Four-State Dairy Nutrition and Management Conference

June 9 & 10, 2021
Virtual Conference

Cooperative Extension for:
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2021

Volume 31

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Wednesday - June 9, 2021

General Session
"Nutrient Requirements of Dairy Cattle"
9:30 - 10:30 - Questions and Discussion <u>Page</u>

Thursday, June 10, 2021

General Session
"Feed Efficiency"
9:30 - 10:30 - Questions and Discussion

Four-State Dairy Nutrition & Management Conference

Update on Estimating Energy Supply and Energy Requirements for Dairy Cows

Dr. Bill Weiss
Ohio State University

Update on Estimating Energy Supply and Energy Requirements for Dairy Cows

Bill Weiss
Department of Animal Sciences (retired)
Ohio Agricultural Research and Development Center
The Ohio State University, Wooster 44691

Summary

Estimated energy balance is an essential output of ration formulation/evaluation software. However, energy balance is calculated from estimated energy intake and estimated energy requirements, both of which are exceedingly difficult to estimate accurately. The most common energy system used in the U.S. is the net energy-lactation (NEL) system. Theoretically this accounts for energy losses via feces, urine, gas (mostly ruminal methane) and heat increment. Fecal energy (averages about 33% of gross energy) and heat increment (averages about 20% of gross energy) are the two largest losses and are the most difficult to estimate accurately. About 25 years ago, we developed an equation to estimate TDN of feeds using commonly measured feed components. The equation was substantially modified in 1992 (Weiss, et al., 1992), and in 2001 it was incorporated into the NRC but was altered to estimate digestible energy (DE) rather than TDN. After years of use, weaknesses have been identified and we modified the equation again in 2018 (Weiss and Tebbe, 2018). The major modifications include replacing nonfiber carbohydrate (NFC) with starch and residual organic matter (ROM). This allows using feed specific starch digestibility coefficients and because ROM is a uniform fraction, ROM from all feeds have the same digestibility coefficient (96%). The digestibility coefficient for fatty acids was changed to 74% based on a large database and lastly the metabolic fecal energy term was modified. New equations have been derived to account for the effects of intake (de Souza, et al., 2018) and dietary starch (Ferraretto, et al., 2013) on DE and those could replace the discount factor used by NRC (2001) which over discounted many diets. Overall, these changes should increase the accuracy of estimating dietary DE. Additional factors that are known to affect digestibility such as dietary concentrations of certain minerals and crude protein need to be incorporated into DE equations. Previously, metabolizable energy (ME) was calculated directly from DE using a regression equation. However, this approach overestimated the ME concentration of diets with excess CP and likely overestimated the ME in high fiber diets. A better approach is to estimate methane production using an equation (e.g., (Nielsen, et al., 2013) and estimate urine energy from estimated urinary nitrogen output (Morris, et al.). These changes should make estimated ME more accurate. The area that has had essentially no improvements is the conversion of ME to NEL. Moraes et al. (2015) re-evaluated older data and derived a slightly different average efficiency (0.66) that can be used to convert ME to NEL. However, this is still a constant which brings into question the value of using NEL rather than ME.

On the requirement side of the equation, other than changing the efficiency of converting ME to NEL from 0.64 to 0.66, current data suggest that the NEL requirements for lactation and gestation are largely adequate. However, several studies have indicated that the equation for the maintenance requirement in NRC (2001) which has been in use since about 1982 likely underestimates the requirement for today's cows. Averaging across several studies, the current equation may underestimate maintenance requirement by an average of about 25%. This will significantly affect total energy requirements for low producing cows and dry cows but will have a relatively small effect on total energy requirements for high producing cows. Improvements in estimating energy supply and energy requirements will increase the accuracy of estimating energy balance of cows which should result in better diets.

See following slide set for details.

References

de Souza, R. A., R. J. Tempelman, M. S. Allen, W. P. Weiss, J. K. Bernard, and M. J. VandeHaar. 2018. Predicting nutrient digestibility in high-producing dairy cows. J Dairy Sci. 101:1123-1135. Online. Available: https://doi.org/10.3168/jds.2017-13344.

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Nielsen, N. I., H. Volden, M. Åkerlind, M. Brask, A. L. F. Hellwing, T. Storlien, and J. Bertilsson. 2013. A prediction equation for enteric methane emission from dairy cows for use in NorFor. Acta Agriculturae Scand Section A — Anim Sci. 63:126-130. Online. Available: https://doi.org/10.1080/09064702.2013.851275.

Weiss, W. P., H. R. Conrad, and N. R. S. Pierre. 1992. A theoretically-based model for predicting total digestible nutrient values of forages and concentrates. Anim. Feed Sci. Technol. 39:95-110.

Weiss, W. P. and A. W. Tebbe. 2018. Estimating digestible energy values of feeds and diets and integrating those values into net energy systems. Trans Anim Sci. 3(3):953-961. Online. Available: https://doi.org/10.1093/tas/txy119.

Update on Estimating Supply and Requirements of Energy

Bill Weiss, Animal Sciences

The Ohio State University
College of Food, Agricultural, and Environmental Sciences

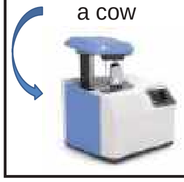
Ohio Agricultural Research and Development Center

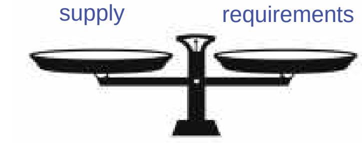
1

Energy nutrition must be looked at as a system

Estimated energy supply is calibrated against requirements (or vice versa)

This is not a cow





2

Approach based on classical energy system

Estimate DE of feeds from nutrients

↓ *DMI and nutrient interactions*

Diet DE

↓ *Standard equation or nutrient-based*

Diet ME

↓ *Standard equations*

Diet NE

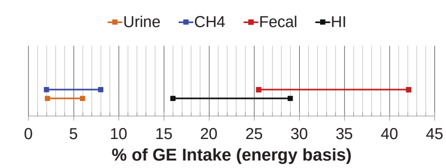
3

Range in **Diet** Energy Losses

(Weiss lab, Wilkerson et al., 1995; 1997)

Mean Losses (% of GE)

Urinary: 3.5%	Fecal: 33%
Methane: 4.8%	HI: 21.5%



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Estimating Feed/Diet DE Values

Old Summative Equation

DE = dCP (CP*$e^{-0.012*ADIN}$)

+ dNDF (NDF*(0.75*NDF-Lig*(1-(L/NDF)$^{0.67}$)
  or NDF*IVNDFD-48h

+ dNFC (PAF*NFC) PAF constant within feed

+ dFA (FA*0.92 *or* (EE-1)*0.92)

- MFE (0.31 Mcal/kg)

ΔH, Mcal/kg

CP = 5.6; NFC = 4.2; NDF = 4.2; FA = 9.4; MFE = 4.4

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Summative Equation (2019 version)

DE = [(RDP + RUP*dRUP) *or CP*$e^{-0.012*ADIN}$*)]*0.056

+ (NDF*{0.75*NDF-Lignin*[1-(L/NDF)$^{0.67}$]}) *0.042
  *or [a*IVNDFD(48 h)-b]*

+ **(Starch*Feed Constant)** *0.042

+ (0.74*FA) * 0.094 (adjustments for supplements)

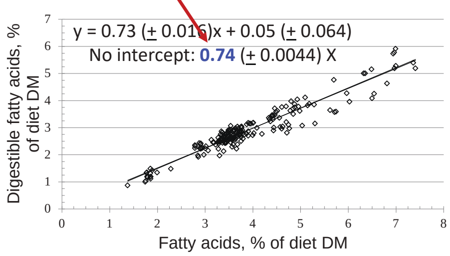
+ (0.96* ROM) * 0.04 (ROM = 100-NDF-CP-Starch-ash-FA)

- 0.31 Mcal/kg (metabolic fecal energy)

Then adjust for **associative effects and DMI**, subtract est. methane and urinary energy, multiply by k and get NEL

6

Estimated True Digestibility of FA (15 studies from The OSU)



Previous true digest of FA = **0.92**

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Energy from NFC: Improved

NFC = Starch + Everything else (ROM)

Sugars, organic acids, sol fiber, glycerol, waxes . . .

Benefits

1. ROM smaller diet fraction than NFC
   (8-24%) (35-45%)
2. Starch is a routine assay
3. Large database on starch digestibility

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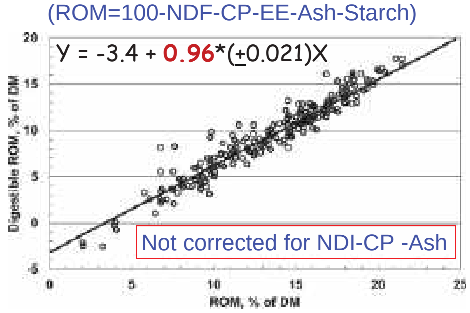
ROM has constant, high digestibility

(ROM=100-NDF-CP-EE-Ash-Starch)



Tebbe et al., 2017

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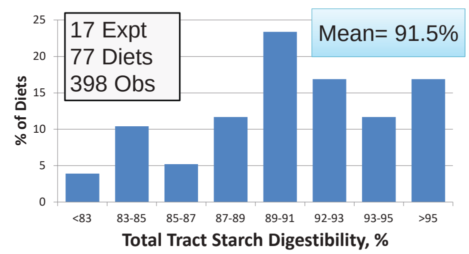
Starch Digestibility in Lactating Cows

(OARDC Dairy Nutrition Lab, 1990-Present)



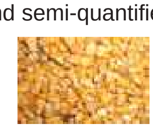
~25% had<87%

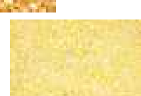
~25% had >94%

10

Variation in starch digestibility

- In 50% of diets, using mean = >2% DE error (~1.5 kg of milk)
- Need a **validated** lab assay to estimate total tract starch digest
- Many sources of variation are known and semi-quantified
  - Grain type
  - Particle size
  - Flake density
  - Moisture content
  - Maturity of corn silage





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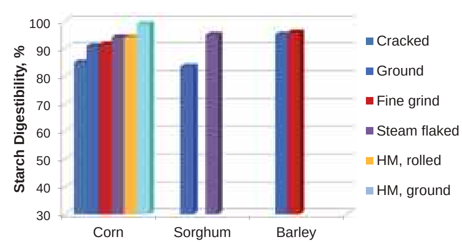
Grain Processing and Starch Digestibility



Literature review, Firkins et al., 2001

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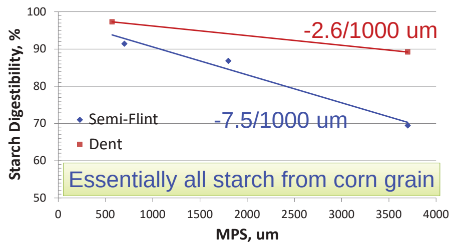
Corn Particle Size and Starch Digest

(Remond et al., 2004)



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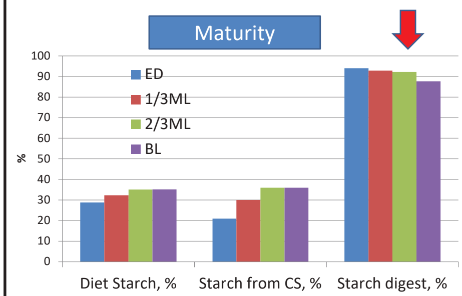
Estimating starch digest in corn silage



- Also kernel processing score
- DM%
- Maybe hybrid

(Bal et al., 1997)

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Estimating NDF Digestibility

1. Lignin-based: lack of sensitivity
2. Kinetic-based: assay precision, variability within feeds
3. IVNDFD: assay precision, variability within feeds, equation accuracy (IVNDFD ≠ in vivo)

- All methods lack vigorous evaluation
- Feed vs. TMR
- Interactions with diet and DMI

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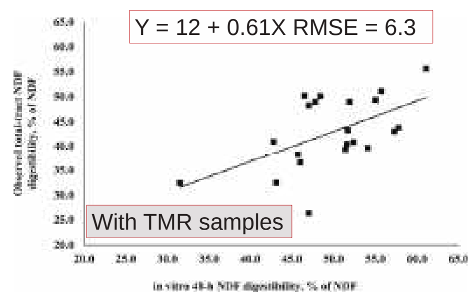
48h In vitro vs. cow in vivo NDF digest



Lopes et al., 2015

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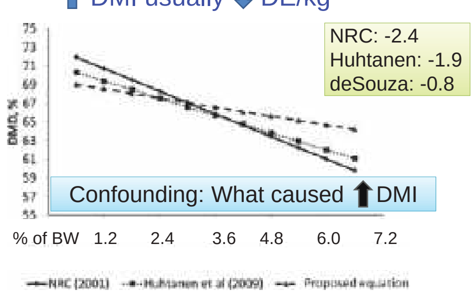
DMI usually DE/kg



De Souza et al., 2018

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Associative and Other Effects

- **NDF digestibility**
  - Starch% = Digestibility
  - CP/RDP% = Digestibility
  - DCAD = Digestibility

Interactions and confounding ? ? ?

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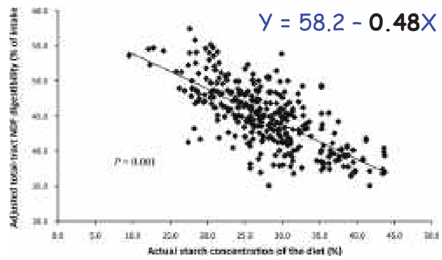
⬆Starch = ⬇NDF Digestibility



Ferraretto et al 2012

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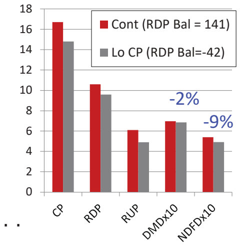
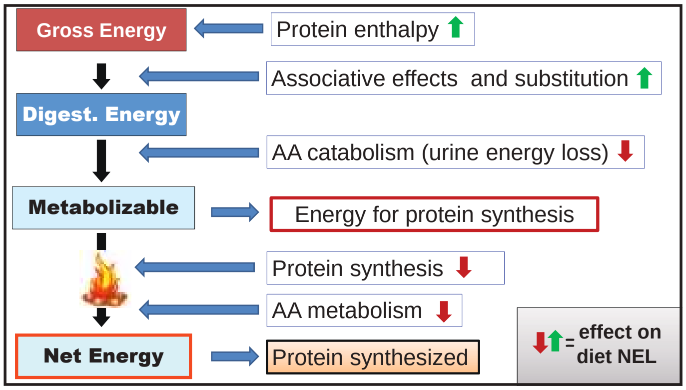
Need to Make Additional Adjustments of Digestibility

1. Additional diet factors to incorporate
   - **CP, RDP,** DCAD, S, sugars …
2. More interactions
   - DMI x diet factors
   - **Nutrient x nutrient interactions**
3. Management factors
   - Feeding frequency, crowdedness, . . .



Lee et al., 2011

20



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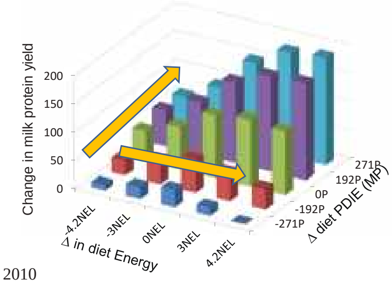
Interaction between energy and protein

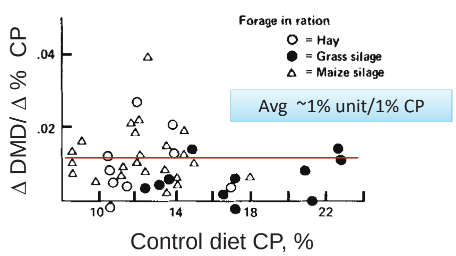
If Energy is extremely deficient, why does ⬆MP ⬆milk protein ?



Brun-Lafleur et al., 2010

22

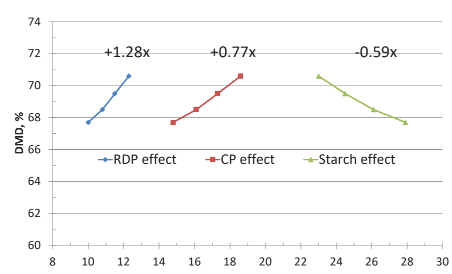
Increasing diet CP often increases DMD (DE)



Oldham, 1984

23

Effect of Changing CP, RDP, or Starch on DMD
(Broderick et al., 2008)



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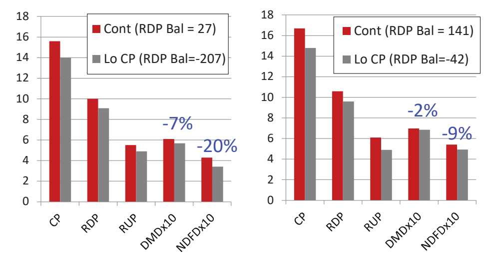
Lower CP can reduce digestibility



Lee et al., 2012 Lee et al., 2011

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Estimating **Diet** ME Values

ME = 0.96DE – 0.3 (Galyean et al., 2016)
ME = 1.01DE – 0.45 (NRC, 2001)
} 0.85-0.88

ME = DE
- CH4 ⟸ dNDF, Fat
- Urine energy ⟸ AA balance, dCP intake, milk protein yield

CH4 = 1.23DMI-0.145FA+0.171dNDF
MJ/d kg/d g/kg g/kg (Nielsen et al., 2013)

Urine Energy = 14.3 kcal/g N

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Either need to account for variation in heat increment or just use ME

NE = ME – Heat Increment

- Dietary fiber and FA
- Starch
- Excess RDP
- Protein synthesis
- AA catabolism

Lack of Adequate Data
NEL = 0.66*ME (0.66 from Moraes et al., 2015)

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Theoretical effect of replacing 2%units of CHO with CP (CHO = 50/50 NDF/Starch)

1. Increase diet GE (5.6 vs 4.2 Mcal/kg) +
   Increase digestibility : 3.12 vs 3.03 Mcal/kg **DE = +2.3 Mcal/d**

2. Increase urinary energy loss:
   56 g N/d x 0.0143 Mcal/g = 0.8 Mcal/d **ME = +1.5 Mcal/d**

3. Increase heat increment (not very accurate)
   +0.88 Mcal/d **NEL = + 0.62 Mcal/d**

Energy equal to about 0.9 kg milk (2 lbs)

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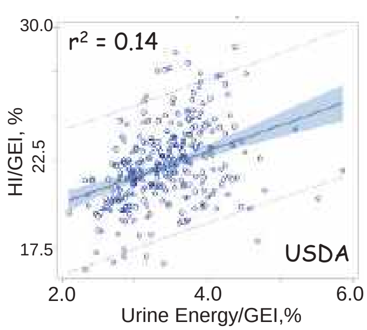
Theoretical effect of replacing 2%units of CHO with CP



15 to 17% CP (DMI = 25 kg)

Change in DE:	**+2.4 Mcal/d**
+~56 g urine N	(+0.8 Mcal/d)
ME	**+1.6 Mcal/d**
HI	(+0.8 Mcal/d)
NEL	**+0.8 Mcal/d**
Milk	~+1.1 kg/d

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Energy Requirements

Maintenance (fasting heat production + some extra)

Milk (heat when milk is combusted; ~0.72/kg for avg Holstein)

Gestation (energy in fetus and conceptus)

Growth (energy in frame gain)

Extra activity (grazing but maybe large pens with 3X milking)

Body reserves (energy in change in BCS)

30

Effect of changing NEL maintenance requirement

Maintenance would increase 25% (i.e., 0.08 to 0.10)

Change in total NEL requirements

- 1550 lb dry cow, 260 d pregnant: +2.7 Mcal/d **(~20%** increase)
- 1440 lb cow, 110 lbs of milk: +2.5 Mcal/d (**~6%** increase)
- 1440 lb cow, 55 lbs of milk: +2.5 Mcal/d (**~9%** increase)
- 1000 lb cow, 50 lbs of Jersey milk +2 Mcal/d (**~7%** increase)

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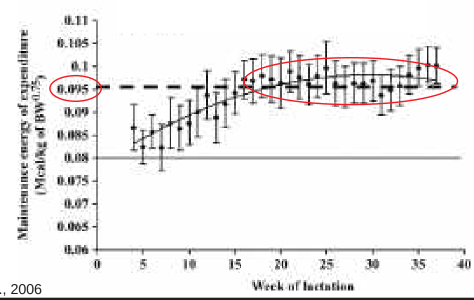
Maintenance of modern dairy cow >0.08* MBW



Ellis et al., 2006

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NEL Maintenance Requirement

Historic: 0.08 x $BW^{0.75}$ (650 kg cow = 10.3 Mcal)

- Underestimates for modern dairy cow
  - Less body fat
  - Greater proportion of body as organs

Maint = ~0.10 x $BW^{0.75}$ (650 kg cow = 12.9 Mcal)

Examples:

Ellis et al., (2006): **0.085 to 0.095**
Moraes et al., (2015): **0.088 to 0.124**
Agnew and Yan (2000): **0.118 to 0.160**

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Milk and Pregnancy NEL

- **Milk energy** is function of fat, protein and lactose conc. and established heats of combustion (9.3, 5.6, and 4 Mcal/kg)
  - ✓ NEL/ME: 0.64 (NRC, 2001)
  - ✓ NEL/ME: **0.60** (60-70's); **0.63** (70 to 80's) and **0.70** (80 to 90's (Moraes et al 2015)

Greater efficiency means diet has more NEL
(i.e., less energy needed to make milk)

- **Pregnancy:** essentially no new data since Bell et al. (1995)

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Activity Requirements

- With pedometers, GPS, heart rate monitors, etc. we have better estimates of energy expenditures of walking cows
- NRC (2001) likely overestimated energy required for walking
- Still have poor estimates on effects of topography
- For Holstein on fairly flat ground: ~0.9 to 1.4 Mcal/day

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Summary

- Summative equation has been improved (starch, FA)
- Equations to account for DMI and starch have been improved but need to incorporate other factors (eg RDP)
- Should predict ME from estimated methane and urinary N
- Maintenance requirement has increased in modern dairy cows
- Other requirements likely haven't changed much

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Four-State Dairy Nutrition & Management Conference

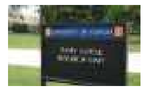
A New System for Determining Nutrient Requirements of Young Dairy Calves

Dr. Jim Drackley
University of Illinois

A New System for Determining Nutrient Requirements of Young Dairy Calves

Jim Drackley

Professor of Animal Sciences
University of Illinois at Urbana-Champaign



1

Feed is the major cost of heifer raising:
Predicting nutrient requirements and performance is critical!

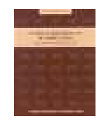
2

Outline

- Problems with existing (NRC, 2001) model
- Development of new model – energy
- Development of new model – protein
- Comparison of new model with NRC, 2001

3

Nutrient Requirements of Dairy Cattle



7th Revised Edition, 2001

National Research Council (NRC)
Subcommittee on Dairy Cattle Nutrition

National Academy Press, Washington, DC

- Separate chapter (chapter 10) for the young calf (<100 kg)

4

NRC 2001: A major advance...

- Importance of the calf
- First step toward recognition of the calf as a dairy animal with variable requirements based on body size and performance (i.e., growth rate)
- Provision of a computer model
- Helped spur years of much-needed research

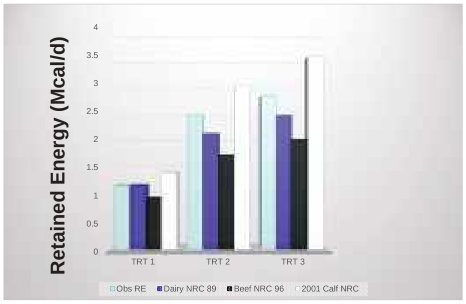
5

General features of existing calf model

- Based on **energy-allowable growth.**
- Protein requirements calculated as maintenance plus body N deposition at energy-allowable growth rate.
- Minerals and vitamins are calculated as percentages of dry matter intake.
- *Prediction of retained energy (i.e., net energy) is central to model performance.*

6

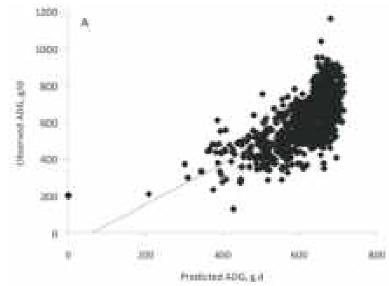
Comparison of Observed and Predicted Retained Energy Values for Pre-ruminant Calves



Diaz et al. 2001

7

Comparison of Observed and Predicted ADG for Pre-weaned Calves

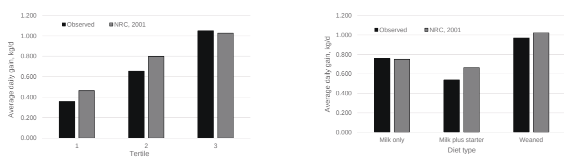


997 individual calves from 20 studies; R2 = 0.42

Hill et al. 2013

8

Comparison of Observed and Predicted ADG for Calves



111 treatment means from the literature

Drackley, unpublished 2021

9

Problem!

10

Problems with NRC 2001 energy equations

- Data from which Toullec ME equation was derived came from studies with heavier veal calves fed milk only.

- Efficiency of converting ME to RE is too high for lighter weight growing calves depositing primarily protein.

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To determine RE we must know composition of BW gain

Comparative slaughter studies

Measured RE = ME intake – Heat production

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Definitions:

	Milk only	Milk + Starter	Weaned
EBW:FBW	0.94	0.93	0.85
EBWG:ADG	0.91	0.91	0.85

- Source of error and confusion with NRC 2001
- All calculations for energy and body composition based on EBW, converted to BW basis

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Example of problem – changing from preruminant to ruminant

Stage	BW, kg	EBW: BW	EBW, kg	ADG, kg/d	EBWG, kg/d	EBWG: ADG
Prewean	80.0	0.94	74.4	---	---	---
Postwean (+20 d)	100.0	0.85	85.0	1.0	0.53	0.53
Postwean (+40 d)	120.0	0.85	102	1.0	0.85	0.85

NRC 2001 actually was more accurate if you used EBW rather than "LBW", but according to original data source (Toullec, 1989), LBW was used

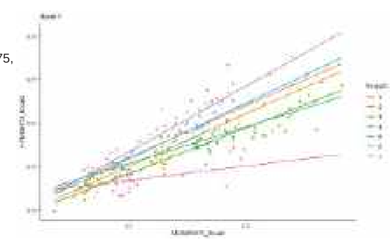
14

Since publication of NRC 2001, several body composition studies have been reported

- Database of 255 calves (7 studies, Cornell, Illinois, Virginia Tech) with full body composition and changes from baseline (RE)
  - 6 published, 1 Ph.D. thesis
  - 6 Holstein, 1 Jersey
  - 2 with starter, 5 without
- Used to derive:
  - maintenance energy
  - relationships between retained energy and empty body weight gain and metabolic body size
  - efficiencies of ME use
  - nitrogen deposition

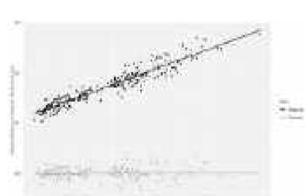
15

Heat production (HP), Mcal/d = MEI Mcal/d – RE, Mcal/d



16

HP, Mcal/kg EBW^0.75 = 0.077 × *e*^(3.3426 × MEI, Mcal/kg EBW^0.75)



NEm, Mcal/kg EBW^0.75 = 0.077

MEm, Mcal/kg EBW^0.75 = 0.107 Mcal/kg EBW^0.75

17

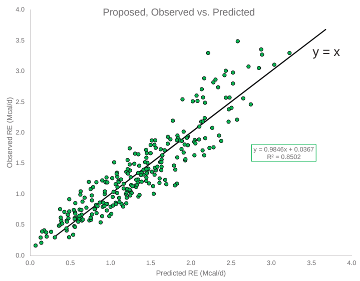
Next need to derive an equation linking retained energy (NEg) to body weight gain

- Ultimately allows linking dietary energy (ME) supply to predicted BW gain
- Equation selected was:

  RE, Mcal/d = (EBG$^{1.100}$, kg/d) × (EBW, kg$^{0.205}$)

18

Derived new equation



RE = (EBWG^1.1)*(EBW^0.205)

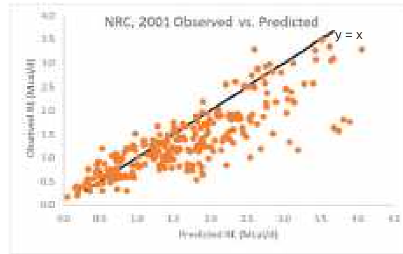
Best equation
(fit, least bias,
lowest RMSE)

Random effect of study

Drackley et al. unpublished

19

Comparison with NRC 2001

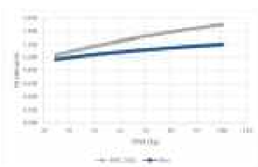


Drackley et al. unpublished

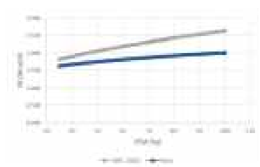
20

Impact of EBW on predicted RE with new equation

EBWG = 0.5 kg/d



EBWG = 0.8 kg/d

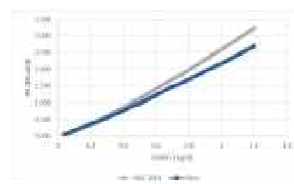


Drackley et al. unpublished

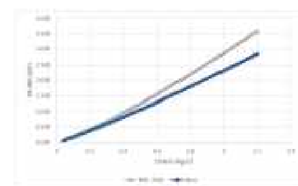
21

Impact of EBWG on predicted RE with new equation

EBW = 45 kg



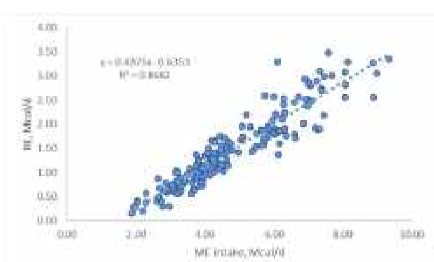
EBW = 60 kg



Drackley et al. unpublished

22

Efficiency of ME use for gain, milk only



23

Efficiency of ME use for gain, milk only

- On a metabolic body weight basis = 46%
- Summary of older studies, basis of NRC 2001 = 69%
- INRA, 2019 = 55%
- Use 55% as compromise to represent all calves
- Efficiency for calves fed milk plus starter is lower

24

Efficiency of ME use from starter

NEg, Mcal/kg DM = (1.1376 × ME) - (0.1198 × ME^2) + (0.0076 × ME^3) - 1.2979

Galyean et al. (2016)

Over typical starter ME range (i.e., 2.5 to 3.5 Mcal/kg), RE:ME varies from 0.38 to 0.44

Efficiency of mixed diet (milk plus starter) is additive

25

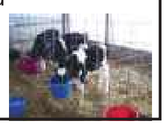
Summary and significance

Using data published since NRC 2001, we are able to more accurately predict RE, and therefore also more accurately predict ADG.

