oxygen is the enemy!***

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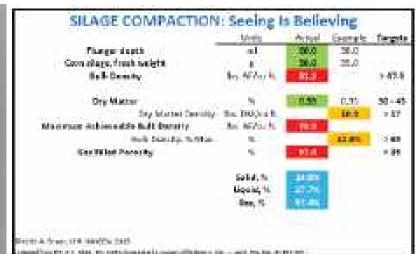
Density & Porosity



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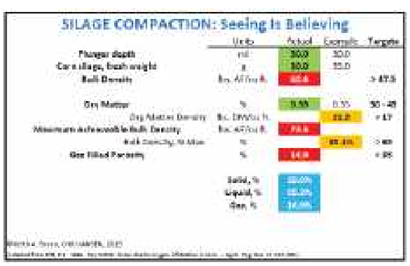
Density & Porosity



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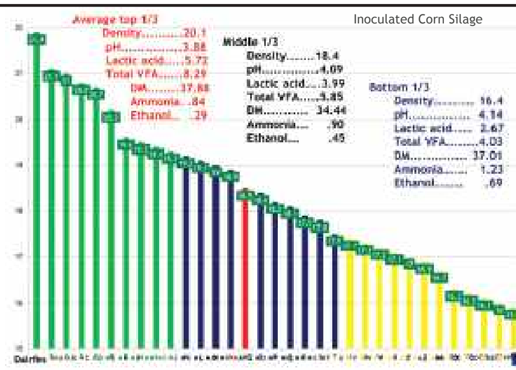

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Inoculant

- Patented inoculant strain to mitigate pathogenic organisms.
- Lactococcus lactis NCIMB 30117 (SR3.54) with patent number 511828 that was submitted on 26 September 1997 and approved on 6 December 1999.
- Swedish patent. The patent states that the identified Lactococcus lactis subsp. lactis strongly reduces development and growth of gram + bacteria, eg. *Listeria monocytogenes, Staphylococcus aureus, Clostridium tyrobutyricum, Bacillus cereus and other lactic acid bacteria. Certain Gram - bacteria are weakly inhibited, eg. Pseudomonas aeruginosa.*
- The following patent claim is made:
  - Lactococcus lactis NCIMB 30117 reduces development of yeast and clostridia and Gram + bacteria and certain Gram – bacteria.

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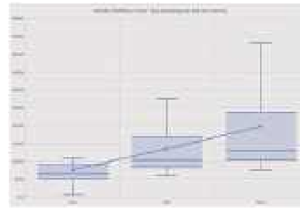
Minimize Air Ingress at Feed-out

- Leading edge of top-layer/face
- Smooth face (rake or rotary de-facer)



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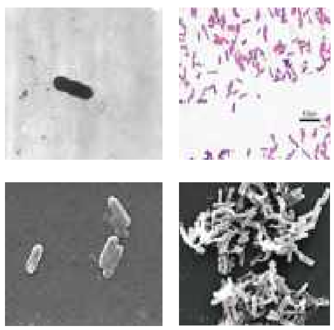
Listeria monocytogenes

Bacillus spp.

Enterobacteriaceae (*E. coli*)

Clostridium

- **Prevalence:**
  - **Oxygen, High pH**
  - **Human health concern**



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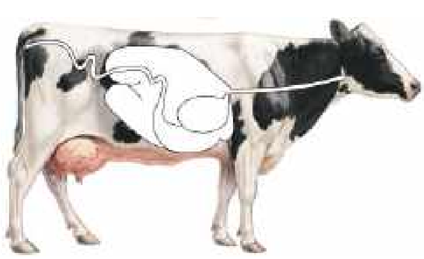
We don't feed the cow…we feed her microbiota!



- Complex symbiotic microbial ecosystem
- Continuous replenishment and perturbation
- Pathogenic & Non-pathogenic organisms within the same *Genus*
- Silage: Inherent vs. Contamination
- Mitigation strategies

HYGIENE MATTERS! Feed her microbiota CLEAN FEED!

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Healthy rumen…healthy lower gut…healthy cow…more productive!

- ***Dysbiosis*** is the abnormal prevalence of specific microorganisms in the GI tract leading to sub-optimal health and productivity of individuals within a herd or flock
- ***Dysbiosis*** can result from:
  - Nutritional imbalances
  - Pathogen ingestion
  - Sub-optimal fermentation of stored forage
  - Diet changes
  - Stress (environmental, social, etc.)
- Science-based, research-proven silage inoculants and probiotics when fed daily and provide **Essential Microbial Support** to stabilize normal GI, digestive and immunological function; re-establishing and maintaining normal health, consistency and optimal productivity

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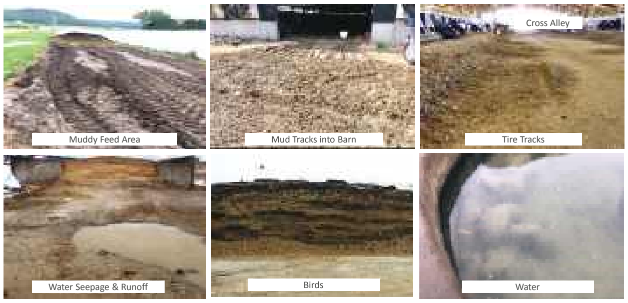
Feed hygiene is a threat to optimal cow health and sustainable performance



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RRL TMR Nutrient Analysis

TMR Nutrient Analysis	Your TMR, % of DM	Avg TMR,
Crude Protein (CP)	17.1%	16.1%
aNDF	32.3%	32.6%
Fat (EE)	5.6%	3.8%
Starch	20.6%	24.8%
Organic Matter (OM)	92.1%	92.0%
uNDF120	14.3%	
Non-Starch NFC	16.6%	14.0%

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RRL TMR-D *in vivo* Analysis

TMR-D in vivo results	Your TMR % Digested	Benchmarks (Prior 4 Year Data) Avg	Goal - 80th Percentile	15th Percentile
OM-D	62.1%	60.3%	71.8%	48.9%
NDFD (% NDF)	51.7%	37.2%	52.0%	21.1%
NDFD (% pdNDF)	82.8%	66.2%	87.5%	41.6%
Starch-D	82.7%	90.3%	96.0%	85.7%
CP-D	58.5%	57.2%	71.1%	41.4%
Fat (EE)-D	75.0%	62.0%	79.2%	44.7%
lb Dig OM	32.2lb	31.8lb	37.2lb	25.4lb

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RRL TMR Anti-Nutrients Analysis (Hygiene)

Anti-Nutrients	
Mold	200,000
Yeast	13,600,000
Vomitoxin, ppm	2.46
Aflatoxin, ppb	
Zearalenone, ppb	
Fumonisin, ppm	
T-2, ppb	
Ochratoxin-A, ppb	
Clostridium perfringens	590
Enterobacteria	180,000

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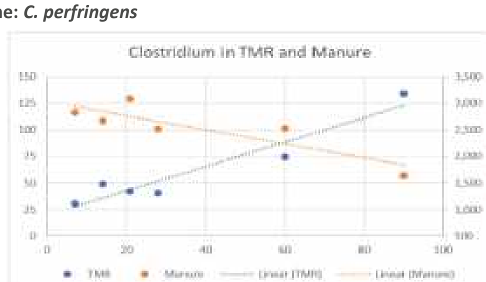
Composite
Hygiene: *C. perfringens*



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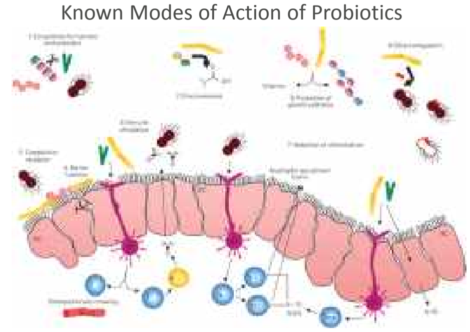
Known Modes of Action of Probiotics



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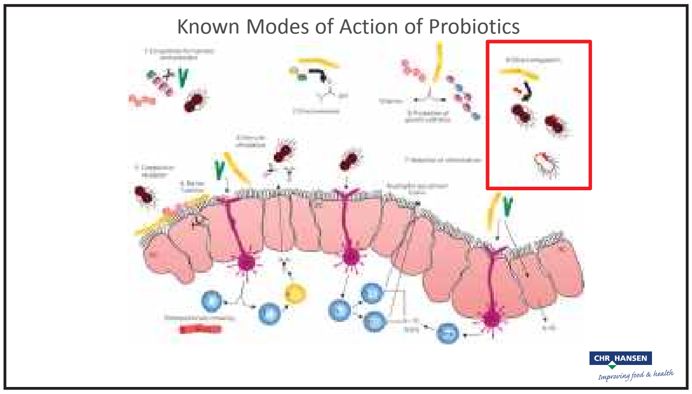

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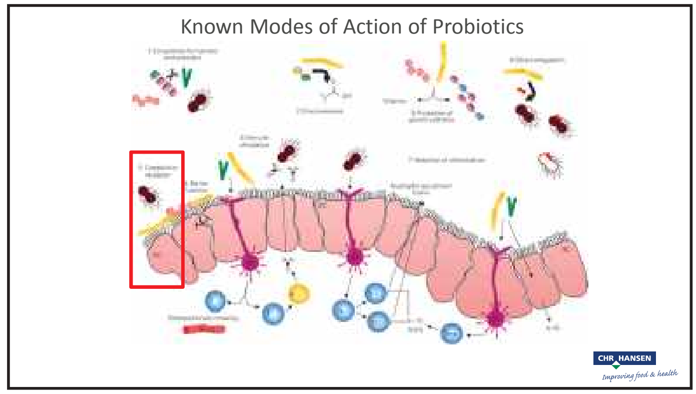

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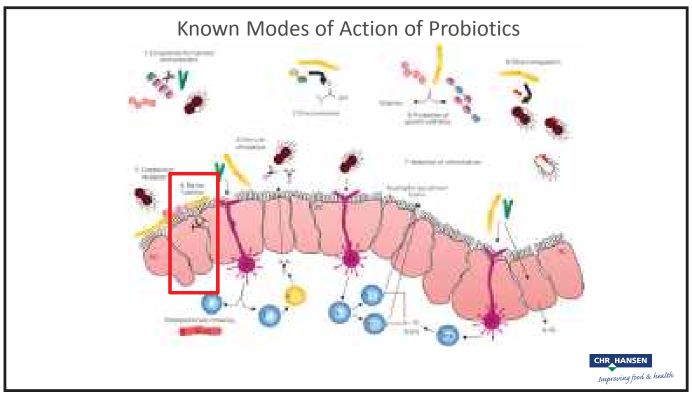

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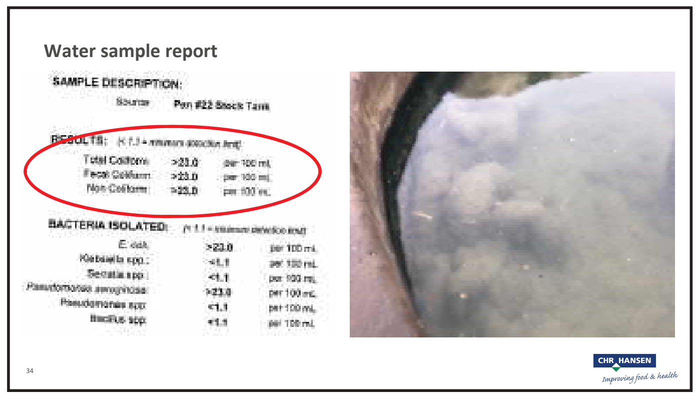

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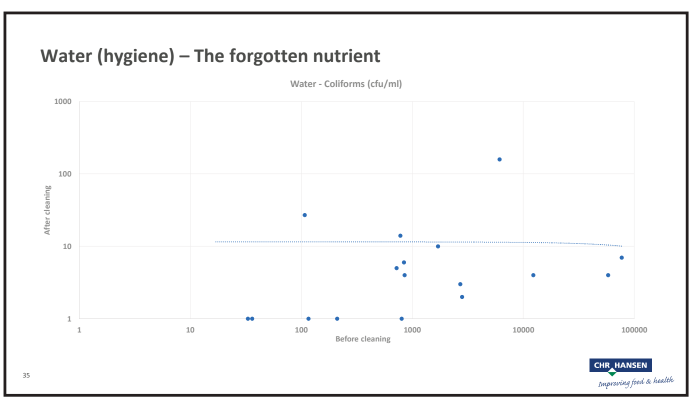

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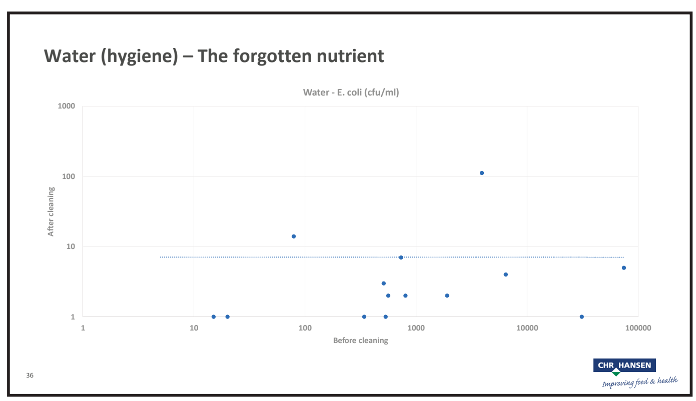

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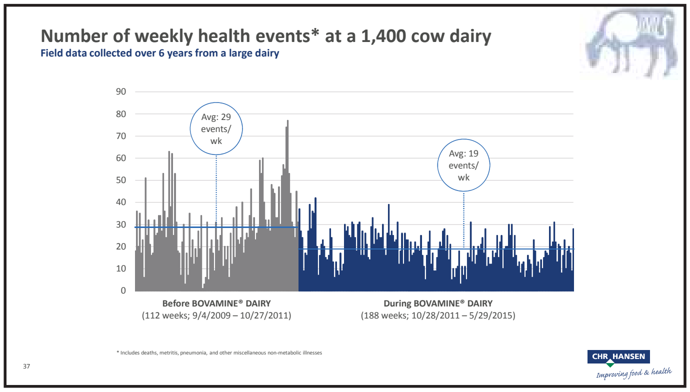
Number of weekly health events* at a 1,400 cow dairy
Field data collected over 6 years from a large dairy
90
80
70
60
50
40
30
20
10
0
Avg: 29 events/ wk
Avg: 19 events/ wk
Before BOVAMINE® DAIRY
(112 weeks; 9/4/2009 – 10/27/2011)
During BOVAMINE® DAIRY
(188 weeks; 10/28/2011 – 5/29/2015)
* Includes deaths, metritis, pneumonia, and other miscellaneous non-metabolic illnesses
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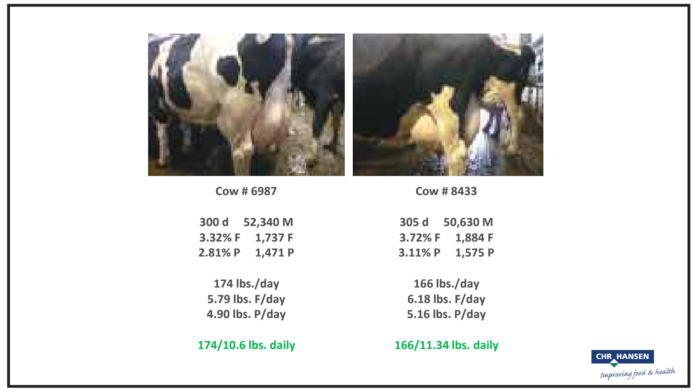
Cow # 6987
300 d 52,340 M
3.32% F 1,737 F
2.81% P 1,471 P
174 lbs./day
5.79 lbs. F/day
4.90 lbs. P/day
174/10.6 lbs. daily
Cow # 8433
305 d 50,630 M
3.72% F 1,884 F
3.11% P 1,575 P
166 lbs./day
6.18 lbs. F/day
5.16 lbs. P/day
166/11.34 lbs. daily
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Thank You!
Four-State Dairy Nutrition & Management Conference
Clean Feed:
Optimizing Health and Nutrition
Dr. Keith A. Bryan
Technical Service Specialist, Chr. Hansen Animal Health & Nutrition
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uskebr@chr-hansen.com
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Lessons Learned from 2019 Growing Season

Dr. Mike Hutjens, University of Illinois

Dr. Steve Woodford, Nutrition Professionals, Inc.

Four-State Dairy Nutrition & Management Conference

Lessons Learned from 2019 Growing Season

Dr. Mike Hutjens, University of Illinois
Dr. Steve Woodford, Nutrition Professionals, Inc.

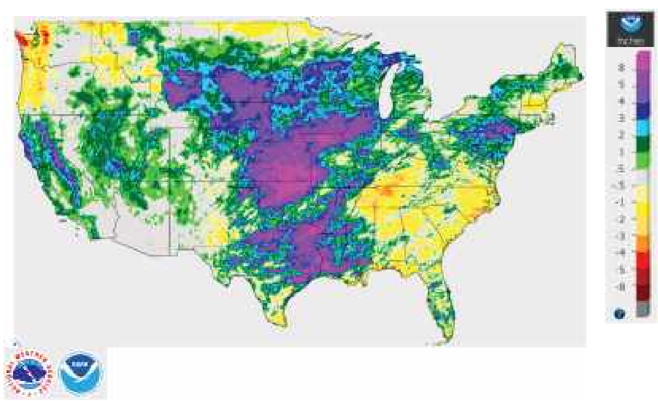
1

A Look At The 2019 Growing Year

- Cold winter killing alfalfa and wheat in some areas
- Wet spring delaying harvesting 1st cutting and planting corn
- Flooded areas
- Large increase in Prevented Plant Acreage (PPA)
- Harvest of (PPA) after Sept 1st including high seeding rate of corn for corn silage
- Variable quality and quantity year
- Early killing frost and snow cover

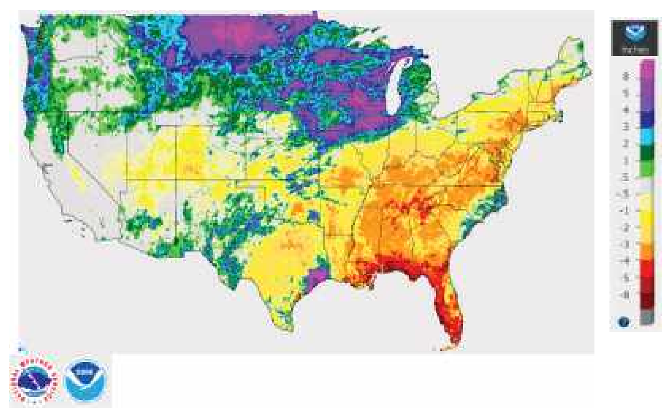
2

Monthly Departure Precipitation: May 1, 2019



3

Monthly Departure Precipitation: September 1, 2019



4

Prevented Plant—19 million acres

- Outlook for 2020 is wet winter and spring
- Limited field work in 2019
- 38.8 million acres of winter wheat (2nd lower acreage)
- Deep ruts and field damage from 2019 harvest
- Flooded acreage may take years to recover

5

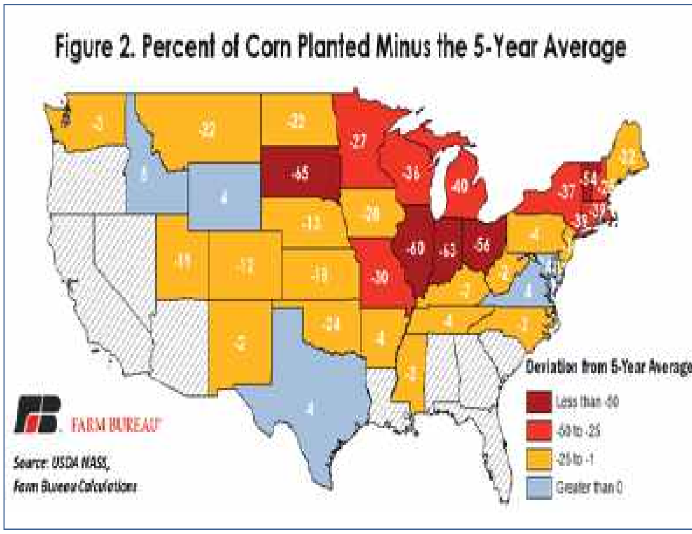
What Happened On Dairy Farms in NE Wisconsin?

6

What Happened On Dairy Farms In NE Wisconsin?

- Above average alfalfa winter kill over 17-18 and 18-19 winters.
- Consequently forage inventories tight.
- An extremely wet spring with alfalfa replanting and corn planting severely delayed.
- By mid June many farms turned to alternative forages like sudan and sorghum and eventually seed was unavailable.
- Very little winter wheat planted fall of 2018.

7



8

- Majority of alfalfa made late, around mid June resulting in lower quality.
- Sorghum-sudan a favored option on prevent plant acres, ended up not yielding well due to cool, wetter year.
- Due to wet fall corn silage was immature, so lower starch, but also made drier than ideal, some was frozen when chopped.
- Very little 4th crop made due to rain, significantly hurting haylage inventories.

9

What Recommendations Were Made And Suggested?

10

What Recommendations Were Made And Suggested?

- As we approached fall it was clear forage inventories would be down
- Suggested looking to contract best value forage-fiber replacements.
- Cottonseed, corn gluten feed, soy hulls, and beet pulp.
- Dry hay generally the higher priced option.

11

What Recommendations Were Made And Suggested?

- As we approached fall it was clear forage inventories would be down
- Suggested looking to contract best value forage-fiber replacements.
- Cottonseed, corn gluten feed, soy hulls, and beet pulp.
- Dry hay generally the higher priced option.

12

What Did Clients Do To Feed Herds In 2019/2020?

13

What Did Clients Do To Feed Herds In 2019-2020?

- First priority was to make sure enough forage-fiber was available.
- Somewhat unprecedented to have low energy fiber such as straw and grass hay more expensive that high energy fiber.
- Oat hulls, rice hulls, cotton gin trash, and sawdust were considered.

14

- It was clear corn silage would be lower starch and lower energy.
- We tried alternative starch sources such as ground wheat, corn starch, and molasses.

15

What Is The Situation Going Into The 2020/2021 Production Year?

16

What Is The Situation Going Into 2020 Production Year?

- In Eastern WI most crops planted by mid-May which is much earlier than average.
- Forage supplies still very tight
- Significant alfalfa winter kill again.
- Many looking at other options on that alfalfa ground including small grains and forage cocktails.
- Opportunity to lock in cheap corn long term.

17

What Long Term Lessons Were Learned?

18

What Long Term Lessons Were Learned?

- Many looking at alfalfa economics given the winter kill we are continually seeing.
- Producers are seeing cows perform fine with a high percentage of by-product fiber, even with shorter ration particle size.
- If current price trends continue, it is more profitable to grow your lower quality forage and buy higher energy fiber.

19

- Really important for good communications between nutritionist and agronomist.
- Cost to buy options versus cost to grow.
- The last 12 months demonstrated the need to source and contract supplies early.
- Covid-19 situation exposed weakness in supply chain.

20

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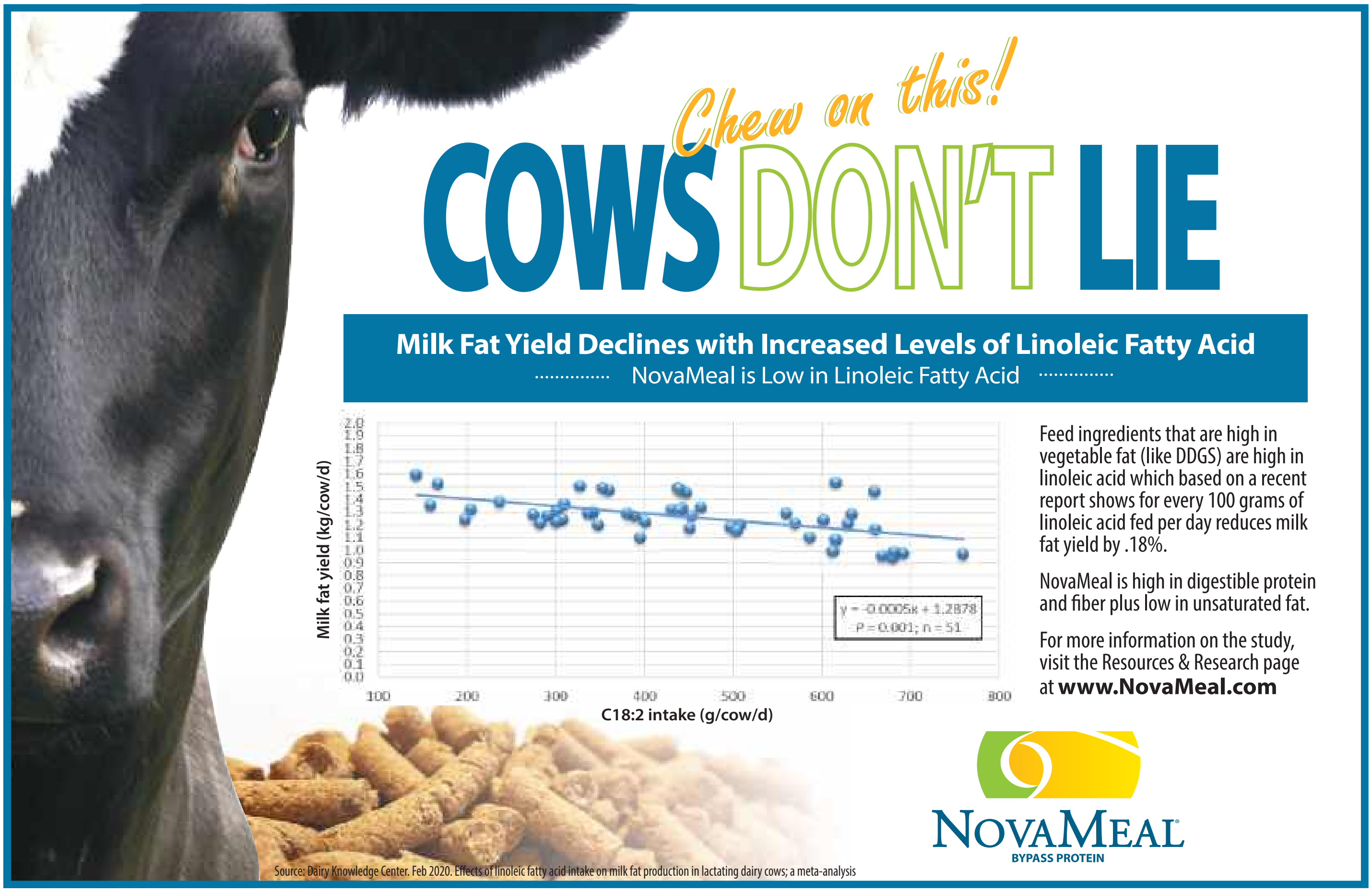

Chew on this!
COWS DON'T LIE
Milk Fat Yield Declines with Increased Levels of Linoleic Fatty Acid
NovaMeal is Low in Linoleic Fatty Acid
Milk fat yield (kg/cow/d)
y = -0.0005x + 1.2878
P = 0.001; n = 51
C18:2 intake (g/cow/d)
Feed ingredients that are high in vegetable fat (like DDGS) are high in linoleic acid which based on a recent report shows for every 100 grams of linoleic acid fed per day reduces milk fat yield by .18%.
NovaMeal is high in digestible protein and fiber plus low in unsaturated fat.
For more information on the study, visit the Resources & Research page at **www.NovaMeal.com**
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Source: Dairy Knowledge Center. Feb 2020. Effects of linoleic fatty acid intake on milk fat production in lactating dairy cows; a meta-analysis