26

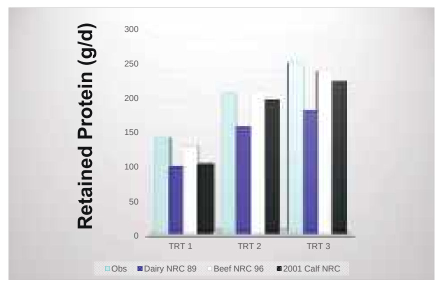
Energy and protein supply

- Must be in correct proportion to each other
- Energy intake is primarily determined by the ***amount*** of milk or replacer fed and amount of starter consumed
- Protein intake is affected both by amount fed and the protein content in the milk replacer and starter



27

Comparison of Observed and Predicted Retained Protein Values for Pre-ruminant Calves



Diaz et al. 2001

28

Metabolizable protein for maintenance

- Relatively small
- Calculated similarly to NRC, 2001 except with addition of scurf protein and reduced efficiency of use (0.68 vs 0.80)

29

Nitrogen Composition of the Gain

NRC 2001 used a mean value of 30 g N/kg liveweight gain (Blaxter and Wood, 1951; Roy, 1970; Donnelly and Hutton, 1976)

- Equivalent to 188 g CP/kg LWG

Re-evaluated using the new database:

NPg = (166.2 × EBW gain, kg/d) + (6.1276 × (RE, Mcal/d / EBW gain, kg/d)

30

Comparison of new system with NRC, 2001

- For a 50-kg calf fed 1.0 kg of milk replacer (28/20) and consuming 0.2 kg of starter daily
- Calculated requirement:
  – New system = 0.88 kg/d
  – NRC, 2001 = 0.96 kg/d

31

Comparison of new system with NRC, 2001

- For a 50-kg calf fed 0.68 kg of milk replacer (26/17) and consuming 0.4 kg of starter daily
- Calculated requirement:
  – New system = 0.63 kg/d
  – NRC, 2001 = 0.72 kg/d

32

Other features of new calf model

- Prediction equations for starter intake
- Refined mineral requirements in quantity per day
- Revised fat-soluble vitamin recommendations

33

Looking ahead

- These recent advances should allow improvement of NRC predictions of calf requirements and predicted performance.
- Modified equations will result in more accurate prediction of growth, both with and without starter.

34

35

Four-State Dairy Nutrition & Management Conference

Essential Amino Acid Supply and Use for Lactating Dairy Cattle

Mark D. Hanigan
Department of Dairy Science
Virginia Tech

Essential Amino Acid Supply and Use for Lactating Dairy Cattle

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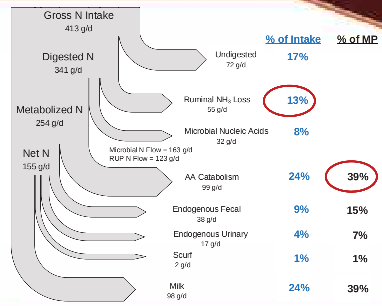
Department of Dairy Science
Virginia Tech

1

N Partitioning in the Lactating Ruminant

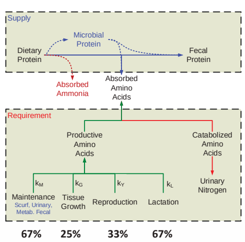
Typical 1990's Diet



Adapted from Arriola et al., 2014

2

NRC 2001 Model



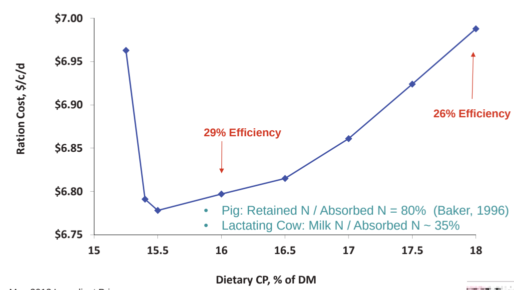
- Ruminal Metabolism
  - RUP/RDP (1st order passage/degradation)
  - Microbes (linear RDP & TDN)
- Absorption
  - Total Tract disappearance: DE, MiP, RUP, Vit, Min
  - Fractional digestibility by Ingredient
- Use
  - ME, MP, Met, Lys, Vit, Min
  - Maintenance and Production Use
  - Linear Conversions of Mx to Nx
  - Factorial summation
  - Balance = Supply - Use
  - Diets balanced to remove -Balance

3

NRC 2001 Least Cost Rations

Balanced to NRC 2001 Requirements (MP & RDP)

36 kg milk, 3.0% protein, 3.6% fat, 23.6 kg DMI



Mar, 2013 Ingredient Prices
ST-Pierre, Progressive Dairyman

4

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

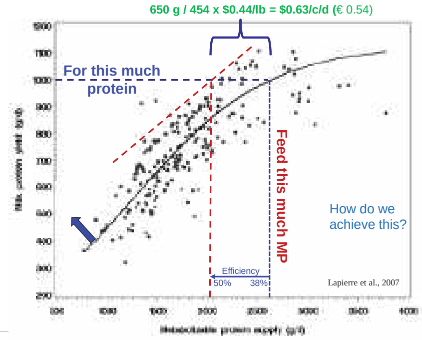
* 1600 lb cow, 80 lbs milk/d, 3.0% protein, 3.5% fat

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

5

Milk Protein vs Metabolizable Protein

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



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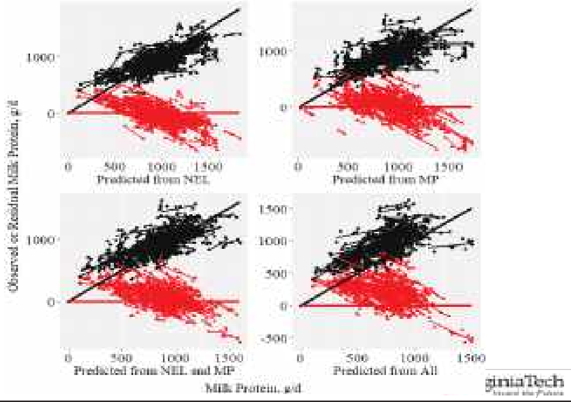


7

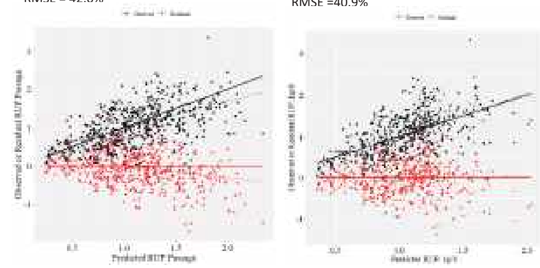
Ruminally Undegraded Protein (RUP)

2001: $RUP = \frac{Kp = fn(Diet)}{Kp + Kd}(CPB) + CPC$

RMSE = 42.0%

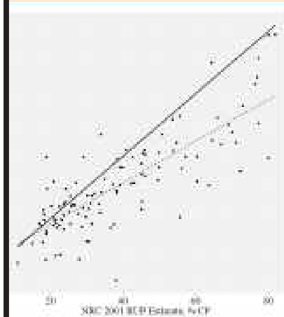
2021: $RUP = 0.05(CPA) + \frac{Kp_{(For,Conc)}}{Kp + Kd}(CPB) + CPC$

RMSE =40.9%



8

2001 vs 2021



Hanigan et al., in press

	2001	2021
Blood meal, high dRUP	76	63
Brewers grains, dry	54	42
Canola meal, solvent extracted	33	25
Cool season grass hay, mid-mat	29	40
Corn gluten feed, dry	28	21
Cottonseed meal	46	42
Dry distillers + sol, high fat	50	36
Feather meal	64	45
Legume silage, mid-maturity	18	23
Meat and bone meal, porcine	56	36
Peanut, Meal, solvent	12	12
Soybean meal, solvent extracted, 48% CP	31	25
Soybeans, whole roasted	38	28
Sunflower meal	15	12

9

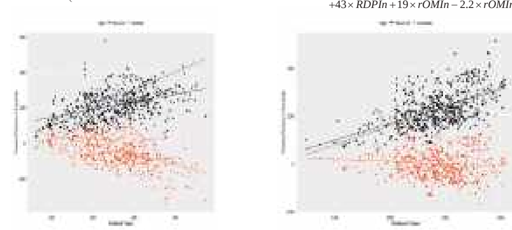
Microbial N Flow Predictions

NRC 2001: RMSE ≈ 30%

$MiN = \begin{cases} 0.85 \times RDP \\ 0.16 \times TDN \end{cases}$

2021: RMSE = 25%

$MiN(g/d) = -20 + 37.6 \times rdStIn + 17 \times rdNDFIn + 43 \times RDPIn + 19 \times rOMIn - 2.2 \times rOMIn^2$



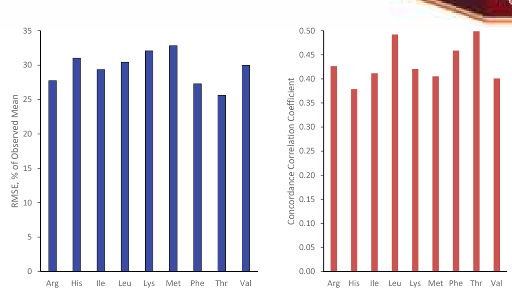
White et al., 2017.

Hanigan et al., in press

10

Prediction Errors for Duodenal AA Flows

with Updated RUP, MiCP, EndoCP, & AA Composition



Fleming et al, 2019
Study effects excluded

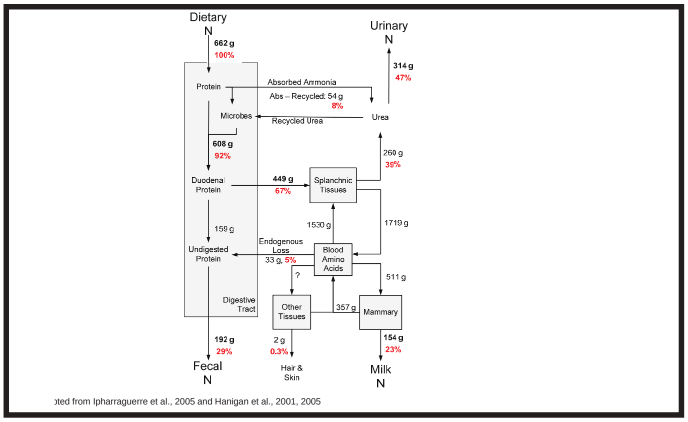
11

Milk Protein Yield Predictions by NRC 2001 and the New Model

Item	NRC 2001 + Digestion Corrections			
	MP Allowable	NEL Allowable	MP & NEL	MP, NEL, & EAA
N	894	934	894	906
Observed Mean, kg	919	918	919	915
Predicted Mean, kg	951	890	830	734
CCC	0.77	0.65	0.70	0.52
RMSPE, % mean	21.3	24.9	22.9	29.0
Mean Bias, % MSE	2.7	1.5	18.0	46.5
Slope Bias, % MSE	37.7	31.8	21.1	5.3
Slope Bias, kg/kg	-0.379	-0.440	-0.342	-0.267

Hanigan et al., in preparation

12



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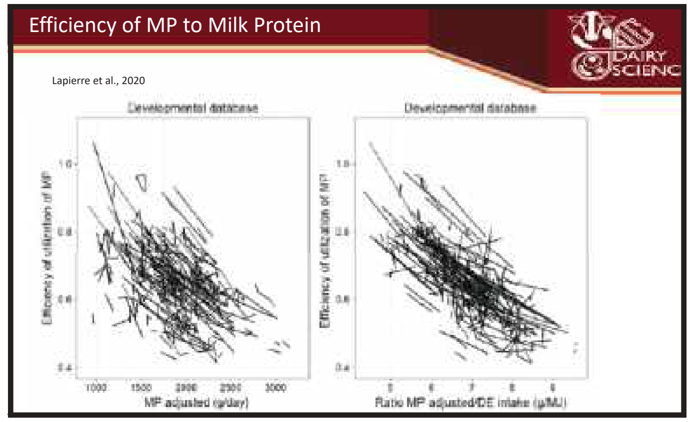

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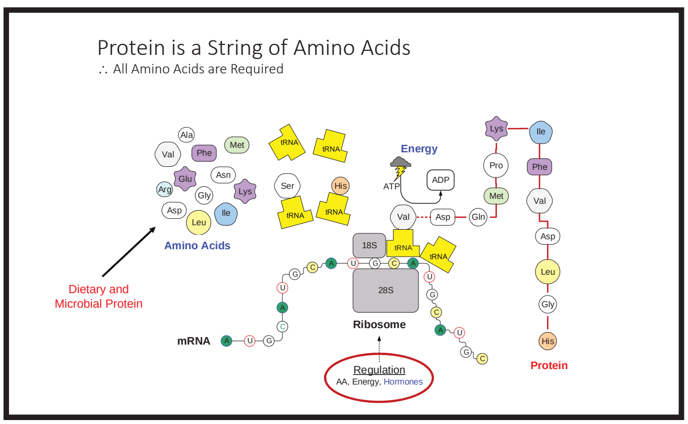

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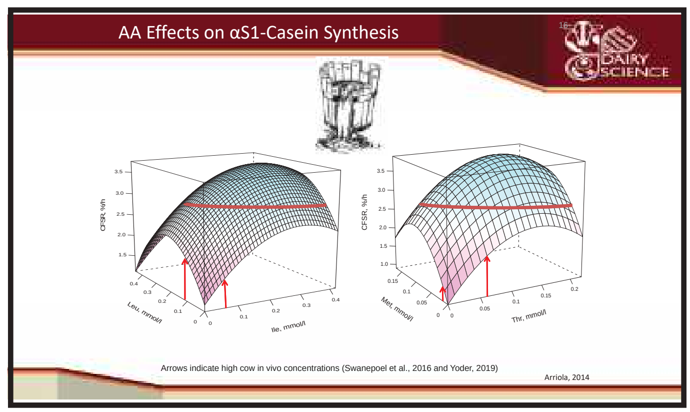
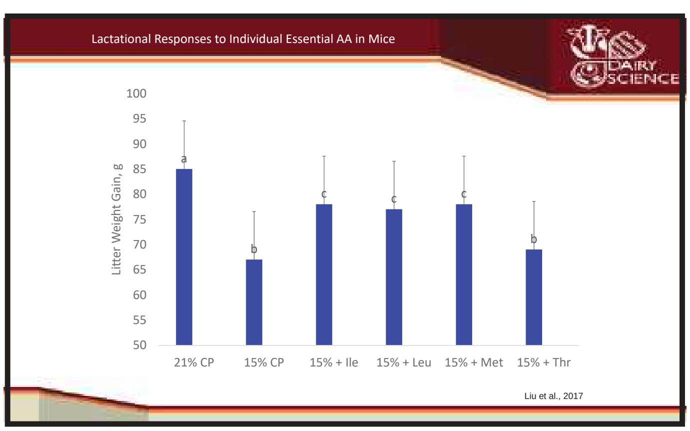


16



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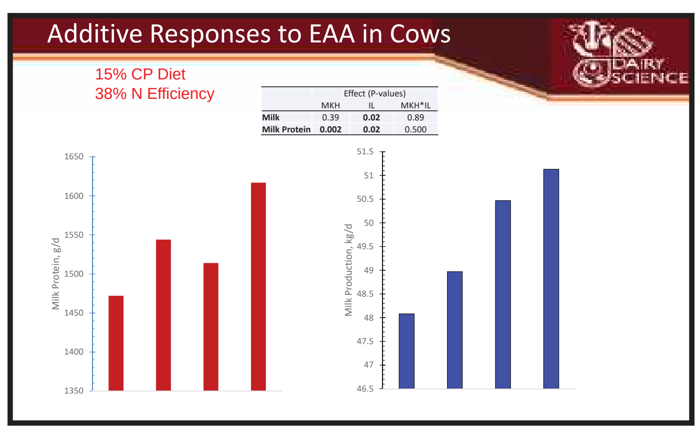


18

Integrated Milk Protein Predictions

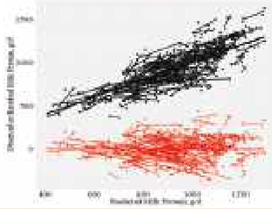
$$mPrt = \alpha Arg + \beta His + \chi Ile + \delta Leu + \varepsilon Lys + \phi Met + \varphi Thr + \lambda NEAA + \kappa dFA + \eta dNDF + \gamma dSt + \pi rOM + \mu BW + \varpi \sum EAA^2$$

Predictors	Intercept	Arg	His	Ile	Leu	Lys	Met	Thr	NEAA	$\Sigma(EAA^2)$	dFAIn	dNDFIn	dStIn	drOMIn	BW
	g/d	g/g									g/kg				
Estimates	19	0.61	2.00	1.47	0.60	1.26	1.66	1.31	0.12	-0.0024	125	17	41	47	-0.36
SE	45	0.26	0.50	0.27	0.16	0.17	0.19	0.55	0.03	0.0002	8	3	2	2	0.04

Cross Evaluation Results – 500 Iterations

Variable	Mean	SE
Observed Mean, g/d	921	17
Predicted Mean, g/d	923	12
RMSE	131	7
RMSE, % mean	**14.3**	**0.8**
Mean Bias, % MSE	0.7	1.0
Slope Bias, % MSE	4.3	3.1
CCC	0.75	0.03

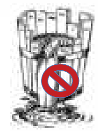
- Arg NS; Leu, Thr, & NEAA trends
- Trp, Phe, and Val → inadequate data



19

Scientific Understanding

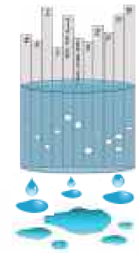
Old Hypothesis



Facts: Only 1 set

- Conservation of Mass does Apply
  - essential nutrient output <= absorbed
- Use efficiency is variable
  - Size of each leak depends on the mix of nutrients
  - RDP and Energy Supply in the Rumen
  - Energy and AA partitioning to Mammary
  - Mammary AA uptake
  - Mammary responses to AA and energy
- Additive, independent milk protein responses
- **Progress requires a change in thought!**

Current Hypothesis



20

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Item	NRC 2001 + Digestion Corrections				New Model
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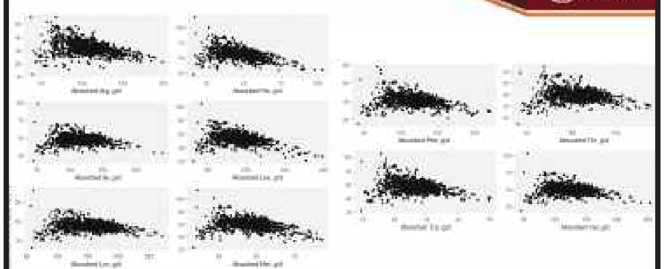
N	894	934	894	906	938
Observed Mean, kg	919	918	919	915	930
Predicted Mean, kg	951	890	830	734	932
CCC	0.77	0.65	0.70	0.52	**0.78**
RMSPE, % mean	21.3	24.9	22.9	29.0	**13.8**
Mean Bias, % MSE	2.7	1.5	18.0	46.5	**0.0**
Slope Bias, % MSE	37.7	31.8	21.1	5.3	**1.6**
Slope Bias, kg/kg	-0.379	-0.440	-0.342	-0.267	**0.10**

Hanigan et al., in progress

21

Efficiency of Absorbed EAA Conversion to Milk EAA



22

Example Diet 3: 35 kg milk , 24.9 kg DM/d, 14.7% CP

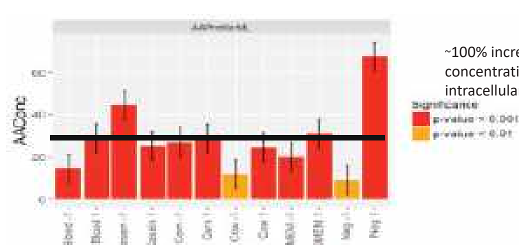
MP Supply: 2117 g, Target MP: 2320 g
NE Allow Milk: 40.9 kg

	Trg Milk NP	Trg Effic	Trg Suppl	Pred Suppl	Pred Effic	Regr Coeff	Milk NP
Int_BW_NDF							-115
DEInp				62		10.79	665
Arg	41			130	0.47	0	0
His	32	0.75	60	54	0.81	1.675	91
Ile	67	0.71	121	133	0.64	0.885	117
Leu	115	0.73	204	205	0.71	0.466	96
Lys	96	0.72	174	170	0.72	1.153	196
Met	33	0.73	55	49	0.80	1.839	91
Phe	57	0.60	127	130	0.57	0	0
Thr	50	0.64	118	118	0.62	0	0
Trp	18	0.86	28	29	0.82	0	0
Val	75	0.74	135	138	0.71	0	0
EAA2	582		1021	1156	0.66	-0.00215	-202
AA_other				1976		0.0773	153
Nutr_Allow	1085				0.69	NA	1092
Milk, kg/d							33.5

23

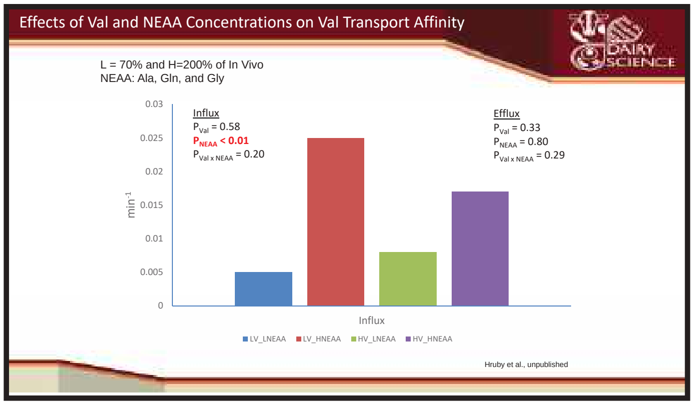
Intracellular Met concentrations

"Equal extracellular Met concentrations"

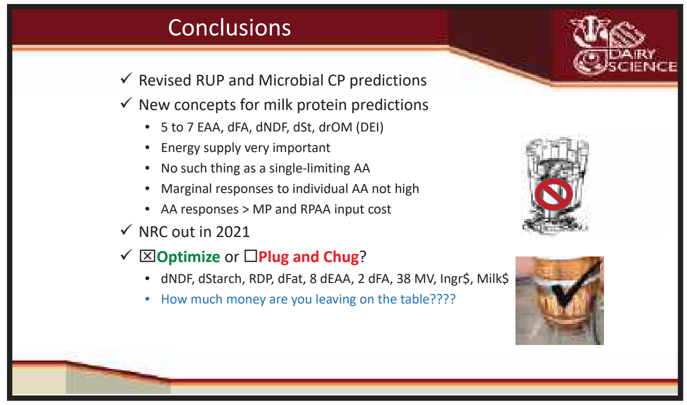


~100% increase in Met concentrations intracellular ($P < 0.001$)

24


Effects of Val and NEAA Concentrations on Val Transport Affinity
DAIRY SCIENCE
L = 70% and H=200% of In Vivo
NEAA: Ala, Gln, and Gly
Influx
P_{Val} = 0.58
P_{NEAA} < 0.01
$P_{Val \times NEAA}$ = 0.20
Efflux
P_{Val} = 0.33
P_{NEAA} = 0.80
$P_{Val \times NEAA}$ = 0.29
min^{-1}
0.03
0.025
0.02
0.015
0.01
0.005
0
Influx
LV_LNEAA
LV_HNEAA
HV_LNEAA
HV_HNEAA
Hruby et al., unpublished

25


Conclusions
DAIRY SCIENCE
✓ Revised RUP and Microbial CP predictions
✓ New concepts for milk protein predictions
• 5 to 7 EAA, dFA, dNDF, dSt, drOM (DEI)
• Energy supply very important
• No such thing as a single-limiting AA
• Marginal responses to individual AA not high
• AA responses > MP and RPAA input cost
✓ NRC out in 2021
✓ ☒Optimize or ☐Plug and Chug?
• dNDF, dStarch, RDP, dFat, 8 dEAA, 2 dFA, 38 MV, Ingr$, Milk$
• How much money are you leaving on the table????

26

Four-State Dairy Nutrition & Management Conference

Guidelines for Feeding Cows in the Future

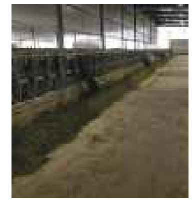
Lee Kloeckner, MS, PAS
Dairy Nutrition and Production Specialist,
Ag Partners

Guidelines for feeding cows in the future

Lee Kloeckner, MS, PAS
Dairy Nutrition and Production Specialist, Ag Partners

1

Ration Philosophy



1. Focus on the rumen
   - aNDFom
   - Rumen available carbohydrates
   - Rumen degradable protein
2. Amino acid balance
   - Lysine & Methionine
   - Blood or blood products
3. Fatty acid balance

2

Common Additives

- Yeast
- Monensin
- Lysine/Methionine
- Blood/Blood products
- Bypass fat
- Chelated trace minerals
- Biotin
- Organic selenium

3

Transition Cows

- Primarily one-group TMR
  - Minimize potassium
  - Amino acids
  - Yeast
  - Monensin
  - Sulfate minerals
- Other additives: anions, B vitamins, choline, chromium, X-zelit

4

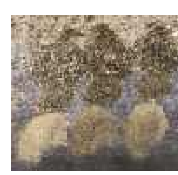
Feed Test Key Considerations

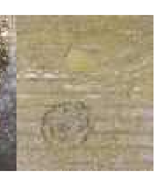
- Moisture
- aNDFom
- uNDFom240
- NDFD30
- pdNDF
- Crude protein
- Starch
- Ash
- NDF kd
- Starch kd

5

Tools

- What do the cows tell me?
  - DMI, milk yield, components, cud chewing, manure
- On farm data
  - DC305, feed management software, activity, rumination, daily milk weights
- Feed & TMR analysis
- Shaker box
- Mycotoxin testing
- Fermentation tests
- Supplier support





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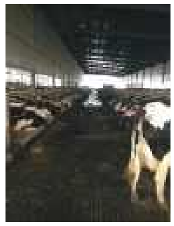
Future Considerations

- Feed and nutrient efficiency
- Merging feed and agronomy
- Improving ration models
- Better characterize feeds
- Interactions & Antagonists
- Environmental concerns



7

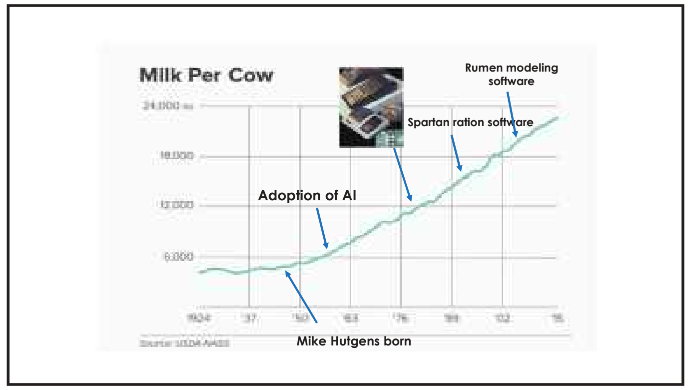
Four-State Dairy Nutrition & Management Conference

Guidelines for Feeding Cows in the Future

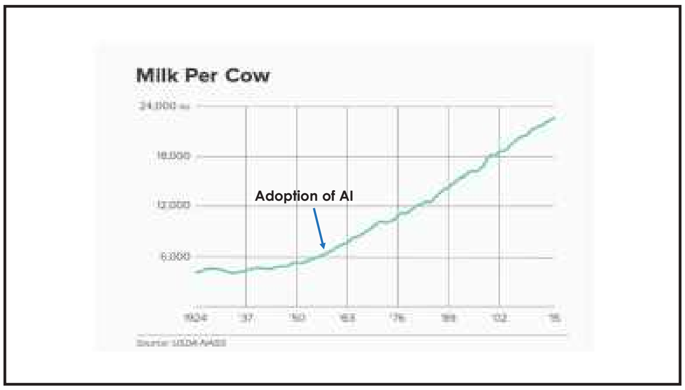
Brian J Gerloff, DVM, PhD
Renaissance Nutrition


The Future of Feeding Cows?
BRIAN J GERLOFF, DVM, PHD
RENAISSANCE NUTRITION

1


Milk Per Cow
24,000
18,000
12,000
6,000
1924
'37
'50
'63
'76
'89
'02
'15
Source: USDA-NASS
Rumen modeling software
Spartan ration software
Adoption of AI
Mike Hutgens born

2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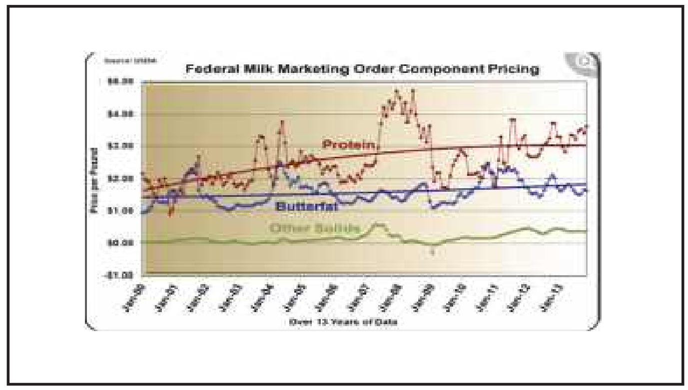
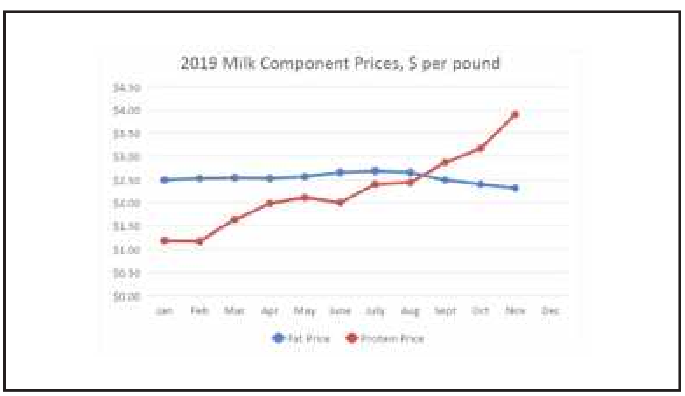
'15
Source: USDA-NASS
Adoption of AI

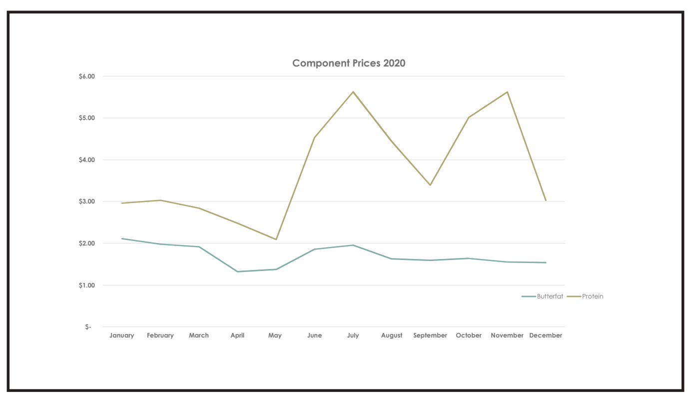
3


Federal Milk Marketing Order Component Pricing
Price per Pound
Protein
Butterfat
Other Solids
Over 13 Years of Data

4


2019 Milk Component Prices, $ per pound
Fat Price
Protein Price

5


Component Prices 2020
January
February
March
April
May
June
July
August
September
October
November
December
Butterfat
Protein

6

On top of all that, we have the reality of processor and cooperative restrictions and quotas

So…

Increasingly, will need to try and affect milk volume and milk components more independently of each other

7

Influencing Milk Protein

Historically, as we have worked to increase milk protein production, we have typically focused on pounds of protein, and often driven improvements through more pounds of milk…

But in the future, that may be less profitable than driving % protein higher, independently of milk production.