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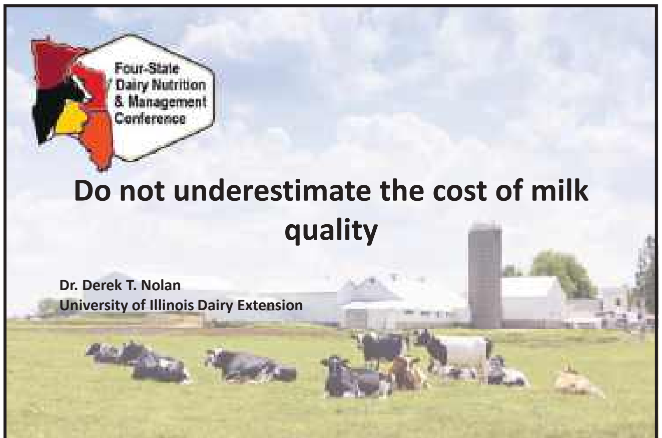
Do Not Underestimate the Cost of Milk Quality

Dr. Derek T. Nolan

University of Illinois Dairy Extension



Do not underestimate the cost of milk quality

Dr. Derek T. Nolan
University of Illinois Dairy Extension

1

The cost of mastitis

- Well known that mastitis is most costly disease in the dairy industry
- Often see estimates of mastitis costs of $150 to $400 per case

$2 Billion to US dairy industry

2

Underestimated

- $2 Billion only considers the cost of mastitis cases
- Incidence rate of mastitis * the estimate of cost of case of mastitis

> $2 Billion to US dairy industry

3

Total mastitis cost

- Cost associated with disease can be explained with simple equation

$$C = L + E$$

- C = Total cost
- L = Losses – benefits taken away (milk production, premiums)
- E = Expenses – resources used to manage a disease (management, labor)

McInerney et al. (1992)

4

Total mastitis cost

- Losses – Failure costs
  - Direct costs:
    - Cost of treatment
    - Discarded milk
    - Cost of culling the cow
  - Hidden costs:
    - Lost milk production
    - Lost reproductive efficiency

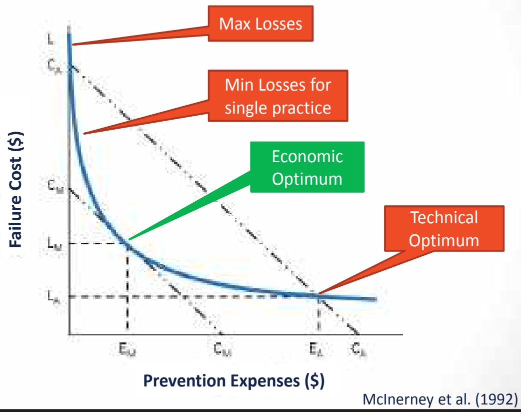
5

Total mastitis cost

- Expenses – Preventative Costs
  - Management practices
    - Proper milking procedures
    - Gloves
    - Milking equipment function
    - Cow environment management
    - Vaccination
  - Labor

6

Loss-Expenditure Frontier



McInerney et al. (1992)

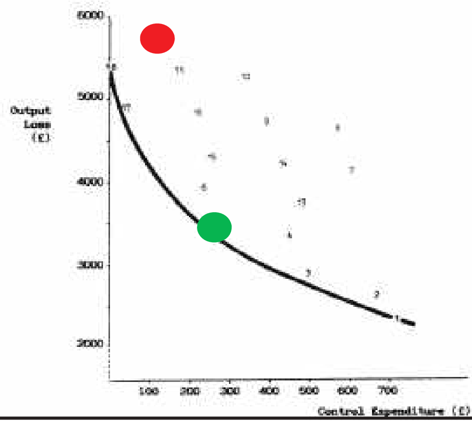
7

McInerney et al. (1992)

- Three different scenarios for subclinical mastitis
  - Teat disinfect – all year long
  - Dry cow treat – every cow at dry off
  - Milk equipment tests – annually

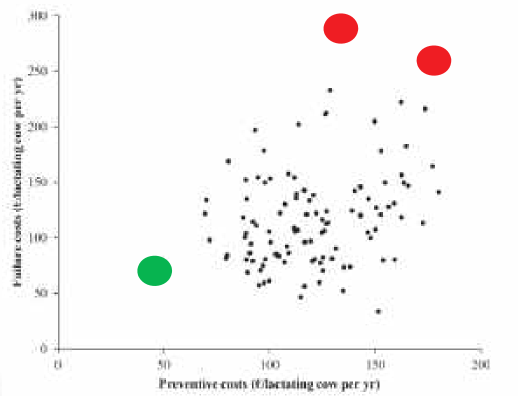
8

McInerney et al. (1992)



9

van Soest et al. (2016)



10

Use of loss-expenditure frontier

- Educate on disease and management practice costs
- Determine if management practices pay off
- Help dairy farmers make more informed decisions

11

Cost of SCC Management

- Base Model:
  - Dairy Herd
  - Data collected from Dairy Records Management Systems
  - Cost of SCC and benefits from management practices
- Stochastic Simulation
  - 1,000 iterations
  - Look at different scenarios
  - Account for variation

12

Base Model

Variable	Input
Herd Size	205
Rolling herd average (lbs)	22,740
Somatic cell count (# cells/mL)	251,000
Percent of herd in 1st lactation	36.1%
Percent of herd in 2nd lactation	26.0%
Percent of herd in 3rd lactation	17.7%
Percent of herd in 4th lactation	11.0%
Percent of herd in 5th lactation	5.8%
Percent of herd in 6th (or greater) lactation	3.4%

13

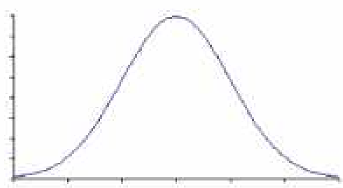
Base Model

- Determine costs of SCC management for herds with differing SCC
  - Farm A – 109,000 cells/mL
  - Farm B – 251,000 cells/mL
  - Farm C – 393,000 cells/mL
    - Based on one standard deviation from average

14

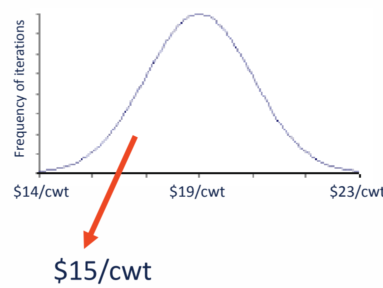
Stochastic Simulation

- Static variables : use single value in model – herd size
- Stochastic variable: want to account for variation



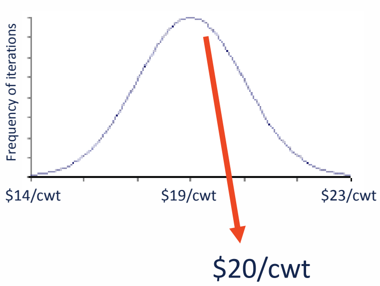
15

Milk price



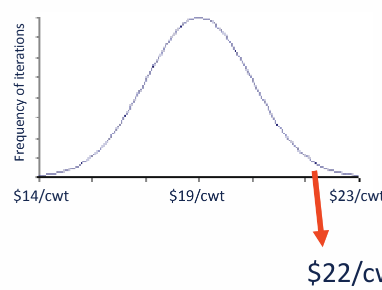
16

Milk price



17

Milk price



18

Cost of SCC

- For each herd the current cost of SCC was calculated
  - Milk loss
  - Lost of premiums

19

Milk Loss

SCC Threshold (SCC*1,000 cells/mL)		Milk loss (lbs/yr) by lactation		
Lower SCC	Upper SCC	1	2	3+
100	200	363	765	838
200	300	431	818	930
300	400	556	976	1,106

20

Premiums

Premium Level SCC (cells/mL)	
< 100,000	
100,000 to 200,000	Farm A
200,000 to 300,000	Farm B
300,000 to 400,000	Farm C

All farms lost $0.25/cwt due to SCC

21

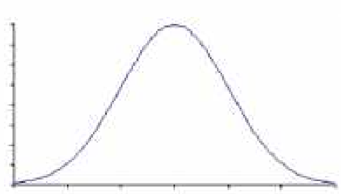
Cost of SCC

- Expenses
  - Management practices : $0.37 to $58.40/cow/yr
  - Teat dips to vaccinations or feed additives

22

Stochastic Variables

- Milk price
- Change in herd SCC
- Cost of management practice

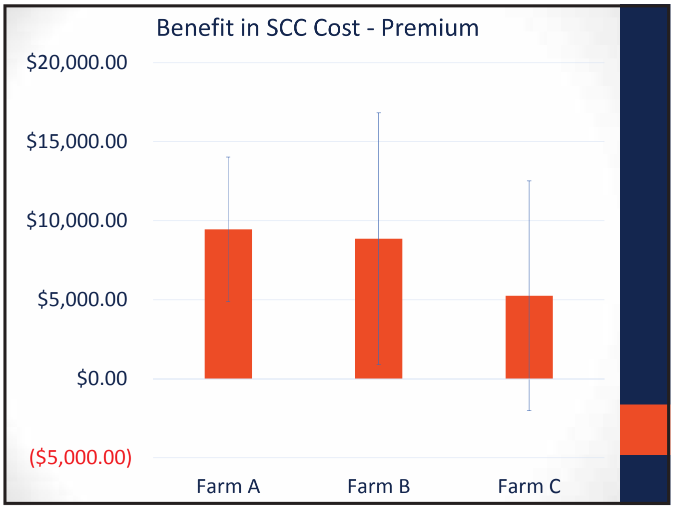


23

Data Analyzed

- Total cost of original SCC (losses)
- Benefits – costs of management practice adoption
- Total cost of new SCC
- Change in cost of SCC after adoption of management practices

24



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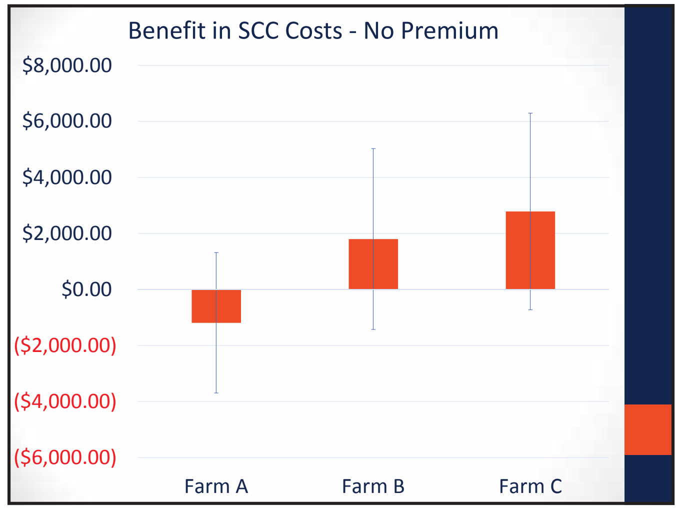

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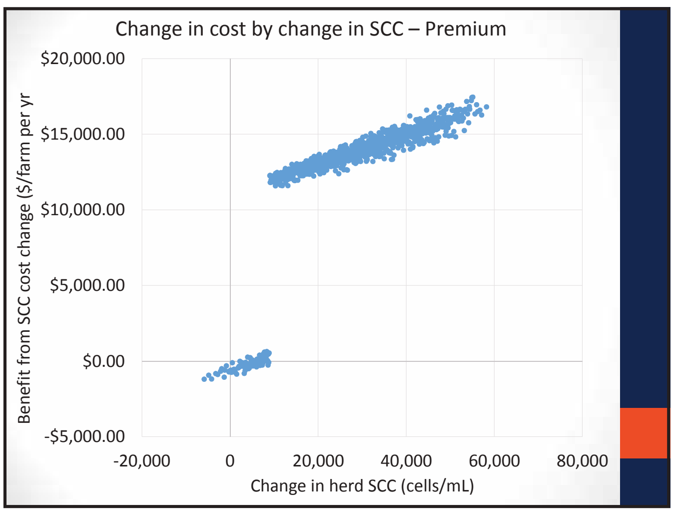

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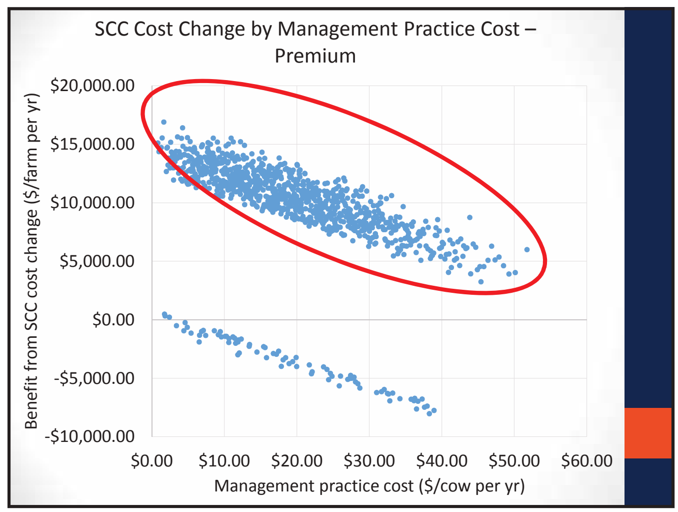

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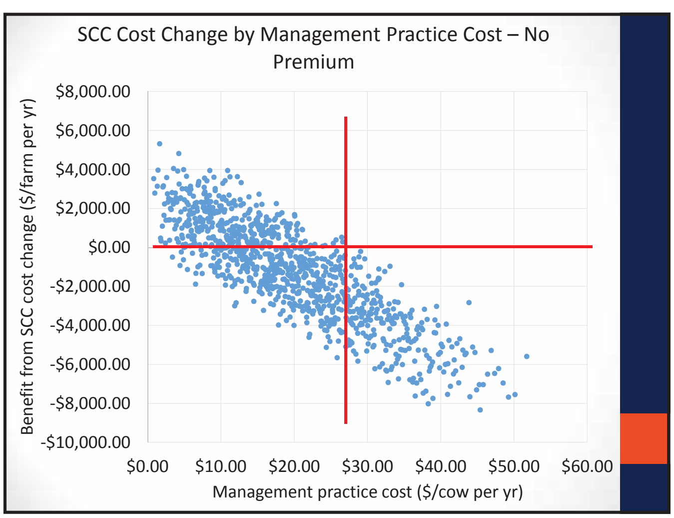

29

Discussion

- Low cost management decisions are the least risky for all producers
- High cost management practices may not be recommended for low SCC herds
- All results highly dependent on original SCC and premium structure
- Current results only account for milk value – do not consider reproductive benefits

30

Take Home Messages

~~$2 Billion to US dairy industry~~

⬆ $

31

Take Home Messages

- Loss-expenditure frontier useful tool to help make decisions
- Help understand failure and preventative costs to aid decision making
- Just because one goes up does not mean the other will go down (van Soest et al., 2016)
- Use premium as investment for milk quality
- Keep up to date with records

32

Thank you

Dairy Extension

ILLINOIS ACES

Dairy Focus Lab

Derek Nolan
University of Illinois
Department of Animal Sciences
dtnolan@Illinois.edu
217-244-7637

33

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Four-State Dairy Nutrition & Management Conference

Effect of Timing of Induction of Ovulation Relative to Timed AI Using Sexed Semen on Pregnancy Outcomes in Primiparous Holstein Cows

Megan R. Lauber and Paul M. Fricke
Department of Dairy Science
University of Wisconsin – Madison

Effect of timing of induction of ovulation relative to Timed AI using sexed semen on pregnancy outcomes in primiparous Holstein cows

Four-State Dairy Nutrition & Management Conference

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Department of Dairy Science
University of Wisconsin - Madison

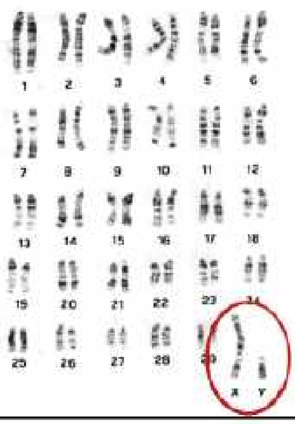
1

Outline

- Introduction to sexed semen
- Timing of insemination relative to increased activity associated with estrus
- Timing of induction of ovulation relative to synchronization of ovulation
- Questions

2

Sperm Differences

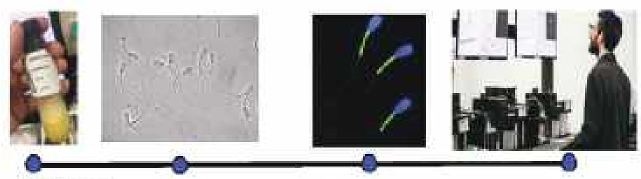


X- bearing bovine sperm have 4% more DNA content than Y-bearing bovine sperm

Garner et al., 1983; Garner et al., 2006; Seidel et al., 2014

3

Sexed Semen Processing



Ejaculates collected and examined

Quality Control
1. Motility
2. Concentration
3. Morphology

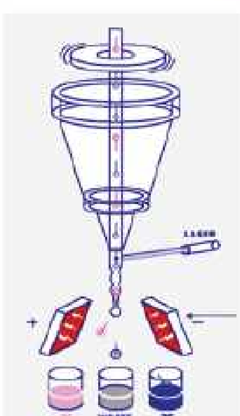
Pool ejaculates and stain with fluorochrome Hoechst 33342 that binds to minor groove of DNA

Stained ejaculates aliquoted and begin sexing process

4

Sex Sorting

STgenetics



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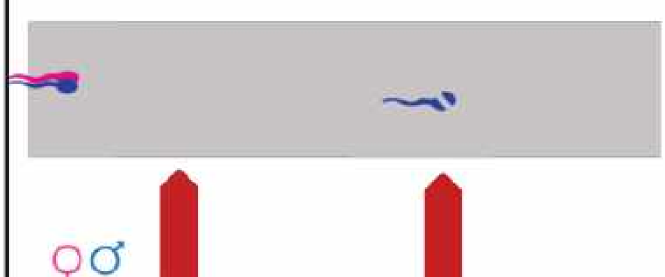
Selective Killing

Sexcel Sexed Genetics



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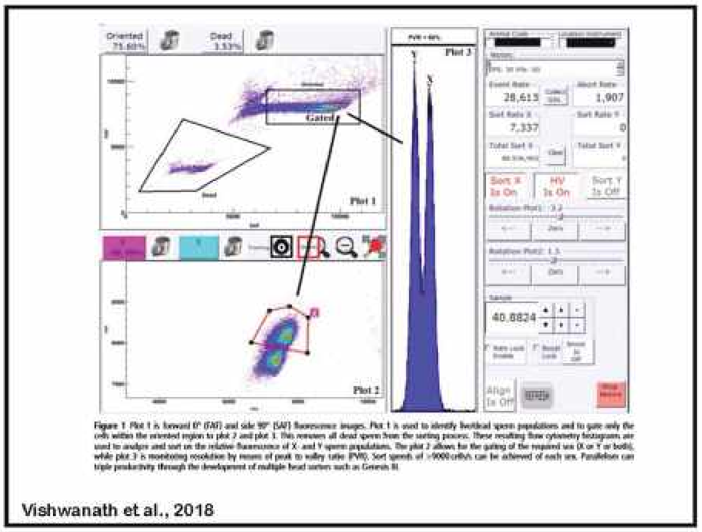
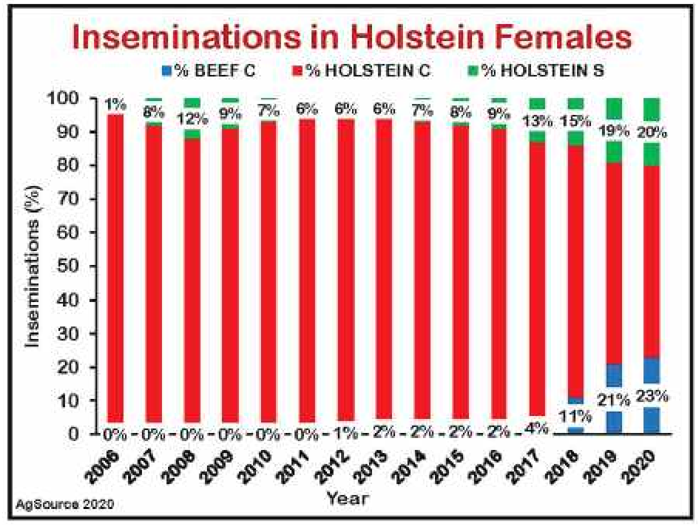
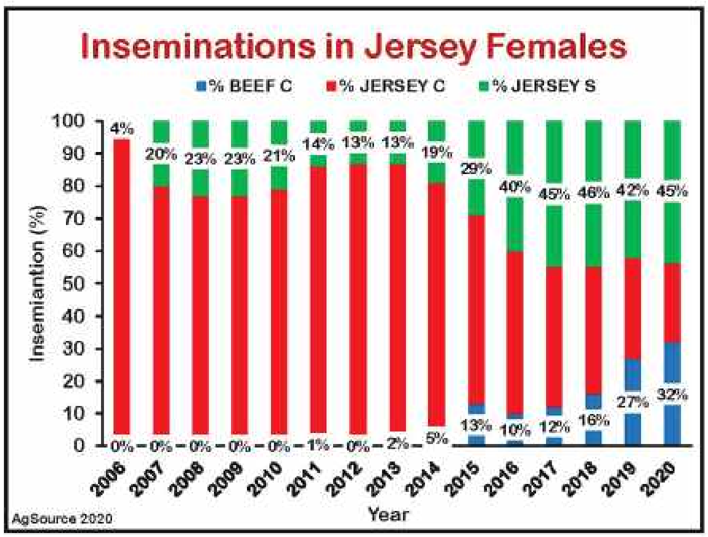

Gated
Plot 1
Plot 2
Plot 3
Vishwanath et al., 2018

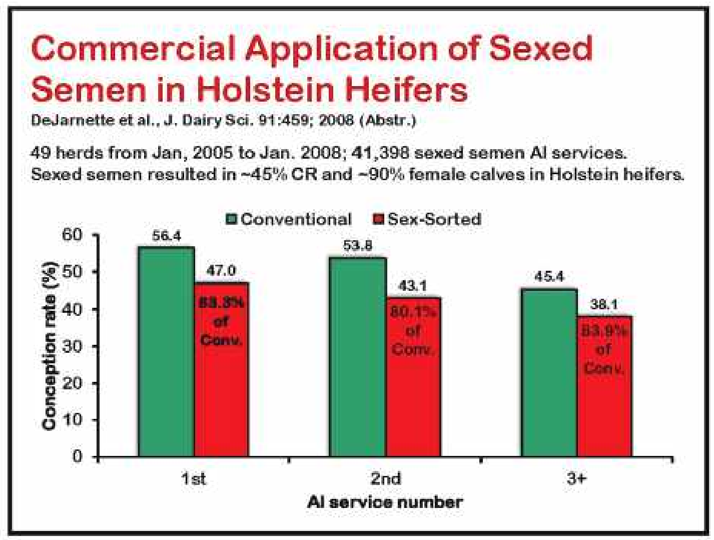
7


Inseminations in Holstein Females
% BEEF C
% HOLSTEIN C
% HOLSTEIN S
1% 8% 12% 9% 7% 6% 6% 6% 7% 8% 9% 13% 15% 19% 20%
0% 0% 0% 0% 0% 0% 1% 2% 2% 2% 2% 4% 11% 21% 23%
Inseminations (%)
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Year
AgSource 2020

8


Inseminations in Jersey Females
% BEEF C
% JERSEY C
% JERSEY S
4% 20% 23% 23% 21% 14% 13% 13% 19% 29% 40% 45% 46% 42% 45%
0% 0% 0% 0% 0% 1% 0% 2% 5% 13% 10% 12% 16% 27% 32%
Insemiantion (%)
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Year
AgSource 2020

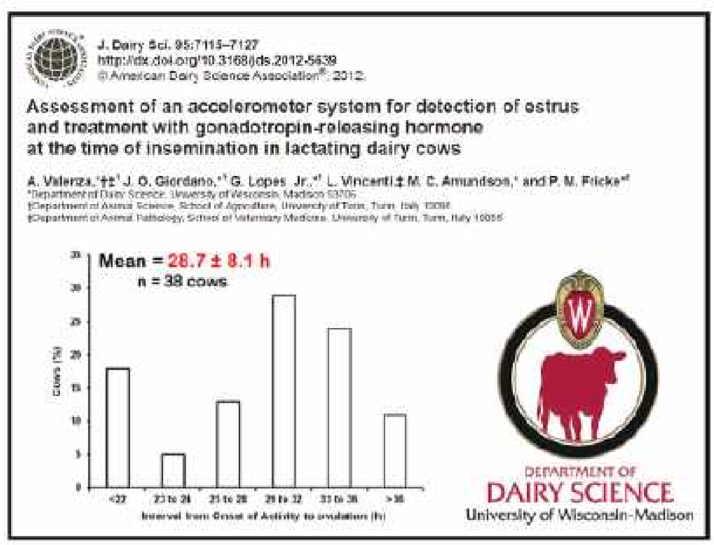
9


Commercial Application of Sexed Semen in Holstein Heifers
DeJarnette et al., J. Dairy Sci. 91:459; 2008 (Abstr.)
49 herds from Jan, 2005 to Jan. 2008; 41,398 sexed semen AI services.
Sexed semen resulted in ~45% CR and ~90% female calves in Holstein heifers.
Conventional
Sex-Sorted
56.4
47.0
83.3% of Conv.
53.8
43.1
80.1% of Conv.
45.4
38.1
83.9% of Conv.
Conception rate (%)
1st
2nd
3+
AI service number

10


Theriogenology
Time of insemination relative to reaching activity threshold is associated with pregnancy risk when using sex-sorted semen for lactating Jersey cows
Journal of Dairy & Veterinary Sciences
Juniper
Time of Insemination Relative to onset of Activity Threshold of Cow Manager ® is Associated with Pregnancy Risk When Using Gender Selected ™ Semen for Jersey Cattle
Inseminating later relative to the onset of activity yielded increased fertility with sexed semen

11


J. Dairy Sci. 95:7115–7127
http://dx.doi.org/10.3168/jds.2012-5639
© American Dairy Science Association®, 2012.
Assessment of an accelerometer system for detection of estrus and treatment with gonadotropin-releasing hormone at the time of insemination in lactating dairy cows
A. Valenza, J. O. Giordano, G. Lopes Jr., L. Vincenti, M. C. Amundson, and P. M. Fricke
Mean = 28.7 ± 8.1 h
n = 38 cows
Cows (%)
Interval from Onset of Activity to ovulation (h)
DEPARTMENT OF DAIRY SCIENCE
University of Wisconsin-Madison

12

New Idea

Inseminating later relative to the onset of activity or estrus will lead to increased fertility with sexed semen

- May be the case when inseminating cows based on estrus or increased activity
- This idea has not been tested in a synchronized breeding protocol in which timing of ovulation is precisely controlled

13

Effect of timing of induction of ovulation relative to timed artificial insemination using sexed semen on pregnancy outcomes in primiparous Holstein cows

Sexcel

Megan Lauber

Graduate Research Assistant
Fricke Lab

Department of Dairy Science
University of Wisconsin-Madison

14

Hypothesis

Induction of ovulation (G2) earlier relative to TAI in a Double-Ovsynch protocol will result in more P/AI

15

Standard Double-Ovsynch Protocol

G2 to TAI = 16 h

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					GnRH a.m.	
					$PGF_{2\alpha}$ a.m.	
	GnRH a.m.					
	GnRH a.m.		G2-16			
	$PGF_{2\alpha}$ a.m.	$PGF_{2\alpha}$ a.m.	G2 p.m.	TAI a.m.		

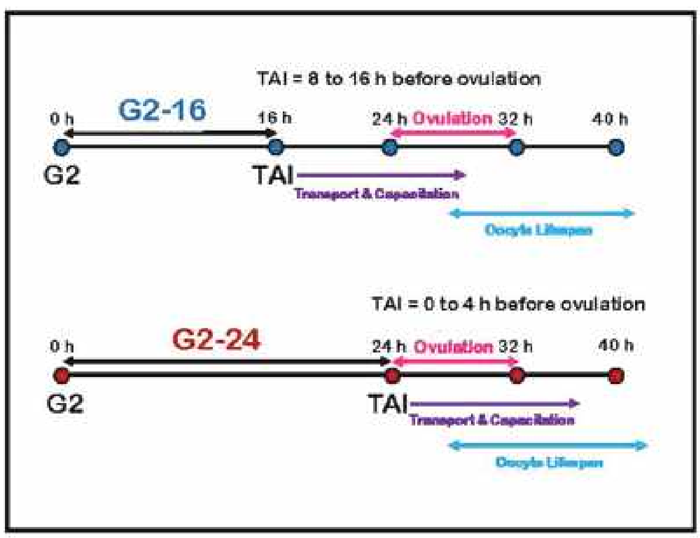
16

Modified Double-Ovsynch Protocol

G2 to TAI = 24 h

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					GnRH a.m.	
					$PGF_{2\alpha}$ a.m.	
	GnRH a.m.					
	GnRH a.m.		G2-24			
	$PGF_{2\alpha}$ a.m.	$PGF_{2\alpha}$ a.m.	G2 a.m.	TAI a.m.		

17



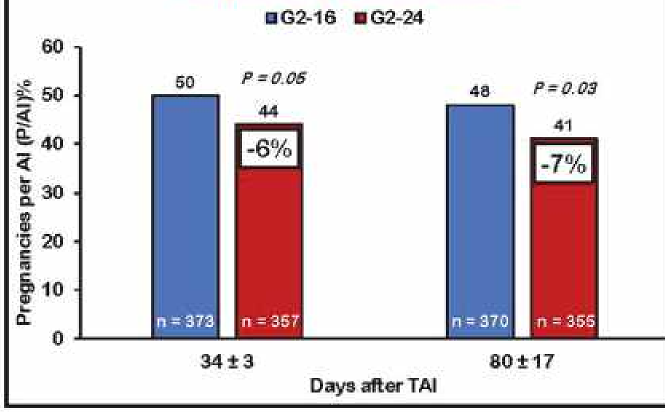
18

Collaborating Farms

- Three locations:
  - Nebraska, Ohio, Wisconsin
- Primiparous cows (n = 730)
- All farms submitted cows for first Timed AI using a Double-Ovsynch protocol
  - Farm A: 6,650 cows; ME305 = 24,900 lb.
  - Farm B: 1,800 cows; ME305 = 28,500 lb.
  - Farm C: 2,260 cows; ME305 = 31,000 lb.

19

Effect of Treatment on Pregnancy Outcomes

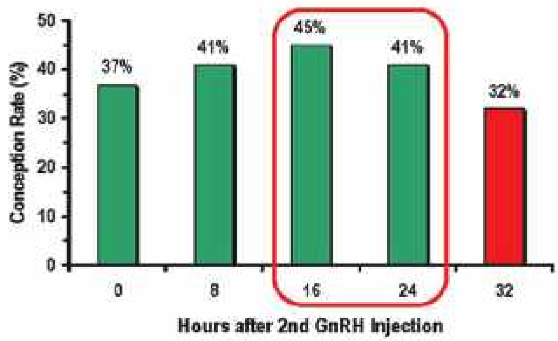


20

Effect of Time of Artificial Insemination on Pregnancy Rates, Calving Rates, Pregnancy Loss, and Gender Ratio After Synchronization of Ovulation in Lactating Dairy Cows

J. RICHARD PURSLEY,[*,1] ROY W. SILCOX,[†] and MILO C. WILTBANK[*,2]

1998 J Dairy Sci 81:2139–2144



21

J. Dairy Sci. 103
https://doi.org/10.3168/jds.2019-17870

Optimization of timing of insemination of dairy heifers inseminated with sex-sorted semen

Ricardo C. Chebel[1,2*] and Thiago Cunha[1]

		Sexed	
Item	Conventional	Early	Late
n	300	415	402
P/AI at 30 d (%)	67[a]	45[b]	47[b]
P/AI at 62 d (%)	63[a]	43[b]	45[b]
Female (%)	43[a]	89[b]	91[b]

P/AI of sexed semen = 69% of conventional semen

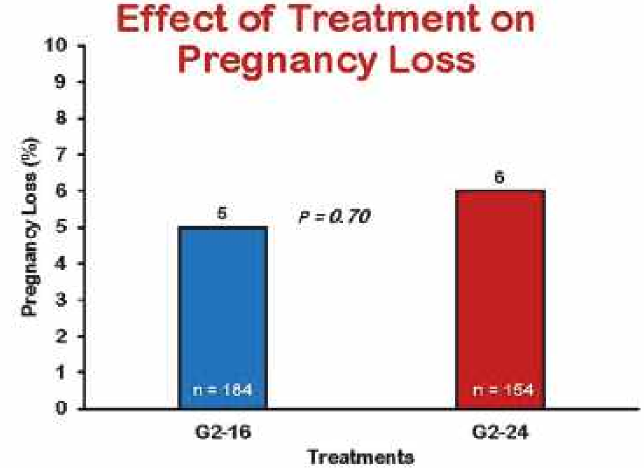
22

Factors affecting fertility

- Time for sperm transport and capacitation
  - G2-16 cows: 8 to 16 h ; G2-24 cows: 0 to 8 h
  - Sustained transport requires 8 to 12 h
- Time for luteolysis
  - G2-24 cows had 8 fewer hours than G2-16 cows
    - Altered estradiol and progesterone concentrations
- Ovulatory follicle size
  - G2-24 cows likely ovulated smaller follicles because they had 8 fewer hours to develop during the synchronized follicular wave than G2-16 cows.

23

Effect of Treatment on Pregnancy Loss



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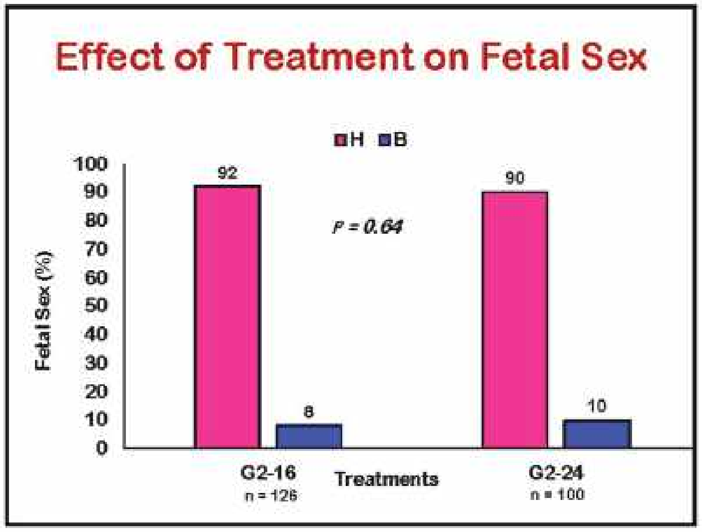

25

Hypothesis

Induction of ovulation (G2) earlier relative to TAI in a Double-Ovsynch protocol will result in more P/AI

Reject

6% and 7% decrease in P/AI 34 ± 3 d and 80 ± 17 d at 24 h interval

No difference in pregnancy loss at 24 h interval

No difference in fetal sex ratio

26

Thank you and Questions?

27


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Investment With New
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New AminoShure®-XM reliably delivers methionine at a substantial savings over other rumen-protected methionine sources. Research shows that savings could be as much as 5¢ per cow per day.*
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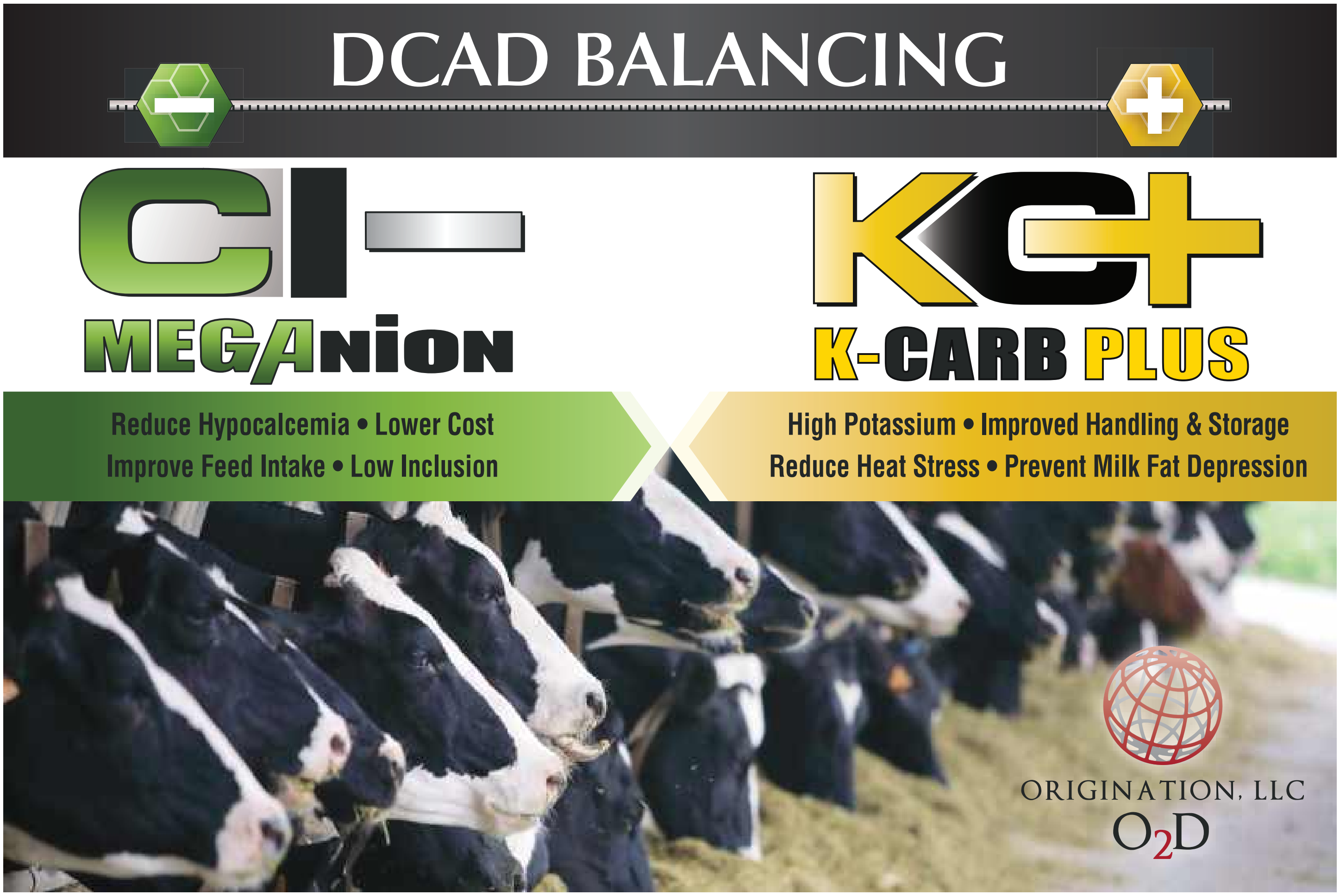
*Based on a 16 g/cow/day feeding rate of a competitive product. © 2020 Balchem Corporation. All trademarks are property of Balchem Corporation. 2006-001


DCAD BALANCING
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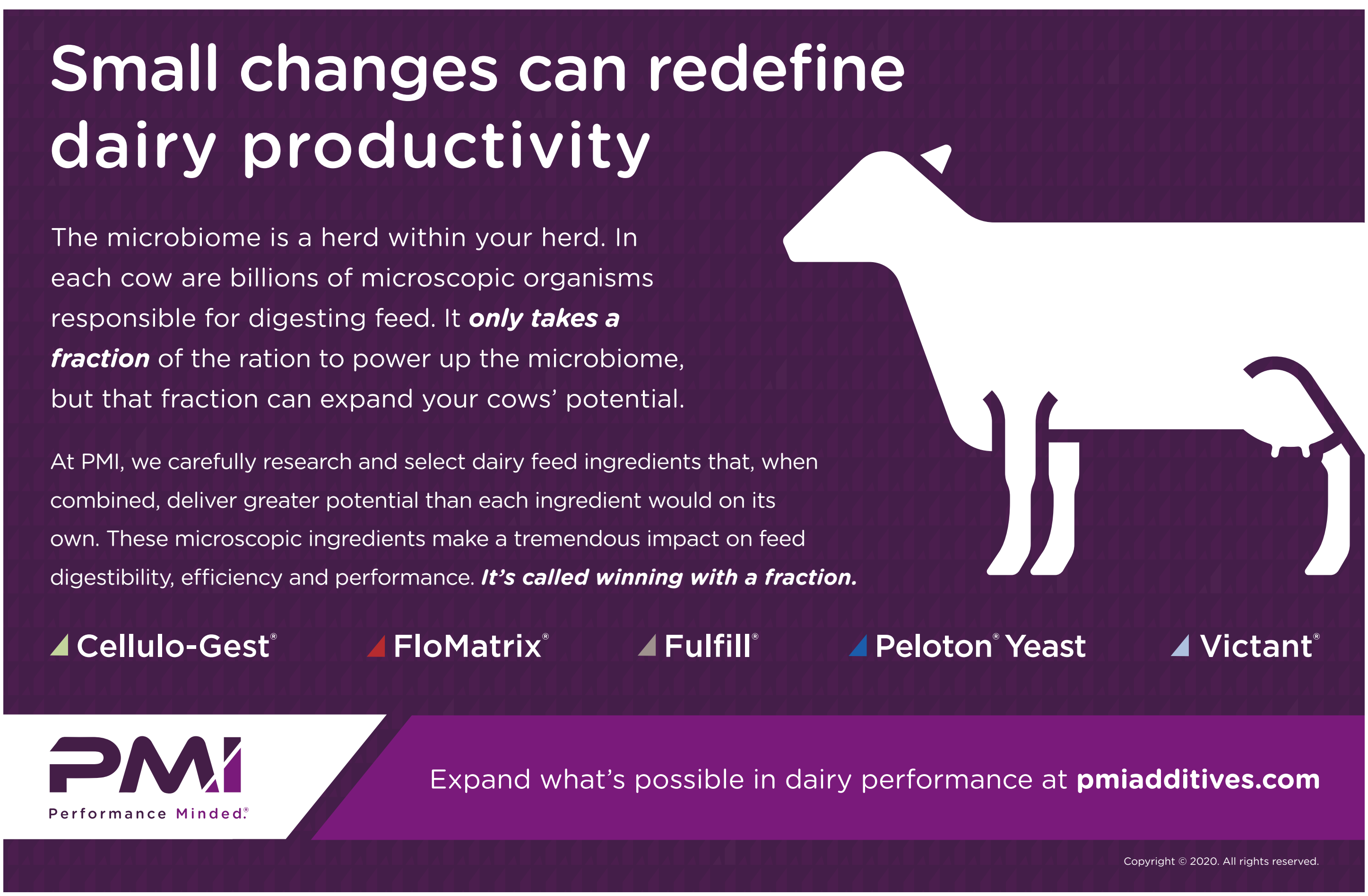
Reduce Hypocalcemia • Lower Cost
Improve Feed Intake • Low Inclusion
High Potassium • Improved Handling & Storage
Reduce Heat Stress • Prevent Milk Fat Depression
ORIGINATION, LLC
O2D


Small changes can redefine dairy productivity
The microbiome is a herd within your herd. In each cow are billions of microscopic organisms responsible for digesting feed. It ***only takes a fraction*** of the ration to power up the microbiome, but that fraction can expand your cows' potential.
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Four-State Dairy Nutrition & Management Conference

Challenges of Barn Design and Performance in Automated Milking Systems

Nigel B. Cook MRCVS
University of Wisconsin-Madison
School of Veterinary Medicine

2020
4-State Dairy Nutrition and Management Conference
Breakout Session

Challenges of Barn Design and Performance in Automated Milking Systems

Nigel B. Cook MRCVS
University of Wisconsin-Madison, School of Veterinary Medicine

1

The US AMS Challenge:

- How do we design and manage an AMS unit to improve milk per cow per day and be labor efficient?

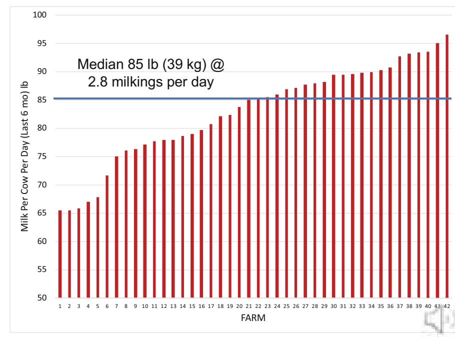
2

UW Upper Midwest AMS Survey 2018

- 42 predominantly Holstein herds
- Mean time milking in AMS: 4.1 years (minimum >1yr)
- Mean herd size: 209
- 83% new, 17% retrofit
- 60% Lely, 31% DeLaval, 4% AMS Galaxy, 2% GEA, 2% BouMatic

3

Milk per Cow (42 AMS herds)



4

Cows per robot
Waiting Time
Heifer Management
Traffic System
Flooring and Alleys
Lameness
Bedding
Footbaths
Ventilation
Transition
Feeding
AMS Unit Design and Gating

5

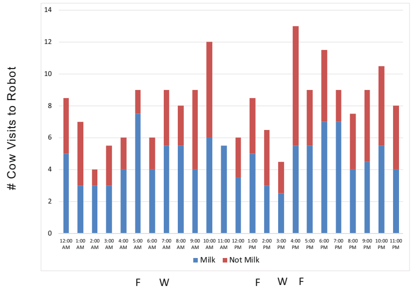
Theoretical Robot Capacity

- Robot availability 22 h per day
- Box time ~7 mins per cow – 60/7 = ~8 cows milked per hour
- 22 x 8 = 176 milkings per day
- At 2.8 milkings per day = 63 cows per robot

- BUT this forgets that cows are cows!

6

Daily Variation in Robot Visits



The desire to be milked is not constant throughout the day!

W=Robot washes
F=Fetch cows

7

No threshold for cows per robot exists in the literature….

- Very little data to support planning to milk more than 60 cows per robot using current settings installed by manufacturer
- Mean cows per robot reported in literature in US and Canada ~49-56 cows
- Greater numbers decrease robot visits and increase fetch rates
- Cow behavior dictates that the theoretical maximum will not be achieved in practice!

- Plan for 55 cows per robot!

8

Cows per robot

Waiting Time

Heifer Management

Flooring and Alleys

Lameness

Traffic System

Bedding

Footbaths

Ventilation

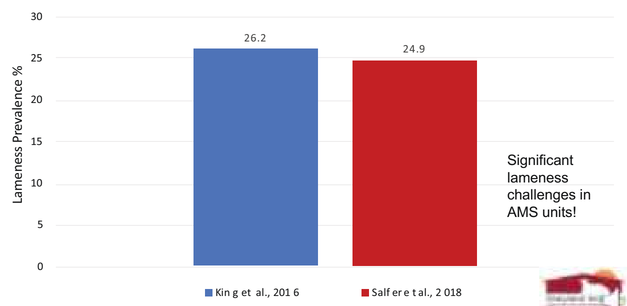
Transition

Feeding

AMS Unit Design and Gating

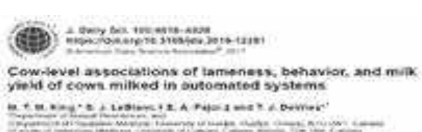
9

Lameness Prevalence in AMS Herds



Significant lameness challenges in AMS units!

10


J. Dairy Sci. 100:4818–4828

Cow-level associations of lameness, behavior, and milk yield of cows milked in automated systems

M. T. M. King, S. J. LeBlanc, E. A. Pajor, and T. J. DeVries

Lame cows compared to non-lame cows in 41 AMS facilities in Canada:

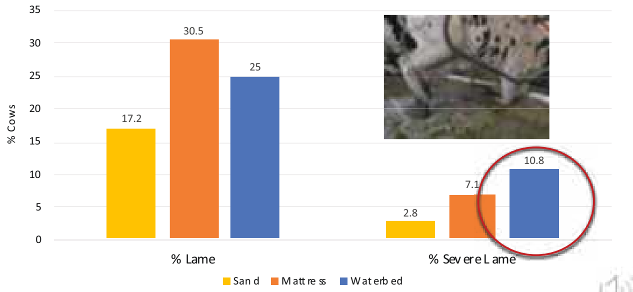
- Produced 1.6 kg (3.5 lb) /d less milk
- Milked 0.3 fewer milkings per day
- 2.2 time more likely to be fetched

11

Easy access to a chute for individual cow attention is essential

12

Impact of Stall Base on Lameness in AMS Units



Salfer et al., JDS 101:8586-8594, 2018 from 54 AMS units in Upper Midwest

13

- Cows per robot
- Waiting Time
- Heifer Management
- Traffic System
- Flooring and Alleys
- Lameness
- Bedding
- Footbaths
- Ventilation
- Transition
- Feeding
- AMS Unit Design and Gating

14

Deep loose bedding is best for cows!

15

Sand Challenges in Robots

- Precludes slatted flooring – GOOD!
- Requires V-shaped scrapers for bedding access (or manual scrape alleys)
- Sand wears the nylon retractor cables and pulleys in LELY units
- Sand scratches the camera lens in DELAVAL units
- ???? GEA units

- We believe most of these issues are manageable!

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Bedding access and scrapers in AMS facilities

17

UW AMS Survey 2018 – Stall Base

- 57% Sand, 24% Mattress, 17% Waterbed, 2% Manure Solids
- Mean milk per cow per day significantly different between deep bedding (sand/manure solids) and mattress (P<0.05), and deep bedding and waterbed (P<0.05)
  - Sand/manure deep bed 85.8 lb (39.0 kg)
  - Mattress 79.0 lb (35.9 kg)
  - Waterbed 78.1 lb (35.5 kg)

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Cows per robot

Waiting Time

Heifer Management

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AMS Unit Design and Gating

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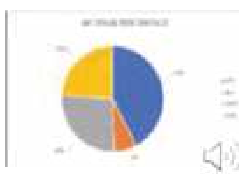
The AMS Footbath Challenge

- Exit lane footbaths decrease robot attendance?
- Pushing cows through a footbath on a crossover has never worked well and producers don't bath frequently enough with this approach!

20

Voluntary footbaths ….
do not work!



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The Ideal Footbath

- 10' (3-3.7 m) long
- 24" (0.6 m) wide sloped to 3' (1 m) at 3' (1 m) high
- 10" (25 cm) high step

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Cows must be selected from the robot to walk through the footbath as they leave the robot area and/or return to the resting area

23

Having to put the footbath in a cross alley is a significant drawback to the L-shape, cross-way and side installation designs!

24

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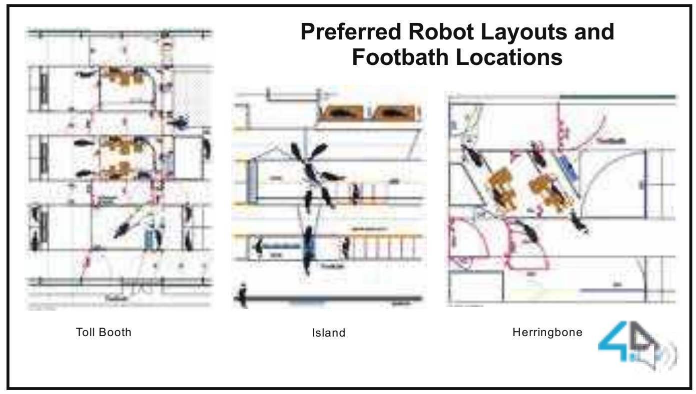

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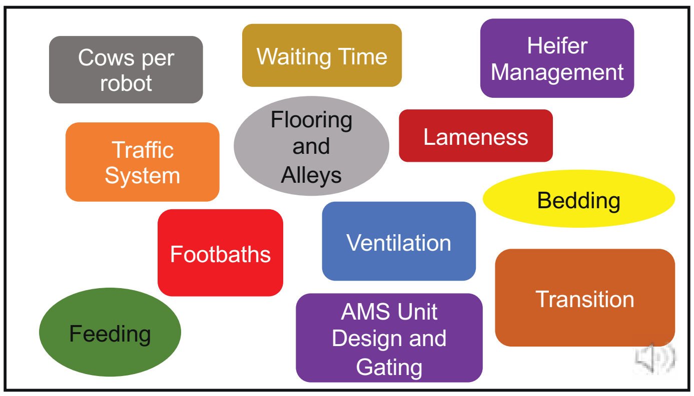

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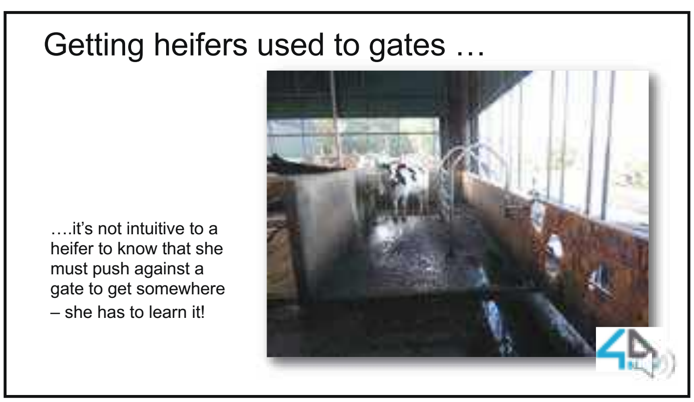

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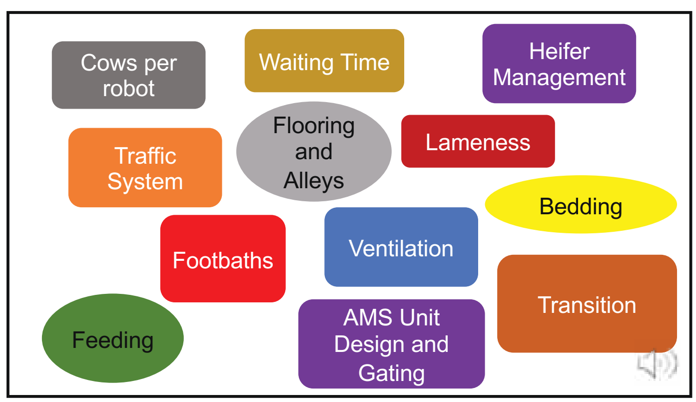

30

UW AMS Survey 2018 – Fresh Cows

- Most AMS units don't separate fresh cows from other lactating cows for very long!
  - DIM fresh mature cows 0-30 (mean 5.1 days)
  - DIM fresh heifers 0-30 (mean 6.6 days)
- 38% of herds separate fresh cows from lactating cow group for 1 day or less (mean 81 lb (36.8 kg) milk per cow per day)
- 7% of herds separated cows for 14 or more days (mean 88 lb (40.0 kg) milk per cow per day)

31

24/7 fresh cow access to the robot

32

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Cows per robot

Waiting Time

Heifer Management

Traffic System

Flooring and Alleys

Lameness

Bedding

Footbaths

Ventilation

Transition

Feeding

AMS Unit Design and Gating

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Alley space is incredibly important in an AMS unit – they allow cows to move toward the robot unhindered!