8

Influencing Milk Fat

Typically, not as valuable as milk protein, but watched very closely by our clients…

But again, driving percent fat higher without increasing milk may be more profitable in the future.

9

Milk Protein

- Amino acid supplementation, especially methionine
- Fermentable carbohydrates, especially NDF

10

Milk Fat

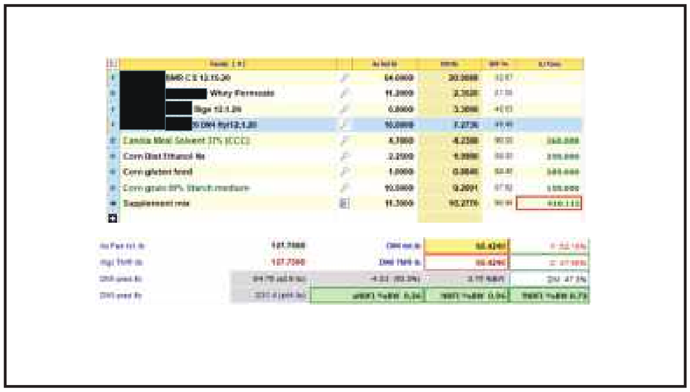
- Amino acid supplementation, especially rumen available methionine
- Fermentable carbohydrates, - complex interaction between NDF and starch
- Fat profile and levels – also complex interaction between starch, NDF and NDFD, and fatty acid profile

11

Example 1:

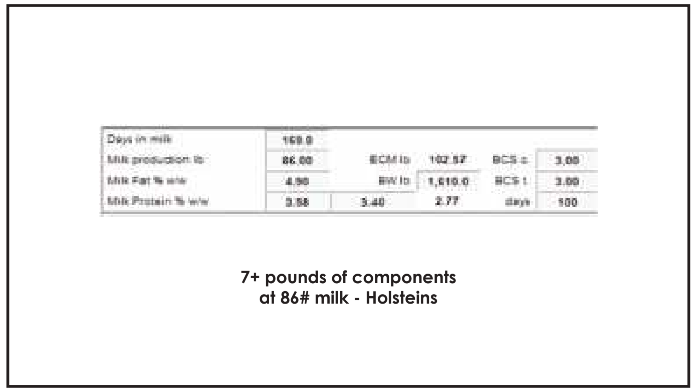
Good milk with very high components

12



	Feeds		As fed lb	DM lb	DM %	$/Ton
	[redacted] BMR C S 12.15.20		64.0000	30.3000	[illegible]	
	[redacted] Whey Permeate		11.2000	2.3520	[illegible]	
	[redacted] ilage 12.1.20		6.8000	3.3000	[illegible]	
	[redacted] % DM Hyl 12.1.20		10.0000	7.2736	[illegible]	
	Canola Meal Solvent 37% (CCC)		4.7000	4.2300	[illegible]	[illegible]
	Corn Dist Ethanol 4x		2.2000	[illegible]	[illegible]	[illegible]
	Corn gluten feed		1.0000	0.8840	[illegible]	[illegible]
	Corn grain 8% Starch medium		10.0000	9.2691	[illegible]	[illegible]
	Supplement mix		11.2000	10.2776	[illegible]	[illegible]

13



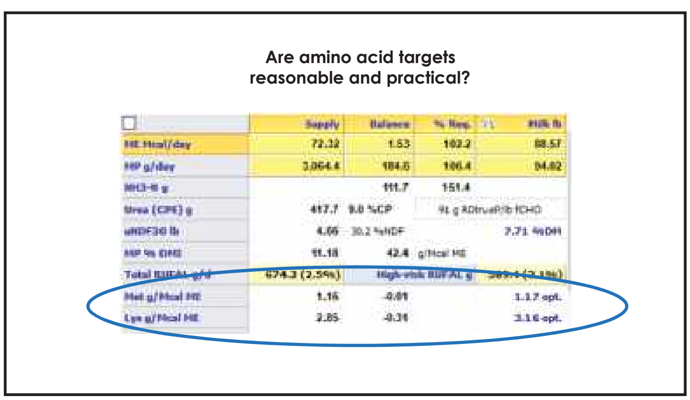
Days in milk	169.0					
Milk production lb	86.00		ECM lb	102.57	BCS c	3.00
Milk Fat % w/w	4.90		BW lb	1,610.0	BCS t	3.00
Milk Protein % w/w	3.58	3.40		2.77	days	100

14

15

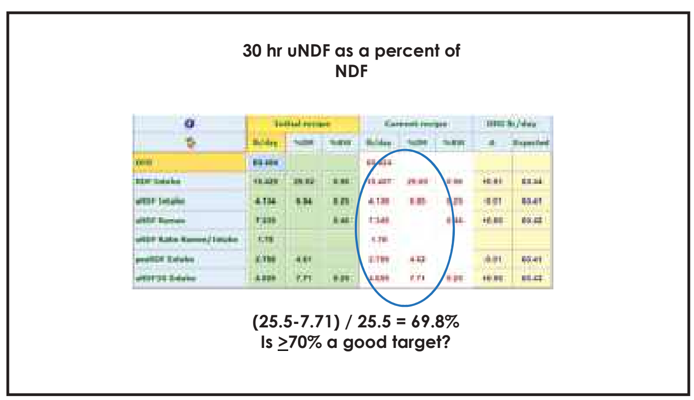
D.M.	%	47.30
CP	%	16.90
Soluble Protein	%	7.15
Ammonia (Prot A1)	%	1.32
Forage	%	52.10
Forage aNDFom	%	19.21
peNDF	%	17.19
aNDFom	%	25.50
CHO C uNDF	%	6.85
ADF	%	17.57
Sugar (WSC)	%	6.51
Starch	%	27.31
Soluble Fiber	%	6.86
NFC	%	43.47
EE	%	5.42
TFA	%	4.14

16



	Supply	Balance	% Req.	Milk lb
ME Mcal/day	72.32	1.53	102.2	88.57
MP g/day	3,064.4	184.6	106.4	94.82
NH3-N g		111.7	151.4	
Urea (CPE) g	417.7	9.0 %CP	91 g ADtrueP/lb fCHO	
uNDF30 lb	4.06	30.2 %NDF		7.71 %DM
MP % DMI	11.18	42.4	g/Mcal ME	
Total RUFAL g/d	674.3 (2.5%)	High-risk RUFAL g		[illegible]
Met g/Mcal ME	1.16	-0.01		1.17 opt.
Lys g/Mcal ME	2.85	-0.31		3.16 opt.

17



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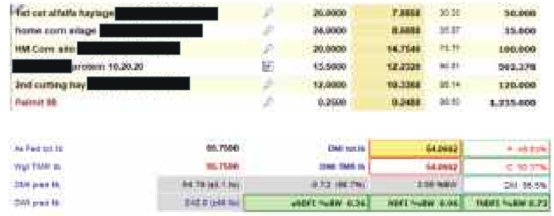
Example 2: Improving 30 hour NDF digestibility

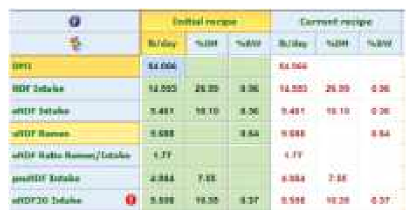
19



20

21

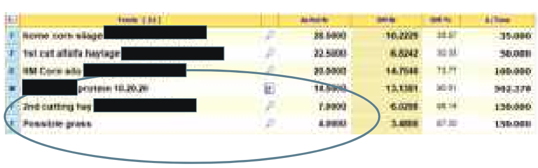
30 hr uNDF as Percent of NDF



(26.99 – 10.35) / 26.99 = 61.6%

Too low!

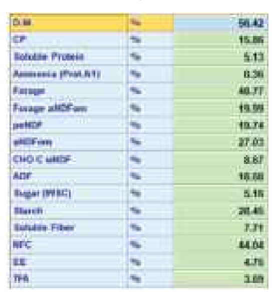
22



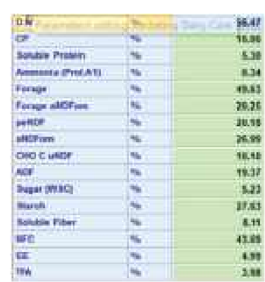
Replace alfalfa with grass

23

With grass

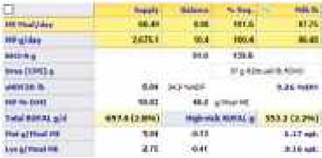


With alfalfa

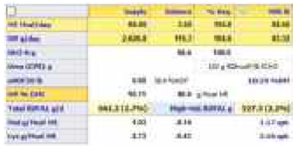


24

With grass



With alfalfa



25

30 hr uNDF as Percent of NDF

	lb/day	%DM	%BW	lb/day	%DM	%BW
DMI	54.449			54.449		
NDF Intake	14.719	27.03	0.97	14.719	27.03	0.97
uNDF Intake	4.719	8.67	0.31	4.719	8.67	0.31
uNDF Rumen	8.350		0.55	8.350		0.55
uNDF Ratio Rumen/Intake	1.77			1.77		
peNDF Intake	3.447	6.33		3.447	6.33	
uNDF30 Intake	5.044	9.26	0.33	5.044	9.26	0.33

(27.03 – 9.26) / 27.03 = 65.7%

26

Result-
Increase of 8# milk, no loss of components

Days in milk	150.0				
Milk production lb	86.00	ECM lb	94.73	BCS c	3.00
Milk Fat % w/w	4.30	BW lb	1,519.7	BCS t	3.00
Milk Protein % w/w	3.36	3.20	2.63	days	100

6.4# CFP

27

The Future of Feeding Cows?

- Better characterize rumen fiber digestion and its effect on milk and component production
- Utilize amino acid nutrition to optimize milk protein production
- Utilize diet characteristics to move milk, fat, and protein production semi-independently of each other

28

Four-State Dairy Nutrition & Management Conference

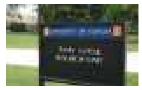
Interpretation and Use of New Passive Immunity Guidelines for Newborn Dairy Calves

Dr. Jim Drackley
University of Illinois

Interpretation and use of new passive immunity guidelines for newborn dairy calves

Jim Drackley

Professor of Animal Sciences
University of Illinois at Urbana-Champaign



1

Colostrum: Nature's first food

- Single most important management factor for calf health and survival
  - 31% of calves deaths preventable by improved colostrum management (Wells et al., 1996)
- Rich first source of nutrients
- Rich in bioactive factors

2

Introduction

- We need to switch acronyms for accuracy:
  - "Passive transfer of immunity" should be "transfer of passive immunity" (TPI)
  - "Failure of passive transfer" should be "failure of passive immunity" (FPI)
- Serum IgG serves as a proxy for other valuable aspects of colostrum intake (nutrition, bioactive factors, fluid, warmth, etc)

3

Introduction

- FPI has long been defined as serum IgG concentrations <10 g/L.
- Studies have shown decreased morbidity (sickness) with serum IgG concentrations higher than traditionally recommended.
- TPI in beef calves is defined at much higher levels than in dairy calves (>24-27 g/L).
- In recent NAHMS survey, 90% of Holstein heifers met industry standards for TPI, yet morbidity remains high.

4

Is it time to revise our standards for what constitutes satisfactory TPI?

What about herd-level goals for TPI management?

5


J. Dairy Sci. 103:7611–7624
https://doi.org/10.3168/jds.2019-17955

Consensus recommendations on calf- and herd-level passive immunity in dairy calves in the United States

J. Lombard, N. Urie, F. Garry, S. Godden, J. Quigley, T. Earleywine, S. McGuirk, D. Moore, M. Branan, M. Chamorro, G. Smith, C. Shivley, D. Catherman, D. Haines, A. J. Heinrichs, R. James, J. Maas, and K. Sterner

6

Methodology

- Data from NAHMS Dairy 2014 Calf Component (Urie et al., 2018a,b) used to determine relationships between serum IgG and calf morbidity and mortality
- Four different models with different number of categories were proposed.
- Option adopted was: <10.0 g/L, 10.0 to 17.9 g/L, 18.0 to 24.9 g/L, and ≥ 25.0 g/L

7

Methodology

- Calves were excluded from analysis when:
  - Blood collected <24 h after birth or >7 d of age
  - Serum IgG <1 g/L, total protein >11 g/L, or Brix score >15%
  - Fed colostrum replacer or supplement

8

Results

Table 4. Consensus serum IgG concentrations and equivalent total protein (TP) and Brix measurements, and percentage of calves recommended in each transfer of passive immunity (TPI) category[1]

TPI category	Serum IgG category (g/L)	Equivalent TP (g/dL)	Equivalent %Brix	Consensus[2] (% calves)	NAHMS study[3] (% calves)
Excellent	≥25.0	≥6.2	≥9.4	>40	35.1
Good	18.0–24.9	5.8–6.1	8.9–9.3	~30	25.7
Fair	10.0–17.9	5.1–5.7	8.1–8.8	~20	26.8
Poor	<10.0	<5.1	<8.1	<10	12.4

[1]Modified from Godden et al. (2019).
[2]Consensus recommendation for percent of a farm's calves in each category.
[3]Percent of calves in National Animal Health Monitoring System (NAHMS) 2014 Dairy study (Shivley et al., 2018) in each consensus category.

9

Table 5. Model predicted morbidity and mortality at specified serum IgG concentrations representing categories for option 3 for calves in the National Animal Health Monitoring System Dairy 2014 study

IgG level (g/L)	Model predicted, percent (95% CI)	
	Morbidity	Mortality
8.0	41.3 (34.6–48.8)	8.2 (6.2–10.7)
14.0	37.8 (31.8–44.3)	6.6 (5.3–8.2)
21.5	33.6 (28.2–39.5)	5.0 (4.1–6.2)
27.0	30.6 (25.2–36.6)	4.1 (3.1–5.4)

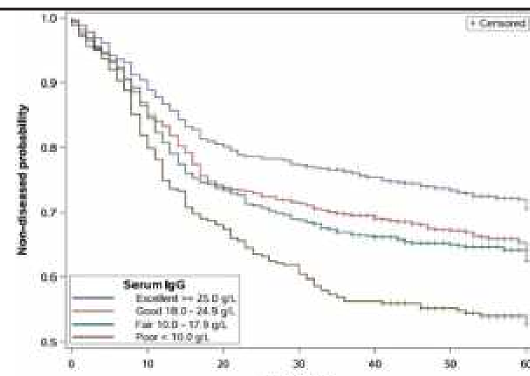
10

Results

Table 6. Number and percentage of heifer calves and calf morbidity and mortality by consensus category of serum IgG and total protein concentration, and Brix percentage for calves in the National Animal Health Monitoring System Dairy 2014 study

Measure	Category	Heifer calves (n = 2,369)		Calf morbidity (n = 900)		Calf mortality (n = 75)	
		Number	Percent	Number	Percent	Number	Percent
Serum IgG (g/L)	<10.0	284	12.0	131	46.1	21	7.4
	10.0–17.9	633	26.7	228	36.1	16	2.6
	18.0–24.9	607	25.7	211	34.8	9	1.5
	≥25.0	839	35.5	238	28.3	21	2.5
Serum total protein (g/dL)	<5.1	348	14.8	165	47.3	22	6.3
	5.1–5.7	638	27.0	225	35.3	17	2.7
	5.8–6.1	429	18.4	135	32.9	12	2.8
	≥6.2	914	38.7	269	29.5	20	2.3
Serum Brix (%)	<8.1	340	14.4	162	47.6	22	6.5
	8.1–8.8	576	24.2	202	35.4	15	2.6
	8.9–9.3	466	19.6	162	33.3	11	3.1
	≥9.4	964	40.0	263	25.5	20	2.1

11



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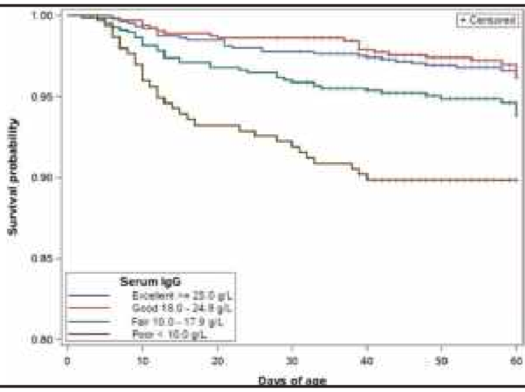

13

Results

Table 7. Descriptive statistics for colostrum management practices for calves in the National Animal Health Monitoring System transfer of passive immunity data set having excellent passive immunity (≥25 g/L serum IgG) and fed single or multiple colostrum feedings

	Single colostrum feeding (n = 251)		Multiple colostrum feedings (n = 453)	
Measurement	Mean	SD	Mean	SD
Calf birth weight (kg)	42.0	5.5	42.1	5.8
Volume of first colostrum feeding (L)	3.3	0.8	2.7	0.9
First feeding colostral IgG fed (g)	290.7	123.0	220.8	112.3
Age at first colostral feeding (h)	2.0	1.9	2.8	2.2
Total volume of colostrum fed in 24 h (L)	3.3	0.8	5.3	1.4
Total colostral IgG fed (g)	290.7	123.0	421.2	137.5
Serum IgG (g/L)	32.0	5.5	31.9	8.2

14

Summary

- We are transitioning to a TPI system with 4 serum IgG categories: excellent, good, fair, and poor.
- Corresponding serum IgG concentrations of ≥25.0, 18.0–24.9, 10.0–17.9, and <10 g/L.
- At the herd level, it is proposed that >40, 30, 20, and <10% of calves are in the excellent, good, fair, and poor TPI categories, respectively.
- Corresponding serum total protein and %Brix values are available.

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16

Four-State Dairy Nutrition & Management Conference

Mineral Availability to Dairy Cows

Dr. Bill Weiss
Department of Animal Sciences (retired)
Ohio Agricultural Research and Development Center
The Ohio State University, Wooster 44691

Mineral Availability to Dairy Cows

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Department of Animal Sciences (retired)
Ohio Agricultural Research and Development Center
The Ohio State University, Wooster 44691

Summary

Minerals need to be absorbed to perform most, but not all, their functions. Because absorption can depend on the source of the mineral, many diet formulation systems are now based on absorbed minerals rather than total dietary minerals. Formulating diets based on available minerals should be superior to formulating for total minerals; however, we have very limited data on mineral availability For most minerals, only source of minerals (e.g., organic feedstuffs vs. dicalcium phosphate vs. monosodium phosphate) affects the estimated absorption coefficient (AC) used by the software even though for some minerals other factors such antagonism and mineral status of the cow have substantial impact on the AC.

Measuring the AC for most minerals is extremely difficult and virtually impossible to do for individual ingredients. For example, dietary calcium can come from corn, corn silage, alfalfa, soybean meal, limestone etc. and we can (with some difficulty) determine the AC for calcium for that diet but we cannot determine the AC for each ingredient. For the electrolytes (sodium, potassium, chloride) and for magnesium (with certain caveats) we can estimate the dietary AC using a statistical approach called the Lucas Test. In this test we regress intake of apparently absorbed mineral (intake – fecal excretion of minerals) on intake of total minerals. The slope of the equation is the true absorption of the mineral and the intercept which must be 0 or a negative number equals the endogenous fecal secretion of the mineral. This approach only works if absorption of the mineral is not regulated by the cow, is not affected greatly by source and is high. Magnesium absorption is affected by source which is why this approach has to be used selectively to estimate AC for magnesium. For all the other minerals we need to use other approaches to estimate AC such as experiments using isotopically labeled minerals or semi-purified diets both of which are expensive and difficult to conduct. This is why we have so few data on mineral availability. Because of a greatly expanded database, we can use the Lucas test to derive improved estimates of magnesium AC. Based on new data, the AC of Mg from feedstuffs is substantially greater than the AC used in NRC (2001) but the AC for average MgO is substantially less.

The NRC (2001) reviewed the literature and published AC for most minerals. Within a mineral, most feedstuffs were given the same AC but the AC of mineral supplements may have varied. We have made little progress in estimating the AC for specific feeds with the exception of phosphorus. Organic feedstuffs contain both inorganic and organic P and the AC of those two fractions differ (0.84 vs 0.68) (Feng, et al., 2015). If labs can partition total P within a feed into organic and inorganic P we can calculate an AC for the specific feedstuff. We have made some progress on accounting for effects of antagonists on mineral absorption. We have adequate data to estimate the effect of dietary potassium on Mg absorption and to estimate the effect of dietary sulfur on copper absorption. Although numerous other antagonists exist we do not have adequate data to develop equations.

Estimating the AC for trace minerals is extraordinarily difficult. Errors are large because we are dealing with such small amounts, generally absorption is tightly regulated and antagonism is common. Therefore, for many trace minerals sources we only have relative absorption values which are then extrapolated to estimate AC. For example, based on change in liver copper concentrations we might know that under a specific situation, copper from supplement 'X' is twice as available as copper sulfate. If we assume the AC for copper sulfate is 0.05 then product X has an AC of 0.10. However, we cannot know with certainty whether copper sulfate in that situation had an AC of 0.05. To calculate relative AC we need to be able to measure something that respond to change in supply of available mineral. For copper, liver concentrations work well, but for minerals such as zinc or manganese, liver is not very sensitive. In addition, relative AC are dependent on the diet and status of the cows used in the experiment. If the diet has antagonists (e.g., high sulfur) the relative AC may be very different than if we conducted the experiment with diets that did not have high sulfur (Spears, et al., 2004).

Another issue of formulating diets based on absorbed mineral is that some minerals do not need to be absorbed to have effects. For example, feeding sulfate trace minerals (copper, zinc, and manganese) tend to reduce ruminal fiber digestion compared to other sources of trace minerals. Source of trace mineral can affect the ruminal and intestinal microbiome (Faulkner, et al., 2017) which could affect immunity . These 'non-absorptive' effects have been poorly quantified and if we balance diets totally on absorbed minerals we may not maximize potential benefits from the minerals.
Details of these topics can be found in the following slide set.

References

Faulkner, M. J., B. A. Wenner, L. M. Solden, and W. P. Weiss. 2017. Source of supplemental dietary copper, zinc, and manganese affects fecal microbial relative abundance in lactating dairy cows. J Dairy Sci. 100:1037-1044.

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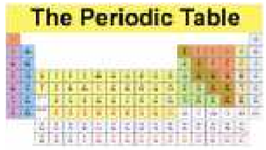
Assessing Mineral Availability and Real-World Implications



The Ohio State University
College of Food, Agricultural, and Environmental Sciences

Bill Weiss
Animal Sciences

Ohio Agricultural Research and Development Center
Ohio State University Extension

1

Most formulation systems in US are based on factorial approach and absorbed minerals

Feed enough **absorbable** minerals to maintain **adequate** labile body stores and fluid concentrations

- Replace inevitable losses via feces and urine (i.e., maint.)
- Replace minerals secreted in milk
- Replace minerals accreted in new tissue (growth)
- Replace minerals accreted in fetus

2

Most formulation systems in US are based on factorial approach and absorbed minerals

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- Replace minerals secreted in milk
- Replace minerals accreted in new tissue (growth)
- Replace minerals accreted in fetus

Must know what's adequate
Is adequacy constant?

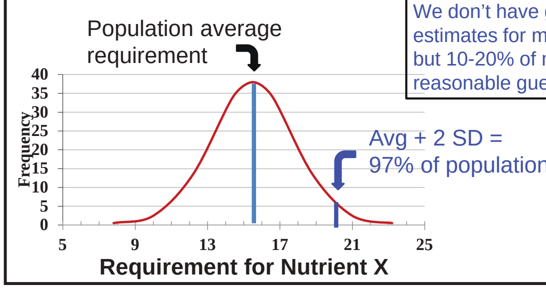
Must know what is absorbed

Must know concentrations

3

Issues with factorial system: *Requirement vs Recommendation*

We don't have good SD estimates for mineral reqt but 10-20% of mean is reasonable guess



4

Absorbed Factorial Mineral Approach

Inputs

Feedstuffs
Mineral concentration

Absorption coefficients

A huge black box in mineral nutrition

g or mg/d of mineral available for use

5

Apparent absorption ≠ Absorption coefficient

- Fecal mineral losses :
  - –Unabsorbed dietary
  - –Endogenous (Metabolic) Fecal ⟸ Part of maint. reqt
  - –Homeostatic excretion

"True" Availability = Intake – (Feces – **Met - Homeo Fecal**) / Intake

AC = True availability measured when cows fed approximately at requirement

6

Estimating True Availability via Lucas Test

Absorbed K, g/kg DM = 1.02(+ 0.06) x Diet K - 2.48(+ 0.74)

True Absorption

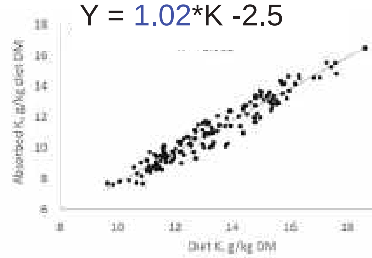
Metabolic Fecal K (implied maintenance)
Error is large (CV = 30%)

- Approach works well if:
  - Absorption rate is not regulated (and high)
  - Surplus mineral is excreted in the urine
  - Sources/diets have similar availability
- Used for the strong ions: K, Na, and Cl
- Can be used with Mg (source adjustment)

7

Obtaining AC and endo. fecal (Lucas plot)

Y = 1.02*K -2.5



NRC (2001)
EndoFecal: *f*(BW)

Correct
EF= *f*(DMI)
- Dry cow vs lact

8

Absorption of Calcium

- AC for $CaCl_2$ = 0.95 (NRC 2001) (calf data)
- AC actually ~0.6 in older cattle
- Other sources were relative to $CaCl_2$
- Based on newer data, EF loss too high

Estimated AC and EF loss are often correlated
(lower AC often = lower EF loss)

9

Absorption of Phosphorus

- Form of P matters (Feng et al: 2015)
  - Inorganic P = 0.84
  - Organic P (including phytate) = 0.68
  - Labs could offer assay

Grass hay: 67% Inorganic; 33% organic:
AC = 0.67*.84 + .33*0.68 = **0.79**
SBM: 7% Inorganic; 93% organic: AC = **0.69**

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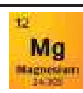
Magnesium



1. Absorbed from rumen
2. Absorption does not appear to be regulated
3. Real world antagonists
   - K (linear)
   - LCFA (-10 to 20%)
   - Soluble CP (must be very high)

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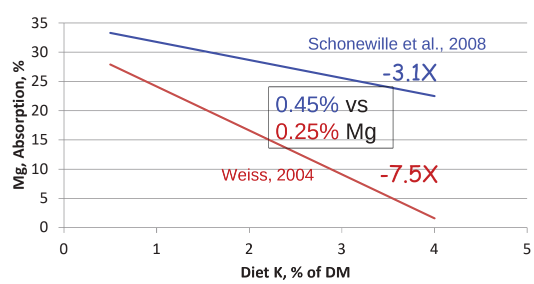
K and Mg Absorption in Dairy Cows



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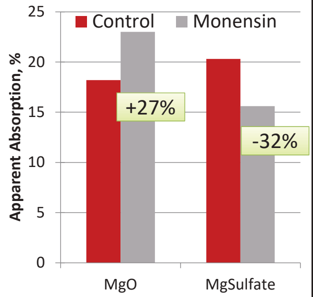
Monensin ⬆ and ⬇ Mg absorption

- All diets 2.1% K (0.8 from K carb)
- 0.35% Mg (0.2 basal)
- Treatments
  - MgO or $MgSO_4$
  - 0.2 vs 0.4% S
  - 0 or 14 mg/kg monensin

Tebbe et al., 2018



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Mg AC in NRC (2001) needs revised

	NRC, 2001	Revised
Basal feeds	0.16	0.30* (± 0.16)
Good MgO	0.70	0.20* to 0.25
$MgSO_4$	0.90	0.35* to 0.40

* Standardized to 1.2% K

Feeds are better, supplements are worse than we thought

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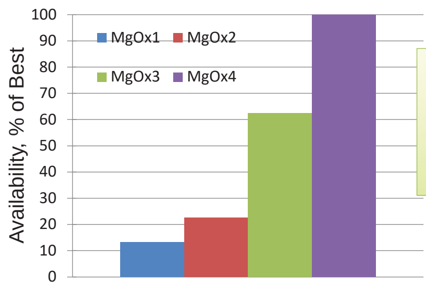
Mg Availability from 4 sources of MgO



Jesse et al., 1981

Can lab test **rank** these ?

Can lab test **quantify** these ?

15

Measuring AC of TM is extremely difficult

- Very low AC (large measurement errors)
- Numerous antagonists
- Likely source x antagonist interactions
- Homeostatic fecal excretion
- Regulated absorption

Diet may have greater effect on AC than mineral source

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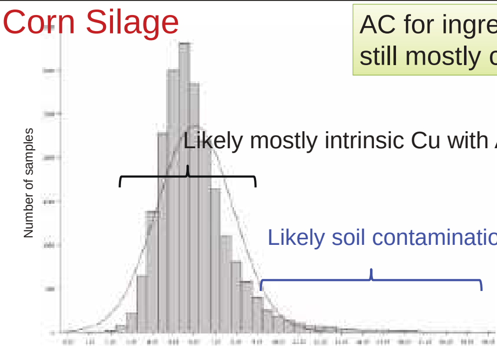
Corn Silage

AC for ingredients are still mostly constants



Knapp and Weiss, 2016

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Known and potential antagonists for TM

Cu (0 to 0.1)
- S
- Soil (clay)
- Mo+S
- Fe
- Zn (?)
- Fiber

Mn (0 to 0.01)
- P
- S
- Ca (?)
- K (?)
- Fe

Zn (0.05 to 0.2)
- S
- Cu (?)
- Phytate (?)
- Fiber

Se
- S
- Ca
- Met (yeast)

Can't quantify yet, but qualitative adjustment may be needed

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Relative Availability (often used for commercial TM)

1. Feed a standard mineral (e.g., $CuSO_4$)
2. Feed test mineral X (same amount)
3. Measure **appropriate response** and report ratio

$$\frac{\text{Liver Cu when fed source X}}{\text{Liver Cu when fed Cu sulfate}}$$

1. Diet specific
2. Animal specific
3. Everything is relative

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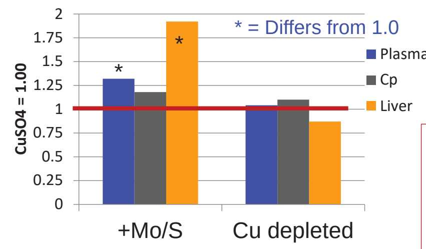
Relative Availability Coefficients

Relative availability of Cu from Tribasic Cu



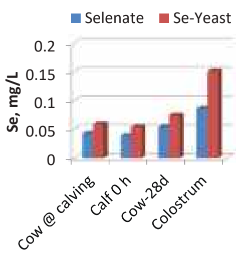
If CuSul AC = 0.05 is TBC = ~0.10 ?
or
is CuSulf = 0.025 and TBC = 0.05 ?