35

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Alley Width Recommendations

Alley Type	Recommended Alley Width feet (m)	
	Conventional	AMS
Stall Alley	10 (3.0)	11 (3.4)
Feed Alley	12 (3.7)	14 (4.3)
Feed and Stall Alley	13 (4.0)	15 (4.6)

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Cows per robot

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Traffic Systems

- Free-flow
- Guided-flow
- Hybrid (Semi-Guided-flow)

40

Free- or Guided-Flow?

- Increased milk per cow with free-flow vs. guided-flow traffic (Tremblay et al., 2016), but in survey only 7% herds had guided-flow and all farms used Lely units, which are biased toward free-flow!
- Each strategy has pros and cons
- Individual farm circumstances should drive the decision
- Facilities can be designed so that both strategies can be adopted

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AMS Traffic Systems – Free-Flow

Pros

- Cows have the freedom to move around the pen – go to the bunk when fresh feed is delivered
- Lower cost – fewer sort gates
- Cows do not get trapped waiting to visit the robot
- Highest producing herds use free-flow

Cons

- Often herds feed more pellet in the robot
- Operation requires more fetching of cows
- Makes footbath use and gating more complex
- May need more FTEs to operate

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AMS Traffic Systems – Guided-Flow

Pros
- Easier to manage, potentially with less labor
- Less fetching of cows
- Feed less expensive pellet in the robot
- Sort options into VIC group/footbath when exiting commitment pen

Cons
- Cows may not be able to access fresh feed at the feed bunk (solved with Hybrid-Flow)
- Cows get trapped in commitment pen for longer periods (solved with alerts)
- Lower milk production being achieved on average
- Still have to fetch cows

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Cows per robot

Waiting Time

Heifer Management

Traffic System

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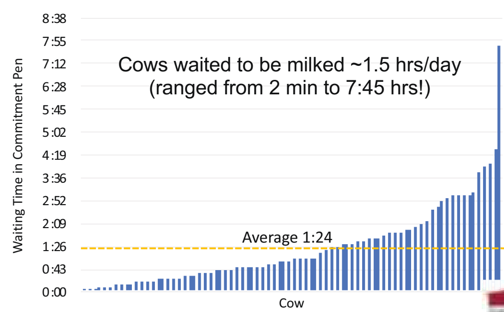
Wait Time for Milking in GF and FF Traffic Systems
(Solano et al., 2020 unpublished)

45

Daily waiting time (hh:mm per day) to be milked in a guided-flow



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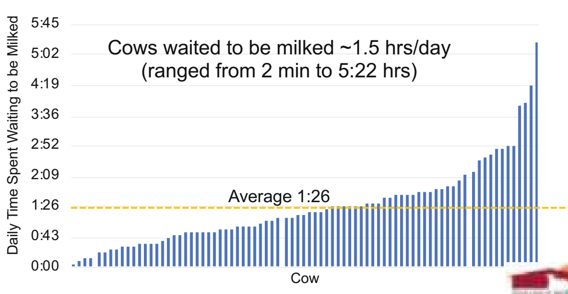
Daily waiting time (hh:mm per day) to be milked in a free-flow



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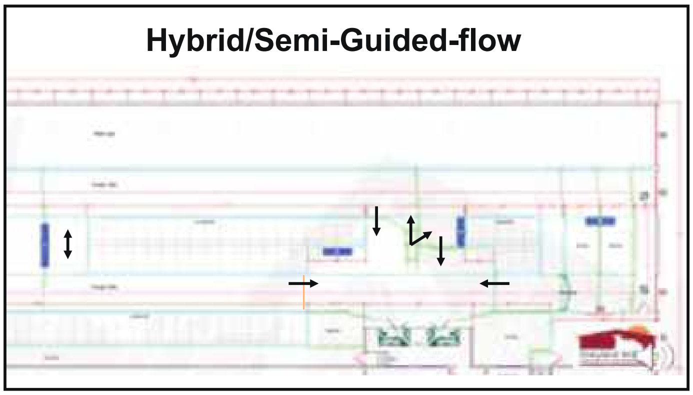

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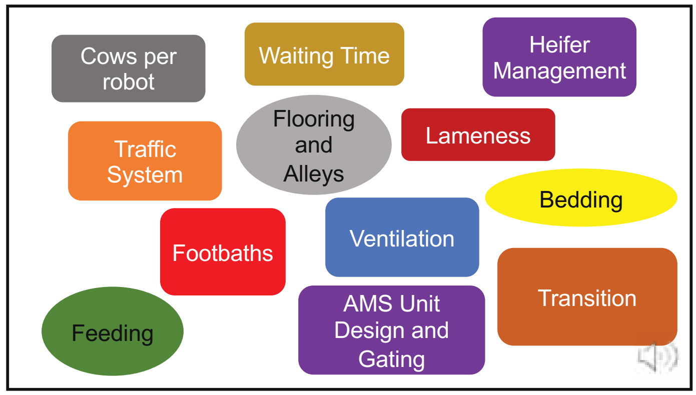

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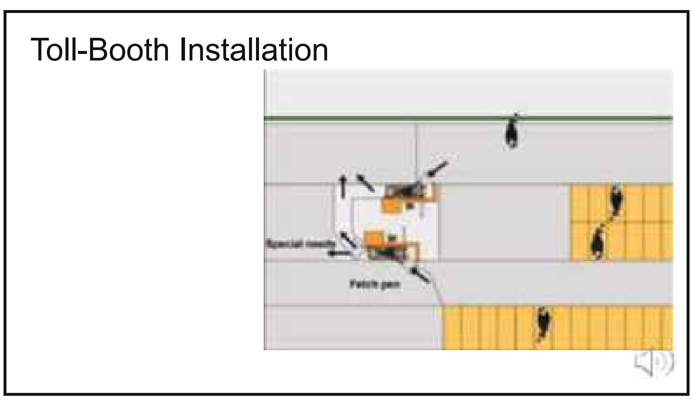

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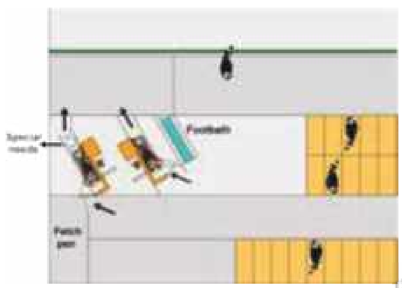
Not this!

56

Herring-bone Installation



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- Cows per robot
- Waiting Time
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AMS Ventilation Challenges

- Sideway installations block the sidewall inlet in natural barns
- Crossway installations block airflow in a tunnel barn
- The robot room blocks inlets and airflow in a cross barn
- Need for climate control around the robot

- While commonly used in AMS units, HVLS fans struggle to provide cooling air speeds!

60

Specific AMS Solutions

- Dead air in robot room shadows
  - Deliberately make robot waiting area hostile – NO!
  - Provide recirculation fans to improve air flow – YES!
- Robot or milk room blocks inlet area or limits fan mounting area
  - Build inlets around side and top of milk/robot room
  - Positive pressure fans to force fresh air into areas with dead air movement

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Add fans to move air in the robot waiting area!

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Cows per robot

Waiting Time

Heifer Management

Traffic System

Flooring and Alleys

Lameness

Bedding

Footbaths

Ventilation

Transition

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AMS Unit Design and Gating

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Conventional vs. AMS Units

Conventional (Cook et al., 2016)	AMS (Salfer et al., 2018)	AMS (Halbach et al., 2019)
70% deep bedding	31% deep bedding	60% deep bedding
0% slatted flooring	22% slatted flooring	11% slatted flooring
73% manual manure removal	26% manual manure removal	2% manual manure removal
100% footbath mean 4.5 X per week	70% footbath and only 27% >3X per week	96% footbath and only 18% >3X per week
TMR fed	PMR fed with pellet in robot	PMR fed with pellet in robot
13% lameness	25% lameness	Not observed
~90 lb (41 kg) milk	~75 lb (34 kg) milk	~83 lb (38 kg)

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AMS General Design Priorities

- 55 cows per robot max to limit fetch rate and optimize robot visits, minimum 2 AMS units per pen
- Free-flow or Hybrid vs. Guided-flow
- Toll-booth, Herringbone or Island preferred designs with selection through a footbath
- Deep loose bedding – sand!
- Sufficient feedbunk space per cow – minimum 24" or 60 cm per cow in the main lactating cow pen
- 24/7 fresh cow access to robot for 10-21 days
- Heifer gate training
- Expert gating and flow modeling

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Dairyland Initiative

Sponsors

Mission

Saputo

Program

Workshop

66


DairylandInitiative
www.thedairylandinitiative.vetmed.wisc.edu
Email: nigel.cook@wisc.edu
Housing Module
Lifestep Lameness Module
Calf Health Module
Thank you!

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Road Map to Fatty Acid Balancing

Palmitic to Oleic Balance
Improve milk fat, milk & body condition

Palmitic 16:0 — ↑ milk fat more than milk yield

Oleic 18:1 — ↑ digestibility of all fatty acids, milk production & body condition

1% Palmitic and 1% Oleic for balanced energy partitioning (%DM)

Manage 18:2 & Rumen Exposure
Too much 18:2 = ↓ milk fat production

Linoleic 18:2 — Found in corn, corn silage, distillers, cottonseed
Too much unprotected 18:2 = ↓ milk fat

300+ grams is considered a milk fat risk factor

Omega-6 to Omega-3 Balance
Improve immune health, milk & repro

Omega-6 18:2 — Inflammatory = lost energy to immune

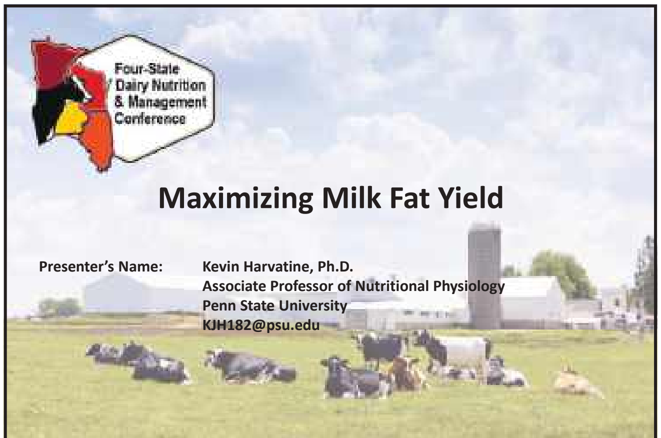
Omega-3 EPA DHA — Anti-inflammatory= ↑ milk & repro

5:1 or ↓ ratio for optimal results in lactating cows

Four-State Dairy Nutrition & Management Conference

Maximizing Milk Fat Yield

Kevin Harvatine, Ph.D.
Associate Professor of Nutritional Physiology
Penn State University
KJH182@psu.edu



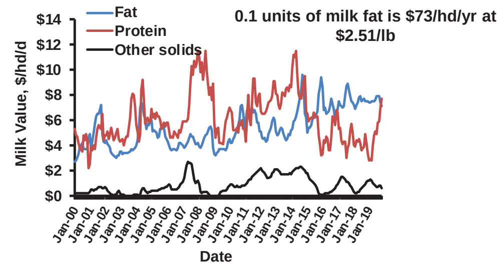
Four-State Dairy Nutrition & Management Conference

Maximizing Milk Fat Yield

Presenter's Name: Kevin Harvatine, Ph.D.
Associate Professor of Nutritional Physiology
Penn State University
KJH182@psu.edu

1

Milk fat and protein yield are the main drivers of cash flow ($/hd/d @80 lb of 3.7 fat & 3.05 protein)



Harvatine unpublished based on USDA NASS milk price

- Milk fat normally most profitable component.
Better to set goals based on Fat + Protein yield!!!

2

How to adapt to "Historic" times

- Production limits/reductions
  - Most are based on milk yield, not components
- Milk fat price bottomed out
  - Profitability depends on my cost to make it
  - Think about "marginal cost"
- Distiller's grains price has increased and corn and soybean meal have decreased
  - Changes risk/value proposition
  - Is rumen available fat cheaper from soybeans or cottonseed?
- Price and some supply changes with some dry fat products

3

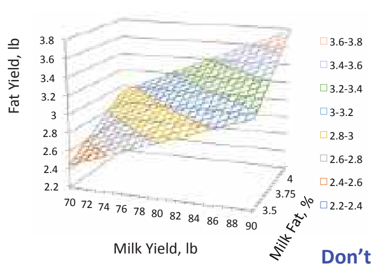
We can have both fat and protein yield!

Maximizing microbial protein yield gets you:

- Optimal amino acid supply
- Normal biohydrogenation
- Optimal acetate yield
- Optimal energy intake
  - Drives milk flow
  - Drives milk protein synthesis
    - (Don't forget insulin-IGF-I story!)

4

"Milk flow" is very important to component yield: You can't give up much yield when seeking to increase milk fat (especially when protein value is high!)



Milk, lb	Milk Fat, %	
	4.0	4.1
80	3.20	3.28
82.5	3.30	3.38

Milk lb

Don't forget protein and going to get protein with milk yield!

5

What should you be thinking about to maximize milk fat yield

1. Set your goal
   - Seasonal pattern
   - Genetics
2. Balance the diet
   - Unsaturated fat
   - Fermentability
   - Fiber digestibility
   - Fat supply
   - Additives
3. Manage the feeding system
   - Feed mixing and delivery
   - Reduce slug feeding
4. Monitor and adjust
   - Milk fat concentration
   - De novo and *trans*-10 C18:1
   - Responses in 7 to 10 d

6

Milk fat is affected by many factors

Nutritional Factors

Inhibited by BH-induced milk fat depression
- Unsaturated fat
- Fermentability
- Acidosis
- Feeding strategies
- Ionophores

Increase by additional substrate
- Acetate (Forage quality)
- Palmitic acid
- High plasma NEFA

Milk fat

Non-nutritional Factors

These set our goals/expectations

- Genetics
- Season
- Stage of lactation
- Parity

7

Milk fat is the most heritable production trait and PTA Fat gives an indication of genetic potential

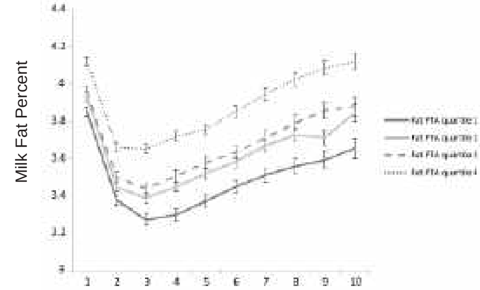
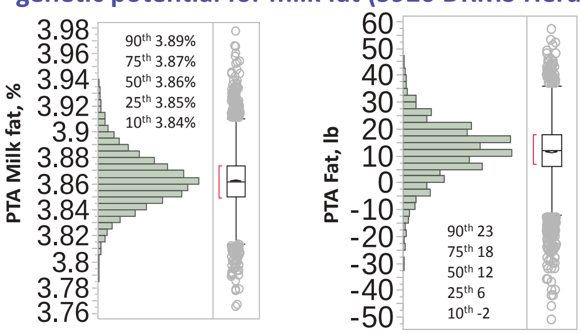


Fig. 2. The effect of sire predicted transmitting ability (PTA) for milk fat percentage quartile on milk fat percentage for the first 10 months of lactation. Data were analyzed using repeated measures ANOVA and the effect of animal nested within farm was controlled in the model as a random effect. Parity was also kept in the model as a fixed effect. Error bars represent 95% confidence interval of the mean.

Bicalho et al. 2014. Theriogenology. 81:257-265

8

There is very little difference between herds for genetic potential for milk fat (5926 DRMS Herds)

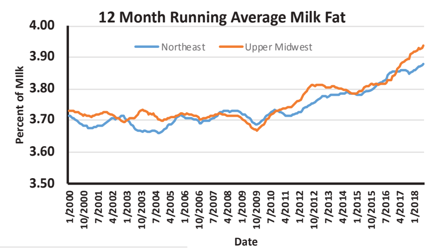


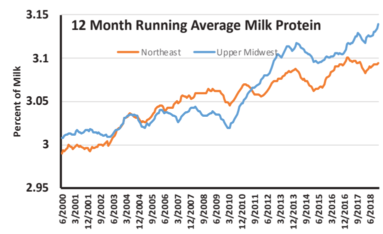
PTA Milk fat % = [(PTAF + 1006) / (PTAM + 26995)] * 100

Harvatine Unpublished

9

Milk fat and protein have been increasing

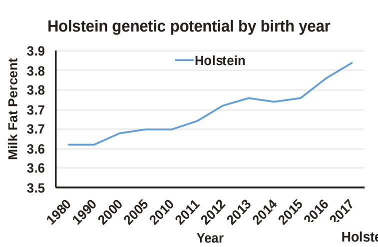




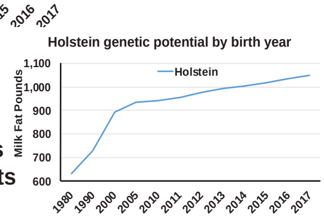
Why?
- Genetics (Yes!)
- Jerseys & Crossbreds?
- Better nutritionists?
- Better DDGS?
- BMR Corn?
- Palmitic acid?

10

Milk fat genetic potential of Holsteins has increased ~0.17 units and 107 lb in 10 years



From Center for Dairy Cattle Breeding



Genetic potential of Jerseys has also increased ~0.15 units and 132 lb in <10 years

11

Let's talk about nutrition: Milk fat can be decreased by BH-Induced Milk Fat Depression (MFD)

- Diet and management risk factors result in a change in the rumen microbes that produces bioactive "*trans*-10" FA intermediates
  - Up to a 50% reduction in milk fat
  - Greater decrease in fatty acids made by the mammary gland (de novo)

This is a very common cause of reduced milk fat yield, but is not meant to explain every change in milk fat!!!

Reviewed by Harvatine et al. 2009

12

We must manage the risk factors that cause "Diet-Induced MFD"

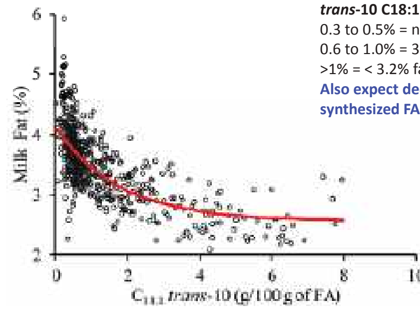
- Dietary fatty acids
  - Level and profile
  - Rate of availability
- Diet fermentability
  - Carbohydrate profile
  - Rate and extent of fermentation
  - Effective fiber
- Adequate RDP/ Ruminal N balance
- Feeding strategies/management
- Ruminal acidosis
- Rumen modifiers- ionophore
- Silage fermentation/quality
- Forage types
- Individual cow effect (level of intake etc)

RUFAL: Rumen Unsaturated Fatty Acid Load (but C18:2 most important)

High producing cows normally most susceptible

13

Can milk fatty acids be used to troubleshoot milk fat problems? Milk *trans*-10 18:1 & Milk Fat %



trans-10 C18:1
0.3 to 0.5% = normal fat
0.6 to 1.0% = 3.2 to 3.5% fat
>1% = < 3.2% fat
Also expect decrease in de novo synthesized FA

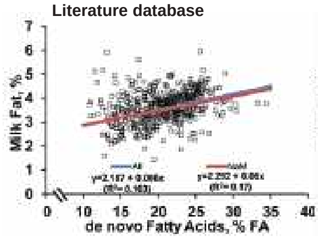
N = 497

Matamoros Unpublished

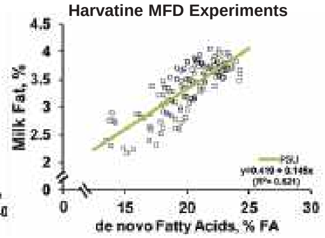
14

There is also a relationship between milk fat and de novo FA, but is not specific for MFD

Literature database



Harvatine MFD Experiments

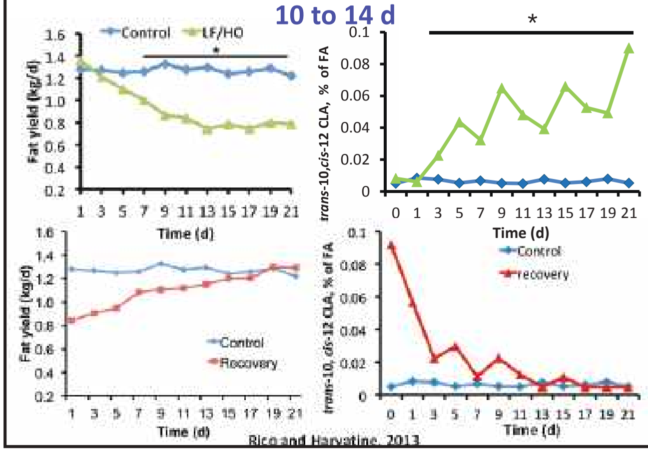


De novo (< 16 C) FA can be predicted by some DHIA labs.

Matamoros Unpublished

15

Diet-induced MFD occurs and can be fixed in 10 to 14 d



Rico and Harvatine, 2013

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Unsaturated fatty acids are a big risk factor

1. Amount of unsaturated fatty acids
   - Fatty acid concentration and profile
   - 18:2 more important than 18:1 and 18:3
2. Rate of availability of the fatty acids
   - Cottonseed vs DDGS

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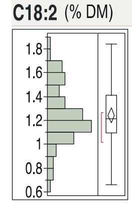
Corn silages differ in C18:2 and should be considered in ration balancing

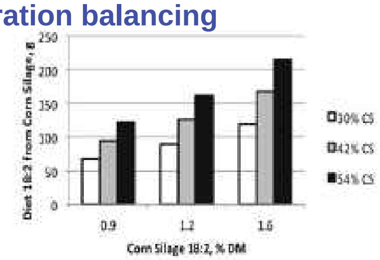
C18:2 (% DM)



Quantiles

90.0%		1.60384
75.0%	quartile	1.4094
50.0%	median	1.2167
25.0%	quartile	1.0954
10.0%		0.93576

67 Corn Silages from Test Plots



~60 to 90 g/d difference in C18:2 intake just in the corn silage

Baldin et al. JDS 2018

18

High oleic soybeans decrease risk of milk fat depression

Feedstuff (% FA)	16:0	18:0	18:1	18:2	18:3	20:1	22:1
Soybean	11	4	23	54	8	-	-
High Oleic Soy	6.5	4	75	7	2.5	-	-

https://www.plenish.com/food/oil-profile/

High oleic soybeans were lower risk for milk fat in previous experiments by Weld and Armentano (2018)

We observed that high oleic soybean increased milk fat ~0.2 units and 0.2 lb/d compared to conventional soybeans

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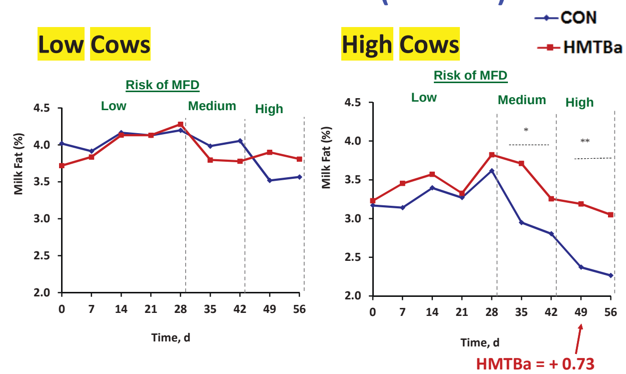
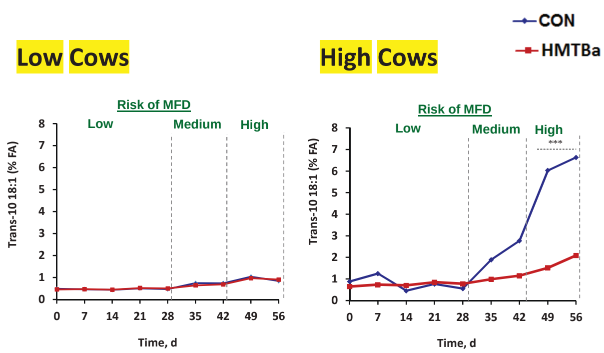
Example of feed additive that reduces risk of MFD: HMTBa (Alimet®)



Baldin et al., JDS 2018

20

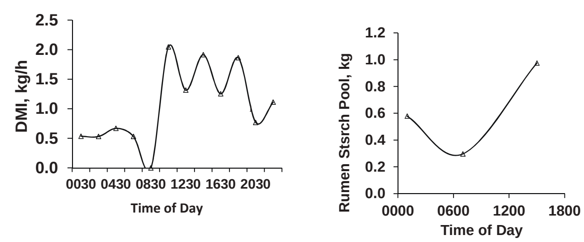
HMTBa prevented increase of *trans*-10 C18:1 in milk



Baldin et al., JDS 2018

21

We need to think about when cows are eating over the day as this can disrupt rumen fermentation!



Timing of feed delivery is our best chance to impact this!

Goal is to spread intake more across the day. Feeding 2x and earlier in the day is best way to do this.

Ying et al. 2015

22

Other dietary effects with smaller impacts

- **Absorbed fat**
  - **Palmitic acid**
- **Acetate supply**
  - **Forage digestibility and rumen function**

23

How much fat does a cow need to provide preformed fatty acids at 4% milk fat and 55% preformed FA at 55% transfer?

Milk, lb	Fat, lb	Milk Preformed, lb	DMI, lb	Diet Fat % Needed
60	2.4	1.3	45	5.3%
90	3.6	2.0	55	6.5%
120	4.8	2.6	65	7.4%
150	6	3.3	75	8.0%

Obviously, cows are making it work, but in some cases we might be limiting milk fat because of limited fat supply

24

Effect of high oleic soybeans on milk fat when increasing risk of MFD

	Treatment Means[1]							
	Conv. Soybean		High 18:1 Soybean			*P*-Values[2]		
Item	5%	10%	5%	10%	SEM	Type	Level	Type* Level
Milk, lb/d	96.4	96.3	95.5	98.6	2.8	0.69	0.28	0.18
Milk Fat								
%	3.28	3.46	3.42	3.66	0.12	<0.05	0.01	0.69
lb/d	3.06	3.22	3.22	3.46	0.24	0.08	0.01	0.55
Milk Fatty acids, % FA								
>16C[5]	37.4	41.5	37.8	41.5	0.70	0.42	<0.001	0.57
*t*10 C18:1	0.79	0.89	0.62	0.63	0.13	0.01	0.96	0.67

25

Palmitic acid is the most consistent to increase milk fat, but others can also increase in some cases

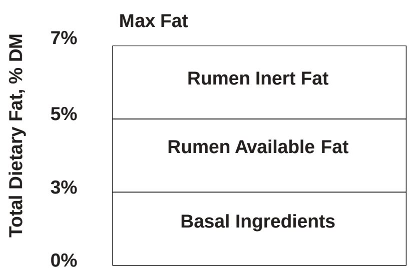
- May depend on concentration of FA in the basal diet, diet type, cow physiology, etc.

Biology of palmitic acid

- **Apparent transfer to milk ~15 to 20%**
- Old isotope data reported 40 to 70% of ^{14}C palmitic acid entered milk (Palmquist and Conrad, 1971)
- I think palmitic decreases the de novo portion of C16:0 in milk fat, but does not decrease de novo as much as C18 FA

26

Make sure you are managing all the fat sources in the diet!



27

Increasing acetate increases milk fat under normal conditions

	Acetate (g/d)					*P*-value	
	0	300	600	900	SE	Linear	Quad.
DMI, lb	59.9	62.2	60.0	59.5	2.2	-	-
Milk, lb	84.9	86.3	88.9	85.6	6.2	-	-
Milk Fat							
g	1382	1468	1582	1577	59	<0.001	-
%	3.64	3.87	4.03	4.10	0.20	<0.001	-

- 600 g/d of acetate increased milk fat by 200 g/d
- Mostly increase in de novo synthesized FA

How do we get more acetate?