Spears et al., 2004

20

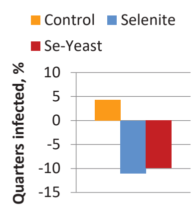
Does the response measure have value ?

Se-Y: 1.2 to 2X better



Weiss and Hogan, 2006

Se-Y = selenite



Malbe et al., 1995

21

How do you use relative availability data?

If data show product X is twice as good as sulfate, *should I feed half as much* ?

1. **Cu**: Yes, adjust for availability
2. **Se**: Don't adjust
3. **Mn:** Probably doesn't matter
4. **Zn:** Don't adjust (microbiome effects?)

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Revised Ingredient AC

Macrominerals

Ca: 0.4 to 0.6
P: 0.7 to 0.9*
Mg: 0.2 to 0.35
K, Na, Cl: ~1.0

* Adjust based on lab tests?

Trace Minerals

Cu: ~0 to 0.1
Fe: 0.05 to 0.15
Mn: ~0 to 0.01
Se: 0.5 to 0.85
Zn: 0.05 to 0.20

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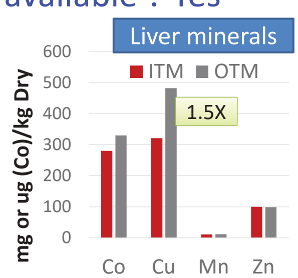
Are OTM more available ? Yes

- -30 to 30 DIM
- Sulfate or AA-complex Cu, Mn, Zn (Co only in AA)
- TMR (mg/kg PF/ Fresh):
  - Zn 83 or 70
  - Mn 76 or 70
  - Cu 14 or 12

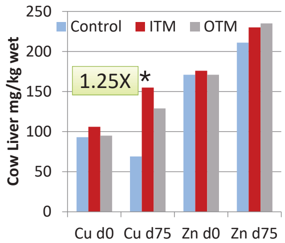


Osorio et al., 2016

24

Are OTM more available? Not always

Late gestation beef cows



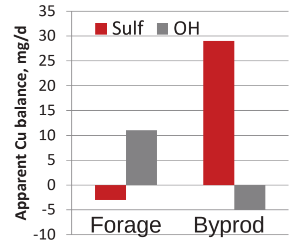
Diet, status, source interactions

Marques et al., 2016

25

Numerous interactions: concluding sulfate consistently < available is incorrect

- High forage vs high byproduct NDF diets
- Ca. 50% of Zn, Cu, Mn from sulfate or hydroxy
- Source x fiber NS for Mn and Zn but P < 0.05 for Cu



Faulkner et al., 2016

26

Do minerals have to be absorbed to affect cow ?

Mineral requirements:	**Absorbed ?**
▪ Maintains body stores	✓
▪ Supports productive functions - growth - lactation - reproduction	✓
▪ Maintains good health	?
▪ GI function/ nutrient digestion	?

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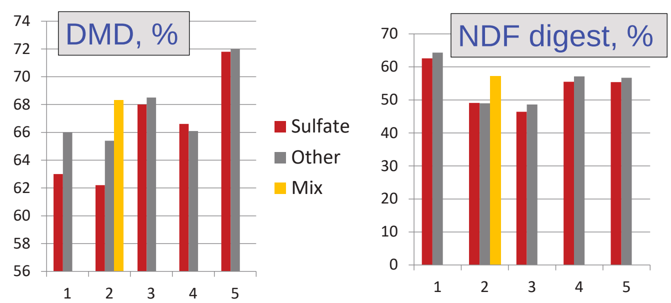
TM Sulfates may reduce digestibility

ElAshry et al.,2012;Wang et al.,2012;Faulkner&Weiss, 2017;Pino&Heinrich,2016; Miller et al.,2020



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Are differences between organic and inorganic TM only bioavailability?

Organic Zn reduced the pathogen associated with digital dermatitis in feces (inorganic did not)

Faulkner et al., 2017

Intestine is a very important immune organ

⇕

Microbiome affects immunity

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Conclusions

- ✓ We need to incorporate more sources of variation into AC
- ✓ AC for TM are still poorly defined but better than using only concentrations
- ✓ Minerals don't have to be absorbed to affect cows

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Four-State Dairy Nutrition & Management Conference

Balancing Lactating Cow Diets for Amino Acids: Using Efficiencies

Mark D. Hanigan

Collaborators: Helene Lapierre*, Roger Martineau*

Department of Dairy Science

VirginiaTech

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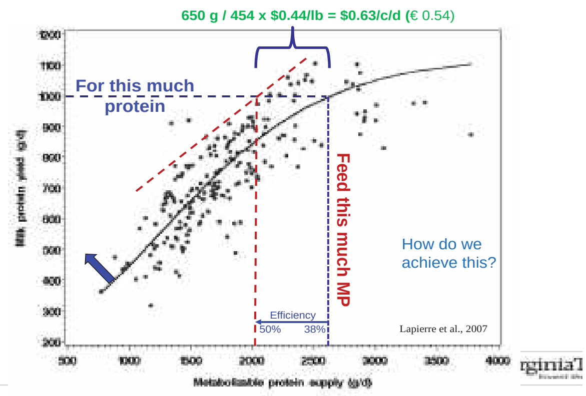
Department of Dairy Science
Virginia Tech

*Agriculture and Agri-Food Canada

Department of Dairy Science at Virginia Tech · dasc.vt.edu

1

Milk Protein vs Metabolizable Protein



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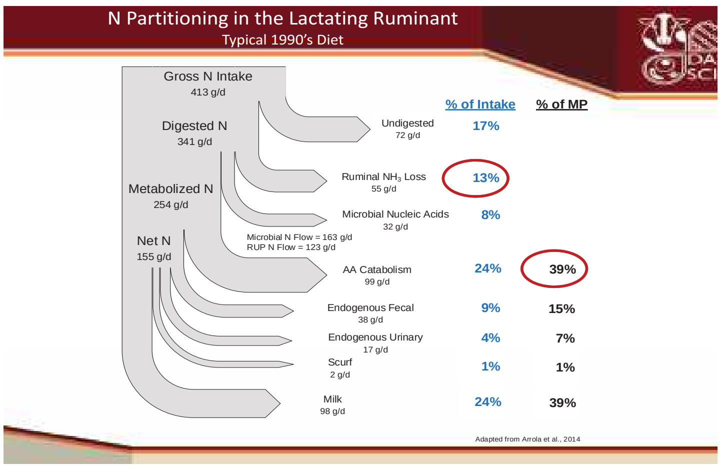

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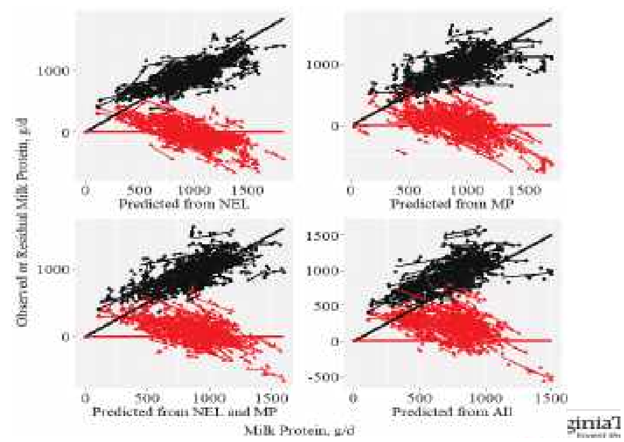

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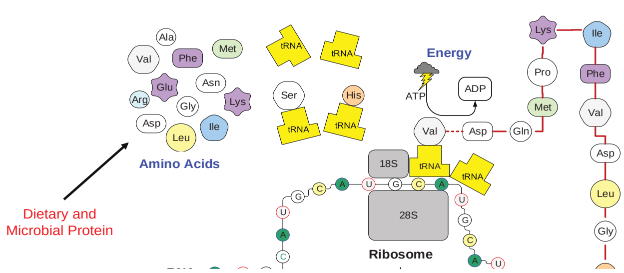
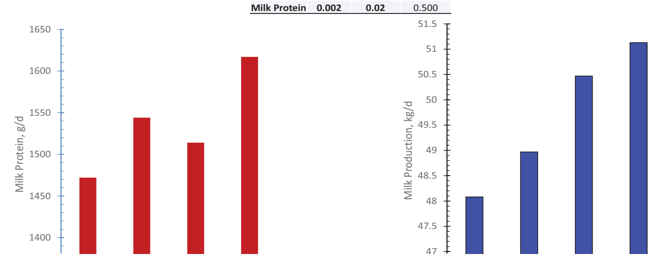


5

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



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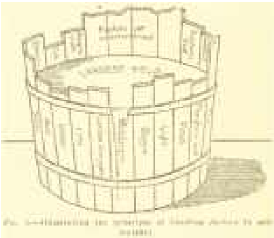
Water Barrel Analogy



Lowest stave limits performance

- **Sprengel, 1828**
  - A soil nutrient can limit plant growth
  - When limiting, growth will be proportion to supply
- **von Liebeg, 1862**
  - If a nutrient is limiting, then growth can't respond to another nutrient
  - "Law of the Minimum"
- **Whitson and Harlow, 1909**
  - Barrel and Stave Analogy
- **Mitchell and Block, 1946**
  - Application to AA in rats
  - Order of limitation
  - Assumes Constant Efficiencies

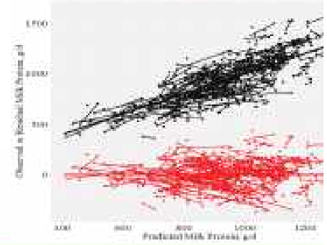
7

	Intercept	His	Ile	Leu	Lys	Met	Thr	NEAA	$\sum(EAA^2)$	dFA	dNDF	dSt	drOM	BW
	g/d	------	------	------	------	g/g	------	------	------	------	------	g/kg	------	------
	52	1.72	1.34	0.36	1.31	1.73	1.58	0.14	-0.0020	122	20	45	47	-0.38

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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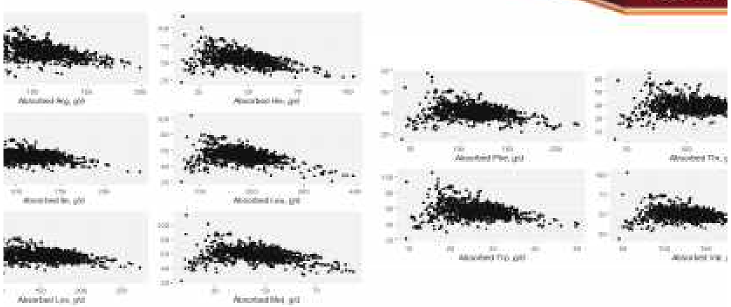
Efficiency of Absorbed EAA Conversion to Milk EAA



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Example Diet 1

MP Supply: 2383 g, Target MP: 2301 g
NE Allow Milk: 40.4 kg

	Trg Milk NP	Trg Effic	Trg Suppl	Pred Suppl	Pred Effic	Regr Coeff	Milk NP
W_NDF							-125
on prot)				59		10.79	638
	41			137	0.45	0	0
	32	0.75	60	57	0.77	1.675	95
	67	0.71	121	142	0.59	0.885	125
	115	0.73	205	214	0.68	0.466	100
	96	0.72	174	182	0.66	1.153	210
	33	0.73	55	52	0.75	1.839	95
	57	0.60	127	138	0.54	0	0
	50	0.64	118	126	0.58	0	0
	18	0.86	28	31	0.75	0	0
	75	0.74	135	147	0.66	0	0
	582		1025	1224	0.62	-0.00215	-225
her				2095		0.0773	162
Allow	1085				0.65	NA	1075
kg/d							34.7

- 35 kg milk
- 24.9 kg DM/d
- 17.5% CP

- Corn Silage
- Legume Silage
- Mixed Hay
- Corn
- SBM
- Expeller SBM

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Example Diet 2

MP Supply: 2249 g, Target MP: 2293 g
NE Allow Milk: 41.8 kg

	Trg Milk NP	Trg Effic	Trg Suppl	Pred Suppl	Pred Effic	Regr Coeff	Milk NP
W_NDF							-115
)				62		10.79	665
	41			130	0.47	0	0
	32	0.75	60	54	0.81	1.675	91
	67	0.71	121	133	0.64	0.885	117
	115	0.73	204	205	0.71	0.466	96
	96	0.72	174	170	0.72	1.153	196
	33	0.73	55	49	0.80	1.839	91
	57	0.60	127	130	0.57	0	0
	50	0.64	118	118	0.62	0	0
	18	0.86	28	29	0.82	0	0
	75	0.74	135	138	0.71	0	0
	582		1021	1156	0.66	-0.00215	-202

- 35 kg milk
- 24.9 kg DM/d
- 15.9% CP

- Corn Silage

- Mixed Hay
- Corn
- SBM
- Expeller SBM

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Example Diet 3

MP Supply: 2117 g, Target MP: 2320 g
NE Allow Milk: 40.9 kg

	Trg Milk NP	Trg Effic	Trg Suppl	Pred Suppl	Pred Effic	Regr Coeff	Milk NP
V_NDF							-115
				62		10.79	665
	41			130	0.47	0	0
	32	0.75	60	54	0.81	1.675	91
	67	0.71	121	133	0.64	0.885	117
	115	0.73	204	205	0.71	0.466	96
	96	0.72	174	170	0.72	1.153	196
	33	0.73	55	49	0.80	1.839	91
	57	0.60	127	130	0.57	0	0
	50	0.64	118	118	0.62	0	0
	18	0.86	28	29	0.82	0	0
	75	0.74	135	138	0.71	0	0
	582		1021	1156	0.66	-0.00215	-202

- 35 kg milk
- 24.9 kg DM/d
- 14.7% CP

- Corn Silage

- Mixed Hay
- Corn

- Corn Distillers
- Soyhulls

12

Conclusions

- ✓ New concepts for milk protein predictions
  - 5 EAA, DEInp, dNDF
  - Marginal responses to individual AA not high
  - Energy supply very important
  - No such thing as a single-limiting AA
- ✓ Efficiency of Use of EAA is a good tool

- ✓ ☒**Optimize** or ☐**Plug and Chug**?
  - dNDF, dStarch, RDP, dFat, 5 dEAA, 2 dFA, 38 MV, Ingr$, Milk$
  - How much money are you leaving on the table????

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Four-State
Dairy Nutrition
& Management
Conference

Strategies to Optimize Fertility with Sexed Semen in Primiparous Holstein Cows and Nulliparous Holstein Heifers

Dr. Paul Fricke, Ph.D.
and
Megan R. Lauber M.S.
University of Wisconsin

Strategies to optimize fertility with sexed semen in primiparous Holstein cows and nulliparous Holstein heifers

ANIMAL & DAIRY SCIENCES
University of Wisconsin-Madison

Paul M. Fricke, Ph.D.
and
Megan R. Lauber M.S.

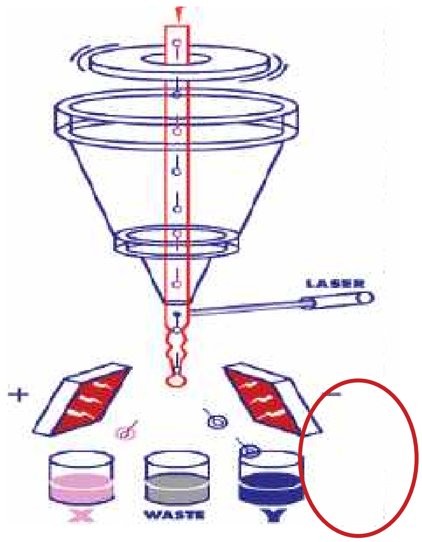
1

Outline

- Background on sexed semen
- Cow Study: Effect of timing of induction of ovulation relative to TAI using sexed semen on pregnancy outcomes in primiparous Holstein cows
- Heifer Study: Comparison of reproductive management programs for submission of Holstein heifers for first AI with conventional or sexed semen based on expression of estrus, pregnancy outcomes, and cost per pregnancy
- Acknowledgments
- Questions

2

Methods for Sexing Semen



- X-chromosome has 4% more DNA
- Sperm stained with dye & sorted or killed by laser
- 85% to 90% accuracy
- 75% of total sperm discarded in process

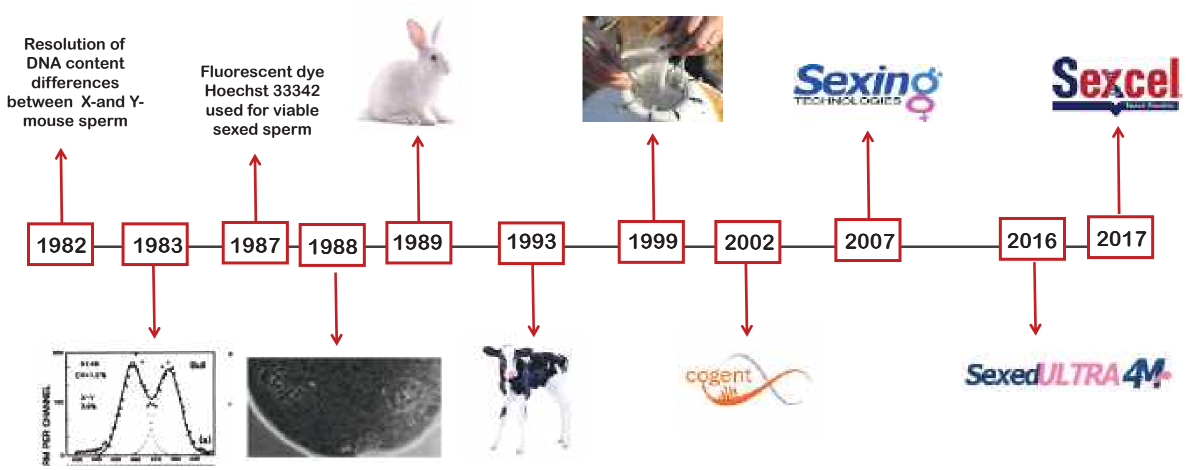
Garner et al., 2006, Garner et al., 2012

3

Selective Killing

4

A Brief History of Sexed Semen



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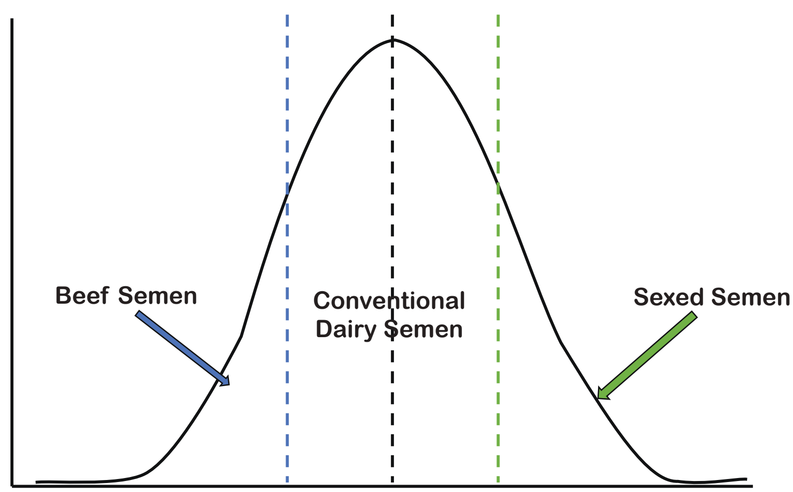
Use of Genomics, Sexed Semen, and Beef Semen



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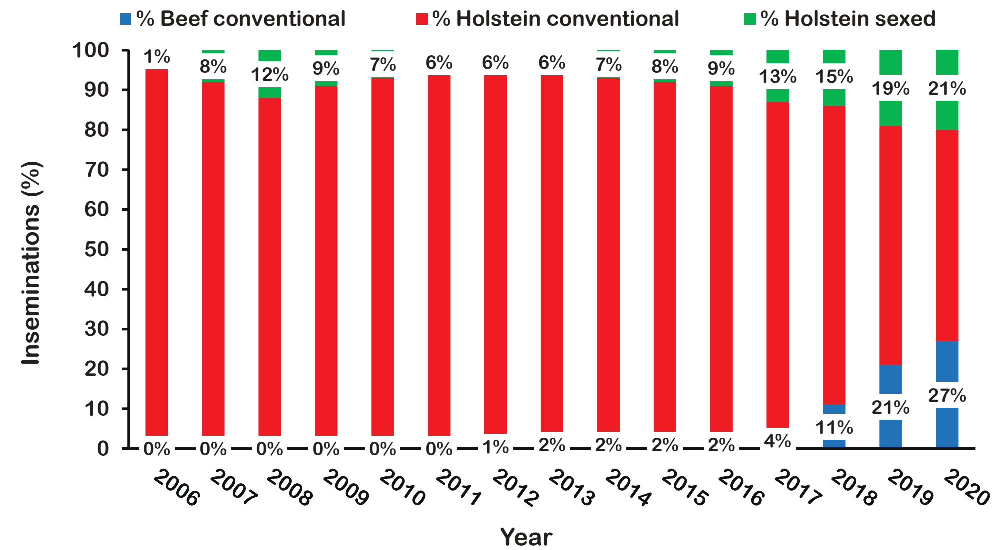
Inseminations in Holstein Females



AgSource 2021

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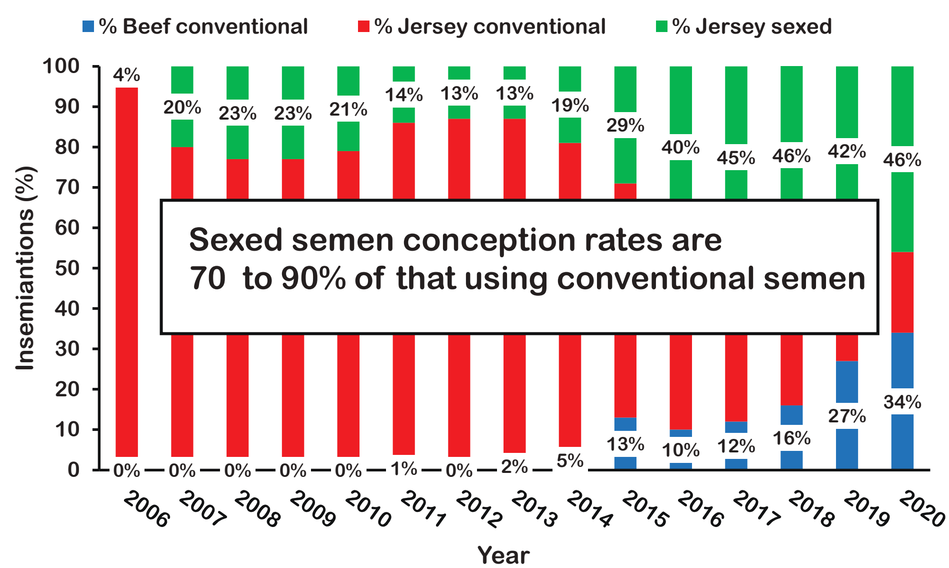
Inseminations in Jersey Females



Karakaya-Bilen et al., 2019, Chebel and Cunha 2020, Drake et al., 2020 AgSource 2021

8

J. Dairy Sci. 103:10856–10861
https://doi.org/10.3168/jds.2020-18836

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

M. R. Lauber,[1] B. McMullen,[2] J. J. Parrish,[3] and P. M. Fricke[1*]
[1]Department of Dairy Science, University of Wisconsin-Madison, Madison 53706
[2]Bridgewater Dairy Group, Montpelier, OH 43543
[3]Department of Animal Sciences, University of Wisconsin-Madison, Madison 53706

Objective

To determine the effect of altering timing of induction of ovulation relative to TAI with sexed semen after a Double-Ovsynch protocol in primiparous Holstein cows

Hypothesis

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

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Contents lists available at ScienceDirect
Theriogenology
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Time of insemination relative to reaching activity threshold is associated with pregnancy risk when using sex-sorted semen for lactating Jersey cows

Gabriel D. Bombardelli[a,b], Henrique F. Soares[a,b], Ricardo C. Chebel[a,b,*]

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Research Article

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

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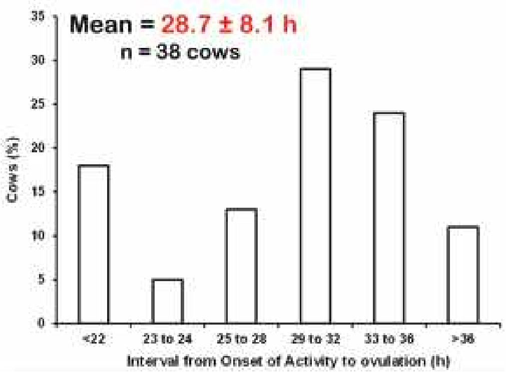
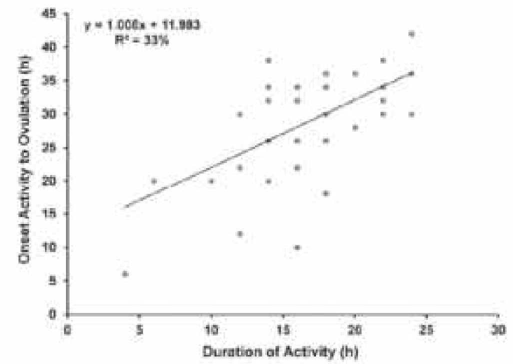
J. Dairy Sci. 95:7115–7127
http://dx.doi.org/10.3168/jds.2012-5639

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,*†‡[1] J. O. Giordano,*[1] G. Lopes Jr.,*[1] L. Vincenti,‡ M. C. Amundson,* and P. M. Fricke*[2]
*Department of Dairy Science, University of Wisconsin, Madison 53706
†Department of Animal Science, School of Agriculture, University of Turin, Turin, Italy 10095
‡Department of Animal Pathology, School of Veterinary Medicine, University of Turin, Turin, Italy 10095





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Current 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**

Bombardelli et al., 2016, Nebel 2018

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Collaborating Farms

- Three locations:
  - Nebraska, Ohio, Wisconsin
- Primiparous cows only (n = 730)
- All farms submitted cows for first Timed AI using a Double-Ovsynch protocol
  - Farm A: 6,650 cows; ME305 = 11,318 kg.
  - Farm B: 1,800 cows; ME305 = 12,954 kg.
  - Farm C: 2,260 cows; ME305 = 14,091 kg.

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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.		

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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.		

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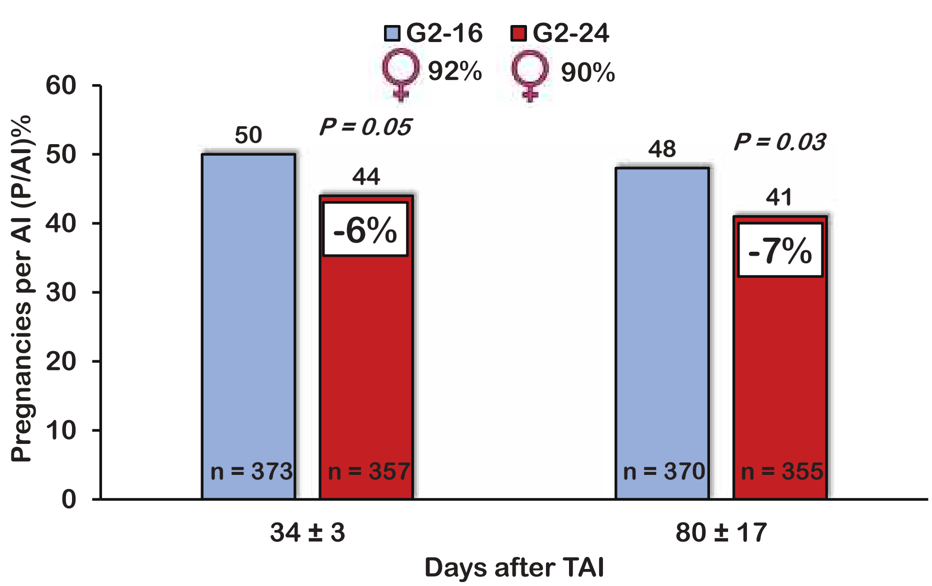
Effect of Treatment on P/AI



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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

Hunter and Wilmut 1983, Peters and Pursley 2003, Carvalho et al., 2018

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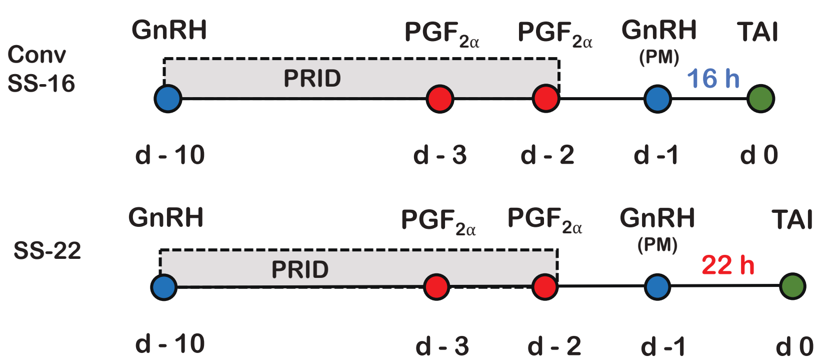
J. Dairy Sci. 103:12059–12068
https://doi.org/10.3168/jds.2020-18847

Evaluation of delayed timing of artificial insemination with sex-sorted sperm on pregnancy per artificial insemination in seasonal-calving, pasture-based lactating dairy cows

E. Drake,[1,2] S. A. Holden,[1] V. Aublet,[1] R. C. Doyle,[1] C. Millar,[1] S. G. Moore,[1] C. Maicas,[1,2] F. Randi,[3] A. R. Cromie,[4] P. Lonergan,[2] and S. T. Butler[1*]
[1]Teagasc, Animal and Grassland Research and Innovation Centre, Moorepark, Fermoy, Co. Cork, Ireland P61 C996
[2]School of Agriculture and Food Science, University College Dublin, Ireland D04 N2E5
[3]Ceva Santé Animale, Libourne, Bordeaux, France 33500
[4]Irish Cattle Breeding Federation, Highfield House, Shinagh, Bandon, Co. Cork, Ireland P72 X050



18

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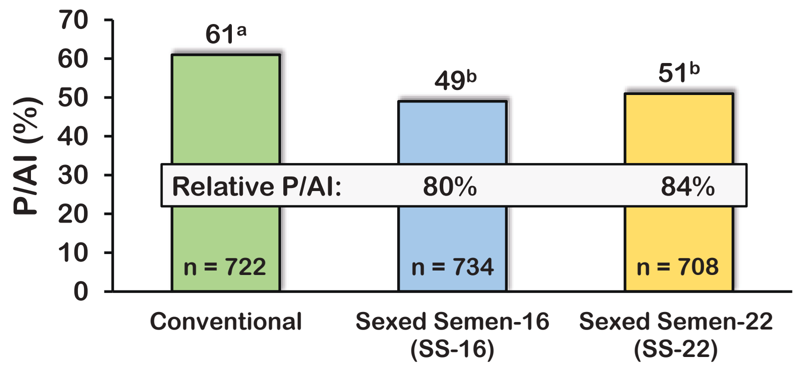

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Hypothesis

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

Reject

20

Heifers!