Forage quality and good rumen fermentation!

Urrutia et al. J. Nutr. 2017

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Nutrition is best practiced as an "Experiment in Progress"!!

- When milk fat is Acceptable

- Inclusion of risk factors is advantageous to feed cost, production, and efficiency

- When milk fat is Low: Look For a Reason

- When did it start and what happened ~7-10 d prior?
- Is it a certain string or group of cows?
  - High producing cows are normally more susceptible
- What season is it?
- Is the sample a daily average?

29

The experiment in progress

1. Diet Polyunsaturated Fatty Acids

- Concentration of C18:2
- Source of C18:2
  - Very different rates of rumen release
  - Ca Salts are more slowly released, but are not inert
- Fish oil is very potent (EPA and DHA)
- Decreasing unsaturated fat has the lowest risk to losing milk yield!

30

2. Diet Fermentability

– Analyze carbohydrate profiles and effective fiber
– Experience with similar diets in the region is important

– Sugars may be beneficial
– Start to titrate down starch and increase fiber
– Switch rapidly fermentable sources for less rapidly fermentable sources
– Increase forage NDF and effective fiber

**Careful….. May Lose Milk!!

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3. Rumen Modifiers

– Rumensin®
  - Risk factor, but does not cause MFD by itself
  - Can be synergistic with other risk factors for induction
– DCAD
  - Increasing DCAD decreases MFD (both Na and K)
– HMTBa
  - Reduces the risk of MFD
– Yeast & Direct Fed Microbials
  - May reduce incidence of MFD in some cases
  - Have not tested their effect on recovery

**Remember we are dealing with many interactions!

32

4. Feeding Strategies

– Number of feeding times per day
– Slick bunks before feeding?
– Feeding times
* You can slug feed TMR!

5. Saturated Fat Supplements

- No risk for induction of milk fat depression
- High palmitic acid (C16:0) supplements may increase milk fat in some cases
- Milk fat depression will reduce the effectiveness of high palm supplements

Monitor milk yield and milk fat over time!!!
**Set Expectations for the Time Required

33

Lets review

Rumen environment is critical to milk fat yield and involves interactions of numerous dietary, cow, and environmental factors

1. Set your goal
2. Balance your diet
3. Manage feeding

Constant "Experiment in Progress" to maximize energy intake, milk yield, and milk fat yield

34

Lab Members:
Cesar Matamoros, Beckie Bomberger, Alanna Staffin, Reilly Pierce, Ahmed Elzennary, and Rachel Walker.

Previous Lab Members:
Chengmin Li, Elle Andreen, Dr. Isaac Salfer, Dr. Daniel Rico, Dr. Michel Baldin, L. Whitney Rottman, Mutian Niu, Dr. Natalie Urrutia, Richie Shepardson, Andrew Clark, Dr. Liying Ma, Elaine Brown, and Jackie Ying

Disclosures
K.J. Harvatine's research in the past 10 years were partially supported by the Agriculture and Food Research Initiative Competitive Grant No. 2010-65206-20723, 2015-67015-23358, 2016-68008-25025 from the USDA National Institute of Food and Agriculture [PI Harvatine], USDA Special Grant 2009-34281-20116 [PI Harvatine], Berg-Schmidt, Elanco Animal Health, BASF, Novus International, PA Soybean Board, Phode Laboratories, Kemin International, Milk Specialties Global, Adisseo, Micronutrients Inc., Organix Recylcing, Insta-Pro Intl., and Penn State University. Harvatine has consulted for Milk Specialties Global, a manufacturer of prilled saturated fat supplements and Micronutrients Inc. as a member of their science advisory boards. Harvatine has also received speaking honorariums from Elanco Animal Health, Novus International, Cargill, Virtus Nutrition, Chr Hansen, NDS, Nutreco, Mycogen, and Milk Specialties Global in the past three years.

Thank You

35


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Nutritional Regulation of Gut Health and Development: Weaning and Beyond

Dr. Michael Steele

University of Guelph


Four-State Dairy Nutrition & Management Conference
Nutritional regulation of gut health and development: Weaning and Beyond
Dr. Michael Steele
University of Guelph
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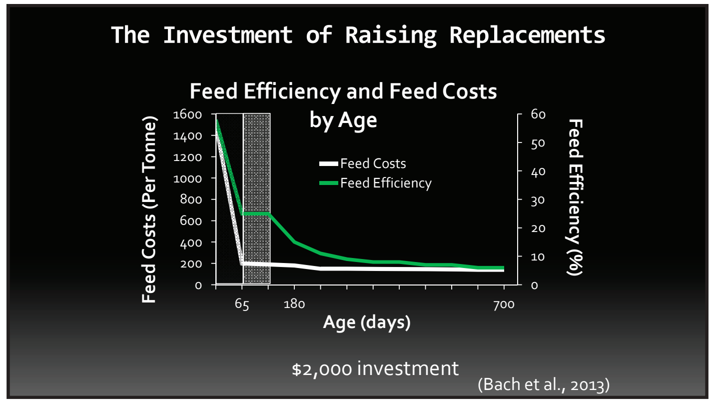
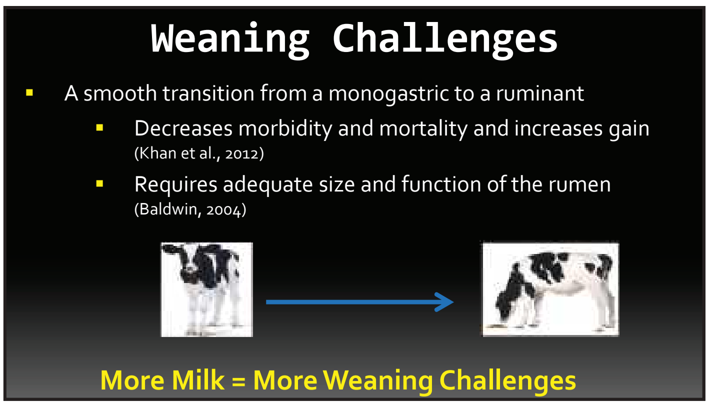
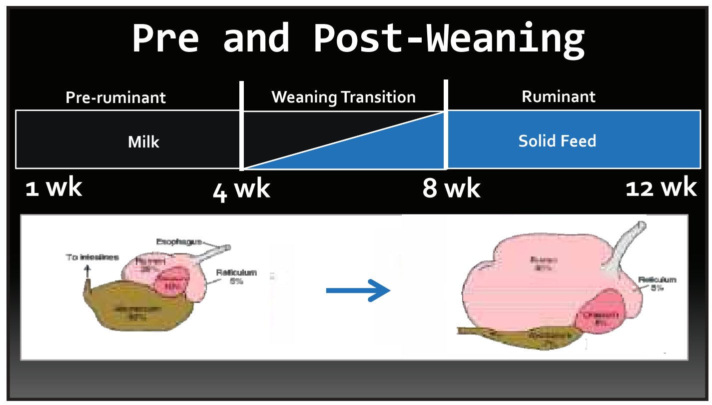
1


The Investment of Raising Replacements
Feed Efficiency and Feed Costs by Age
Feed Costs
Feed Efficiency
Feed Costs (Per Tonne)
Feed Efficiency (%)
1600
1400
1200
1000
800
600
400
200
0
60
50
40
30
20
10
0
65
180
700
Age (days)
$2,000 investment
(Bach et al., 2013)

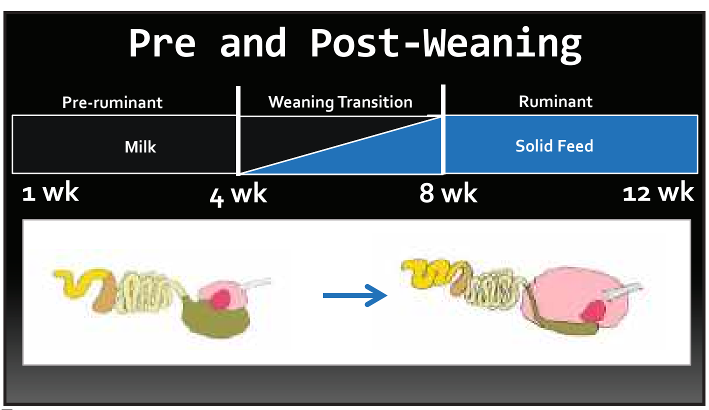
2


Weaning Challenges
A smooth transition from a monogastric to a ruminant
Decreases morbidity and mortality and increases gain
(Khan et al., 2012)
Requires adequate size and function of the rumen
(Baldwin, 2004)
More Milk = More Weaning Challenges

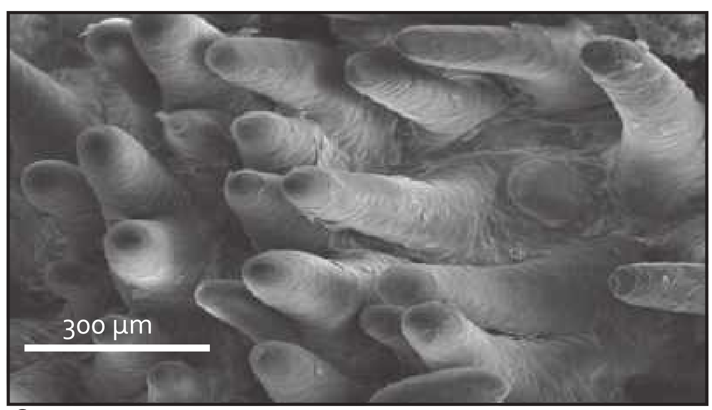
3


Pre and Post-Weaning
Pre-ruminant
Weaning Transition
Ruminant
Milk
Solid Feed
1 wk
4 wk
8 wk
12 wk
To intestines
Esophagus
Reticulum 5%

4


Pre and Post-Weaning
Pre-ruminant
Weaning Transition
Ruminant
Milk
Solid Feed
1 wk
4 wk
8 wk
12 wk

5


300 μm

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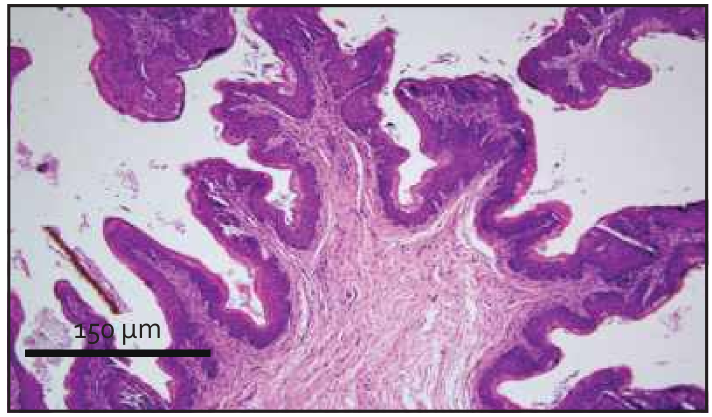

150 µm

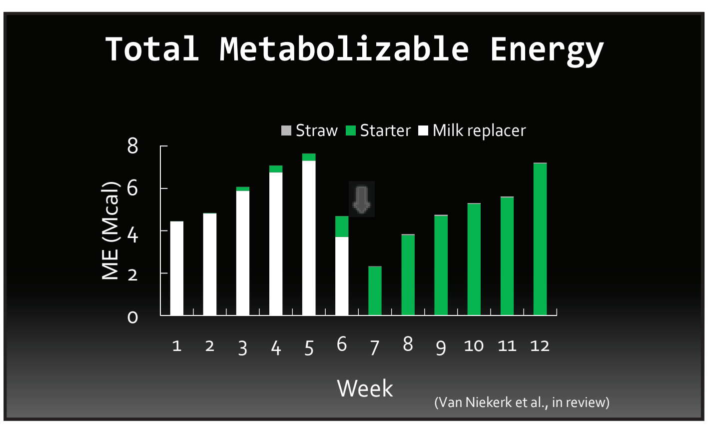
8


Rumen Papillae - Transition

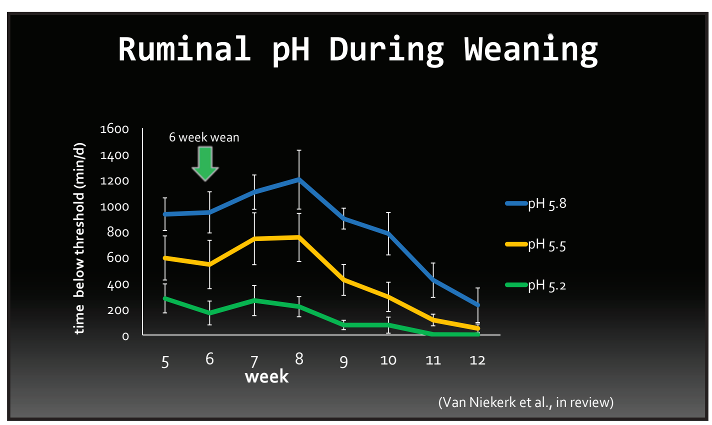
9


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?
Parakeratosis

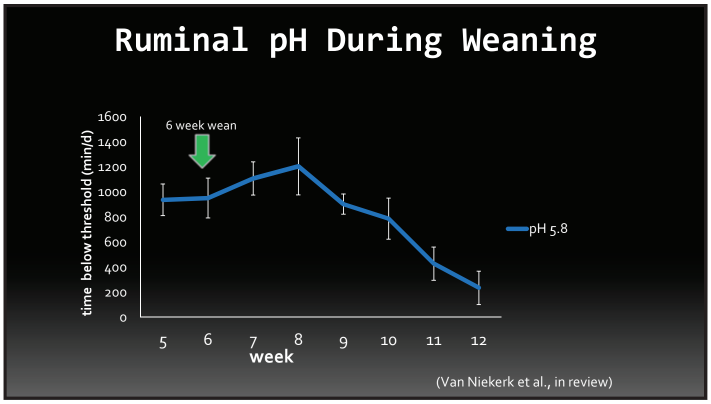
10


Total Metabolizable Energy
Straw
Starter
Milk replacer
ME (Mcal)
0
2
4
6
8
1 2 3 4 5 6 7 8 9 10 11 12
Week
(Van Niekerk et al., in review)

11


Ruminal pH During Weaning
6 week wean
time below threshold (min/d)
0
200
400
600
800
1000
1200
1400
1600
5 6 7 8 9 10 11 12
week
pH 5.8
pH 5.5
pH 5.2
(Van Niekerk et al., in review)

12



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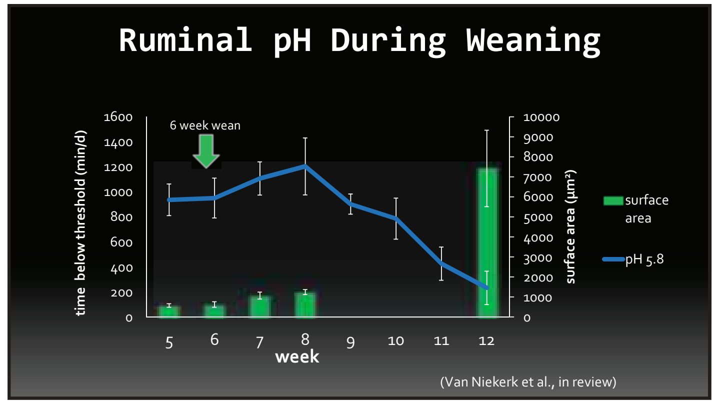

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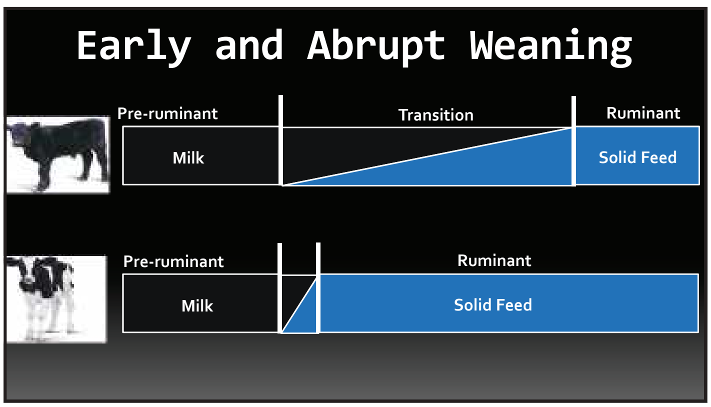

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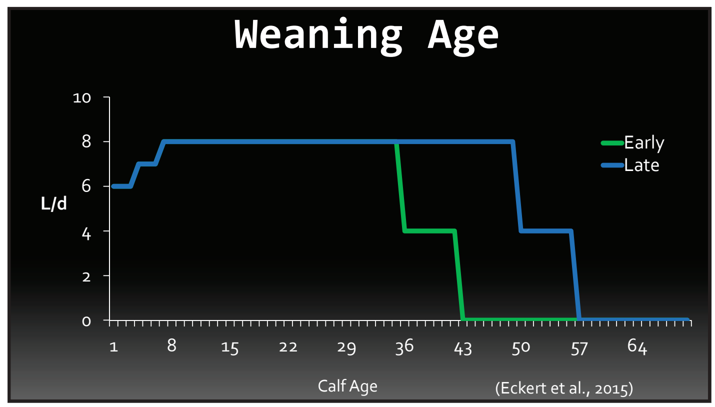

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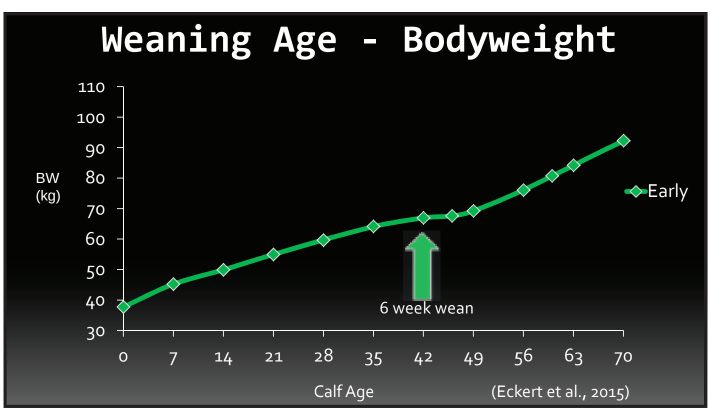

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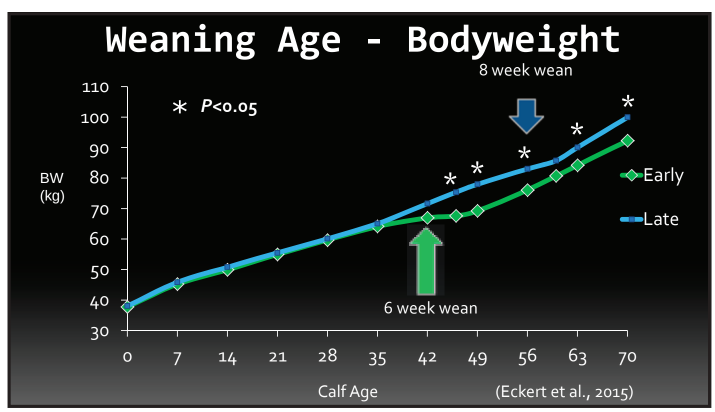

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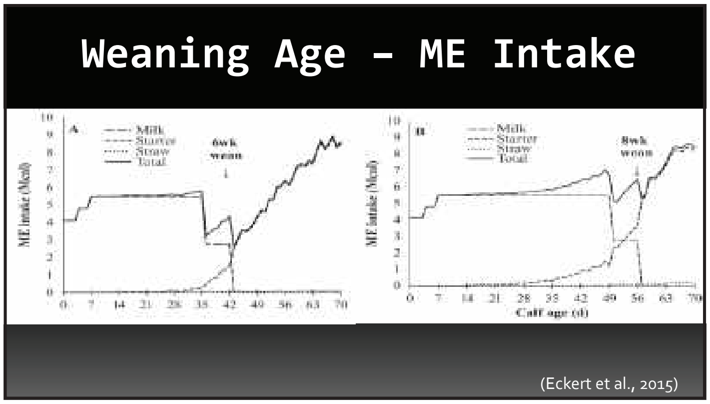

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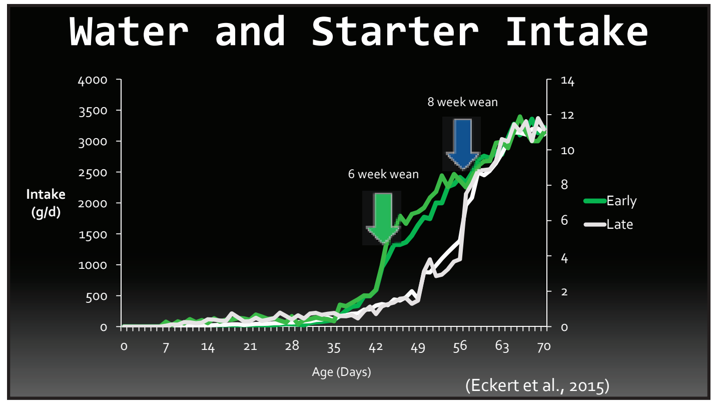

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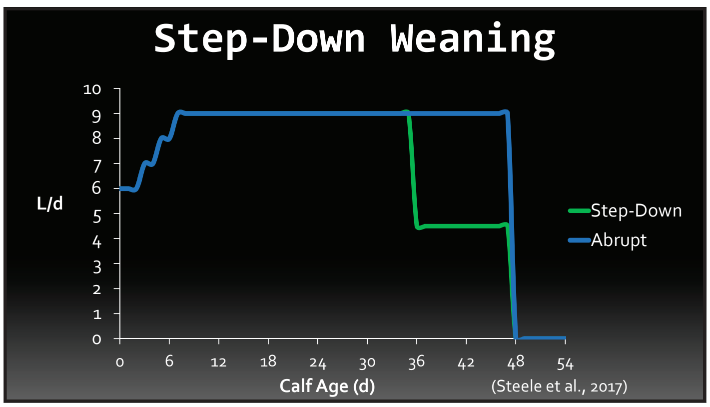

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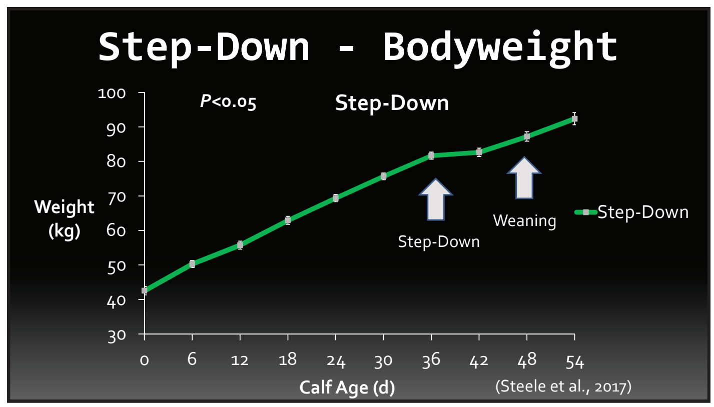

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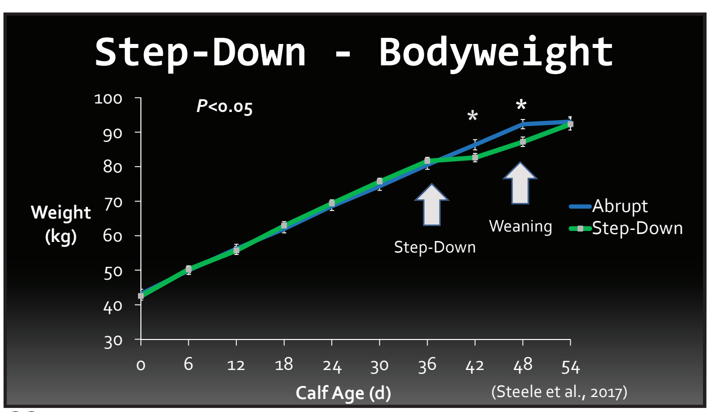

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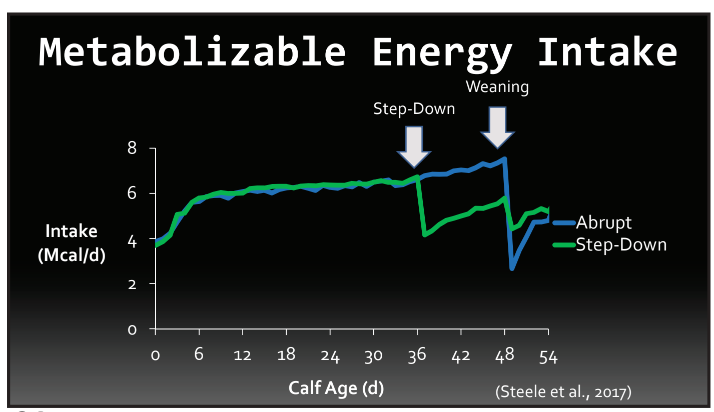

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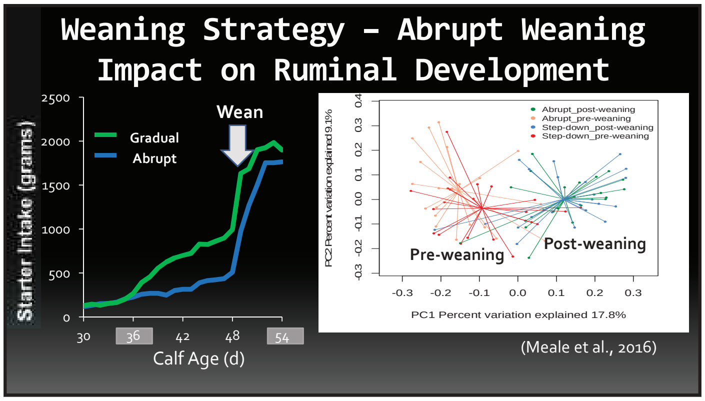

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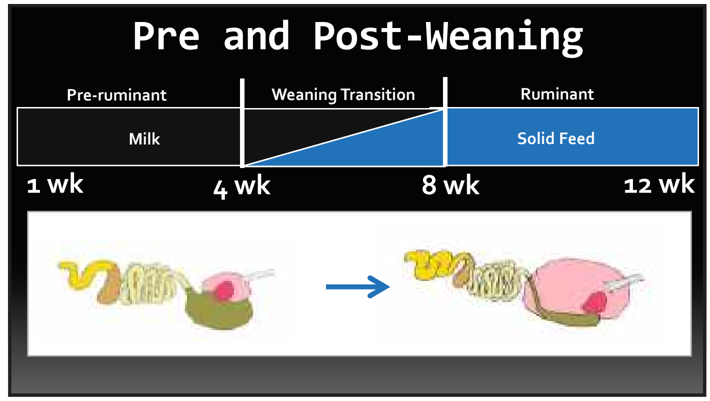

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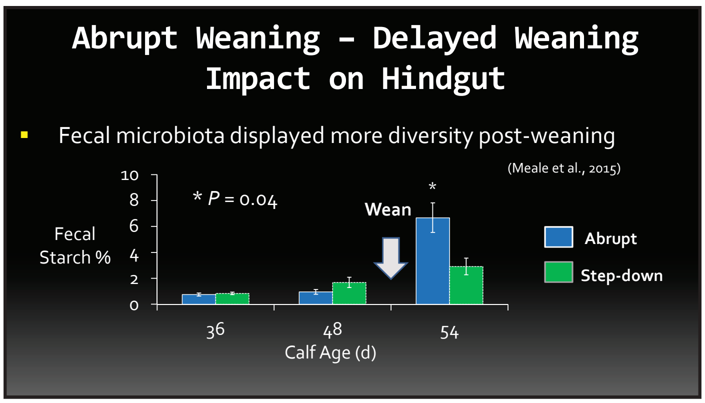