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Comparison of reproductive management programs for submission of Holstein heifers for first insemination with conventional or sexed semen based on expression of estrus, pregnancy outcomes, and cost per pregnancy

M. R. Lauber, E. M. Cabrera, V. G. Santos, P. D. Carvalho, C. Maia, B. Carneiro, V. E. Cabrera, J. J. Parrish and P. M. Fricke

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J. Dairy Sci. 89:4907–4920
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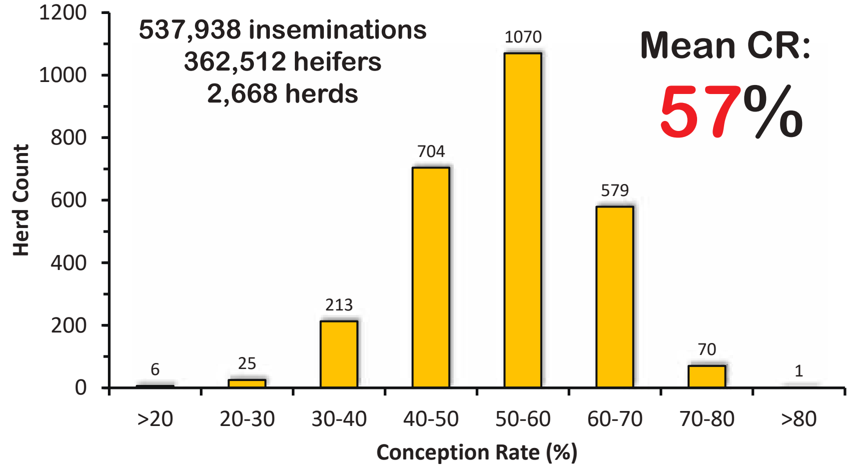
Characterization of Holstein Heifer Fertility in the United States

M. T. Kuhn, J. L. Hutchison, and G. R. Wiggans
Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD 20705-2350



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J. Dairy Sci. 102:2593–2606
https://doi.org/10.3168/jds.2018-15588
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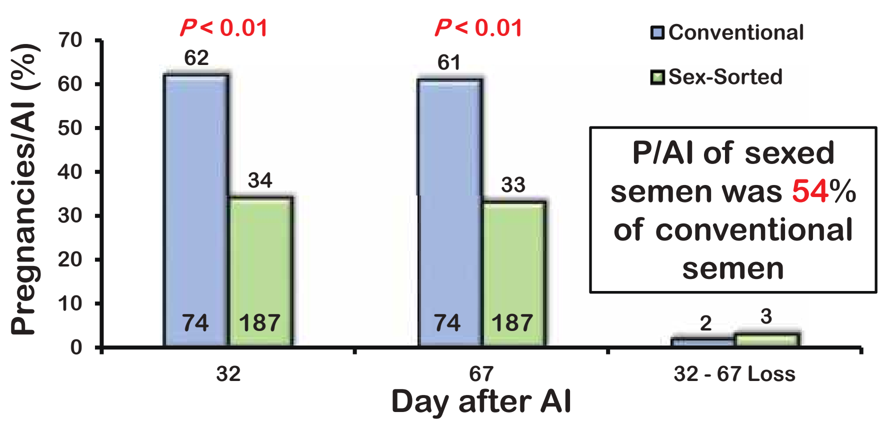
Effect of treatment with human chorionic gonadotropin 7 days after artificial insemination or at the time of embryo transfer on reproductive outcomes in nulliparous Holstein heifers

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



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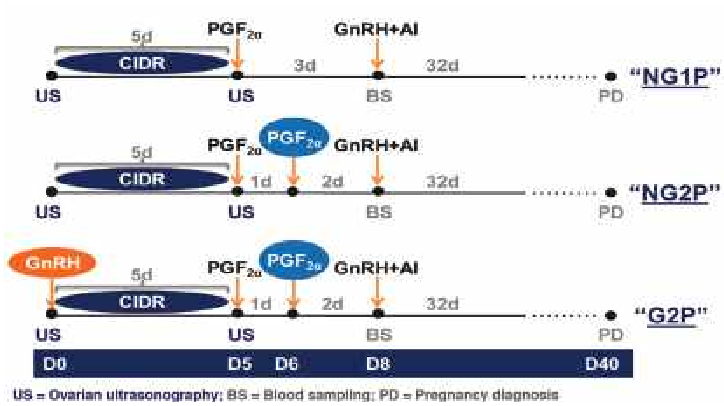
J. Dairy Sci. 96:7054–7065
http://dx.doi.org/10.3168/jds.2013-7093

Hormonal manipulations in the 5-day timed artificial insemination protocol to optimize estrous cycle synchrony and fertility in dairy heifers

F. S. Lima,* E. S. Ribeiro,* R. S. Bisinotto,* L. F. Greco,* N. Martinez,* M. Amstalden,† W. W. Thatcher,* and J. E. P. Santos*[1]
*Department of Animal Sciences, University of Florida, Gainesville 32611
†Department of Animal Sciences, Texas A&M University, College Station 77843



P/AI, 60 d

49% (348/711)

52% (359/696)

59% (420/711)

25

J. Dairy Sci. 98:7810–7822
http://dx.doi.org/10.3168/jds.2015-9704

Synchronized ovulation for first insemination improves reproductive performance and reduces cost per pregnancy in dairy heifers

T. V. Silva,*† F. S. Lima,‡ W. W. Thatcher,*† and J. E. P. Santos*†[1]
*Department of Animal Sciences, and
†D. H. Barron Reproductive and Perinatal Biology Research Program, University of Florida, Gainesville 32611
‡Department of Veterinary Clinical Medicine, University of Illinois, Urbana 61802

		Treatment		
Semen type		Estrus	TAI	P-value
Conventional		66 (155/240)	65 (151/231)	0.86
Sexed	48% of Conventional	32 (18/57)	55 (40/73)	85% of Conventional

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Objective of Experiment 1

To determine the effect of delaying PRID removal by 24 h until d 6 during a 5-d PRID-Synch protocol on early expression of estrus before TAI and P/AI in nulliparous Holstein heifers inseminated with conventional semen

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Hypothesis for Experiment 1

Delaying PRID removal by 24 h until d 6 will decrease early expression of estrus before scheduled TAI without affecting P/AI in nulliparous Holstein heifers inseminated with conventional semen

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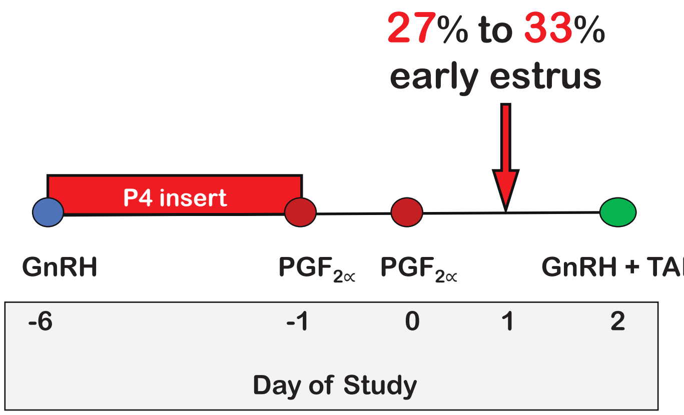
Estrus ≥ 24 h before TAI



Silva et al., 2015, Masello et al., 2019

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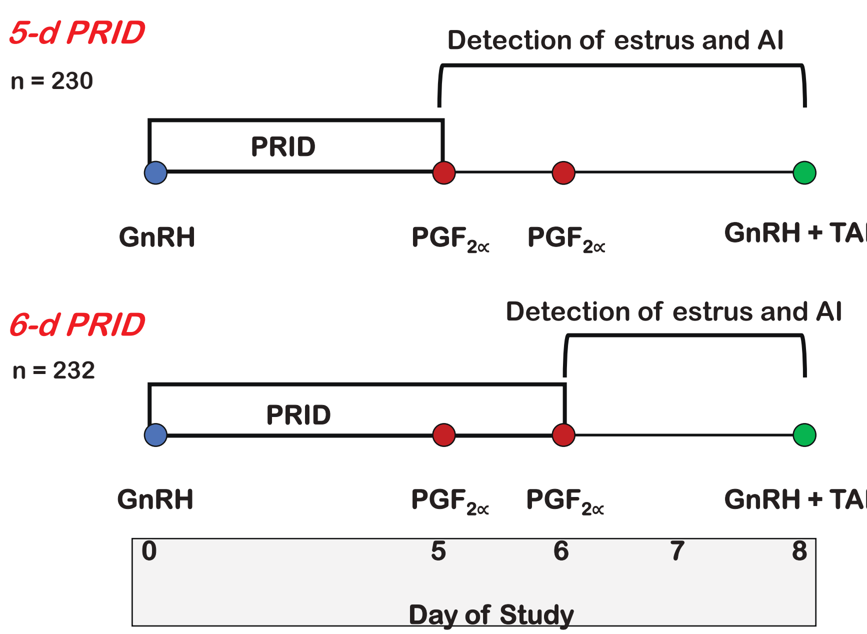

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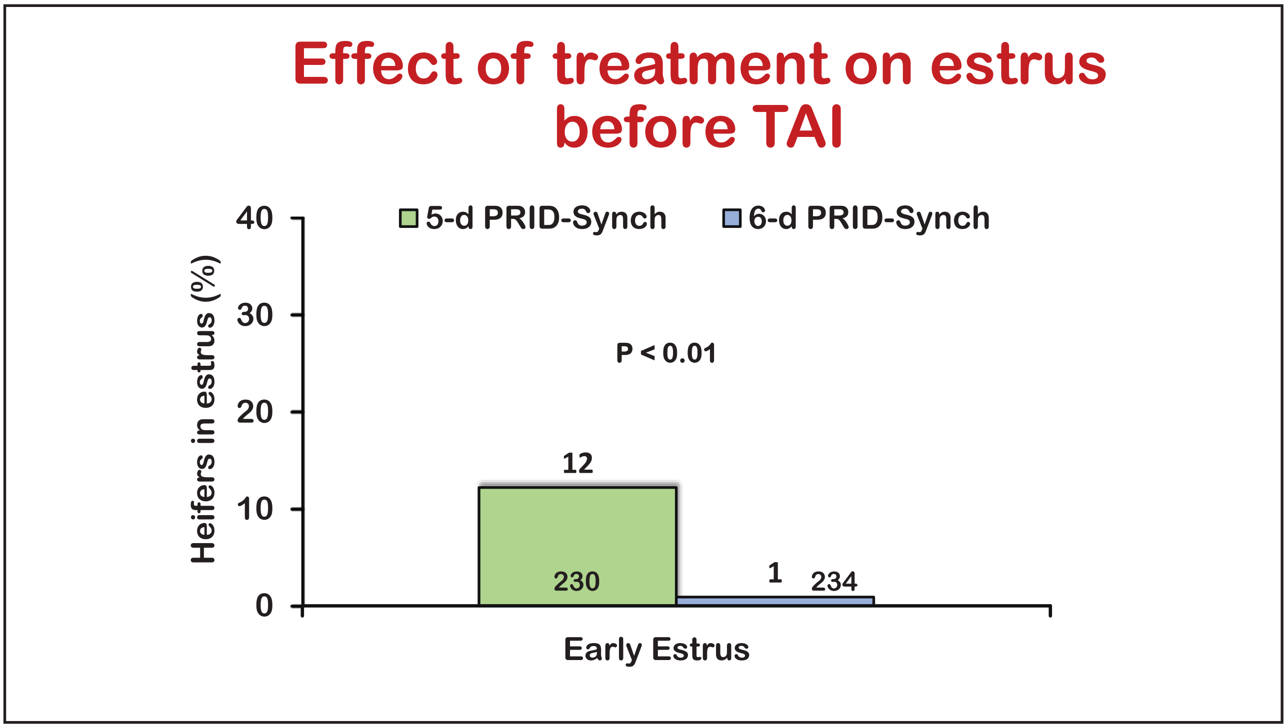
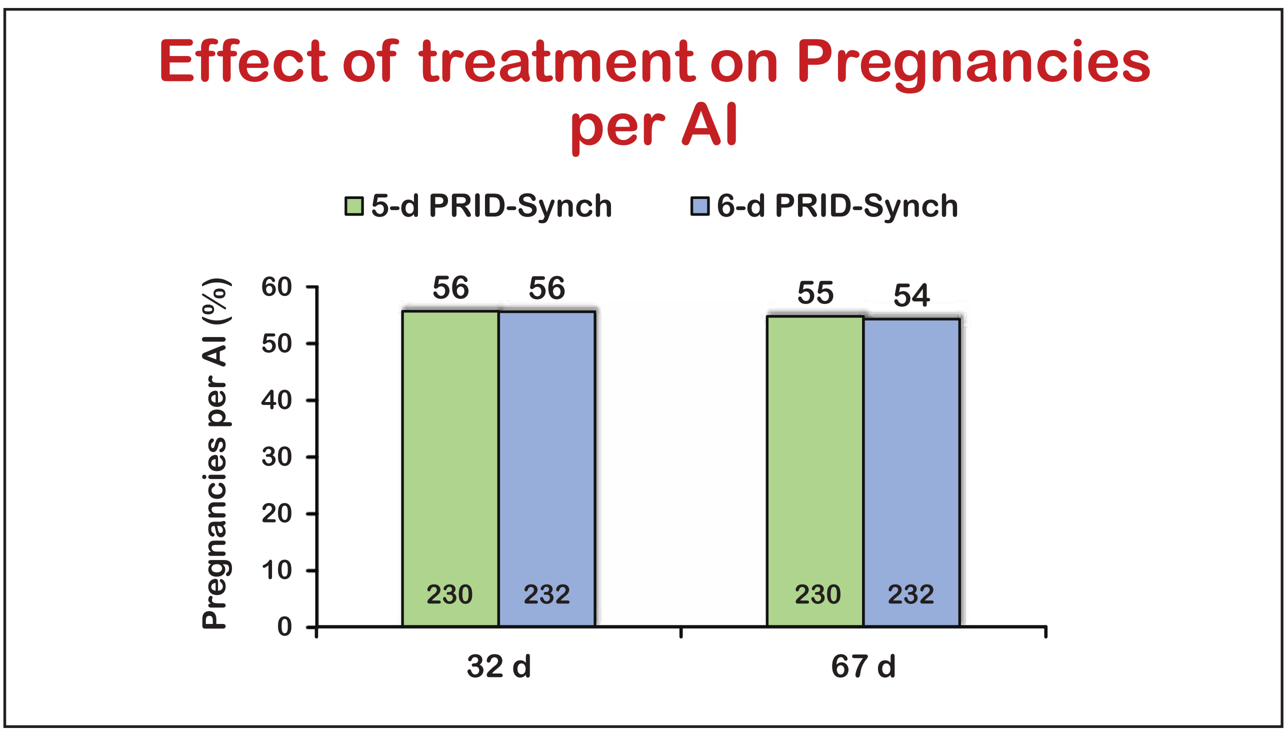

Effect of treatment on estrus before TAI
5-d PRID-Synch
6-d PRID-Synch
Heifers in estrus (%)
40
30
20
10
0
P < 0.01
12
230
1
234
Early Estrus

31


Effect of treatment on Pregnancies per AI
5-d PRID-Synch
6-d PRID-Synch
Pregnancies per AI (%)
60
50
40
30
20
10
0
56
56
55
54
230
232
230
232
32 d
67 d

32

Objectives of Experiment 2

1. To determine the effect of delayed CIDR removal by 24 h during a 5-d CIDR-Synch protocol on expression of estrus and P/AI of heifers inseminated with sexed semen
2. To compare TAI versus once-daily detection of estrus (EDAI) for first AI on P/AI and days to first AI and pregnancy
3. To compare costs per pregnancy during an 84-d breeding period when TAI or EDAI was used for first AI

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Hypotheses for Experiment 2

1. Delayed CIDR removal will decrease expression of estrus before TAI with no effect on P/AI for nulliparous Holstein heifers inseminated with sexed semen
2. TAI will increase P/AI and decrease days to AI and pregnancy for heifers inseminated with sexed semen compared with EDAI
3. The cost per pregnancy will be less for TAI than EDAI because of fewer days on feed

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Collaborating Farms

- Three farms in south-central WI
- Nulliparous Holstein heifers (n = 828)
- Once-daily detection of estrus with tail chalk

	Farm		
	A	B	C
Heifers	1,434	815	805
Cows	643	1,061	879
ME305	14,266	12,452	14,600

Sexcel Sexed Genetics

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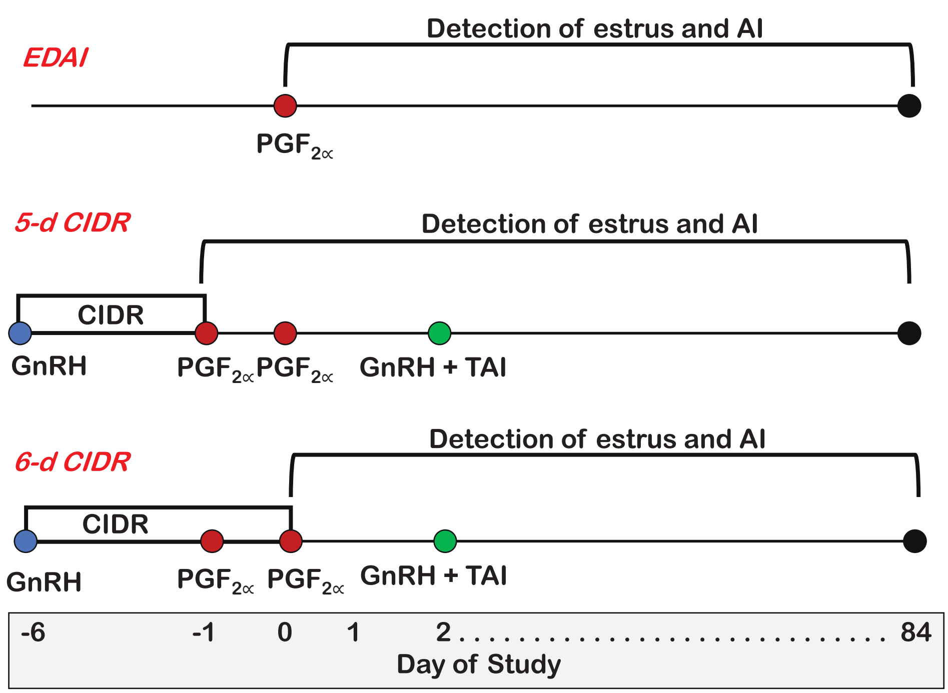

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Enrollment

	Treatment			
	5-d CIDR	6-d CIDR	EDAI	Total
Initial	277	269	282	828
Excluded	22	15	55	92
Final	255	254	227	736

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Heifer Weight and Age

	Treatment			
Item	5-d CIDR	6-d CIDR	EDAI	P - value
n	255	254	227	
Weight[1] (kg)	426.08 ± 2.17	423.37 ± 2.19	419.47 ± 2.27	0.15
Age (d)[2]	400.59 ± 0.93	400.17 ± 0.92	399.52 ± 0.79	0.47

[1] Weight in kg of nulliparous Holstein heifers on d 0
[2] Age in days at enrollment (d -6)

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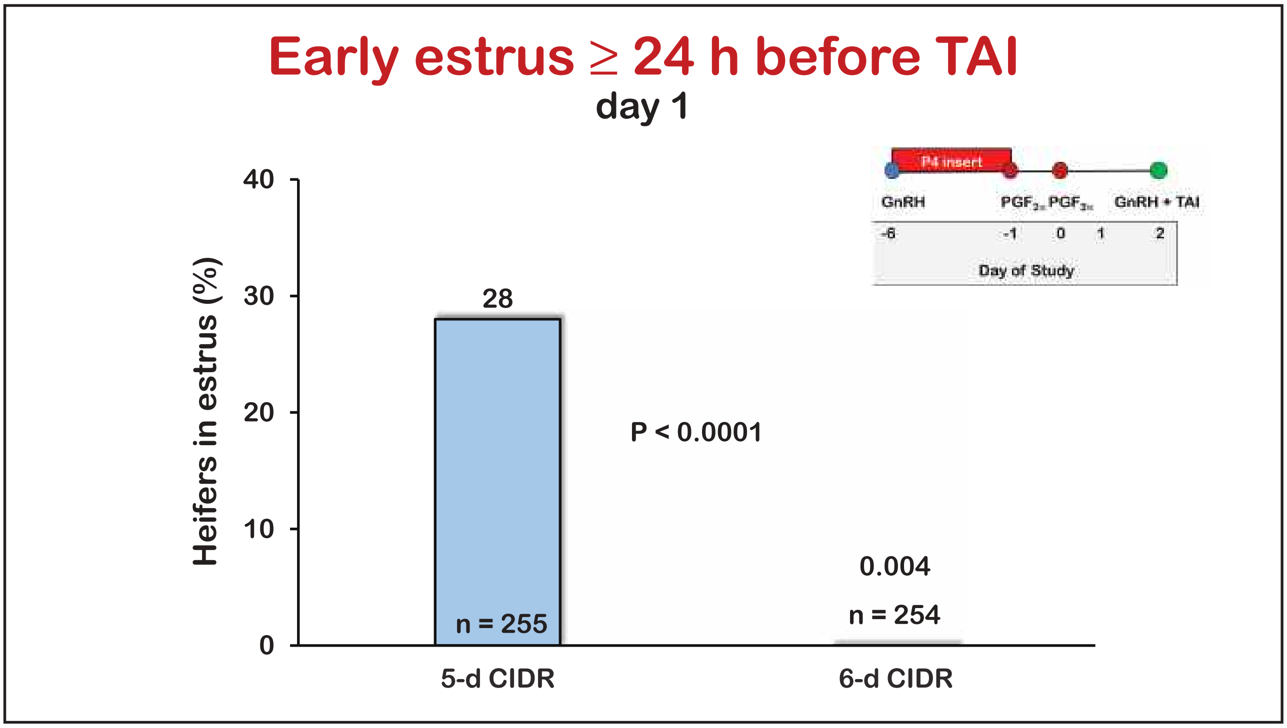

Early estrus ≥ 24 h before TAI
day 1
P4 insert
GnRH
PGF2α PGF2α
GnRH + TAI
-6
-1
0
1
2
Day of Study
Heifers in estrus (%)
40
30
20
10
0
28
P < 0.0001
0.004
n = 255
n = 254
5-d CIDR
6-d CIDR

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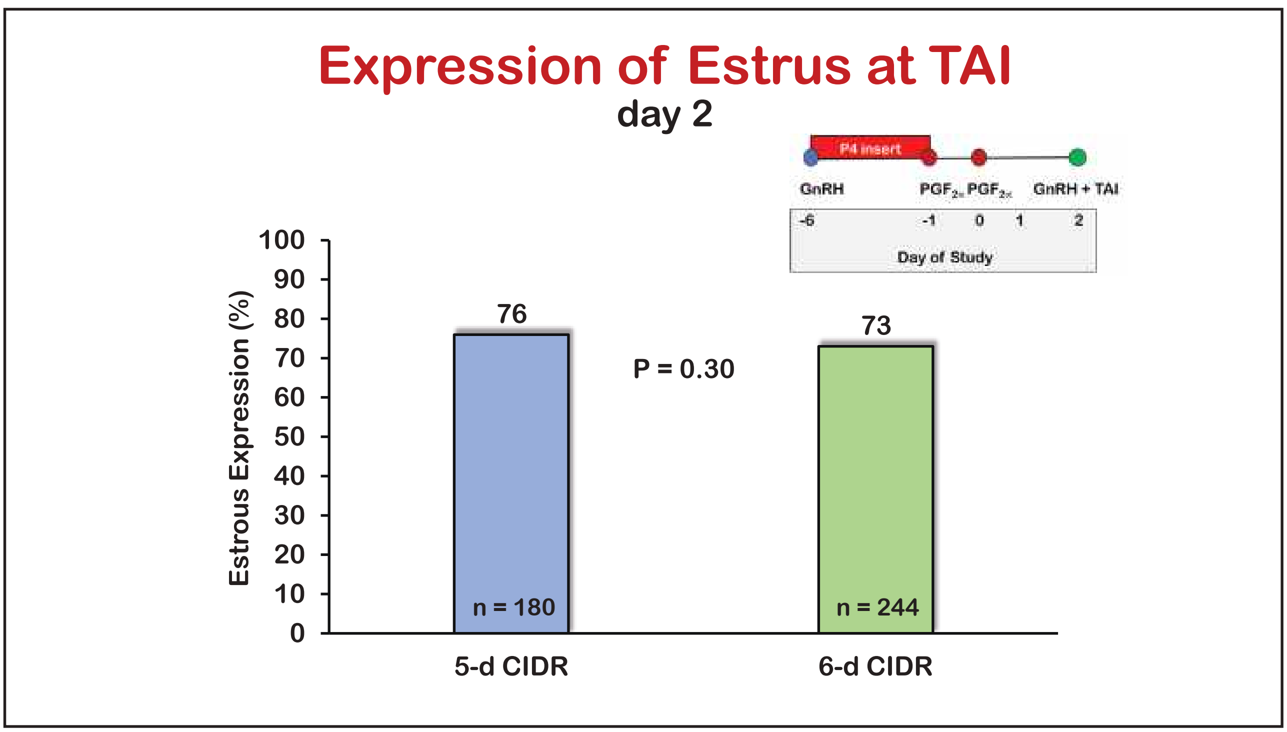
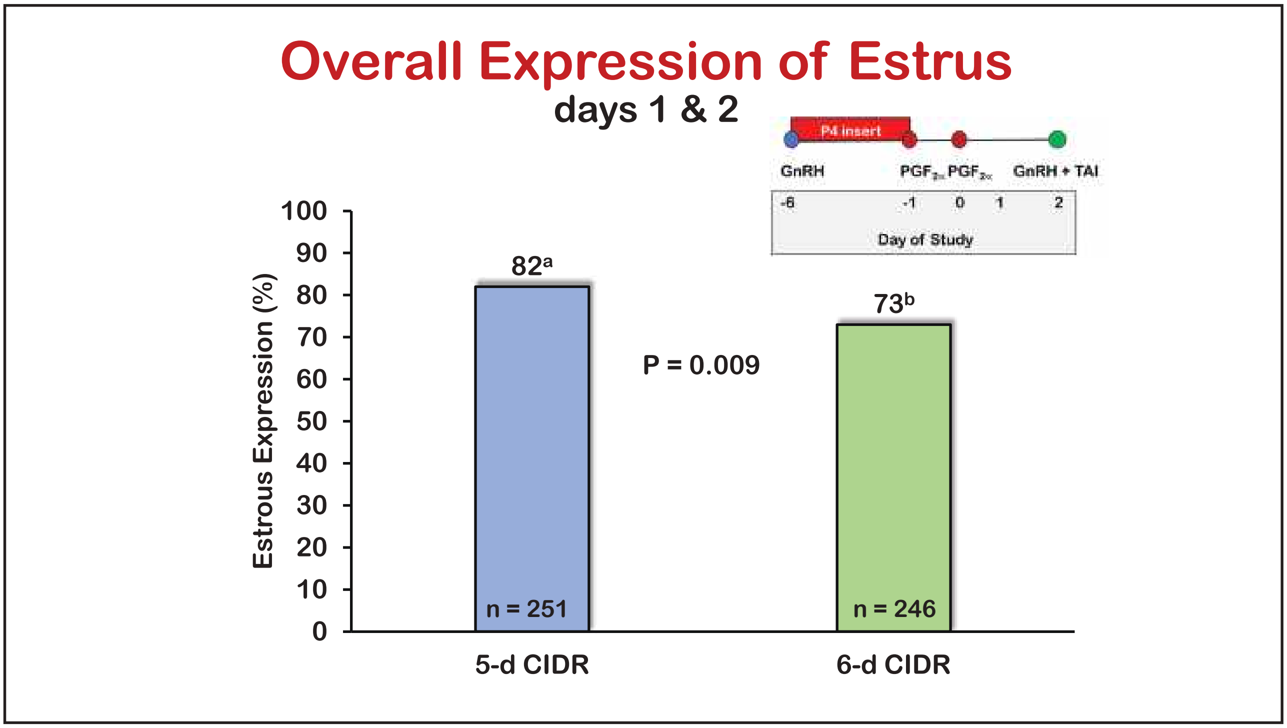


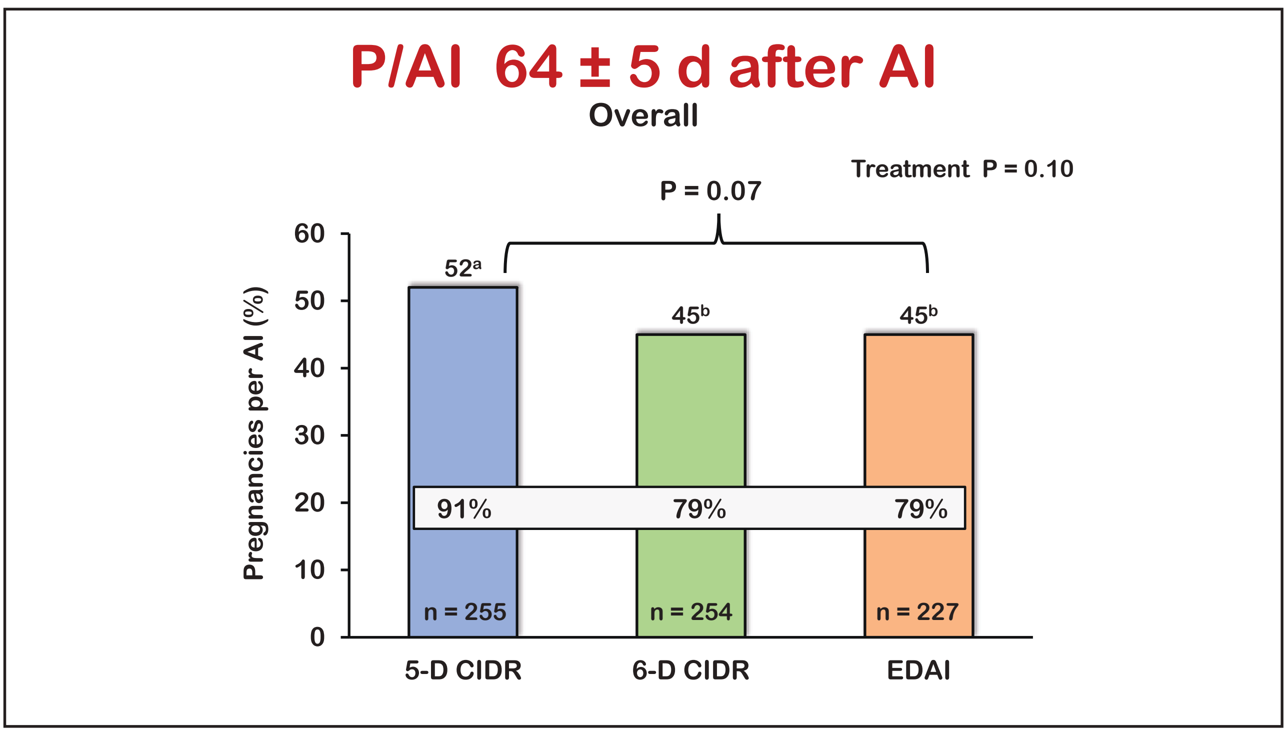
Expression of Estrus at TAI
day 2
P4 insert
GnRH
PGF2α PGF2α
GnRH + TAI
-6
-1
0
1
2
Day of Study
Estrous Expression (%)
100
90
80
70
60
50
40
30
20
10
0
76
73
P = 0.30
n = 180
n = 244
5-d CIDR
6-d CIDR

40



Overall Expression of Estrus
days 1 & 2
P4 insert
GnRH
PGF2α PGF2α
GnRH + TAI
-6
-1
0
1
2
Day of Study
Estrous Expression (%)
100
90
80
70
60
50
40
30
20
10
0
82a
73b
P = 0.009
n = 251
n = 246
5-d CIDR
6-d CIDR

41



P/AI 64 ± 5 d after AI
Overall
Treatment P = 0.10
P = 0.07
Pregnancies per AI (%)
60
50
40
30
20
10
0
52a
45b
45b
91%
79%
79%
n = 255
n = 254
n = 227
5-D CIDR
6-D CIDR
EDAI

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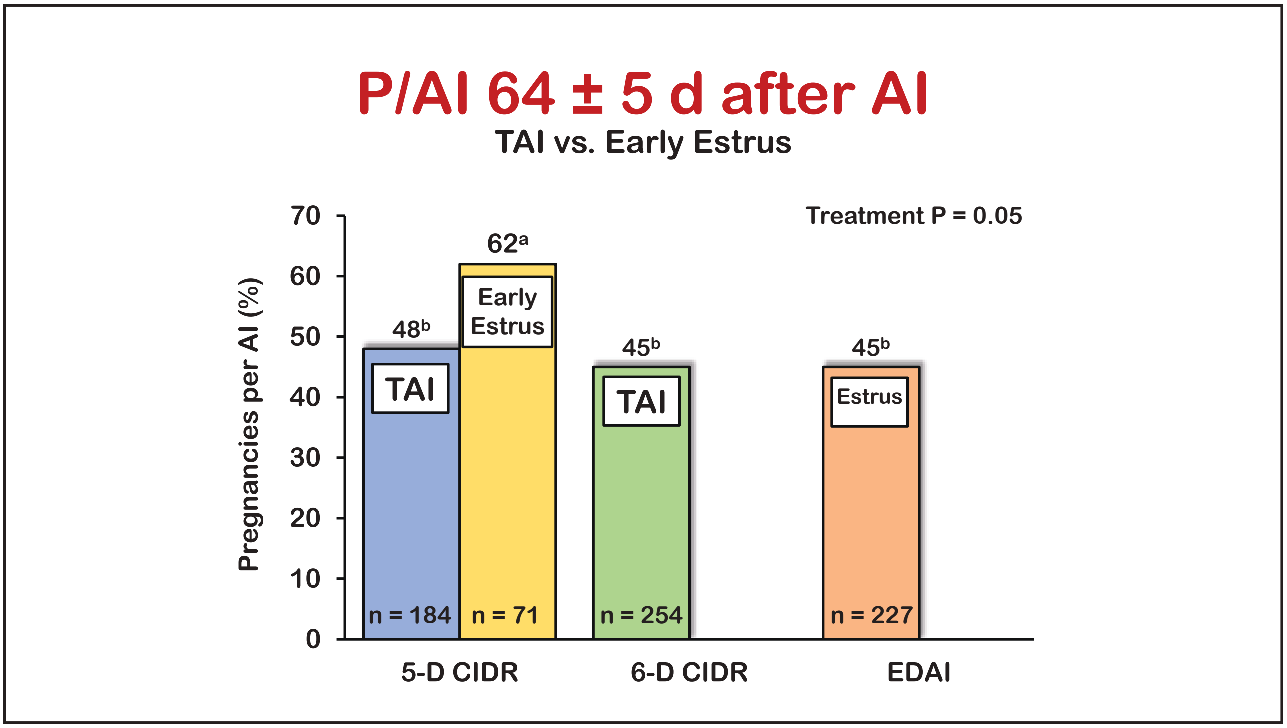
P/AI 64 ± 5 d after AI
TAI vs. Early Estrus
Treatment P = 0.05
Pregnancies per AI (%)
70
60
50
40
30
20
10
0
48b
62a
45b
45b
TAI
Early Estrus
TAI
Estrus
n = 184
n = 71
n = 254
n = 227
5-D CIDR
6-D CIDR
EDAI

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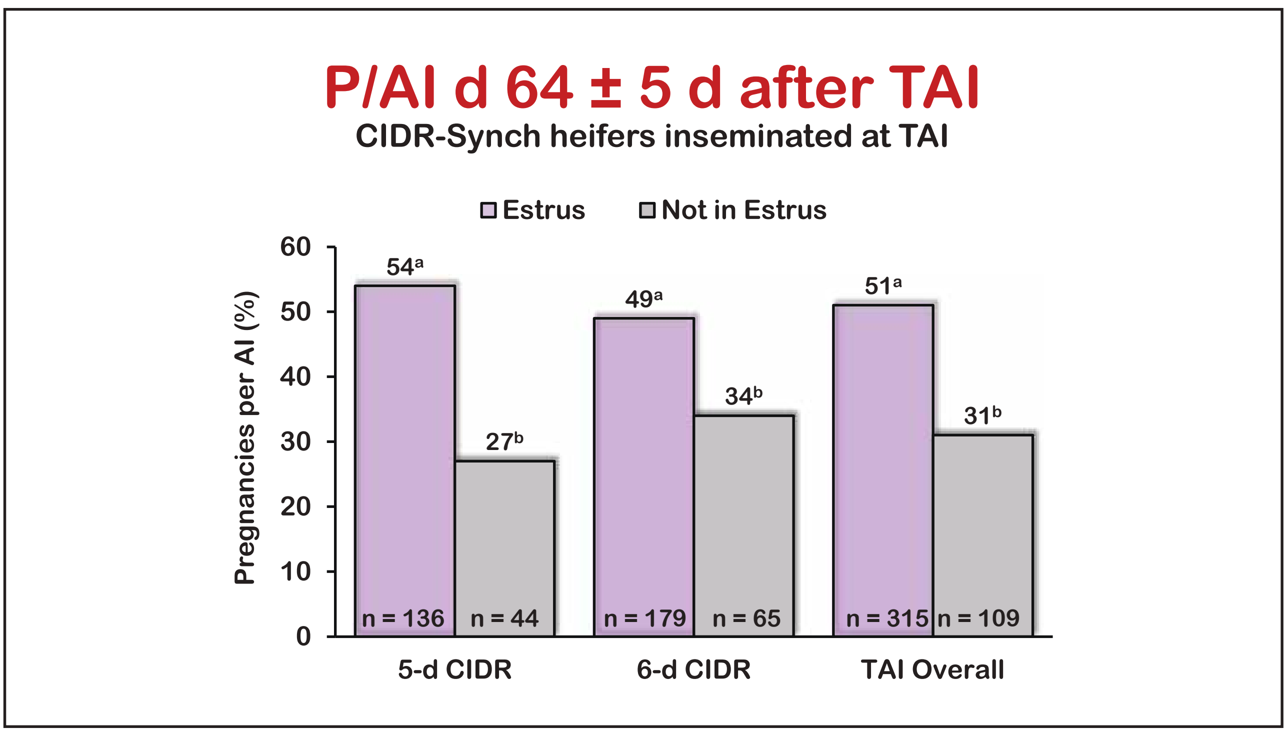
P/AI d 64 ± 5 d after TAI
CIDR-Synch heifers inseminated at TAI
Estrus
Not in Estrus
Pregnancies per AI (%)
60
50
40
30
20
10
0
54a
27b
49a
34b
51a
31b
n = 136
n = 44
n = 179
n = 65
n = 315
n = 109
5-d CIDR
6-d CIDR
TAI Overall

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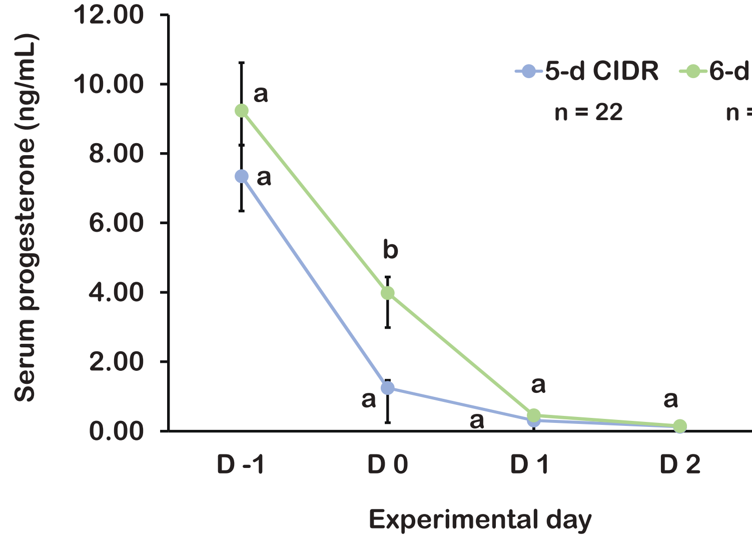
Serum Progesterone Concentrations



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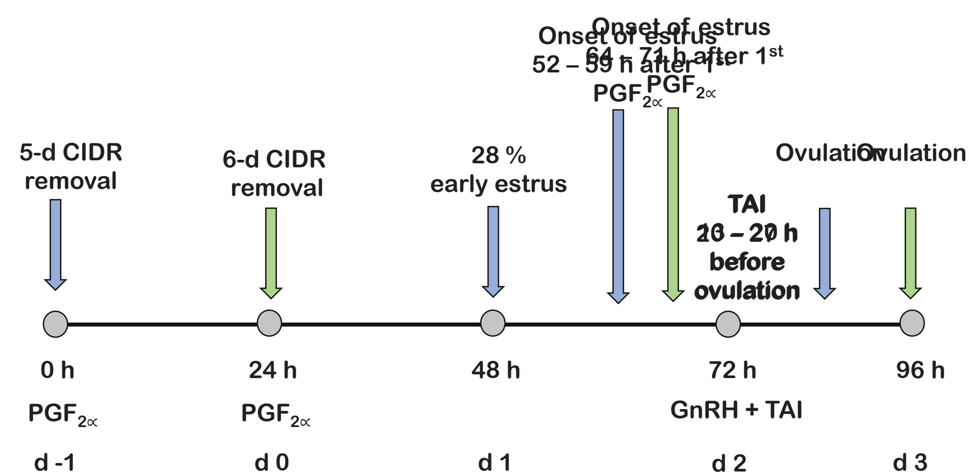
Physiology of Delayed CIDR Removal



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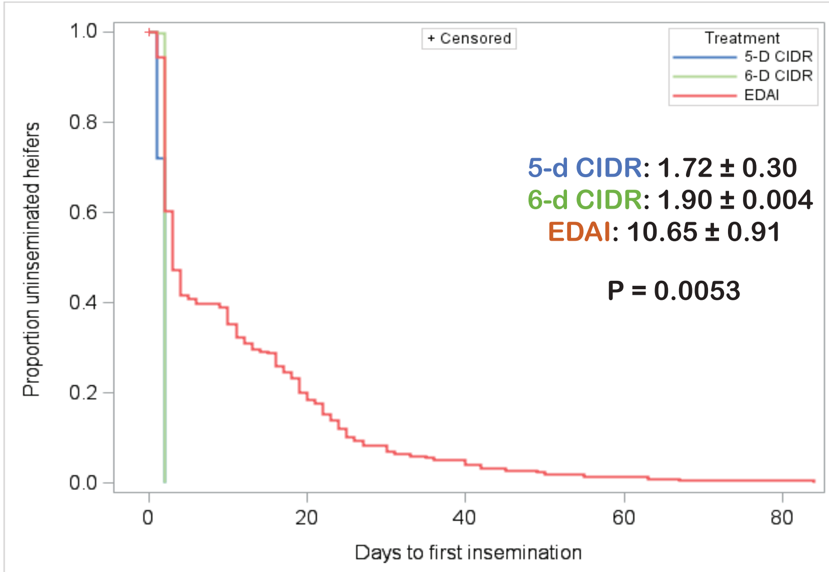
Survival Analysis of Days to First AI



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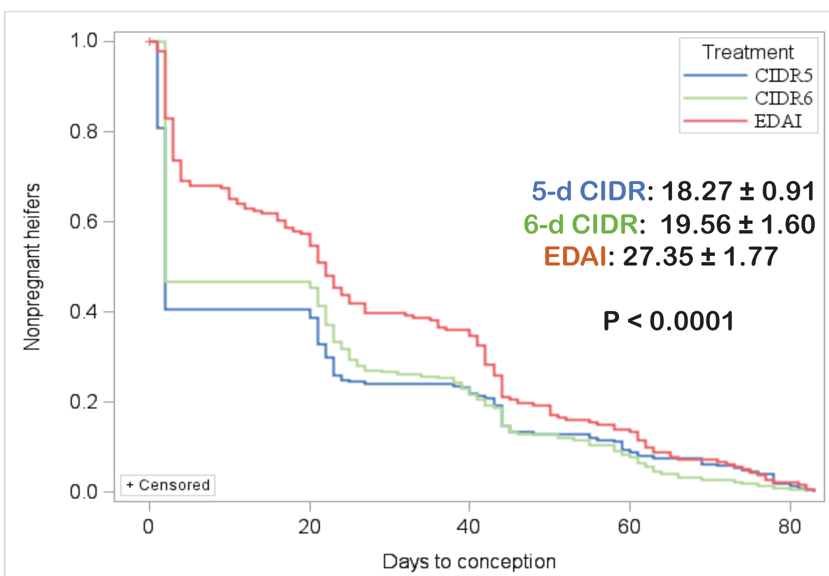
Survival Analysis of Days to Conception



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Partial Budget Analysis

	Treatment			
Cost per pregnancy, US$	EDAI n = 181	5-d CIDR n = 225	6-d CIDR n = 218	P- value
Hormonal treatment	4.05 ± 0.38[a]	22.29 ± 0.36[b]	21.85 ± 0.36[b]	< 0.0001
Detection of estrus	3.04 ± 0.19[a]	2.03 ± 0.18[b]	2.18 ± 0.17[b]	< 0.0001
Semen and AI	70.50 ± 2.47	69.78 ± 2.37	72.02 ± 2.28	0.39
Pregnancy diagnosis	9.55 ± 0.24	9.50 ± 0.14	9.42 ± 0.13	0.42
Feed	82.79 ± 3.01[a]	50.10 ± 2.73[b]	56.84 ± 2.56[b]	< 0.0001
Total per pregnancy	169.92 ± 5.55[a]	153.26 ± 5.36[b]	162.75 ± 5.03[ab]	0.04

$153.26 - $169.92 = - $16.66

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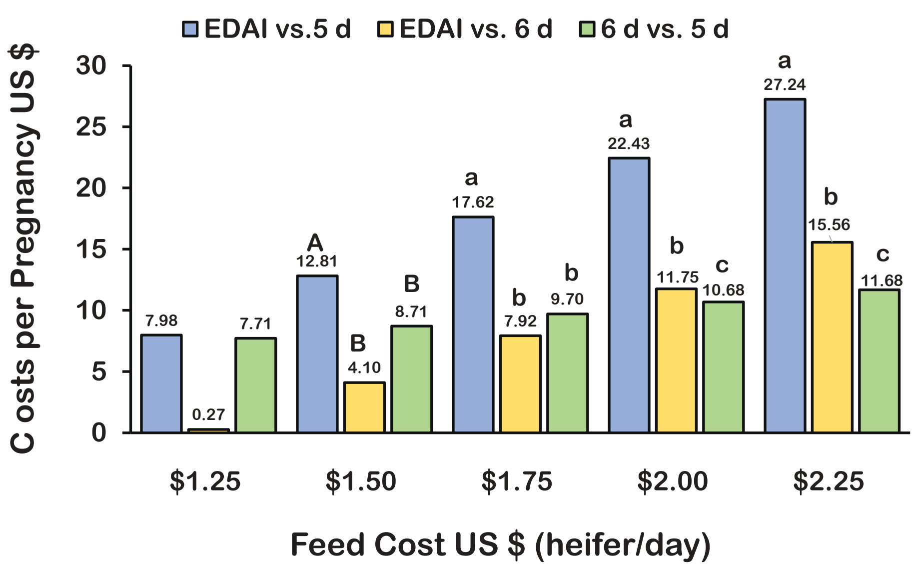
Feed Cost Sensitivity Analysis

Difference in Cost per Pregnancy by 84 d



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Hypotheses

1. Delayed CIDR removal will decrease expression of estrus before TAI with no effect on P/AI for nulliparous Holstein heifers
   - Experiment 1 with conventional semen: Accept
   - Experiment 2 with sexed semen: Reject
2. TAI will increase P/AI and decrease days to AI and pregnancy for heifers inseminated with sexed semen compared with EDAI
   - Accept
3. The cost per pregnancy will be less for TAI than EDAI because of fewer days on feed
   - Accept

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Acknowledgments

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CARE project 2021-68008-34105

Farms & Veterinary Clinics
Bridgewater Dairy
Rams Horn Dairy
Double-P Dairy
Helt Dairy LLC
Mulcahy Farms LLC
G&N Endres Farms LLC
Lodi Veterinary Clinic
Waunakee Veterinary Services

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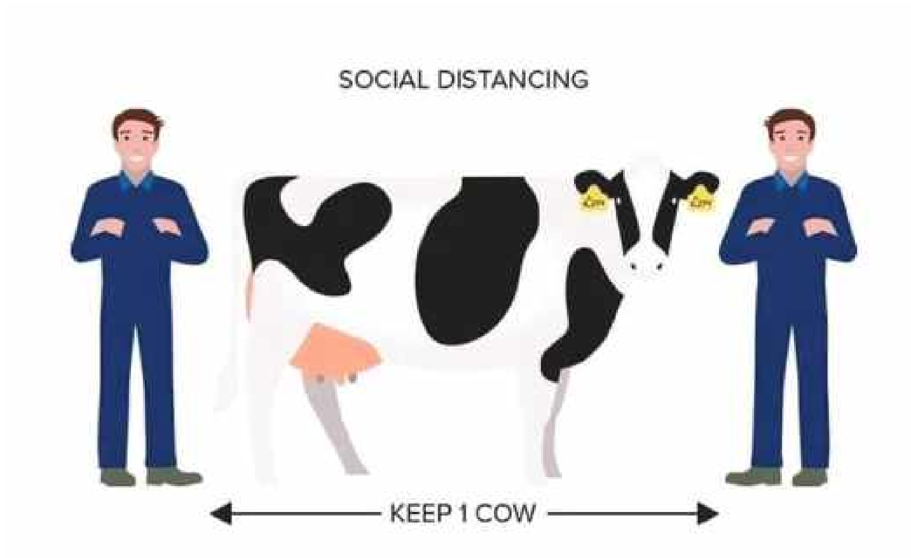
Questions?



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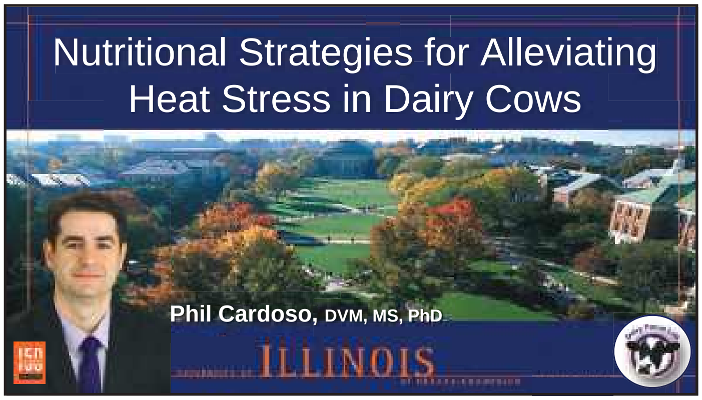
Four-State Dairy Nutrition & Management Conference

Nutritional Strategies for Alleviating Heat Stress in Dairy Cows

Dr. Phil Cardoso
University of Illinois



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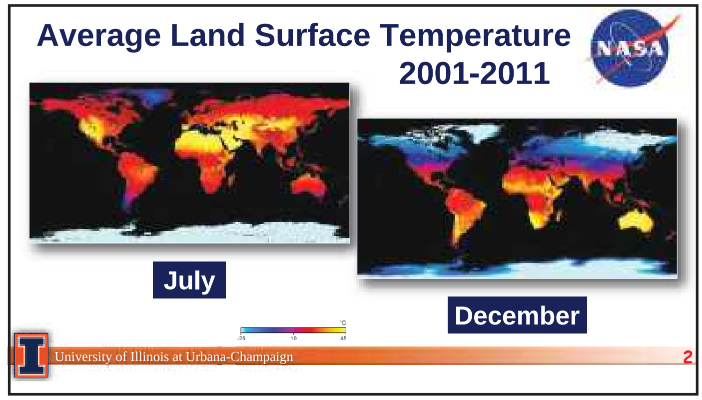

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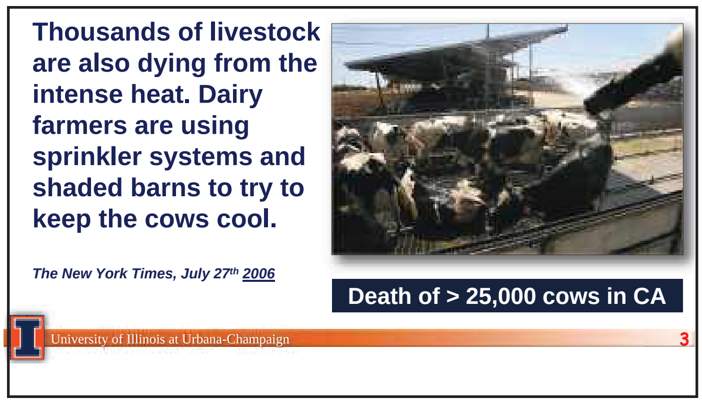

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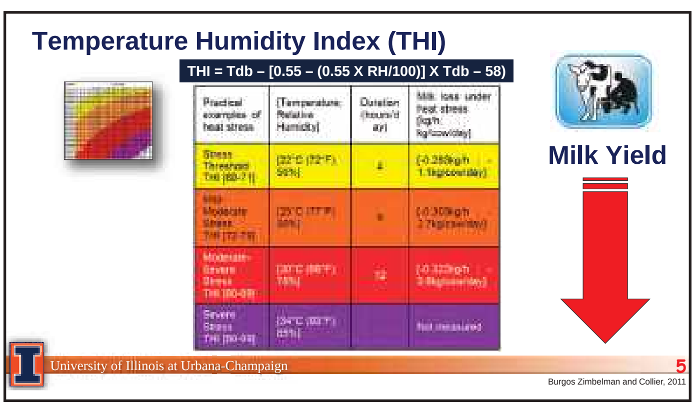

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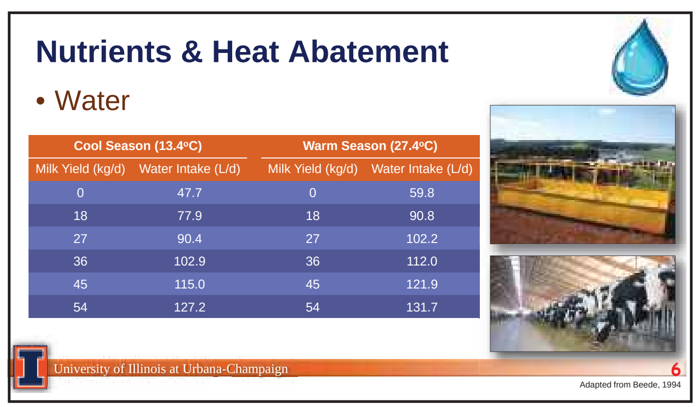
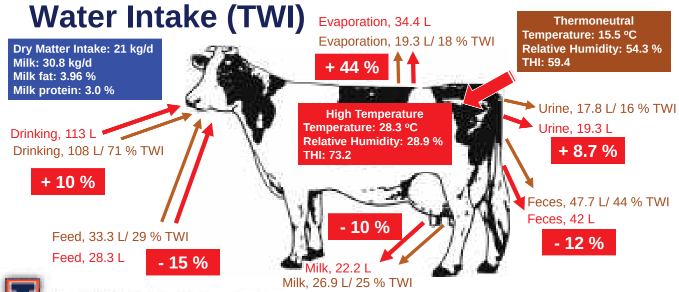


Cool Season (13.4°C)		Warm Season (27.4°C)	
Milk Yield (kg/d)	Water Intake (L/d)	Milk Yield (kg/d)	Water Intake (L/d)
0	47.7	0	59.8
18	77.9	18	90.8
27	90.4	27	102.2
36	102.9	36	112.0
45	115.0	45	121.9
54	127.2	54	131.7

6

Water Flow in Liters per Day or % of Total Water Intake (TWI)



Kehelil-Arfa et al., 2014

7

8

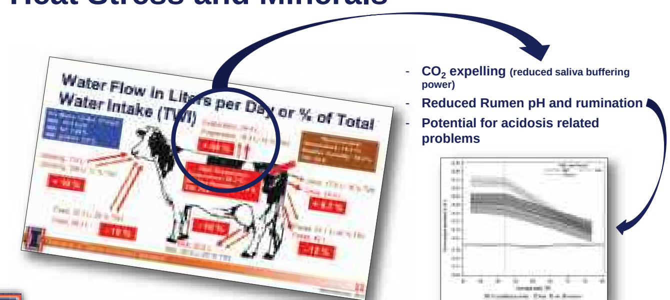
Nutrients & Heat Abatement

- Water
- **Minerals**
  - Macro (DCAD)
    - K, Na, Mg
  - Trace
    - Se, Zn
- Vitamins
  - Niacin (B_3)
- **Protein**
  - Amino acids (Methionine)
- Energy (not a nutrient)
  - Fat
  - Starch
  - Fiber
- Feed additives
  - Yeast, buffer

Beede, 1994; Gao et al., 2017; Kaufman et al., 2018; Opgenorth et al., 2020; Bagath et al., 2019; Zimbelman et al., 2013; Sanchez et al., 1994; Iwaniuk and Erdman, 2015; Knapp and Grummer, 1991; Gonzalez-Rivas et al., 2018; West, 1999; NRC, 2001; Rhoads et al., 2013; Pate et al., 2020

9

Heat Stress and Minerals



- CO_2 expelling (reduced saliva buffering power)
- Reduced Rumen pH and rumination
- Potential for acidosis related problems

Müschner-Siemens et al., 2020

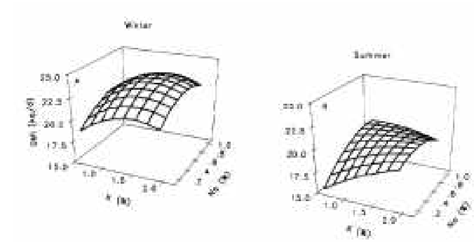
10

Recommendations for Lactation – (% DM)

Mineral	NRC 1989	NRC 2001	U of I Summer
Calcium	0.66	0.60	
Phosphorus	0.41	0.38	
Magnesium	0.25	0.21	0.40
Sodium	0.25	0.22	0.40
Potassium	1.00	1.07	1.20
Chloride	0.25	0.29	
Sulfur	0.20	0.20	

11

Response Surface for DMI in Winter and Summer Plotted Against Na and K Concentrations (% DM)



Sanchez et al., 1994

12

DCAD (Dietary cation-anion difference)

DCAD mEq (milliequivalents)/100g (grams) dietary DM

[(%Na × 43.5 + %K × 25.6) − (%Cl × 28.2 + %S × 62.5)], NRC 2001

Mineral % are on a dry matter (DM) basis

Na + K – Cl – 0.6S, Goff et al. (2004)

Negative DCAD: prevent metabolic disorders (dry cows)

Positive DCAD: increase milk yield and composition (lactating cows)

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DCAD Lactating Cows

- Positive DCAD of 250 to 400 mEq/kg DM is effective and adequate to maximize feed intake and milk production.
- Improve milk yield and DM intake of lactating dairy cows in hot or cool environmental conditions.
- Useful in **heat stress** conditions. Cows under heat stress experience losses of bicarbonate and potassium.