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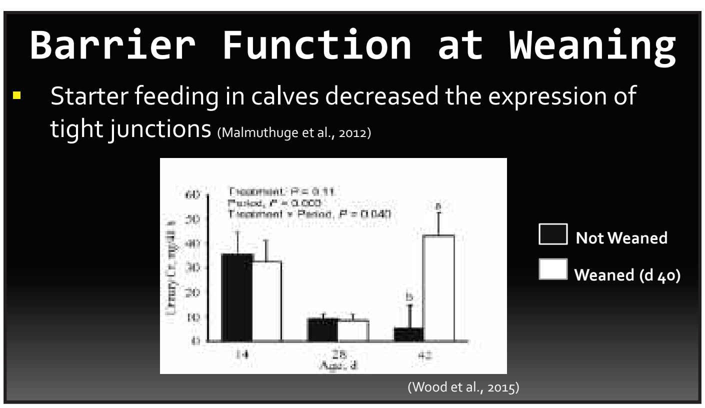

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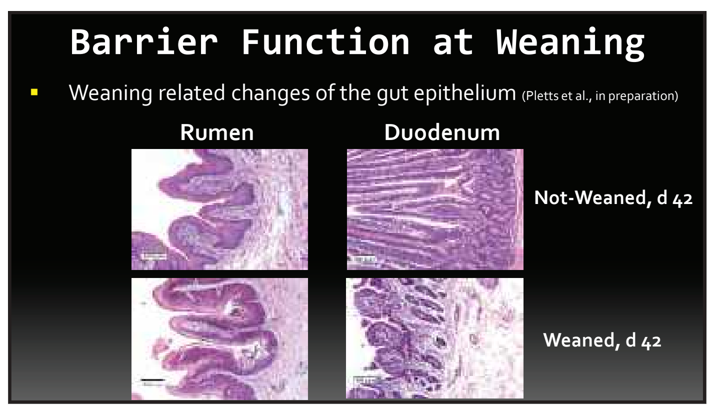

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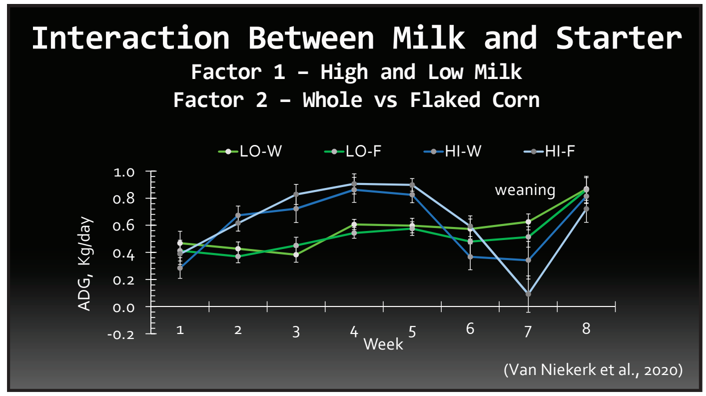

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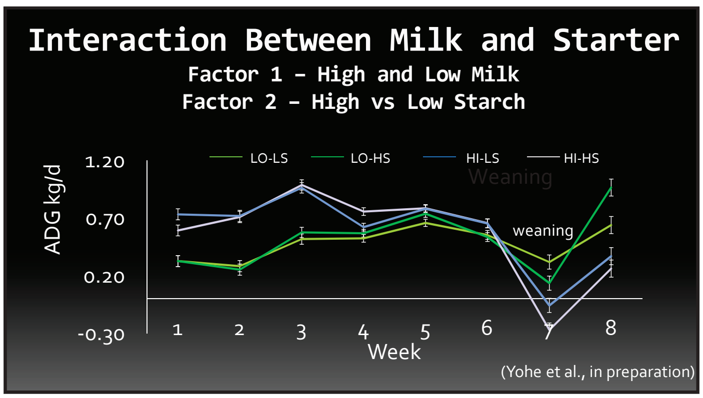

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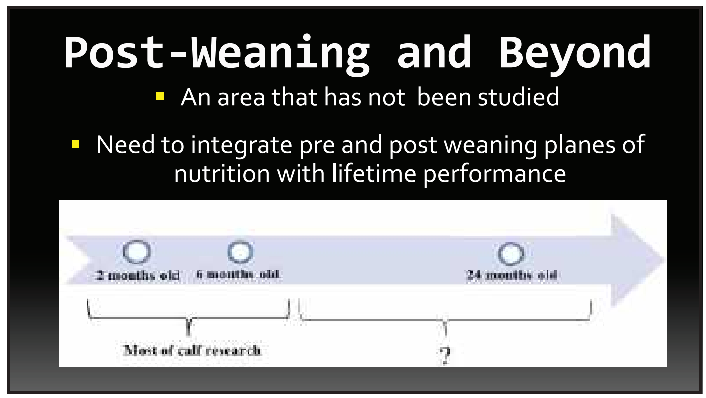

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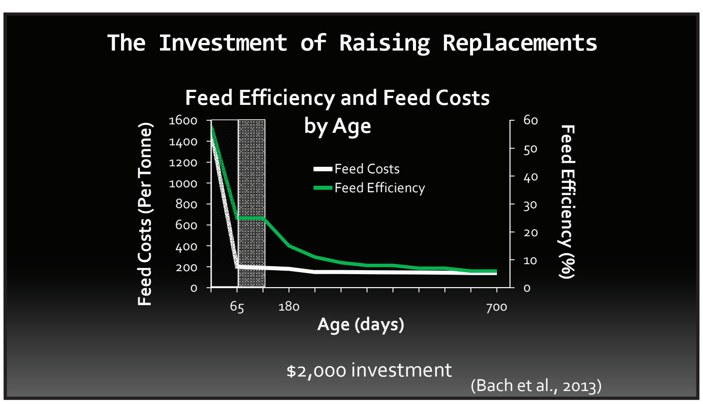

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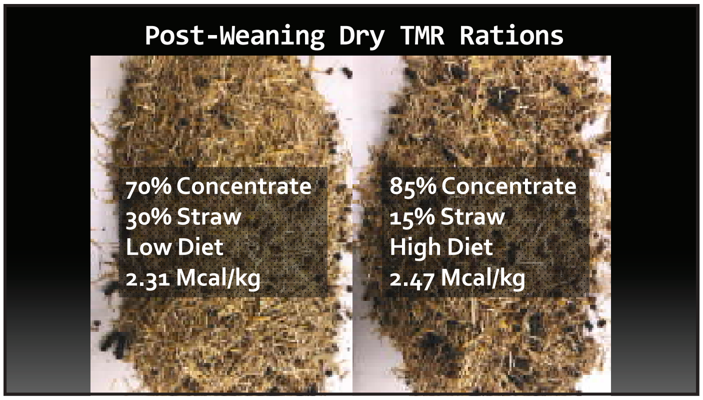

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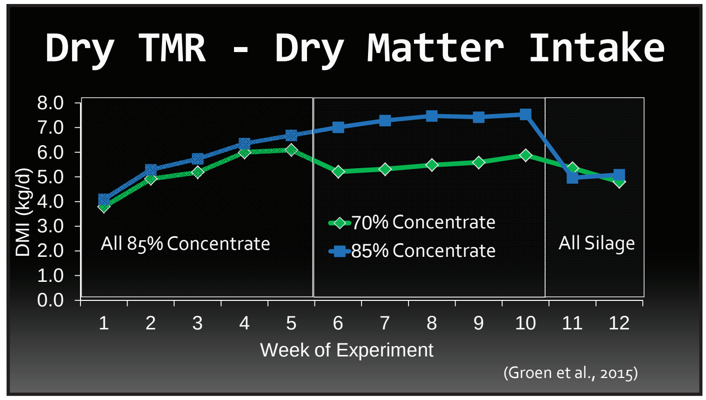

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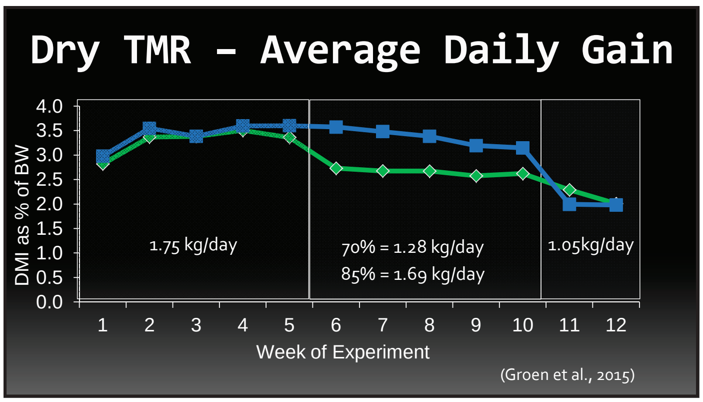

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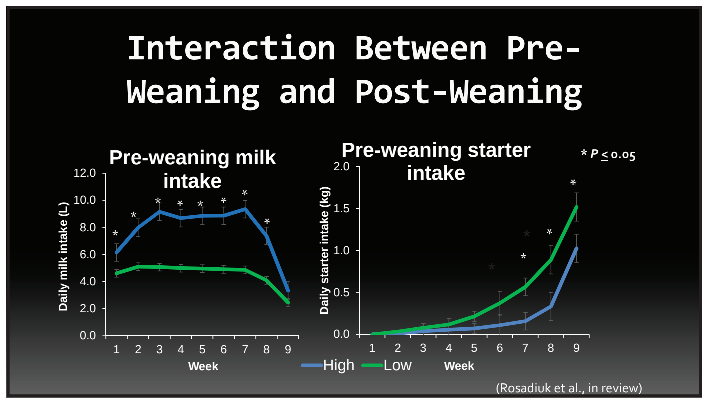

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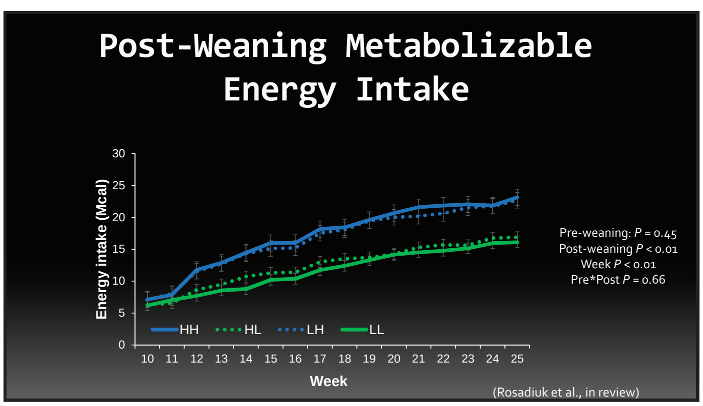

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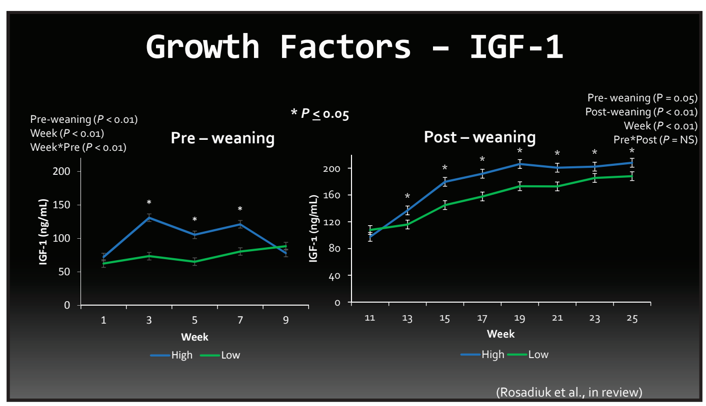

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Reproductive Development

- Heifers offered the higher post-weaning plane of nutrition had:
  - Enhanced development of reproductive tract (larger uterus and ovarian follicles) before puberty
  - Higher chances of achieving puberty by 30 wk of age
  - Higher number of ovarian antral follicles during the estrous cycle after they achieved puberty (31 vs. 21 follicles, P < 0.01)

(Bruinjé et al., 2019)

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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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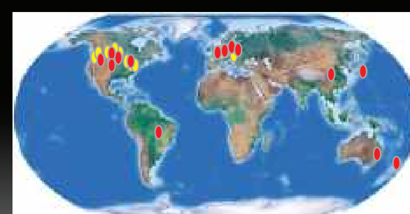
Industry Collaborators

45

Academic Collaborators



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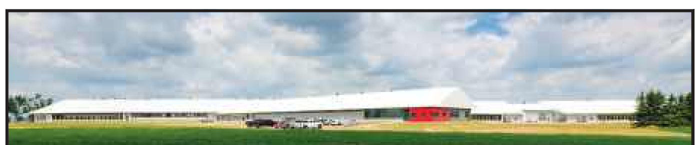
Thanks to my Team

Alberta, 2017

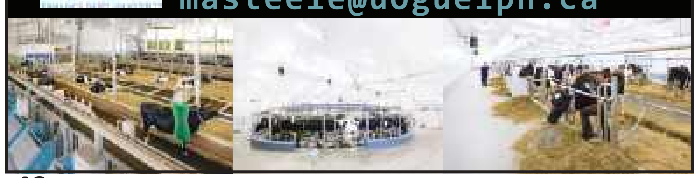
Guelph, 2019

47



DAIRY at GUELPH

Mike Steele
masteele@uoguelph.ca



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The High Fertility Cycle

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University of Wisconsin–Madison
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The High Fertility Cycle

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[2]Department of Animal Science, Michigan State University
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SUMMARY

- Over the past two decades, a reproduction revolution has occurred in the dairy industry in which average 21-day pregnancy rates have more than doubled from around 14% to more than 30% in many herds.
- Much of this increase in reproductive performance has been driven by development and adoption of fertility programs.
- In spite of the dramatic increase in 21-day pregnancy rates, substantial variation exists among herds using the exact same reproductive management suggesting that factors other than fertility programs can affect fertility.
- Change in body weight or body condition score postpartum or during the periparturient period dramatically affects embryo quality, reproductive outcomes, and transition cow health.
- Although some cows lose body weight or body condition score after calving, some cows maintain, whereas some cows even gain body weight or body condition score during this time period.
- Surprisingly, milk production during early lactation is not affected based on body condition score change during the first 3 weeks postpartum; however, peak milk measured near 60 DIM was less in both primiparous and multiparous cows that either gained or maintained compared to cows that lost body condition during the 1st 30 DIM.
- The high fertility cycle coupled with the dramatic increases in reproductive performance due to the development and adoption of fertility programs is a new paradigm that we can now use to explain much of the variation in reproductive performance among herds.
- The high-fertility cycle: How timely pregnancies in one lactation may lead to less BCS loss, fewer health issues, greater fertility, and reduced early pregnancy losses in the next lactation.

INTRODUCTION

Over the past two decades, a reproduction revolution has occurred in the dairy industry. Twenty years ago, the 21-day pregnancy rate in U.S. dairy herds averaged about 14% with conception rates rarely exceeding 40%. In 1998, the annualized 21-day pregnancy rate goal was 20% which few herds could achieve. Today, the average 21-day pregnancy rate in the U.S. exceeds 21% with more than 60% of DRMS Holstein herds achieving 21-day pregnancy rates greater than 20% with average conception rates that exceed 50% in high-producing Holsteins. The development of fertility programs and their adoption by the dairy industry over the past decade has largely driven this reproduction revolution (Carvalho et al., 2018). Fertility programs, such as Double-Ovsynch or G6G protocols for first timed AI not only increase the AI service rate, but also increase pregnancies per AI (P/AI) beyond that achieved based on AI to a detected estrus (Santos et al., 2017). Despite this increase in reproductive performance, many veterinarians, nutritionists, and consultants observe dramatic variation in reproductive performance among herds that manage reproduction using the exact same reproductive management programs. Although on-farm protocol compliance with complex fertility programs that require multiple treatments across many days remains an issue, it cannot explain all of this variation among herds.

The "Britt Hypothesis"
In 1992, Dr. Jack Britt sorted 76 lactating Holstein cows based on whether they Lost (Lost, n = 30) or Maintained (n = 46) BCS during the first 5 weeks after calving (Britt, 1992). Body condition scores were recorded for the first 10 weeks after calving for these two groups of cows (Figure 1).

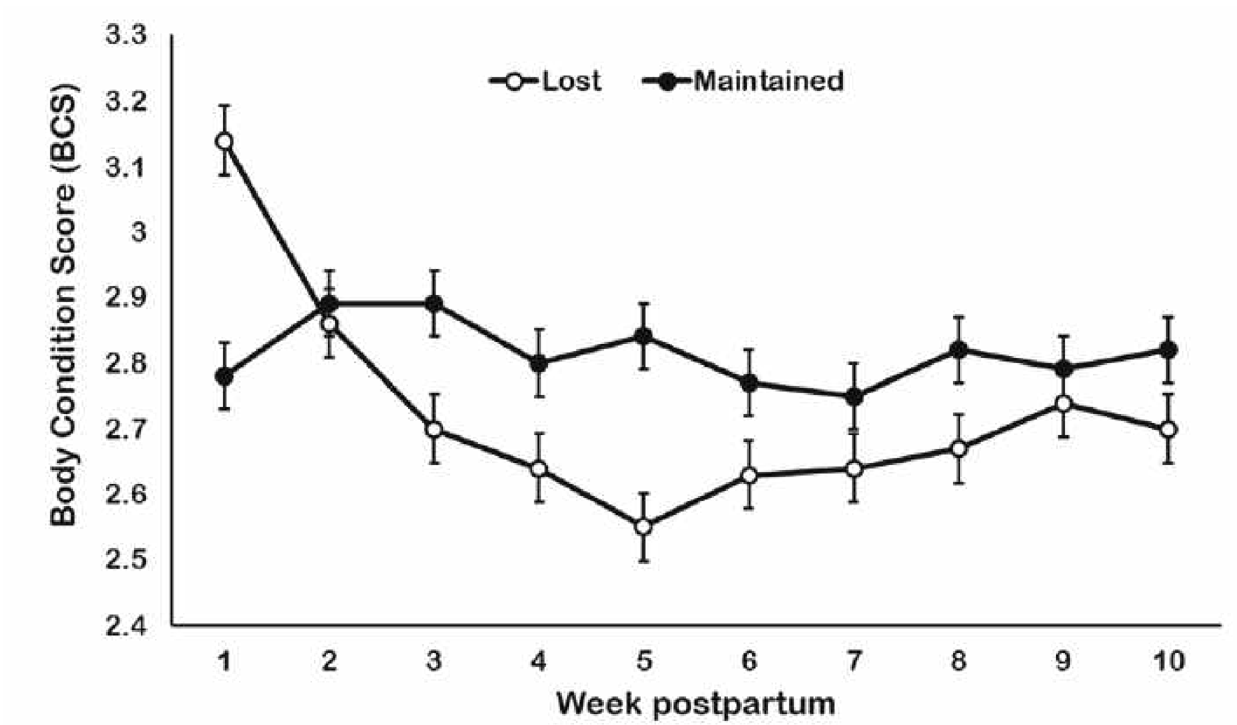

Figure 1. Change in body condition score (BCS) in Holstein cows (n = 76) during the first 10 weeks postpartum. Cows were sorted into two groups based on whether they Lost (Lost, n = 30) or Maintained (n = 46) BCS during the first 5 weeks postpartum. Adapted from Britt (1992).

Cows that maintained BCS post calving had a greater conception rate at first service than cows that lost BCS post-calving (Table 1). Based on these data, Dr. Britt speculated that high producing cows which experience severe weight losses during the first 3 to 5 weeks after calving presumably subject their developing follicles to adverse metabolic conditions associated with the rapid weight loss that compromises fertility later during lactation at first insemination (Britt, 1992). The results from three recent studies; two from the University of Wisconsin - Madison, and one from Michigan State University, support Dr. Britt's observation from 1992 and challenge the long-held assumption that all cows normally lose BCS after calving.

Table 1. Results of retrospective analysis of data from Holstein cows sorted based on BCS change during the first 5 weeks postpartum. Adapted from Britt, 1992.

Item	Lost	Maintained
n	30	46
BCS[1] change		
Week 1 to 5	-0.58[a]	+0.06[b]
Week 5 to 10	+0.17[a]	-0.02[b]
Interval to first ovulation (d)	23.3[a]	17.2[b]
Milk yield		
Mean during first 70 d (lbs)	60	58
Mean 305 d lactation (lbs)	18,198	17,941
Interval to first AI (d)	82.9	84.9
Conception rate		
First service (%)	25[a]	62[b]
All services (%)	42[a]	61[b]

[a,b]Items with different superscripts differ ($P < 0.05$)
[1]Body condition scores based on a 1 (thin) to 5 (fat) scale.

Effect of body weight change on embryo quality
The first study from the first paper (Carvalho et al., 2014) included an experiment in which lactating Holstein cows (n = 71; 27 primiparous and 44 multiparous) were weighed weekly from calving until 10 weeks postpartum. Cows were divided into quartiles based on percent body weight change from the first week after calving (Figure 2). The quartile analysis divided cows based on those that gained weight (First Quartile), maintained weight (Second Quartile), slightly lost weight (Third Quartile), and dramatically lost weight (Fourth Quartile), and the majority of the body weight change occurred during the first 3 weeks postpartum (Figure 2). Cows in the Fourth Quartile that dramatically lost weight had increased NEFA concentrations during the first 3 weeks after calving, whereas NEFA concentrations did not differ at 10 weeks postpartum when superovulation and embryo flushing was performed (Carvalho et al., 2014).

To assess embryo quality, cows were superovulated using a modified Double-Ovsynch protocol. All cows were inseminated and flushed by two technicians, and cows were inseminated twice at 12 and 24 h after GnRH treatment. Seven days after GnRH treatment, ova/embryos were recovered using a nonsurgical shallow uterine horn flushing technique. Embryo characteristics were affected based on body weight quartile in which cows in the Fourth Quartile that dramatically lost weight during the first 3 weeks postpartum had overall poorer embryo characteristics than cows in the other three quartiles (Table 2).

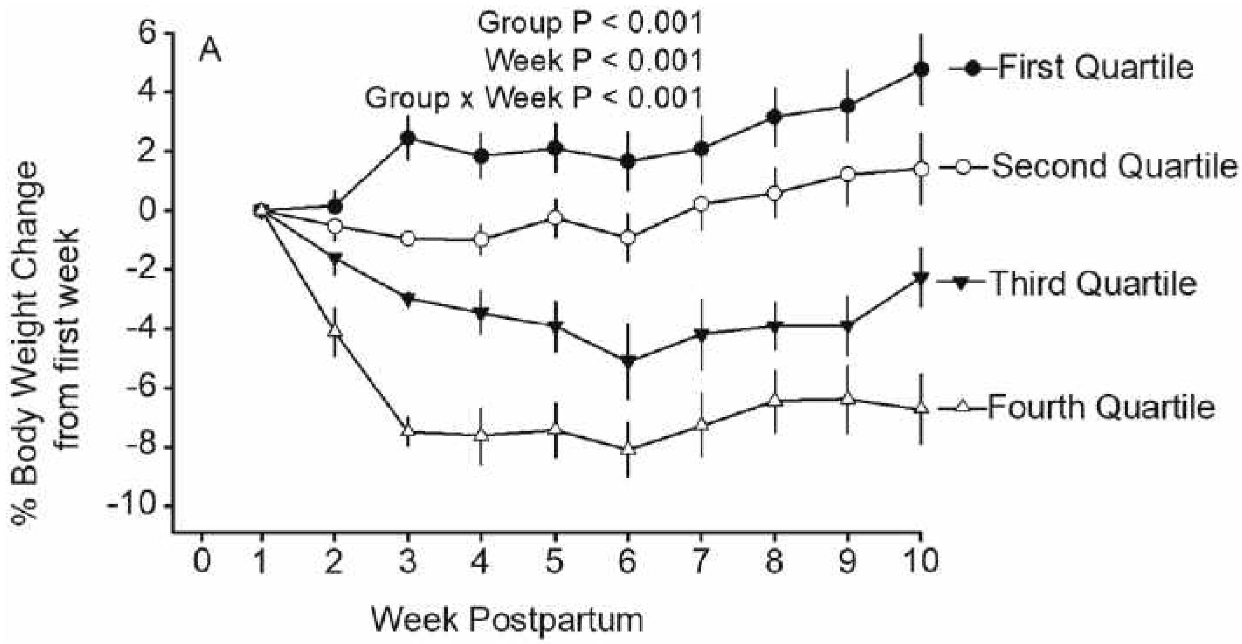

Figure 2. Quartile analysis of percent body weight change from the first week postpartum in Holstein dairy cows. Adapted from Carvalho et al. (2014).

Table 2. Embryo characteristics of lactating Holstein cows based on body weight change[1] from first to third week postpartum. Adapted from Carvalho et al. (2014).

Item	Fourth Quartile	Third Quartile	Second Quartile	First Quartile	*P*
CL (number)	18.4 ± 2.6	18.4 ± 1.7	19.0 ± 1.7	16.0 ± 2.0	0.67
Fert structures (#)	7.6 ± 2.1	7.3 ± 1.1	4.8 ± 1.1	5.8 ± 1.4	0.43
Deg embryos (#)	2.7 ± 0.7^{a}	1.7 ± 0.7^{ab}	0.7 ± 0.2^{b}	0.6 ± 0.2^{b}	0.02
Quality 1 & 2 (#)	4.2 ± 1.4	5.3 ± 0.9	3.9 ± 1.1	4.9 ± 1.4	0.47
Quality 1, 2 & 3 (#)	4.9 ± 1.6	5.6 ± 0.8	4.1 ± 1.1	5.3 ± 1.4	0.49
Fertilized (%)	76.9 ± 7.1	77.0 ± 6.6	77.6 ± 7.6	78.4 ± 7.1	0.99
Degenerate (%)	35.2 ± 8.5^{a}	12.6 ± 4.6^{b}	14.5 ± 6.3^{b}	9.6 ± 3.7^{b}	0.02
Quality 1 & 2 (%)	38.0 ± 8.7^{b,B}	61.3 ± 8.2^{ab,A}	60.6 ± 9.4^{ab,A}	63.4 ± 8.6^{a,A}	0.14
Quality 1, 2 & 3 (%)	41.7 ± 8.8^{b,B}	64.4 ± 8.2^{ab,A}	63.1 ± 9.3^{ab,A}	68.9 ± 8.7^{a,A}	0.13
Degen of Fert (%)	46.9 ± 9.6^{a,A}	17.4 ± 6.4^{b,B}	24.8 ± 9.3^{ab,A}	16.2 ± 7.0^{b,B}	0.04
1 & 2 of Fert (%)	48.4± 9.5^{b}	78.3 ± 6.6^{a}	72.6 ± 9.5^{a}	77.7 ± 7.4^{a}	0.05
1, 2 &3 of Fert (%)	53.2 ± 9.6^{b,B}	82.6 ± 6.4^{a,A}	75.2 ± 9.3^{a,AB}	83.8 ± 7.0^{a,A}	0.04
Recovery Rate (%)	45.6 ± 7.4	55.1 ± 6.9	35.4 ± 6.7	45.3 ± 5.8	0.25

^{a,b}Items with different superscripts within the same row differ (P < 0.05).
^{A,B}Items with different superscripts within the same row differ (P < 0.15).
[1]First quartile = gaining body weight; Fourth quartile = most body weight loss.