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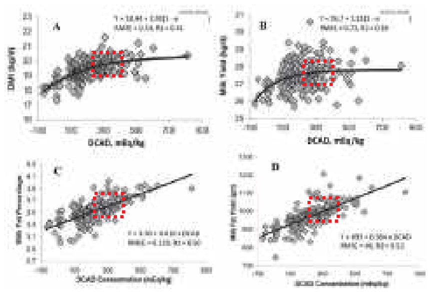
Meta-Analysis on Responses to Increasing DCAD



Iwaniuk and Erdman, 2015

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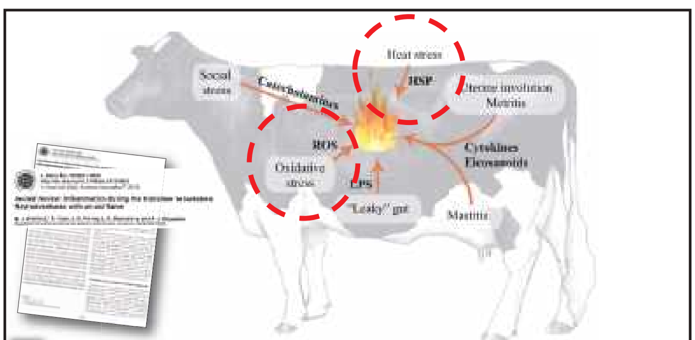

Bradford et al., 2015

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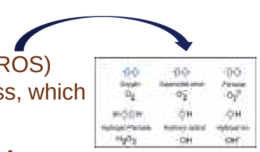
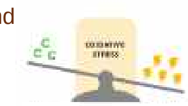
Heat Stress

- Enhances reactive oxygen species (ROS) production an induces oxidative stress, which can lead to cytotoxicity
- Similar to oxidative stress, because of correspondences in the genes expressed after heat exposure (heat-shock proteins and antioxidant enzymes), in comparison with those expressed following oxidant agents' exposure





Rhoads et al., 2013; Slimen et al., 2016

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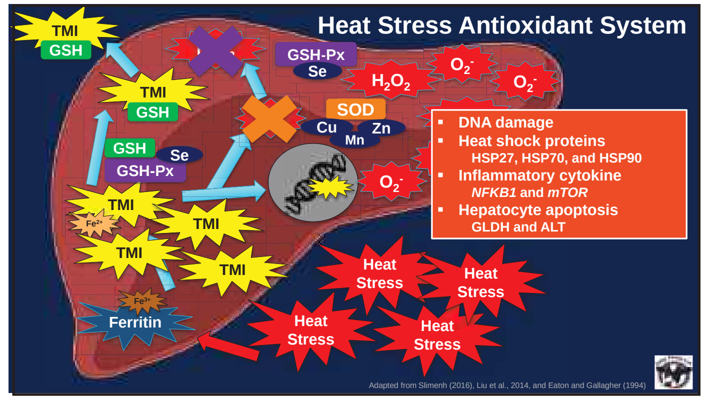

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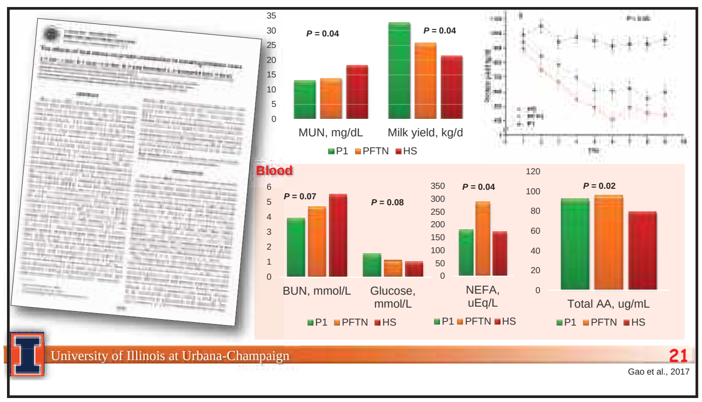

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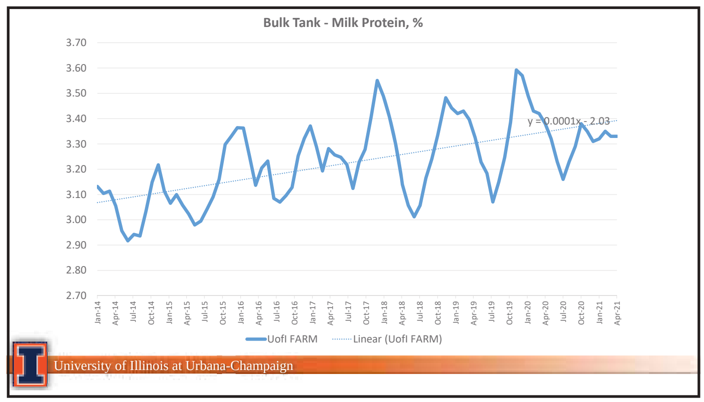

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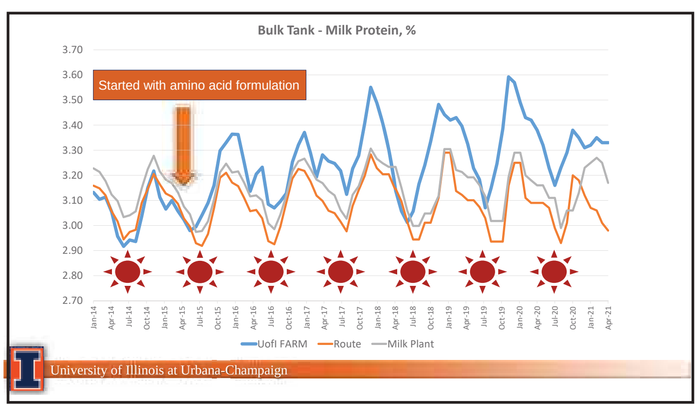

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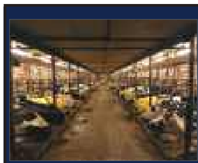

Materials and Methods

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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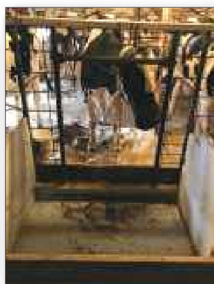
Environmental Treatment: **Pair-Fed Thermoneutral**



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Pate et al., 2020

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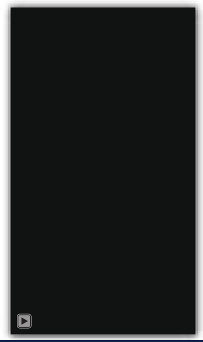
Heat Stress Challenge



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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Pate et al., 2020

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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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Pate et al., 2020

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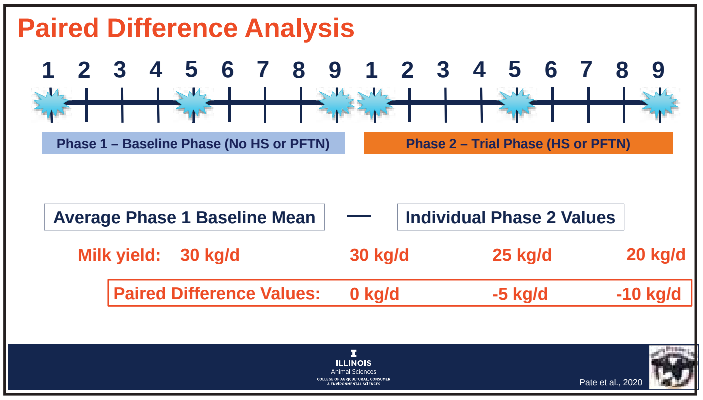

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Diet Formulation	
Ingredient	% of DM
Corn silage	40.9
Dry ground corn grain	17.7
Alfalfa silage	12.3
Corn gluten feed pellets	8.4
Alfalfa hay	6.3
Grain and mineral mix	6.7
Soybean meal RUP source	3.4
Molasses	3.3
Canola meal	1.7
Rumen protected lysine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

32

Item	RPM	CON
CP, % of DM	16.08	16.02
Met as % of MP	2.57	2.03
Met g/Mcal ME	1.09	0.85
Lys as % of MP	7.01	7.05
Lys g/Mcal ME	2.96	2.97
Lys to Met Ratio	2.73	3.47

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AMTS.Cattle.Pro version 4.7

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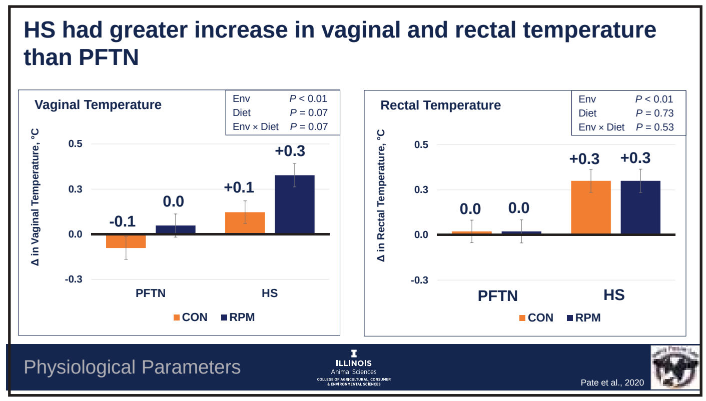

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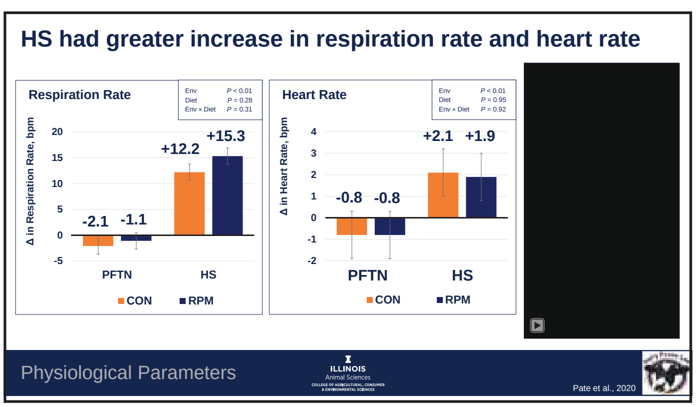

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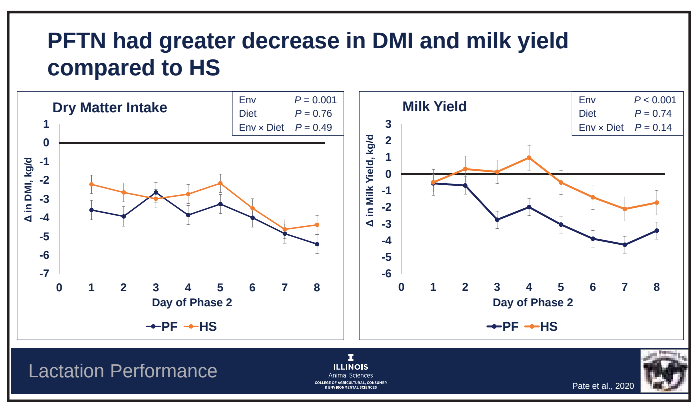

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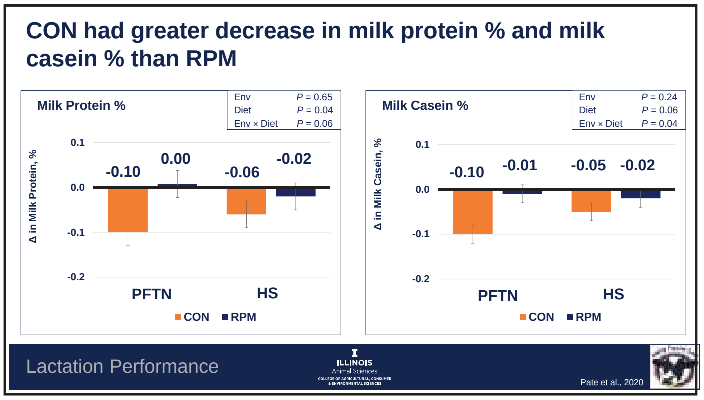

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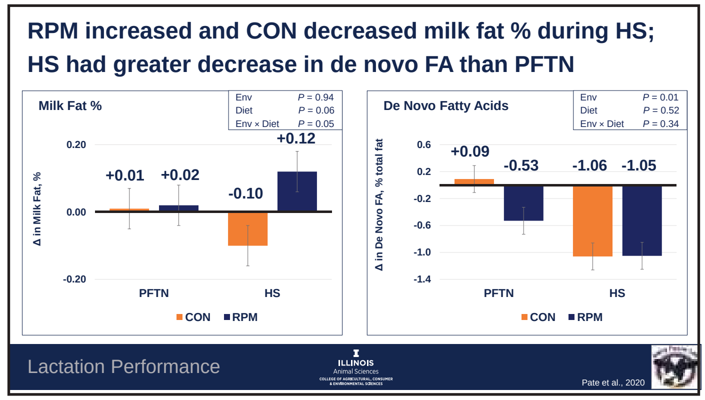

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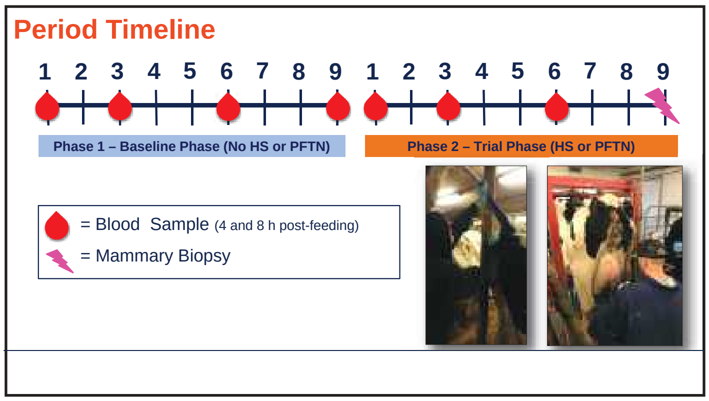

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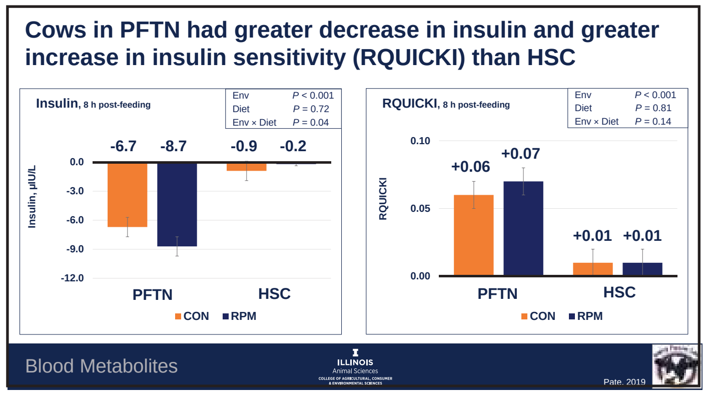

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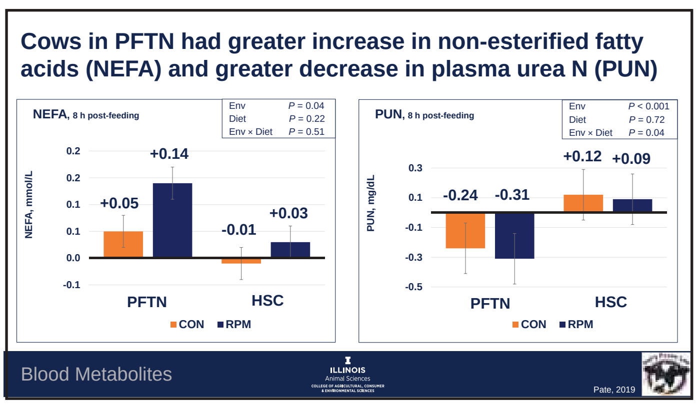

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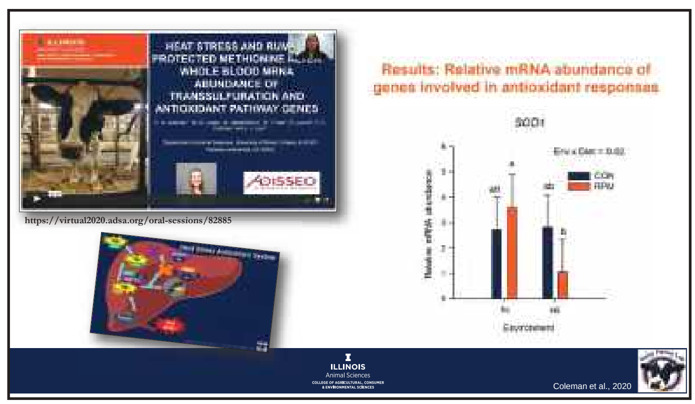

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From these studies:

Feeding RPM did not alter physiological parameters, but had a positive impact on lactation performance during a HS challenge

HS challenge caused marked changes in metabolism and immune system of dairy cows; while RPM improved mammary cellular protection capacity

Feeding RPM during heat stress may also help cows maintain their hepatic homeostasis and may enhance the antioxidant response

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Summary

- There is no dietary magic pill
  - Minerals
    - K, Na, Mg (DCAD)
    - Se (GP_X)
  - Amino acids
    - Methionine

Improve cow's ability to maintain or recover homeostasis

- Heat stress abatement (shade, soakers, fans, etc.) should be the primary strategy!

University of Illinois at Urbana-Champaign 45

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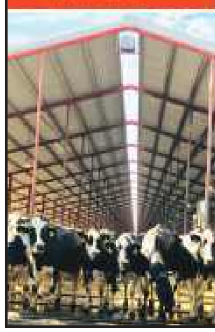
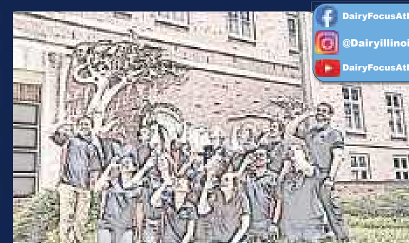
ILLINOIS Animal Sciences

THANK YOU!





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@DairyIllinois
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cardoso2@Illinois.edu

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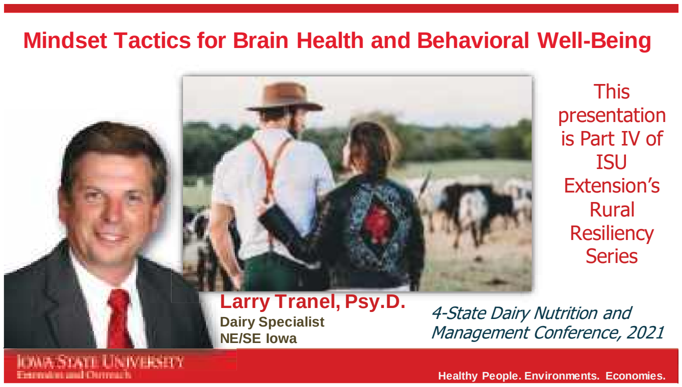
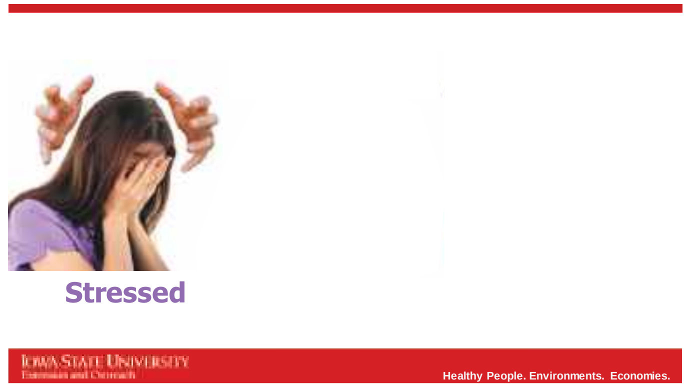
Four-State Dairy Nutrition & Management Conference

Mindset Tactics for Brain Health and Behavioral Well-Being

Larry Tranel, Psy.D.
Dairy Specialist
Iowa State University


Mindset Tactics for Brain Health and Behavioral Well-Being
This presentation is Part IV of ISU Extension's Rural Resiliency Series
Larry Tranel, Psy.D.
Dairy Specialist
NE/SE Iowa
4-State Dairy Nutrition and Management Conference, 2021
IOWA STATE UNIVERSITY
Extension and Outreach
Healthy People. Environments. Economies.

1


Stressed
IOWA STATE UNIVERSITY
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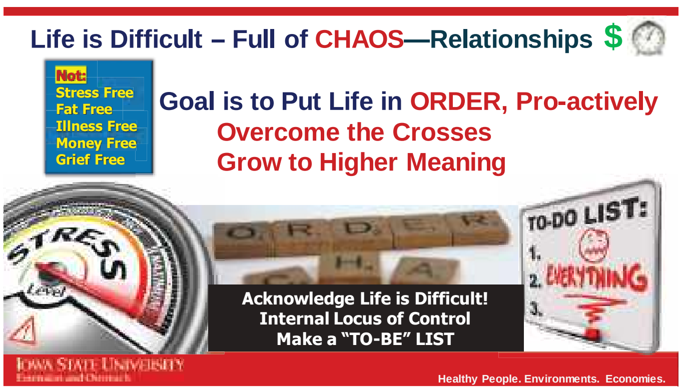
2


Life is Difficult – Full of CHAOS—Relationships $
Not:
Stress Free
Fat Free
Illness Free
Money Free
Grief Free
Goal is to Put Life in ORDER, Pro-actively
Overcome the Crosses
Grow to Higher Meaning
STRESS Level
ORDER
CHAOS
TO-DO LIST:
1.
2. EVERYTHING
3.
Acknowledge Life is Difficult!
Internal Locus of Control
Make a "TO-BE" LIST
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3


Co-VID 19 Changes Social Interactions
← Happy ☺
Forward Looking
Defensive
Protective Mode
Layers of Stress adds to
Stress and Compounds Issue
What is the Emotion Behind the Mask?
Even without COVID, What's behind the mask!
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4


How we think of stress and how we handle stress
is often more important than the stress itself!
30,000 person study
43% increase in dying from stress
BUT only for those reported
being under stress and
thinking stress was bad!
For those who didn't think stress was bad,
there wasn't a difference
Keller, et.al., 2012
Believing that stress is bad for us
has Correlation NOT Causation!
Adaptive Cognition? I-L-O-C?
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5


My Concern:
Farmers think ALL stress is bad maybe
because that's what we tell them
Attention to negativity of stress
might increase emotionality to stress!
Causing MORE STRESS!
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6


Those who think stress is…
BAD
Have increased heart rate
and blood vessel constriction.
GOOD
Still have increased heart rate,
but the blood vessels stay relaxed
just as if experiencing joy and courage
Kelly McGonigal, Stanford University Psychologist
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7


Acknowledging arousal
and performance
"stress" as good
is GOOD!!!
Distress NOT so GOOD!!!
So keep from going there!
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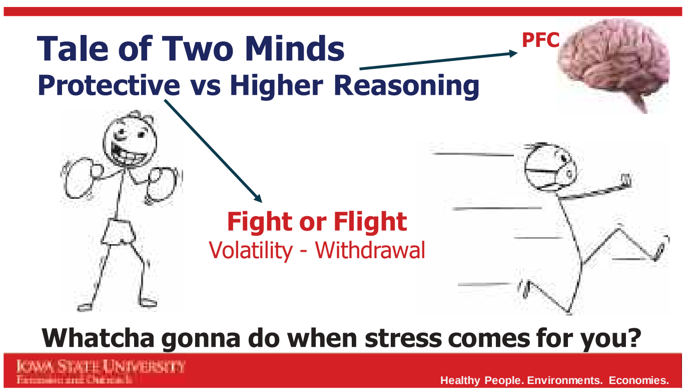
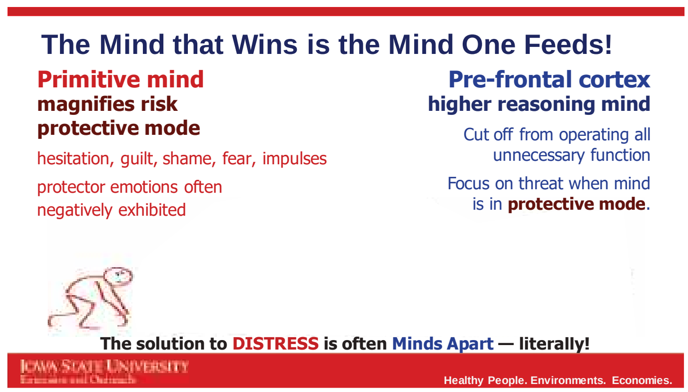

Tale of Two Minds
Protective vs Higher Reasoning
PFC
Fight or Flight
Volatility - Withdrawal
Whatcha gonna do when stress comes for you?
Healthy People. Environments. Economies.

9


The Mind that Wins is the Mind One Feeds!
Primitive mind
magnifies risk
protective mode
hesitation, guilt, shame, fear, impulses
protector emotions often
negatively exhibited
Pre-frontal cortex
higher reasoning mind
Cut off from operating all
unnecessary function
Focus on threat when mind
is in protective mode.
The solution to DISTRESS is often Minds Apart — literally!
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10


Tale of Two Minds
Protective vs Higher Reasoning
Mental or Physical Risk
• instinctively go into protection mode
• focus overwhelmingly on the risks
• refrain from higher purpose reasoning
• often self-defeating our good behaviors
We avoid possible pain much
more than seeking better gain!
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11


How can we use the best of both minds?
A Holstein "Hack" or Jersey "Hijack"
54321 zyxwv
INTERNAL CONFLICT
We can TRICK our protective mind to better deal with STRESS
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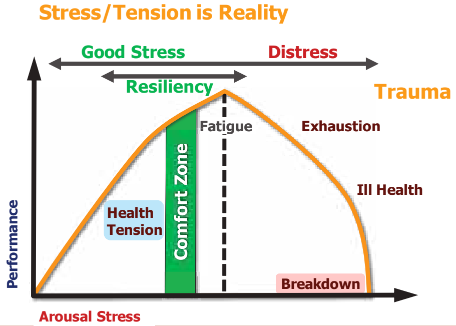
12

Human Function Curve
Dr. Peter Nixon, 1979

Tip
Some Stress is GOOD
TOO Much is NOT!



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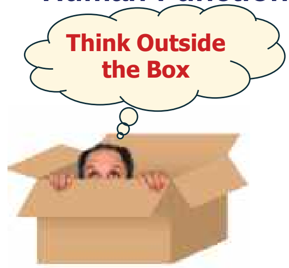
13

Human Function Curve



Goal: optimal human function in comfort zone
- **NOT** at one's highest performance level.
- YES, Can push beyond for higher performance

Cost is often living beyond the margins:
- time, energy, focus **brain health**
- relationships, self-care **behavioral health**

We need to operate INSIDE the Box – WITHIN Margins!

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14

Neuron Code
Change Thought → Code → Emotion +

Families who **reinterpret** initial **negative situations** to more **positive meanings** are more likely to:

- be in control of stressors
- find possible solutions to crisis situations
- adapt well eventually to the crisis

Xu, 2007

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15

Damage of Negative Facials on Brain Health

Disgust **Cortisol Concern Long Term**
- hormone release (cortisol);
- attitude towards source;
and typically - behavior.

Distrust
not trust the markets, system, themselves, spouse, kids, or others to do the right thing.

Frown (scowl)
- difficult planning, - communication,
- relationships; - decision-making.

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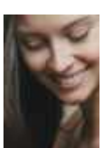
16

Damage of Negative Facials on Brain Health

The Way we **Face** Stress, Can Help us **Better Face** Stress ☺
Larry Tranel

Be like a proton
be positive <u>and</u> smile!



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Damage of Negative Facials on Brain Health

Facial movements had small-to-medium effects on self-reports of happiness, anger, and disgust. APA, Coles et.al. 2019

Be your own scientist:

In your real world, how does a smile impact you compared to a frown?

What do you want to see come in door or in mirror?

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Dr. Larry's "B-S" Minute
Breathe and Smile 😁

1. Lay, recline, sit or stand in a **relaxing position**
2. Eyes open or closed, picture/think **something positive**
3. Breathe in slowly, **fake smiling** as you do so
4. Breathe out slowly, **fake smiling** to the bottom
5. Chuckle (**fake laugh**) at bottom of the breath

Repeat 2 through 6, breathing deeper, smiling wider and chuckling more each time for total of one minute.

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Smiling and laughter has a mimic reflection
it's contagious!


20

Dr. Larry's "B-S" Minute
Breathe and Smile 😁

After doing so, people tend to report:

- Feeling better and **more relaxed/less stressed**
- **Smiling continued** shortly afterwards
- Having **more energy/enthusiasm** afterwards
- Frowning was more difficult shortly afterwards
  if not, try doing the exercise again and try to frown
- Facial Disgust was more difficult shortly afterwards
  If not, try doing the exercise again and show disgust
- Overall **well-being increased** afterwards

21

Dr. Larry's "B-S" Minute
Breathe and Smile 😁

The "B-S Minute"
is anything but BS
it increases serotonin!

22

Standing Tall is "Posturing for Success"

Neurochemistry of victory and defeat (**success** or **failure**) can be **self-promoting** or **self-defeating**, often dependent on one's postural flexion

our posture reaction!

23

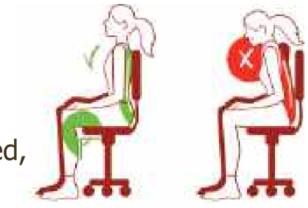
Standing Tall is "Posturing for Success"

Just like smiling increases serotonin, a **"look up and stand tall posture"**, with shoulders back **increases serotonin**.

24

Standing Tall is “Posturing for Success”

Serotonin drops
when feeling defeated,
as one’s posture droops,
look down, feel threatened,
hurt, anxious or weak.



25

Standing Tall is “Posturing for Success”

Want to lower your attitude
and social status?

Lower your posture!

The 2 Minute Power Pose -- Hulk
↑ serotonin/testosterone ↓ cortisol

26

Take Care of Self and Your “Perspective” Situation in Life

Some people…

take better care of their pets,
their crops, their livestock
than care for themselves
(own worse employee/boss).

27

Take Care of Self and Your “Perspective” Situation in Life

Some people…

wallow in self-pity
even when things
are good.

28

Take Care of Self and Your “Perspective” Situation in Life

Some people…

treat others with
more respect
than selves.

Take Care of Self and Your “Perspective” Situation in Life

Some people…

amplify their **suffering** and **stress** for attention or by branding it as injustice (unfair markets, no societal respect)

Take Care of Self and Your "Perspective" Situation in Life

Some people…

refuse to strive to improve (**neutral not good**).

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Take Care of Self and Your "Perspective" Situation in Life

Don't Be These

Some People

as Not Happy ☹

No Matter What!

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32

Desire to Improve Needed for Progress

In order to improve one must:

- Have **desire** to improve or **admit** there is a problem
- **Take responsibility** for one's life or the problem
- **Act** accordingly (difficult in distress)
- Get **help** if needed (pro-active, not passive)

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Desire to Improve Needed for Progress

Neutral is not associated with personal growth or happiness.

Might work harder just to maintain the same level of success.

Just keeping one's life or finances above water +

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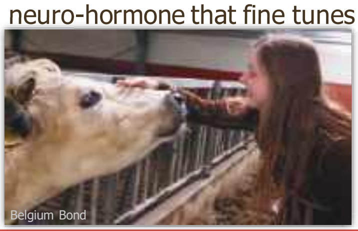
Brain Health Tied to the Heart

Oxytocin, a bonding hormone, or a **"milk letdown"** hormone to some, is a neuro-hormone that fine tunes close relationships, empathy, help and support for people one cares about.



Belgium Bond

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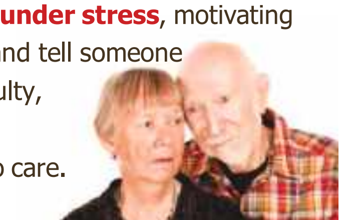
Brain Health Tied to the Heart

Oxytocin – also a stress hormone that pumps out as much as adrenaline when **under stress**, motivating people to **seek support** and tell someone how you feel. Under difficulty, a stress response is being surrounded by people who care.

Psychologist Kelly McGoginal



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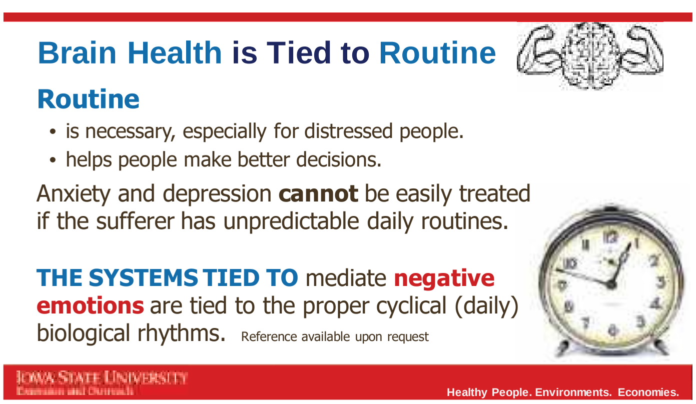

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42

Brain Health is Tied to Gut Health

Behavioral health is a function of gut biochemistry, **heavily impacted by diet**.

Serotonin "Happy Hormone" is 90-95% secreted by the gut, only 5-10% by the brain.

Turn off NEWS while Eating! Mild stress can tip gut microbial balance making one more vulnerable to infectious disease and **negative nervous system feedback**.