Effect of BCS change after calving on fertility

The second study from the first paper (Carvalho et al., 2014) included a retrospective analysis in which 1,887 Holstein cows from two commercial dairy farms in Wisconsin were submitted to a Double-Ovsynch protocol for first timed AI, and BCS was evaluated at calving and 21 days after calving. Overall, 42% of cows lost BCS, 36% of cows maintained BCS, and 22% of cows gained BCS during the first 3 weeks of lactation (Table 3).

Table 3. Effect of BCS change on pregnancies /AI (P/AI) for cows on Farm 1 and 2 classified as losing, maintaining or gaining BCS from parturition to three weeks postpartum. Adapted from Carvalho et al. (2014).

	BCS[2] change		
Item	Lost	Maintained	Gained
All cows			
% of cows, (n)	41.8 (789/1887)	35.8 (675/1887)	22.4 (423/1887)
P/AI at 40 d, % (n/n)	25.1 (198/789)[c]	38.2 (258/675)[b]	83.5 (353/423)[a]
P/AI at 70 d, % (n/n)	22.8 (180/789)[c]	36.0 (243/675)[b]	78.3 (331/423)[a]
Pregnancy Loss, % (n/n)	9.1 (18/198)	5.8 (15/258)	6.2 (22/353)
BCS at parturition	2.93 ± 0.01 [a]	2.89 ± 0.02 [b]	2.85 ± 0.02 [b]
BCS at 21 DIM	2.64 ± 0.01 [c]	2.89 ± 0.02 [b]	3.10 ± 0.02 [a]
ECM (kg/d)[1]	30.9 ± 0.4	31.5 ± 0.4	28.7 ± 0.4

[a,b,c]Items with different superscripts within the same row differ ($P < 0.05$).
[1]Mean Energy Corrected Milk from calving to 21 DIM.
[2]Body Condition Score was evaluated at calving and at 21 DIM based on a point 5 scale.

Similar to the experiment by Britt (1992), energy corrected milk (ECM) did not differ among cows based on BCS change (Table 3). Most impressively, P/AI 40 d after timed AI was only 25% for cows that lost BCS, 38% for cows that maintained BCS, and was 84% for cows that gained BCS. It is important to note that there were dramatic farms effects in this study in which one farm had most of the cows that gained BCS (Carvalho et al., 2014). Based on data presented thus far, the key question is: can we increase the proportion of cows that gain BCS after calving? The next study by Barletta et al. (2017) helps us to answer this question.

Effect of BCS change during the periparturient period on reproduction and health

In the second study (Barletta et al., 2017), BCS change was evaluated in 233 Holstein cows from 3 weeks before the expected date of calving until 3 weeks after calving (Table 4). Similar to the experiment by Carvalho et al. (2014), P/AI 30 d after AI for cows submitted to first timed AI was 18% for cows that lost BCS (28% of cows), 27% for cows that maintained BCS (23% of cows), and 53% for cows that gained BCS (49% of cows). Average milk production during the first 3 weeks of lactation did not differ among cows based on BCS change during the periparturient period.

Table 4. Effect of changes in body condition score (BCS) during the transition period on pregnancies per artificial insemination (P/AI) and pregnancy loss. Adapted from Barletta et al. (2017).

	Change in BCS[1]			
Item	Gained	Maintained	Lost	*P*-value
Cows, % (no./no.)	28 (69/245)	22 (54/245)	50 (122/245)	
P/AI 30 d, % (no./no.)	53.0 (35/66)[a]	26.9 (14/52)[b]	18.3 (21/115)[b]	< 0.01
P/AI 60 d, % (no./no.)	45.5 (30/66)[a]	25.0 (13/52)[b]	15.7 (18/155)[b]	< 0.01
Pregnancy loss, % (no./no.)	14.3 (5/35)	7.1 (1/14)	14.3 (3/21)	0.79

[a/c]Within a row, items with different superscripts differ (P < 0.05).
[1]BCS was evaluated during the transition period (-21 to 21 d) using a 5-point scale.

In addition to increased fertility, cows that gained BCS during the periparturient period were also healthier, with less than 40% of these cows experiencing more than one health event, whereas greater than 60% of cows that lost BCS after calving experienced more than one health event (Table 5).

Table 5. Effect of changes in body condition score (BCS) during the transition period (-21 to 21) on incidence (%) of retained placenta, mastitis, ketosis and pneumonia for cows that lost, maintained, or gained BCS. Adapted from Barletta et al. (2017).

	Change in BCS[1]			
Item	Gained	Maintained	Lost	*P*-value
n	66	52	116	
Metritis	19.70 (13/66)	21.20 (11/52)	23.30 (27/116)	0.85
Mastitis	16.70 (11/66)[b]	17.30 (9/52)[a,b]	29.30 (34/116)[a]	0.09
Ketosis	15.20 (10/66)	19.20 (10/52)	26.70 (31/116)	0.18
Pneumonia	9.10 (6/66)	11.50 (6/52)	14.70 (17/116)	0.55
> 1 Health problem	39.4 (26/66)[b]	46.2 (24/52)[b]	62.9 (73/116)[a]	0.007

In this study by Barletta et al. (2017), the major factor associated with BCS change during the transition period was BCS 3 weeks before expected calving. Only 34% of cows with BCS less than 3.0 lost BCS during the transition period, whereas 51% of cows with BCS = 3.0 lost BCS and 92% of cows with BCS > 3.0 lost BCS. So, how can we ensure that more cows gain BCS after calving? Nearly all of the cows in the study by Barletta et al. (2017) that gained BCS during the transition period had a BCS less than 3.0 3 weeks before calving. Thus, calving cows at a lower BCS was associated with less BCS loss, greater fertility, and fewer health issues. Based on data presented thus far, the next question is: how do I prevent calving cows with a high BCS? The final study provides the answer to this question.

The High Fertility Cycle

The final study evaluated BCS change within 1 week of calving until 30 days after calving in 851 Holstein cows on a commercial dairy farm in Michigan (Middleton et al., 2019). This study linked previous calving intervals of individual cows to BCS changes after calving. Calving interval is determined by the fixed interval of gestation length and the highly variable interval of calving to conception. Thus, cows with longer calving intervals during the previous lactation took longer to get pregnant than cows with shorter calving intervals. In this study, cows with longer calving intervals in the prior lactation had greater BCS at calving and lost BCS during the first 30 days after calving. In agreement with the first two studies (Carvalho et al., 2014; Barletta et al., 2017), cows that maintained or gained BCS after calving had greater conception rates, less pregnancy loss, and were healthier than cows that lost BCS after calving (Middleton et al., 2019). Amazingly, even when cows with health problems were removed from the data set, differences in conception rates and pregnancy losses in favor of cows that maintained or gained body condition during the 1st 30 DIM were maintained. An excellent overview of the results from this study is captured by the title of the paper: The high-fertility cycle: How timely pregnancies in one lactation may lead to less BCS loss, fewer health issues, greater fertility, and reduced early pregnancy losses in the next lactation (Figure 3).

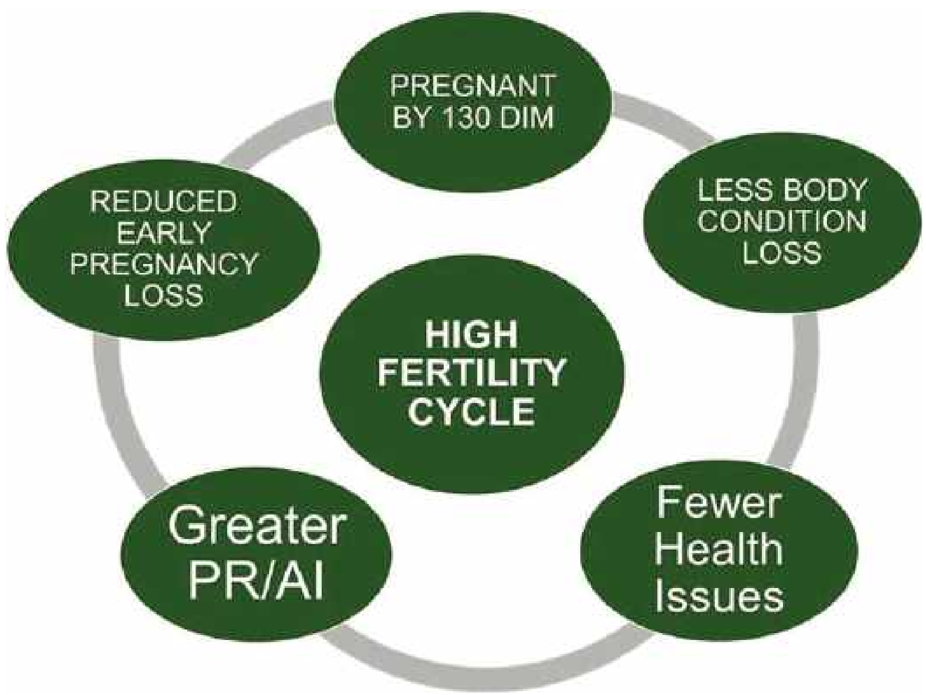

Figure 3. The high-fertility cycle: How timely pregnancies in one lactation may lead to less BCS loss, fewer health issues, greater fertility, and reduced early pregnancy losses in the next lactation. Adapted from Middleton et al. (2019).

CONCLUSION

Based on the collective results from these studies we can now clearly define a relationship in which herds that manage to get their cows pregnant rapidly after the end of the voluntary waiting period calve cows at a lower BCS which in turn leads to more cows maintaining or gaining BCS after calving. Cows that maintain or gain BCS after calving have greater fertility than cows that lose BCS. The High Fertility Cycle coupled with the dramatic increases in reproductive performance due to the development and adoption of fertility programs is a new paradigm that we can now use to explain much of the variation in reproductive performance among herds. The goal of every farm should be to strive to get their cows into the high-fertility cycle and keep them there. The following are key considerations to achieve this: 1) implement BCS monitoring for transition cows 3 weeks before calving, at calving, 3 weeks after calving, and at AI; 2) use fertility programs to help get cows pregnant quickly after the end of the voluntary waiting period; 3) set a hard cutoff for the number times individual cows will be inseminated; and 4) consider nutritional strategies to prevent late lactation cows from gaining too much body condition.

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Four-State Dairy Nutrition & Management Conference

Using MUN to Manage Protein Feeding

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2020
4-State Dairy Nutrition and Management Conference
Breakout Session

Using MUN to Manage Protein Feeding

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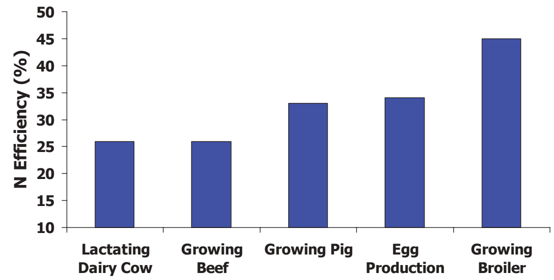
1

N Conversion Efficiencies for Different Production Systems



Bequette et al., 2003

2

Dairy Nutrient Values – 5-year Average

Nutrient values derived using Sesame
Buckeye Dairy News: Vol 22, Issue 2 (March, 2020)

Nutrient	Cost/Unit	Daily Supply*	Cost/cow/d
NEL (3X, NRC 2001) MCal	$0.08	35.4 Mcal	$2.83
Metabolizable Protein (NRC) Lbs	$0.43	5.44 lbs	$2.34
Effective NDF (forage NDF) Lbs	$0.14	10.4 lbs	$1.46
Non-effective NDF (Total NDF – Forage NDF) Lbs	-$0.02	7.3 lbs	-$0.15
Total Cost for Energy, Protein and Fiber			$6.48

* 1600 lb cow, 80 lbs milk/d, 3.0% protein, 3.5% fat

https://dairy.osu.edu/newsletter/buckeye-dairy-news/volume-22-issue-2/milk-prices-costs-nutrients-margins-and-comparison
Sesame can be licensed and used for local markets

3

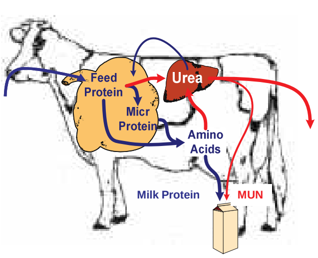
Environmental Impact of Waste N

Eutrophication

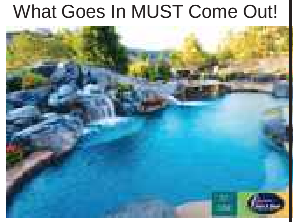
Air Quality and High N Rain

4

RDP/RUP and MUN



What Goes In MUST Come Out!

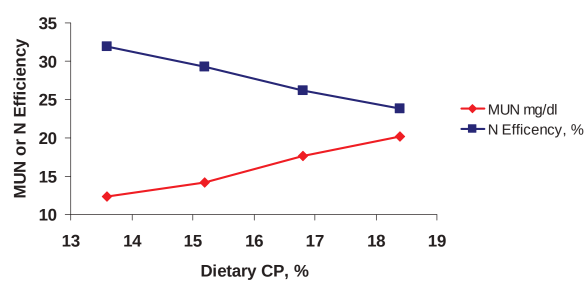


RDP = Ruminally Degraded Protein
RUP = Ruminally Undegraded Protein

CP = RDP + RUP
MP = Digestible (Microbial Protein + RUP)

5

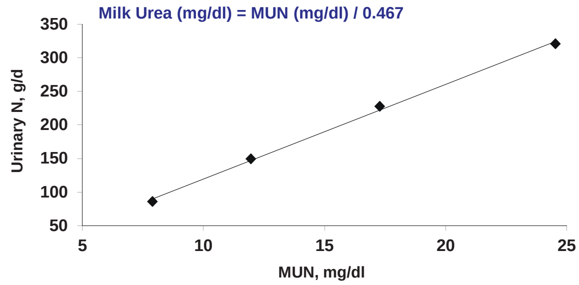
Effects of Dietary Protein (RDP) on MUN and N Efficiency



Cyriac et al., 2006

6

Relationship of MUN and Urinary N Output

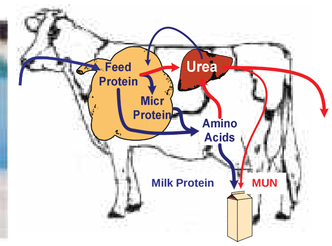


Burgos et al., 2007

7

MUN Responses to RDP/RUP

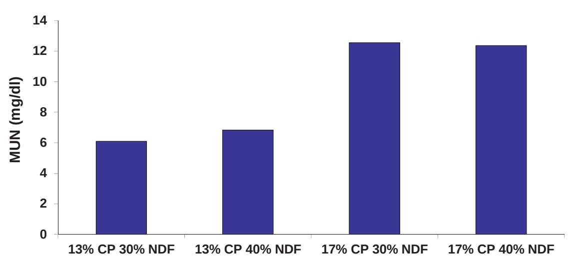
Does it Matter where the Water Enters the Pool?



Ruminally available CHO?

8

Effects of Protein and CHO on MUN



Kaufman and St-Pierre., 2001

9

High Salt Reduces MUN

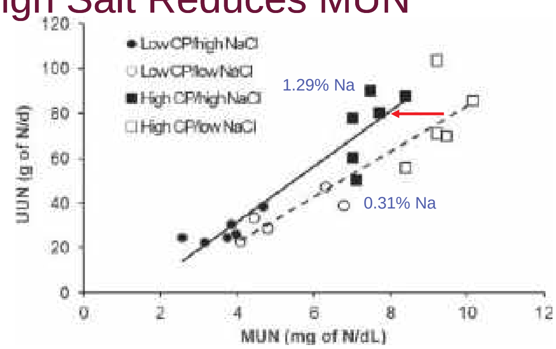


Figure 2. Relationship between MUN concentration (mg of N/dL) and urinary urea nitrogen excretion (UUN; g of N/d) for low NaCl (3.1 g of Na/kg of DM; dashed regression line) and high NaCl (12.9 g of Na/kg of DM; solid regression line) diets.

Spek et al., 2013

10

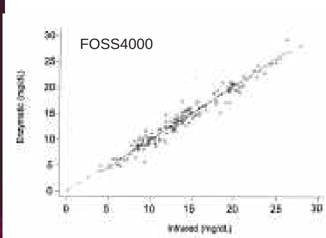
Genetics and MUN

Effect	Estimate	SE	*P*<
Intercept	-166	26	0.002
Dietary CP, % of DM	5.4	1.1	0.0001
Dietary NDF, % of DM	2.84	0.45	0.0001
Milk Yield, kg/d	0.66	0.12	0.0001
Milk Protein, %	37.7	7.3	0.0001
CP x NDF	-0.038	0.018	0.03
CP x Milk Yield	-0.0194	0.0057	0.001
CP x Milk Protein	-0.73	0.24	0.003
NDF x Days in Milk	-0.00005	0.00002	0.009
NDF x Milk Protein	-0.65	0.11	0.0001
Milk x Milk Protein	-0.073	0.023	0.002
Random Effects			
Herd	**1.6**		**0.08**
Cow(Herd)			**0.0001**

Aguilar et al., 2012

11

Are MUN Data Reliable?



Arunvipas et al., 2003 Can. J. Vet Res.

Table 1. Percent recovery of urea nitrogen among analytical methods.

Method	Recovery(%)[1]	SE(%)
Bentley	92.1[a]	2.76
CL-10	85.0[b]	2.76
Foss4000	47.1[c]	9.88
Foss6000	95.4[a]	10.1
Skalar	95.1[a]	7.61

[a,b,c]Means within a column with unlike superscripts differ (*P* < 0.05).
[1]Recovery = (Treated MUN - Control MUN)/4 mg/dL.

Peterson et al., 2004 JDS

United DHIA - Bentley
$0.25 / cow for full test
$10 for a single bulk tank sample

12

Monitor MUN to Achieve Optimum Return

1. Establish a baseline for your herd
   - Balance ration to NRC 2001 or equivalent
   - Feed ration for 2 weeks and Measure MUN (~11 mg/dl)
2. Systematically reduce RUP (0.25% units at a time)
   - For example, CP from 16.5% to 16.25% via RUP ($0.06/c/d)
   - Keep RDP and energy constant
   - Feed for 1 week; Monitor MUN and milk yield
   - MUN should ↓ by ~0.5 mg/dl
   - Any milk loss will be half of NRC predicted loss
   - Calculate Income/Feed Cost (IOFC)
   - If greater, retain reduction and lower another 0.25%
3. Reduce RDP by 0.5% of Diet DM while holding RUP constant
   - Same approach as for RUP, e.g. 16% to 15.5% ($0.02/c/d)
   - RDP ≥ 9% of DM is safe
   - ↓ DMI is first sign of deficiency
4. MUN at maximal IOFC is target for the herd
   - Can operate at 8 or below
   - May require RPAA → IOFC
   - High MUN = overfeeding protein
   - Low MUN = lost milk

13

13

Summary

1. Excess N harms the environment and cost $
   - Environmental regulations are not going away!!!!!
2. Feed to requirements
   - 2001 RDP requirements are too high
   - MP Requirements → AA in 2021
3. Feeding Management is Critical
   - Monitor feeds for nutrient content
   - Balance to requirements
   - Monitor programs for feeding accuracy
   - Verify milk processor MUN accuracy
   - Monitor MUN as a process indicator

14

VirginiaTech

14

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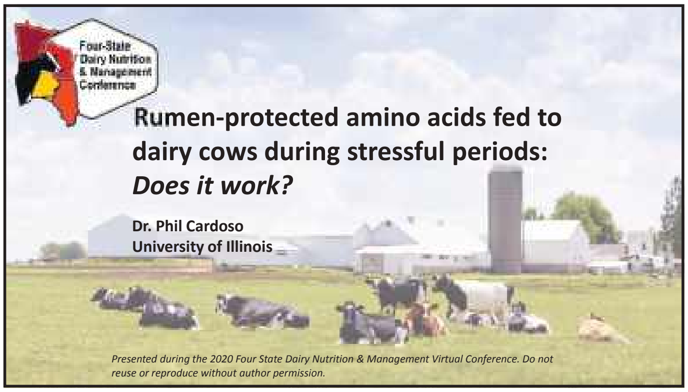
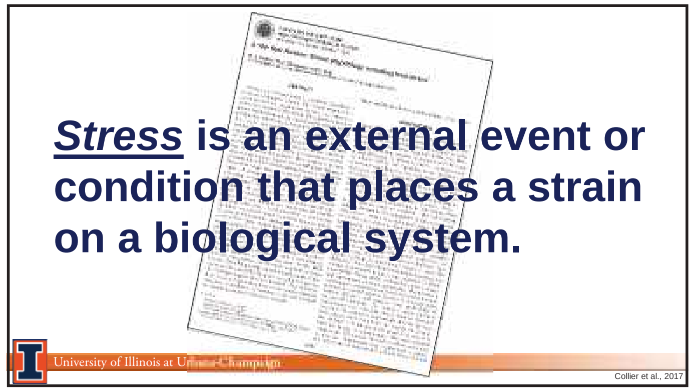

Four-State
Dairy Nutrition
& Management
Conference
Rumen-protected amino acids fed to dairy cows during stressful periods:
Does it work?
Dr. Phil Cardoso
University of Illinois
Presented during the 2020 Four State Dairy Nutrition & Management Virtual Conference. Do not reuse or reproduce without author permission.

1


Stress is an external event or condition that places a strain on a biological system.
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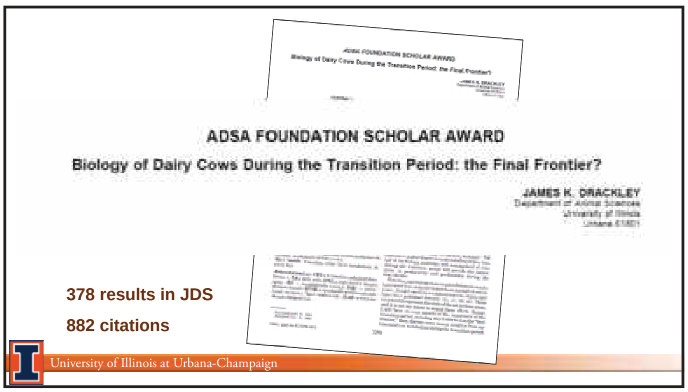
Collier et al., 2017

2


ADSA FOUNDATION SCHOLAR AWARD
Biology of Dairy Cows During the Transition Period: the Final Frontier?
JAMES K. DRACKLEY
378 results in JDS
882 citations
University of Illinois at Urbana-Champaign

3


So, What do we want from this cow?
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4


We should feed and manage dry and transition cows to:
1. Minimize health disorders
2. Maximize production
3. Maximize reproduction
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5


Rx

6

7

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Dietary Recommendations for Dry Cows

- **NEL:** Control energy intake at 14 to 16 Mcal daily [diet ~ 1.32 Mcal/kg (0.60 Mcal/lb) DM] for mature cows
- **Crude protein:** 12 – 14% of DM
- **Metabolizable protein (MP):** > 1,200 g/d
- **Starch content:** 12 to 15% of DM (NFC < 26%)
- **NDF from forage:** 40 to 50% of total DM or 4.5 to 6 kg per head daily (~0.7 – 0.8% of BW). Target the high end of the range if more higher-energy fiber sources (like grass hay or low-quality alfalfa) are used, and the low end of the range if straw is used (2-5 kg)
- **Total ration DM content:** <50% (add water if necessary)
- **Minerals and vitamins:** follow guidelines (For close-ups, target values are 0.40% magnesium (minimum), 0.35 – 0.40% sulfur, potassium as low as possible (Mg:K = 1:4), a DCAD of near zero or negative, calcium without anionic supplementation: 0.9 to 1.2% (~125g) calcium with full anion supplementation: 1.5 to 2.0% (~200g), 0.35 – 0.42% phosphorus, at least 1,500 IU of vitamin E, and 25,000 – 30,000 IU of Vitamin D (cholecalciferol)

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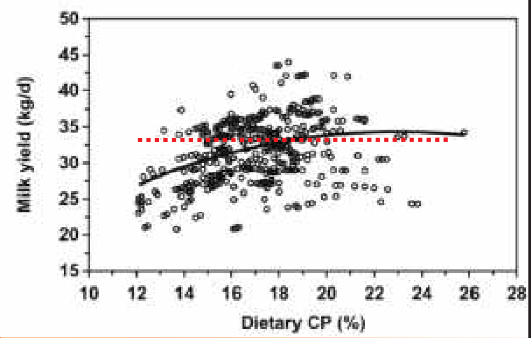
Relationship between milk yield and dietary CP (%) for lactating dairy cows



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Ipharraguerre and Clark, 2005

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Dietary Recommendations for Dry Cows

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- **Crude protein:** 12 – 14% of DM
- **Metabolizable protein (MP):** > 1,200 g/d → Methionine, Lysine
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- **NDF from forage:** 40 to 50% of total DM or 4.5 to 6 kg per head daily (~0.7 – 0.8% of BW). Target the high end of the range if more higher-energy fiber sources (like grass hay or low-quality alfalfa) are used, and the low end of the range if straw is used (2-5 kg)
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Effects of Rumen-Protected Methionine or Choline Supplementation on the First Dominant Follicle

- 72 Holstein cows entering 2nd or greater lactation
- Experimental design was a randomized block design
- Housed in tie stalls with sand bedding
- Milked 3x per day
- Fed same basal TMR to meet but not exceed 100% of the energy requirements as outlined by NRC, 2001
  - From -34 d to calving: prepartum diet
  - From 0 to 30 DIM: fresh cow diet
  - From 31 to 72 DIM: high cow diet
- Treatments were given as top-dress

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Acosta et al., 2016

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Effects of Rumen-Protected Methionine or Choline Supplementation on the First Dominant Follicle

1. Rumen-protected methionine (MET; n = 20, received 0.08% of the DM of the diet/d as methionine, Smartamine M®, Adisseo, Alpharetta, GA, USA, to a Lys:Met = 2.9:1)
2. Rumen-protected choline (CHO; n = 17, received 60 g/d choline, Reassure, Balchem Corporation, New Hampton, NY)
3. Both rumen protected methionine and choline (MIX; n = 19, received 0.08% of the DM of the diet/d as methionine to a Lys:Met = 2.9:1 and 60 g/d choline)
4. No supplementation to serve as control (CON; n = 16, fed TMR with a Lys:Met = 3.5:1)

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Acosta et al., 2016

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Diets

Ingredients	Pre-Fresh -21 d to calving	Fresh Calving to 30 DIM	High 31 to 73 DIM
	% DM		
Alfalfa silage	8.35	5.07	6.12
Alfalfa hay	4.29	2.98	6.94
Corn silage	36.40	33.41	35.09
Wheat straw	15.63	2.98	---
Cottonseed	---	3.58	3.26
Wet brewers grain	4.29	9.09	8.16
Soy hulls	4.29	4.18	4.74
Concentrate mix	26.75	38.71	35.69

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Acosta et al., 2016

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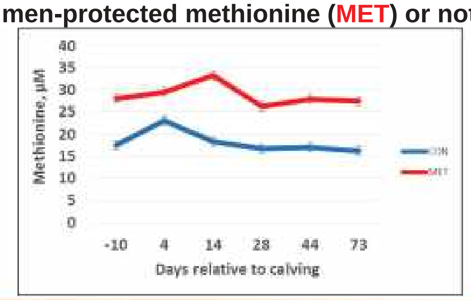
Serum Methionine Concentration from Cows Fed rumen-protected methionine (MET) or not (CON)



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Control: n = 7; Methionine: n = 10

Stella et al., 2018

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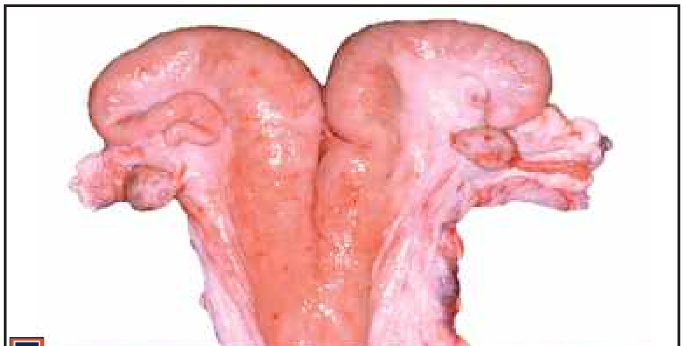

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http://loribovinesection.blogspot.com/2013_07_01_archive.html

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International Journal of Veterinary Science and Medicine

Full Length Article

Effects of rumen-protected methionine and choline supplementation on vaginal discharge and uterine cytology of Holstein cows

Cassandra S. Skenandore, Diego A. Velasco Acosta, Zheng Zhou, Maria L. Rivelli, Márcio N. Corrêa, Daniel N. Luchini, Felipe C. Cardoso

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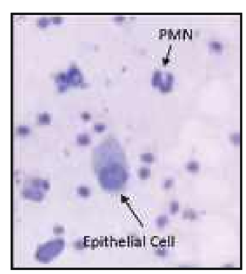
Uterine Cytology – Polymorphonuclear (PMN)



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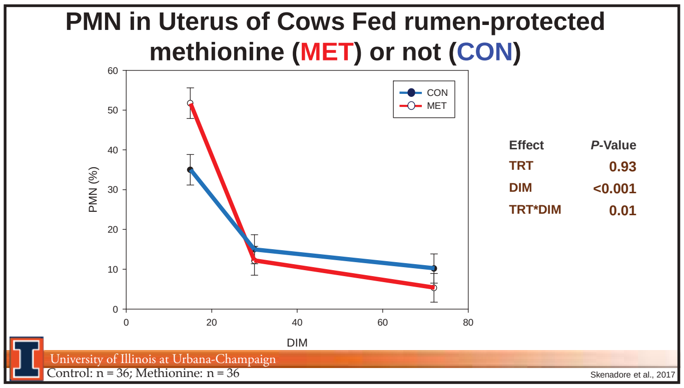

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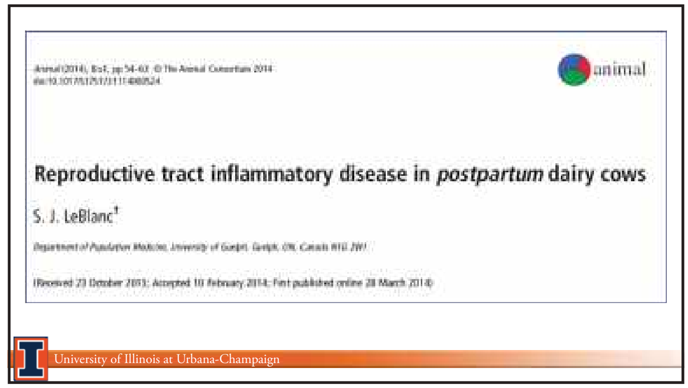

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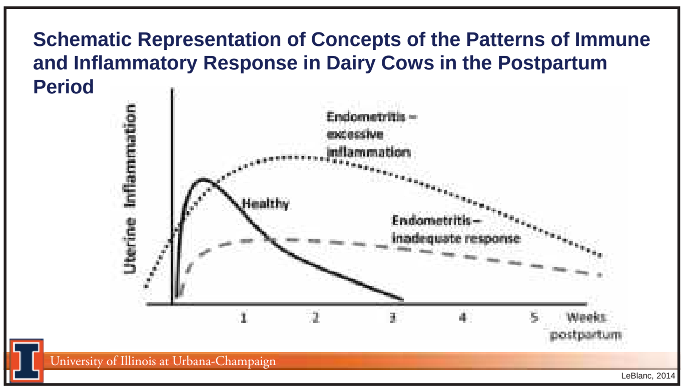

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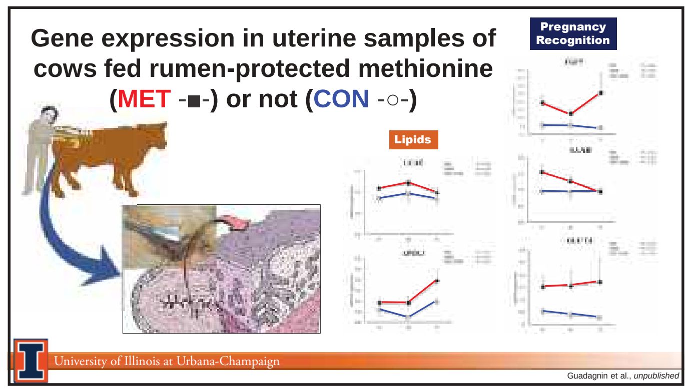

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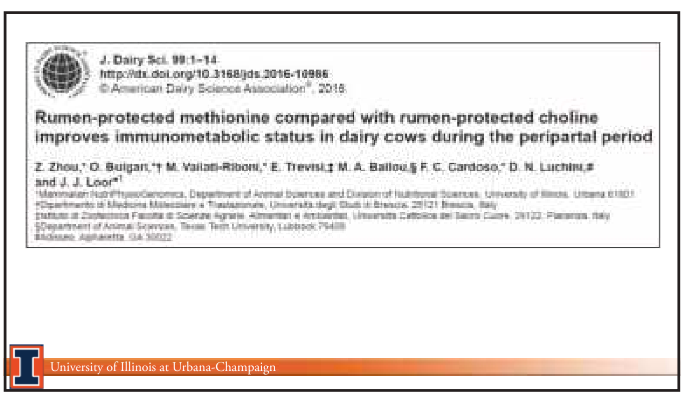

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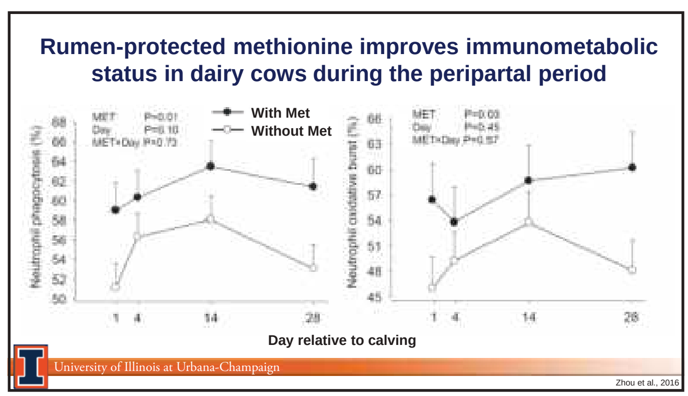

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J. Dairy Sci. 100:6720–6732
https://doi.org/10.3168/jds.2016-12299
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Differences in liver functionality indexes in peripartal dairy cows fed rumen-protected methionine or choline are associated with performance, oxidative stress status, and plasma amino acid profiles

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†Department of Animal and Veterinary Sciences, Clemson University, SC 29634
‡Istituto di Zootecnica Facoltà di Scienze Agrarie, Alimentari e Ambientali, Università Cattolica del Sacro Cuore, 29122, Piacenza, Italy
§Adisseo NA, Alpharetta, GA 30022

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Liver Functionality Index: LFI

Uses changes in plasma concentrations of several blood biomarkers
(i.e., albumin, cholesterol, and bilirubin)

- Low LFI (**LLFI**) is indicative of a pronounced inflammatory response and less favorable circulating AA profile, which together suggest a more difficult transition from gestation to lactation
- High LFI (**HLFI**) is suggestive of a smooth transition

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Trevisi et al., 2012

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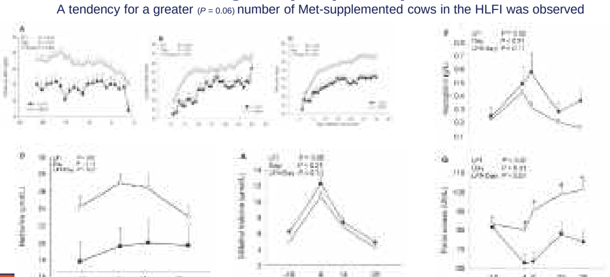
Rumen-protected methionine improves LFI in dairy cows during the peripartal period

A tendency for a greater ($P = 0.06$) number of Met-supplemented cows in the HLFI was observed



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Zhou et al., 2017

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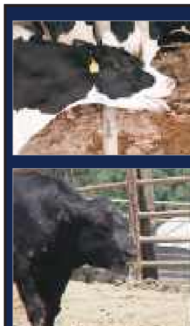

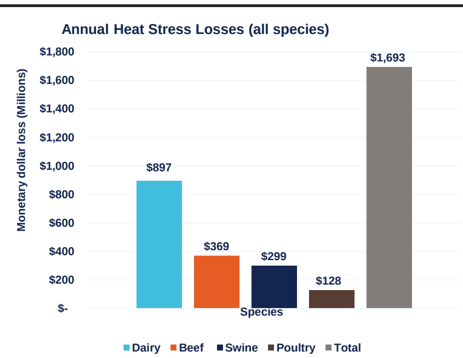

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Adapted from St.-Pierre et al. (2003)

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Heat Stress

Approximately $900 million lost annually

Physiological and production responses

- ↑ Respiration rate
- ↓ Dry matter intake
- ↓ Milk yield

Altered milk content and composition

- ↓ Milk fat %
- ↓ Milk protein %

Altered protein metabolism

- ↓ Total plasma AA concentration
  - ↓ Sulfur-AA (i.e. Methionine)

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Silanikove et al. (2000); Kadzere et al. (2002); St. Pierre et al (2003); Rhoads et al. (2009); Cowley et al. (2015); Gao et al. (2017)

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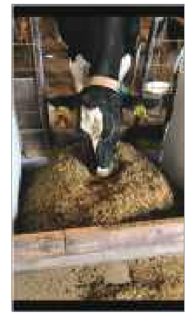
Heat Stress Challenge Experimental Objectives

- Evaluate the effects of commercially available rumen-protected methionine source (Smartamine M; Adisseo Inc.) fed at 0.105% of DMI on lactation performance and physiological responses of lactating, multiparous Holstein cows during heat stress



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Pate et al., 2020

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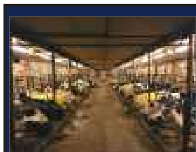

Materials and Methods

Crossover design

- September to December 2018

32 multiparous Holstein cows

- 184 ± 59 d in milk
- 2.8 ± 1.1 lactation number

2 dietary treatments

- **RPM –** 0.105% of DMI [~30g] as RPM*
- **CON –** No RPM*

2 environmental treatments

- **HS –**using electric heat blanket (EHB), ad libitum intake
- **PFTN –** thermoneutral conditions, pair-fed to HS counterparts

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Pate et al., 2020

* Mixed with 300 g molasses

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Environmental Treatment: **Electric Heat Blankets**

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Pate et al., *2020*

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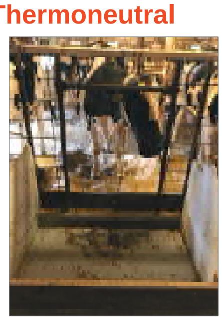
Environmental Treatment: **Pair-Fed Thermoneutral**



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Pate et al., 2020

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Split-Plot Crossover Design

		Period 1 (18 d)				Period 2 (18 d)	
Environmental Treatment (E)	Adaption (7 d)	**Phase 1 – Baseline (9 d)**	**Phase 2 – Trial (9 d)**	Wash-out period (14 d)	Adaption (7 d)	**Phase 1 – Baseline (9 d)**	**Phase 2 – Trial (9 d)**
Heat stress challenge	---	---	**Group 1** (RPM and CON)		---		**Group 2** (RPM and CON)
Thermal neutral and pair-fed	---	---	**Group 2** (RPM and CON)	---	---		**Group 1** (RPM and CON)
Thermal neutral and ad libitum	**Group 1** (RPM and CON) **Group 2** (RPM and CON)	**Group 1** (RPM and CON) **Group 2** (RPM and CON)	---	**Group 1** **Group 2**	**Group 1** (RPM and CON) **Group 2** (RPM and CON)	**Group 1** (RPM and CON) **Group 2** (RPM and CON)	---

Sequence (S)

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Period Timeline

1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9

Phase 1 – Baseline Phase (No HS or PFTN) | Phase 2 – Trial Phase (HS or PFTN)

Physiological Measurements
- Vaginal Temperature (10 min)
- Rectal Temperature (3×/day)
- Respiration Rate (Daily)
- Heart Rate (Daily)

Performance Measurements
- Milk Yield (Daily)
- Dry Matter Intake (Daily)
- Milk Composition (3 d/phase)

= Milk Sample (3×/d)

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Paired Difference Analysis

1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9

Phase 1 – Baseline Phase (No HS or PFTN) | Phase 2 – Trial Phase (HS or PFTN)

Average Phase 1 Baseline Mean — Individual Phase 2 Values

Milk yield: 30 kg/d | 30 kg/d | 25 kg/d | 20 kg/d

Paired Difference Values: 0 kg/d | -5 kg/d | -10 kg/d

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Diet Formulation

Ingredient	% of DM
Corn silage	40.9
Dry ground corn grain	17.7
Alfalfa silage	12.3
Corn gluten feed pellets	8.4
Alfalfa hay	6.3
Grain and mineral mix	6.7
Soybean meal RUP source	3.4
Molasses	3.3
Canola meal	1.7
Rumen protected lysine	0.4

Chemical Analysis*

Item	Mean	SD
DM, %	47.0	1.0
CP, % of DM	15.6	0.2
ADF, % of DM	18.5	0.7
NDF, % of DM	29.0	0.6
Starch, % of DM	31.8	2.2
Crude fat, % of DM	5.1	0.2
Ash, % of DM	7.5	0.9

*Phase 1 and 2 from periods 1 and 2 (**n = 4**)

TMR Analysis

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NRC (2001)
Pate et al., 2020

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Item	RPM	CON
CP	16.08	16.02
Met as % of MP	2.57	2.03
Lys as % of MP	7.01	7.05
Lys to Met Ratio	2.73	3.47

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NRC (2001)

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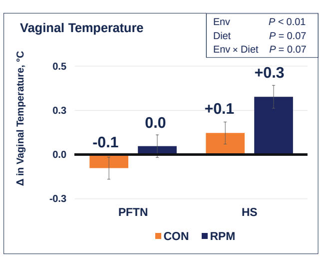
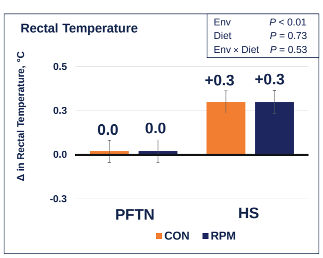
HS had greater increase in vaginal and rectal temperature than PFTN





Physiological Parameters

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Pate et al., 2020

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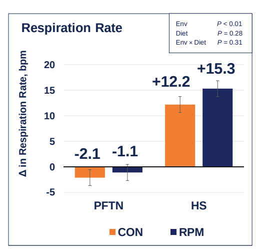
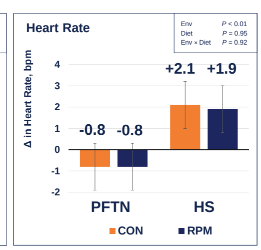
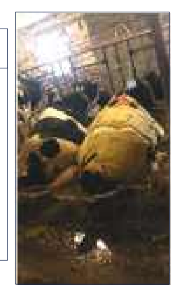
HS had greater increase in respiration rate and heart rate







Physiological Parameters

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Pate et al., 2020

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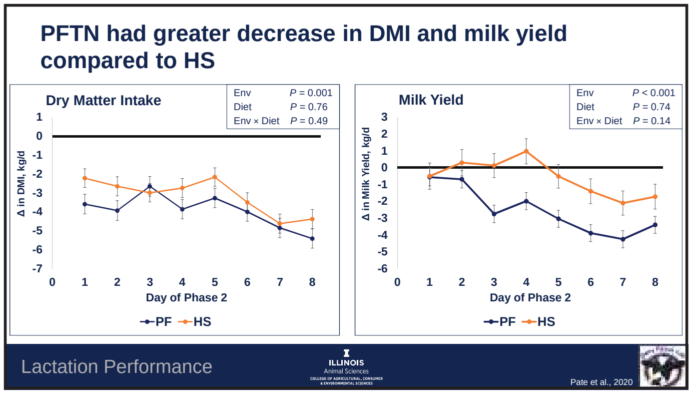

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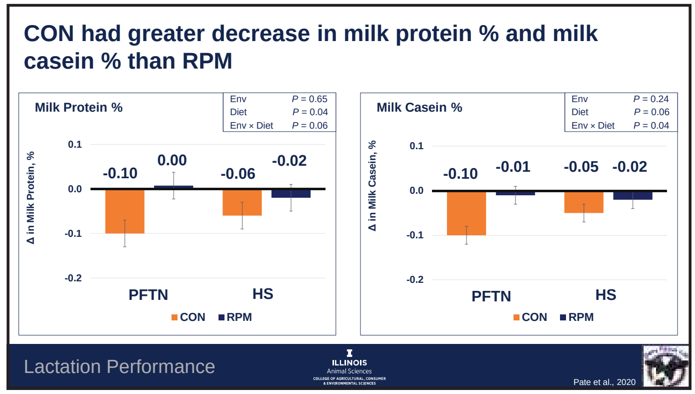

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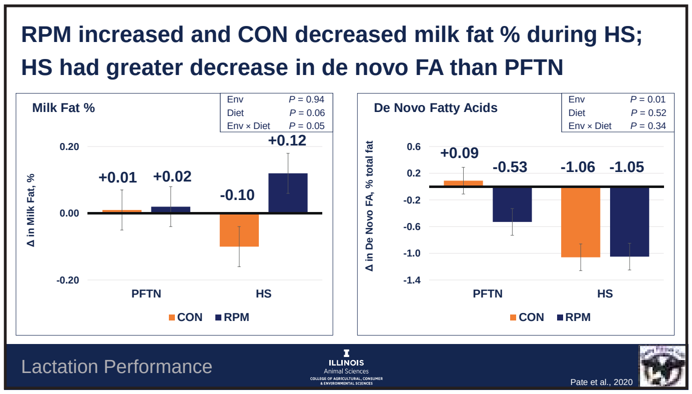

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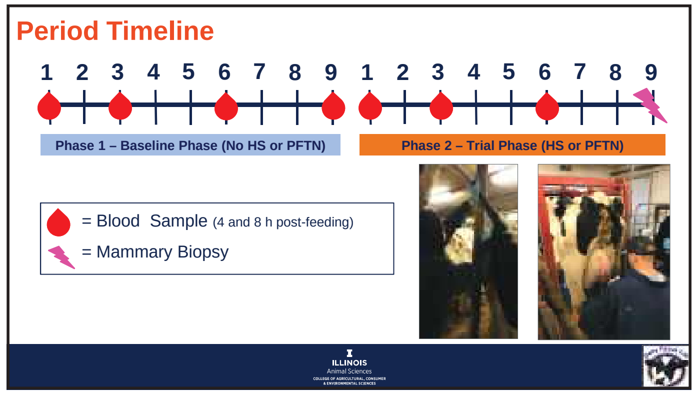

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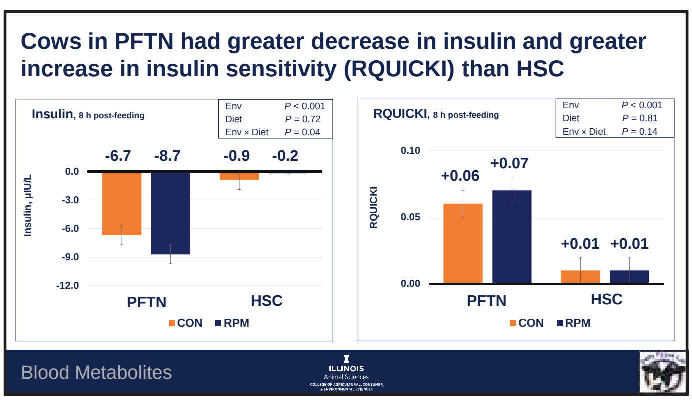

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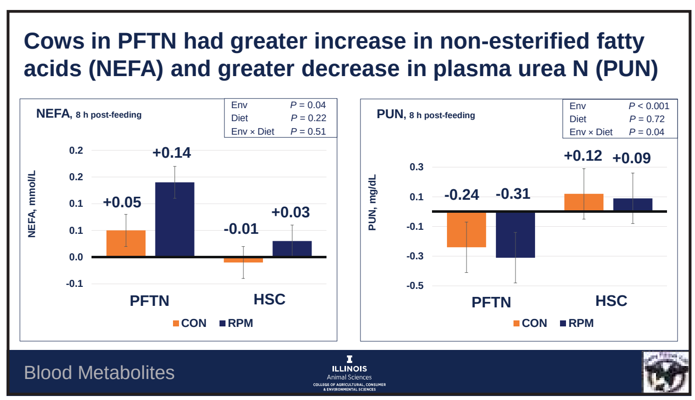

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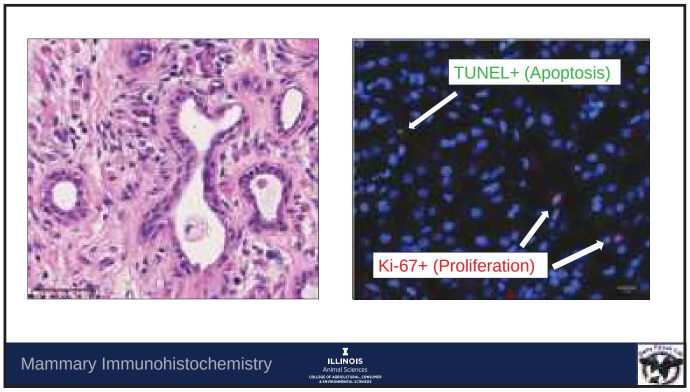

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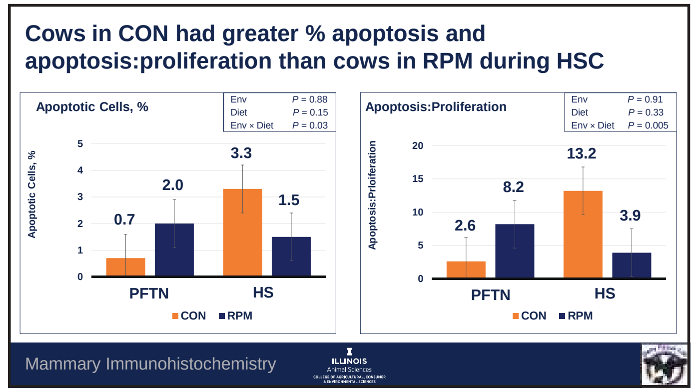

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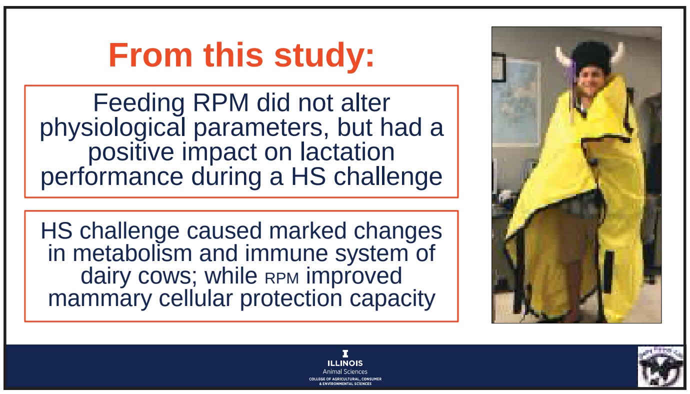

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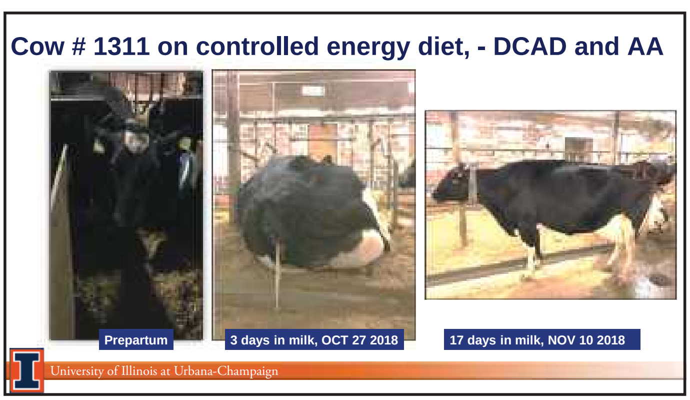

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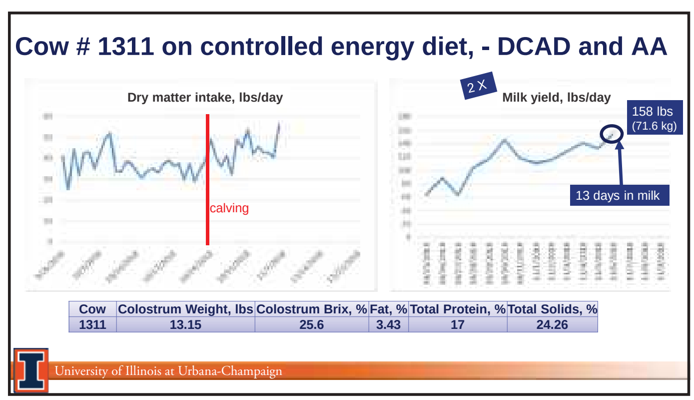

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Summary

Feeding rumen-protected methionine and lysine during the transition period and heat stress

–Impacted (+)

– Dry matter intake
– Milk Yield
– Milk components
– Uterine environment
– Pregnancy recognition
– Pregnancy loss
– Oxidative burst
– Phagocytosis
– Liver Functionality Index

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Summary

- Manage dietary ingredients for
  - Manage for adequate CP (~13% Dry & 16% Lactation)
  - Metabolizable methionine in TMR (30 g/d Dry & 46 g/d Lactation)
    - ~ 15 g/d Dry & 20 g/d Lactation of rumen-protected methionine
  - Metabolizable lysine in TMR (84 g/d Dry & 129 g/d Lactation)
    - ~ 26 g/d Dry & 36 g/d Lactation rumen-protected lysine
    - Balanced for the ratios: Met 2.6% MP; Lys, 7.0% MP (8% PRE) (LYS:MET 2.7:1)
    - Methionine supply relative to energy is ~ 1.15 (no less than 1) – 1.19 g/Mcal ME
    - Lysine supply relative to energy is ~ 2.9 – 3.16 g/Mcal ME
  - Pregnancy rate > 20% (go for > 25%; conception rate at first AI > 40%)
  - Embryonic death < 15% (go for < 10%)

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Smart science brings us more than data and devices. It delivers the industry's most effective immune support product — NutriTek®.
Working naturally* with the cow's biology, NutriTek helps maintain immune strength for optimal health and more quality milk.
Healthy herd. Total dairy performance.
Life Stage Solutions®.
Only from Diamond V.
*natural as defined by AAFCO
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protected minerals
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Lifetime
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AVAILA DAIRY
Begin With Reproduction
From calf to cow, dairy cattle thrive when they receive optimal trace mineral nutrition throughout their life. It's what we call "Lifetime Performance®." In fact, research[1] shows that when dry and lactating cows were fed the complexed minerals in Availa®Dairy they experienced a 7% increase in pregnancy and 13 fewer days open.
Contact your Zinpro representative or visit Zinpro.com/lifetime-performance to learn more.
[1]Rabiee, A. R., I. J. Lean, M. A. Stevenson, and M. T. Socha. 2010. Effects of feeding organic trace minerals on milk production and reproductive performance in lactating dairy cows: A meta-analysis. J. Dairy Sci. 93:4239.
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