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Brain Health is Tied to Gut Health

Know Your **"Gut Feeling"** is **Cooperating with Your Brain!**

regulating mood and cognition

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Brain Health Tied to Added Sugars & Processed Carbs

The **sugar** we eat **in 7 hours** is what a person in 1822 ate **in 5 days!**

3x2Much!

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45

Brain Health Tied to Added Sugars & Processed Carbs

Much like cocaine, **sugar is addictive**, as the brain then releases dopamine, creating more receptors for dopamine, thus craving it even more.

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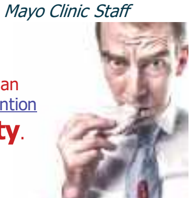
Brain Health Tied to Added Sugars & Processed Carbs

Common Fact: Extra sugar **spikes insulin levels**.

Insulin and weight gain often go hand in hand, Mayo Clinic Staff



Your Brain on Sugar

It's pretty clear excessive glucose in the form of refined sugar can be very detrimental to your brain, ultimately affecting your attention span, your short-term memory, and your **mood stability**.

***Teresa Aubele, Ph.D.**, is a coauthor of Train Your Brain to Get Happy. Neuroscientific researcher at Florida State University.*

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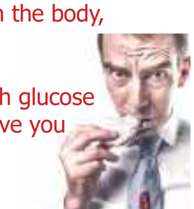
Brain Health Tied to Added Sugars & Processed Carbs

High glucose levels resulting from quick, easy sugar intake slowly but surely damage cells everywhere in the body, **especially those in the brain**.

Salk Institute in California Research



Having too little glucose and having too much glucose are both problematic. Either extreme can leave you feeling woozy, nervous, fatigued, and shaky.

***Teresa Aubele, Ph.D.**, is a coauthor of Train Your Brain to Get Happy. Neuroscientific researcher at Florida State University.*

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Brain Health Tied to Added Sugars & Processed Carbs

Relative hypoglycemia is one of the most common causes of neuropsychiatric illness, treated by a diet high in protein and fat and low in carbohydrate. Salzer, 1966 (emphasize healthy fat and refined carbohydrate).

Preliminary results of Italian study indicate that perceived work stress can be statistically associated with increased blood glucose. Pub Med.gov A Sancini, et.al, 2017 Alexandria Rowles, RD, 2017 Healthline

49

Brain Health Tied to Added Sugars & Processed Carbs

Distress causes high cortisol release causing **craving** of pleasurable food intake, especially added sugars and unprocessed carbohydrates (turns into simple sugar).

Less sleep can also initiate the **craving**, spiking insulin.

One is often blind to the robber until one is robbed blind - **a sugary truth!**

50

Brain Health Tied to Smart Phone Use?

Dopamine **rewards users** with each like, each post, each search—addictive!

51

Brain Health Tied to Smart Phone Use?

Can be as **addictive** as a slot machine and provide excessive stimulation, increased emotionality, and decreased real social interaction.

Can **move users into distress**, with constant interruptions, notifications, dopamine releases, social stimulations, unending searches and the conjuring of both real and false spectacles of life.

52

Brain Health Tied to Smart Phone Use?

The natural rhythms of the brain are interrupted, **every 6-12 minutes** for most people with many struggling to go even 10 minutes without phone.

One often blind to the robber until one is robbed blind **- a smartphone truth!**

53

Brain Health Tied to Smart Phone Use?

Those constantly **"connected"** are:

- more stressed
- feel lonelier
- are more likely to experience depression or a sleep disorder.

Pew Research – U of Missouri 2015

54

Brief Health Tied to Smart Phone Use?

Regular use of social media increased the likelihood of **envy and depression**.

Smartphone overuse **can reduce performance, social interaction, sleep, and mental health** by increasing stress, anxiety, depression, envy, other - mindsets.

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Brain Health Tied to Smart Phone Use?

Using phone to get a **"feel-good" dopamine response**, needing more of it each time to get the same level of response, then finding it just isn't there, **can end in negative emotion**, anxiety, depression, and false reality

Don't Let Family Relationships Hide Behind Screens!

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Smart Phones Need Scheduled Time Off

Disable notifications stealing attention from real moments at hand.

Detox phrase: Family B4 Phone!

Smart Phones Need Their Places

The blue light inhibits melatonin, reducing both quality and quantity of sleep.

Detox Phrase: Out of sight, out of mind!

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Smart Phones are Secondary to Relationships

Raw dopamine and spontaneous conversation is changing in households, classrooms and on the farm.

Detox Phrase: Get Dopamine Raw - Face to Face!

Being Bored is more important than checking this every 5 minutes?

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Maintain Sense of Aim, Direction and Control

Farm distress is experienced when one senses loss

loss of direction, control, finances, way of life, farm and family dreams, hope for future, security of family, one's position/lot in life, or when tragedy strikes.

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Maintain Sense of Aim, Direction and Control

People that have a larger **WHY** in life (virtues in something larger than self), seem to deal with problems in a **healthy, proactive way**.

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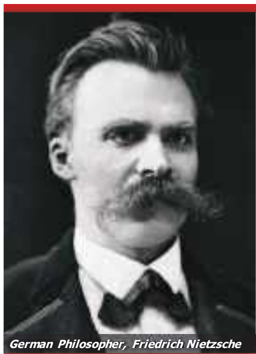

"He whose life has a
WHY
can bear almost any
HOW."

Know your **WHY**,
Don't lose your **WHY**,
your **Hope in Life**

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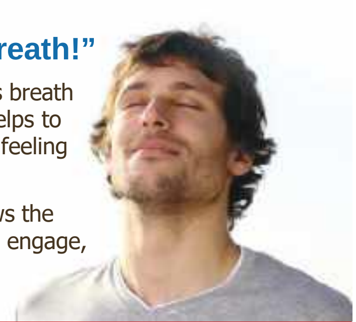
Behavioral Health
Simply Hold Your Breath!"



Research shows holding one's breath for 15 seconds significantly helps to **"purge the urge"** to let the feeling pass and not act on it..

This 15 second breather allows the **brain's logic connection** to engage, giving logic in time to "purge the urge."

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When experiencing failure, research shows don't be too hard by guilt or shame as it increases anxiety, keeping one's mind stuck in impulse mode, and **actually encourages the behavior to continue**

Hold breath
Stare at that sweet snack!
Let the urge pass!

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Behavioral Health Tied to Communication Skill

1. Others do not always think and feel the same way
2. Others may have different values, right or wrong
3. If glued to a point of view, it is difficult to see other's view
4. Anger can skew a person's point of view
5. Positive Feelings change a person's reality

Primitive Mind Focus on Ego-Protective Self
What is Best for Good of All?

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Behavioral Health Tied to Communication Skill

6. Negative feelings change another person's reality
7. When distressed, expressions of care and empathy are often not as effective and genuine
8. Active listening does not guarantee the message was received correctly
9. Emotions transfer quickly to others
10. Judging other's emotions/intentions is often a faulty judgement

Skill:
Think good, well-wishing thoughts to those you meet = ↑ joy

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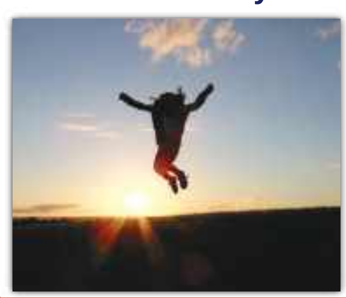
Mindset Tactics to Increase Resiliency

Loss can build a Cross
resurrect us to newer life

Pain can turn to Gain
moving onward/upward

Stress can turn to Best
helps motivate us

Grieve to Believe
in love of what was lost



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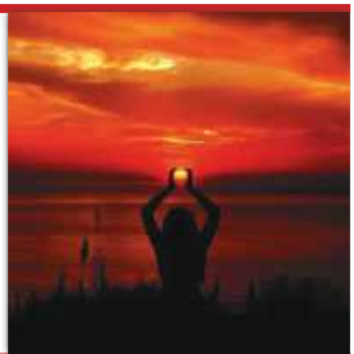
Phrase of the Week
Smile 😁 Be Happy

Words of the Year
Breathe/Relax/Stand Tall

Tip:
Mindset Tactics aim to give inspiration and higher level reasoning.



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Know the Value of "Being" versus Doing "Things"

Moons ago
Life was more about **being** and much less about **things**.

Mindfulness vs Thingsfulness
Make life more about **being** and less about **things**.

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Know the Value of "Being" versus doing "Things"

Time **"to be"** versus time **"to do"** or to **"take care of things"**

Tight margins of **time/energy/attention** focus more on short term **threats and pleasures**, **not long-term vision/happiness**.

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Know the Value of "Being" versus Cost of "Things"

Anxiety or problems with health or relationships can arise as one meanders through chaos in life with less time for **"being"** and more time spent on **"doing things"** or just take care of **"things"**.

Human "Beings"	versus	Human "Doers" or "Tied to Things"

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Be Mindful of Present

Breathe – Smile - Stand Tall

Take Care and Have Respect for Self

Be Proactive and Responsible for Self/Life

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Realize Life's Value Goes Well Beyond the Farm

Leave Pity Parties to Attend to Higher Virtues/Values

Swap Processed Carbs and Added Sugars OUT!

Don't let SCREEN Time deplete DREAM Time

Generosity/Gratitude increased Happy Hormones

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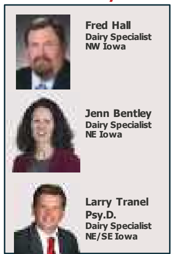
Meditative Prayer: Caring for You and Yours

ISU Extension and Outreach Dairy Team



Help me, _____, to use higher reasoning thoughts,
to better face and manage my emotions,
breathing deeply and smiling widely,
caring in my words and actions,
cautious in what I eat and drink,
exercising to my heart's content,
portraying positive posture, attitude and intent,
keeping my ears to the ground for others,
with my eyes fixed on the bigger horizon,
looking forward and upward for myself,
and for my greater WHY in life. Amen.

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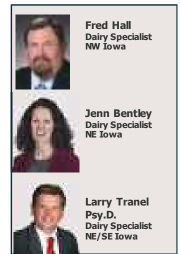
Rural Resiliency: Caring for You and Yours

ISU Extension and Outreach Dairy Team



4 Part Series archived on our Dairy Team Website:

Part I: Farm Stress Resiliency and Grief

Part II: Personality Keys When **"Married"** to Farm Stress

Part III: Stress of **Men, Women, and Kids**

Part IV: Brain and **Behavioral Health** "Hacks" to Mitigate Distress

https://www.extension.iastate.edu/dairyteam/stressresiliency

Contact: tranel@iastate.edu or 563-583-6496

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Four-State Dairy Nutrition & Management Conference

Hypocalcemia can be Reduced. Steps That We Know will Work

Jesse Goff, DVM, PhD
Iowa State University
College of Veterinary Medicine

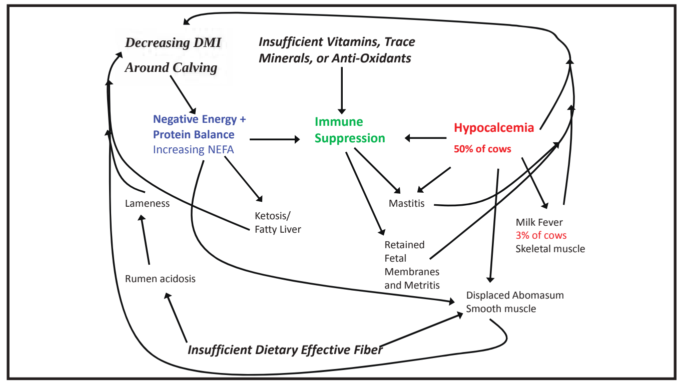
"Hypocalcemia can be Reduced. Steps That We Know will Work"

Jesse Goff, DVM, PhD

Iowa State University

College of Veterinary Medicine

1



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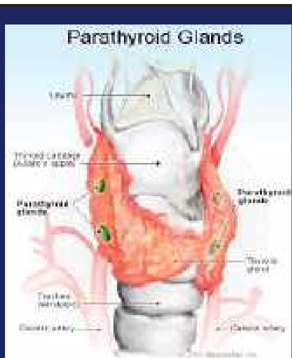


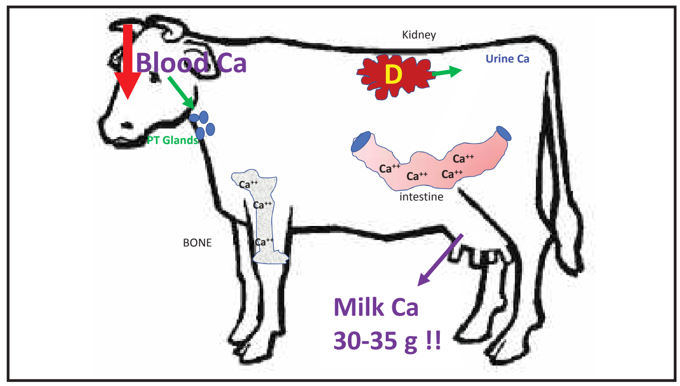
Parathyroid Glands located in neck

Monitor Ca concentration in branch of carotid artery.

Any decrease in Ca concentration causes rapid secretion of parathyroid hormone (PTH)

.

3



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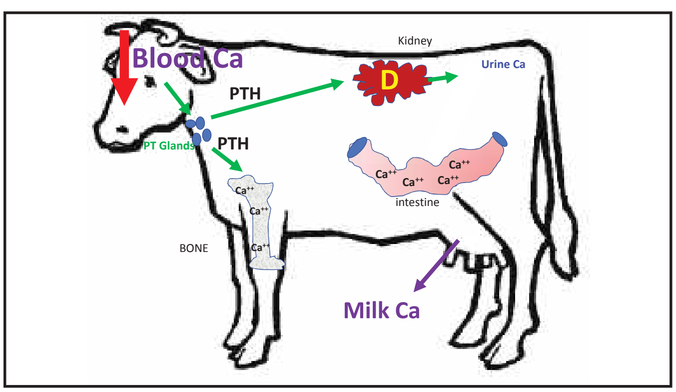

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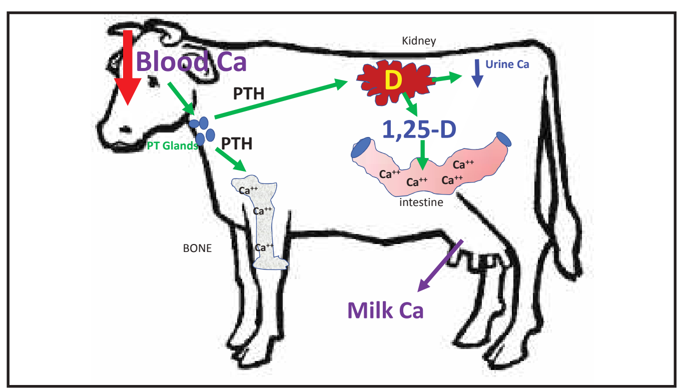

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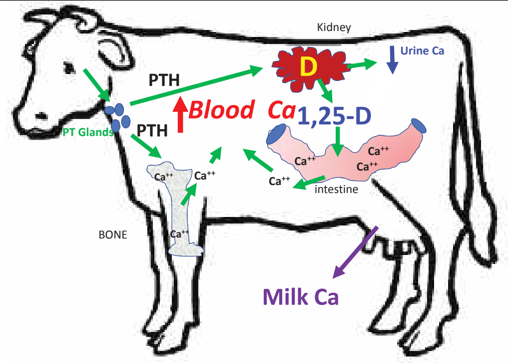


7

Why doesn't Ca Homeostasis work for all cows???

Aged cows lose vitamin D receptors in intestine

Aged cows have fewer sites of active bone resorption (fewer osteoclasts) capable of responding to PTH rapidly

BLOOD pH AFFECTS TISSUE RESPONSIVENESS TO PTH!

8

Blood pH is dependent on Diet Cation –Anion Difference

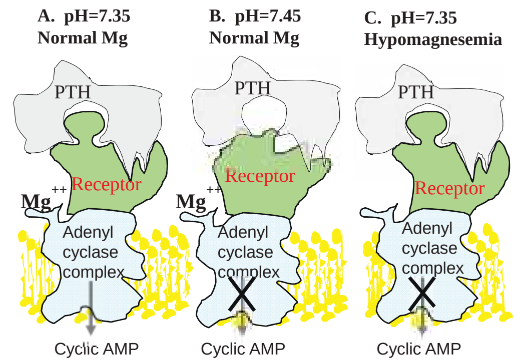
DCAD = (mEq Na^+ + mEq K^+)- (mEq Cl^- + mEq SO^{-2}_4)

High DCAD diets, where K and Na are in much greater concentration than Cl or SO_4 cause Alkalosis & milk fever

Cations (+) ***absorbed*** from forages and diet cause the blood and urine of the cow to become alkaline

Anions (-) ***absorbed*** from forages and diet cause the blood and urine of the cow to become acidic

9



10

Milk Fever & Hypocalcemia Prevention

1. **Avoid very high potassium forages for close-up cows so they are not highly alkalinized;**

Practiced by many dairies in US.

11

Low K Forages

Use forage from fields with no manure application

Warm season grasses (corn!) accumulate less K than cool season grasses

As plants mature they contain lower K concentration (wheat straw! Maybe NOT oat straw)

12

2

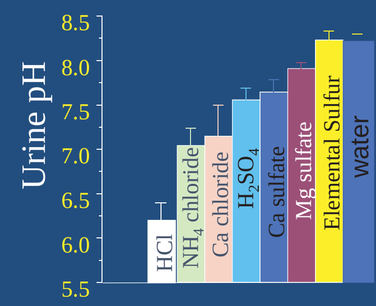
Milk Fever & Hypocalcemia Prevention

1. Avoid very high potassium forages for close-up cows; practiced by most dairies in US.
2. **Add anions (Cl or Sulfate) to diet to reduce blood and urine pH and improve tissue ability to respond to PTH!.**

Choosing the right anion sources

13

2 Eq of each anion source fed



Goff, et al 2006

14

Milk Fever & Hypocalcemia Prevention

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Choosing the right anion sources

Palatability Issues

Over and under acidification

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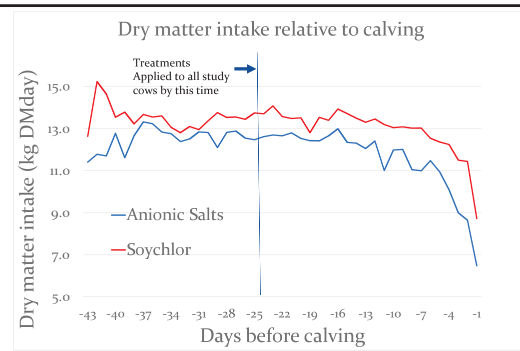

Strydom & Swiegart, 2016 ADSA

16

Milk Fever & Hypocalcemia Prevention

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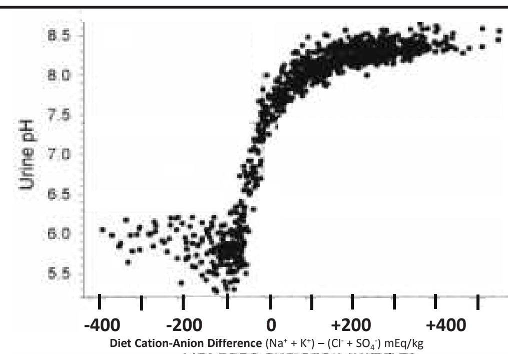
Choosing the right anion sources

Palatability Issues

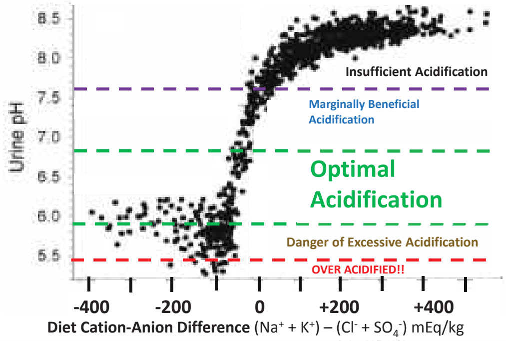
Over and under acidification

17



Adapted from Constable et al., 2017; Spanghero, 2004; and Charbonneau et al., 2006

18



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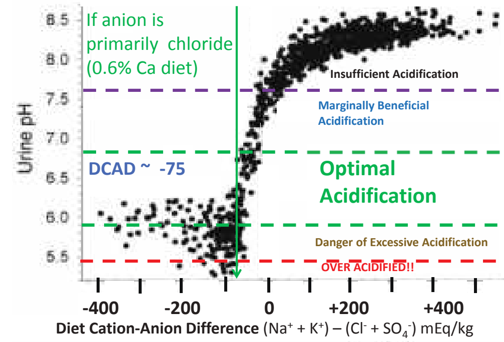
19



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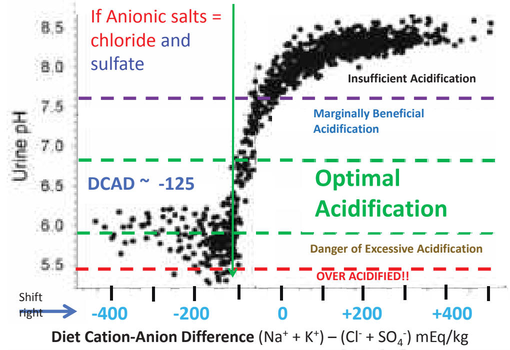
DCAD Equations

1. Traditional equation (Na + K) – (Cl + S)

   Does not account for fact S is not as acidifying as Cl

2. (Na + K) – (Cl + 0.6 S) may be more biologically correct!!!
   - **which means mathematically you need to feed a more negative diet on paper when using the sulfate salts to acidify**

21

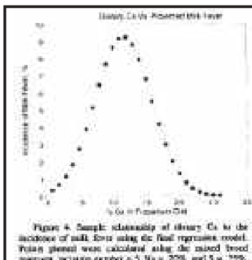


Adapted from Constable et al., 2017; Spanghero, 2004; and Charbonneau et al., 2006

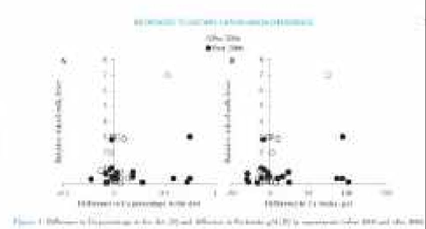
22

How much Ca should I feed with a low DCAD diet???

23



Oetzel, 2006



Lean et al 2018

Santos et al., 2019

24

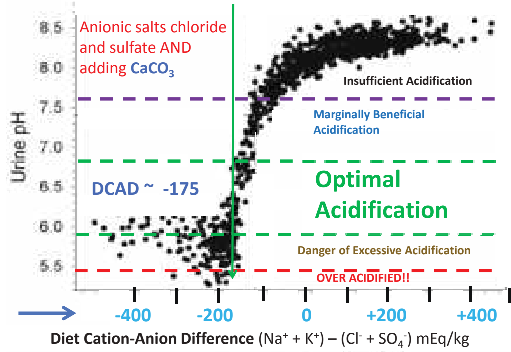
DCAD Equations

1. Traditional equation (Na + K) – (Cl + S)

   Does not account for fact S is not as acidifying as Cl

2. Better !! (Na + K) – (Cl + 0.6 S)
   - but does not account for alkalinizing effect of diet Ca^{++} coming from Calcium carbonate/ Limestone

25



Adapted from Constable et al., 2017; Spanghero, 2004; and Charbonneau et al., 2006

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Impact of Reducing DCAD on health and milk production

Lean et al., 2019. Meta-analysis indicates significant beneficial effects (P<0.02) on:

Milk Fever, Blood Ca (the day of calving and "postpartum"), Retained Placenta, Metritis, and risk of Multiple Health Events

But not on Mastitis (P=0.63) and LDA (P= 0.73)

Milk Production – Multiparous → + 1.1 kg/day
Nulliparous → - 1.28 kg/day

Santos et al., 2019 reducing DCAD from +200 to -100
Multiparous → 1.7 kg more milk / day (+1 kg DMI/d)
Nulliparous → 1.4 kg less milk / day

27

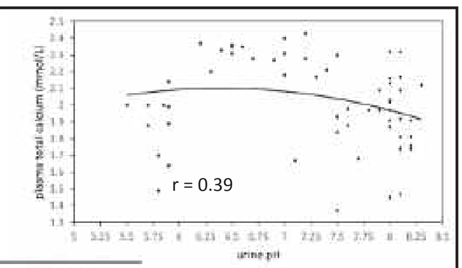
Mecitoglu et al., 2016

Fed 115 cows anionic salts and had 13 cows (11%) develop LDA. Found cows with LDA had lower prepartum urine pH than non-LDA cows. Concluded that urine pH below 6.0 increased likelihood of a cow developing a LDA.

Table-1. Mean (± SE) urine pH, serum ionized Calcium (mmol/L) and blood pH for LDA and healthy groups

	LDA Group	Healthy Group	P value
Urine pH	6.11 ± 0.2	6.65 ± 0.1	P < 0.05
Serum iCa^{++}	1.39 ± 0.01	1.36 ± 0.01	Not significant
Blood pH	7.27 ± 0.01	7.32 ± 0.01	P < 0.05

28

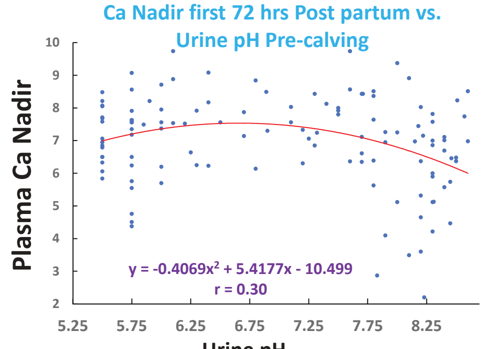


Urine pH	Stillborn %
<6.0 (n = 22)	13.6[a] (3/22)
6.0–7.0 (n = 46)	8.7[ab] (4/46)
>7.0 (n = 135)	4.4[b] (6/135)

Melendez et al., Animal:2021

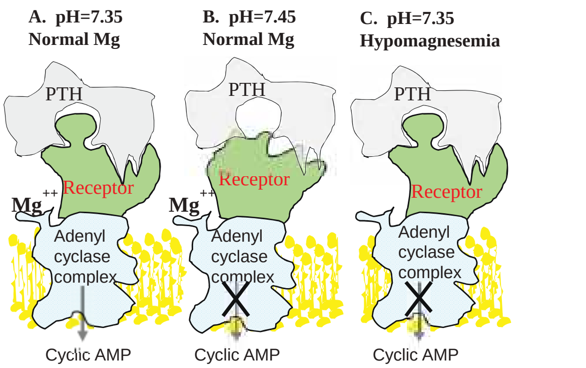
29

Ca Nadir first 72 hrs Post partum vs. Urine pH Pre-calving



Goff, Unpublished data

30



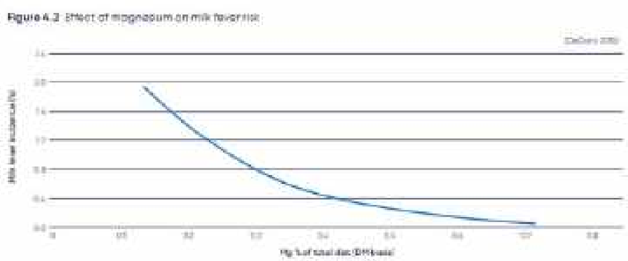
31

Milk Fever & Hypocalcemia Prevention

1. Avoid very high potassium forages for close-up cows; practiced by most dairies in US.
2. Add anions (Cl or Sulfate) to diet to reduce blood and urine pH; various forms practiced.
3. **Diet Mg ~ 0.4% and Diet P < 0.35%, better below 0.25%**

32

Increasing diet magnesium pre-calving reduces the risk of milk fever.



33

Magnesium sources

Pre-calving

- using $MgSO_4$ or $MgCl_2$ as "anions" also supplies readily available, soluble Mg.

-The better anion supplements on the market include Mg in this form to remove Mg worries pre-calving.

Post-calving is the bigger issue!!!!!!
Magnesium Oxide – supplies Mg and acts as rumen alkalinizer.

MgO must be available for absorption by rumen wall!!!!

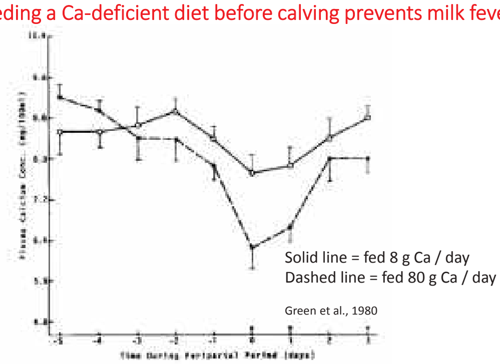
34

Milk Fever/ Hypocalcemia Prevention Strategies

1. Avoid high potassium forages for close-up cows so cows are less alkaline
2. Add anions (Cl or Sulfate) to diet to reduce blood (and urine) pH.
3. Diet Mg ~ 0.4% , Diet P <0.35%!
4. ***Reduce diet Ca to stimulate parathyroid hormone release well before calving.***

35

Feeding a Ca-deficient diet before calving prevents milk fever!!



36

Milk Fever Prevention Strategies

1. Avoid high potassium forages for close-up cows so cows are less alkaline
2. Add anions (Cl or Sulfate) to diet to reduce blood (and urine) pH.
3. Diet Mg = 0.4% must be available to cow
4. ***Reduce diet Ca to stimulate parathyroid hormone release well before calving.***
   Zeolite may make it realistic to achieve
5. Oral calcium therapies (IV Ca?)

37

Zeolite A (Thilsing-Hansen, et al. 2001)

In a test tube the sodium aluminosilicate can bind 1 g of Ca for every 10 g zeolite.

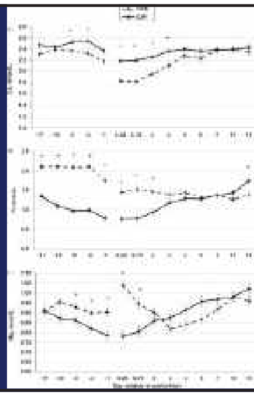
Seems to bind phosphate and magnesium as well. Trace minerals?? Transient reduction blood Mg and Phos.

38

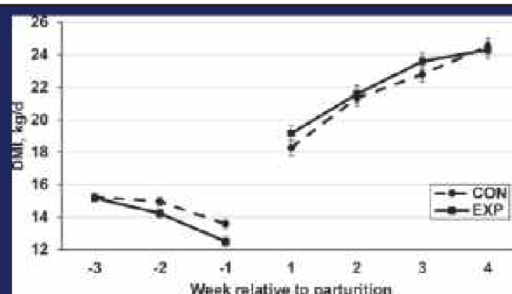
Kerwin et al., 2019

Added 0.5 kg zeolite to a diet that was :

0.65 % Ca ,
0.39% Phos,
0.42% Mg
DCAD of + 268 mEq/kg



39



DMI Treatment X week P= 0.04
Rumination rate significantly decreased with zeolite prepartum.P=0.03

40

Milk Fever & Hypocalcemia Prevention

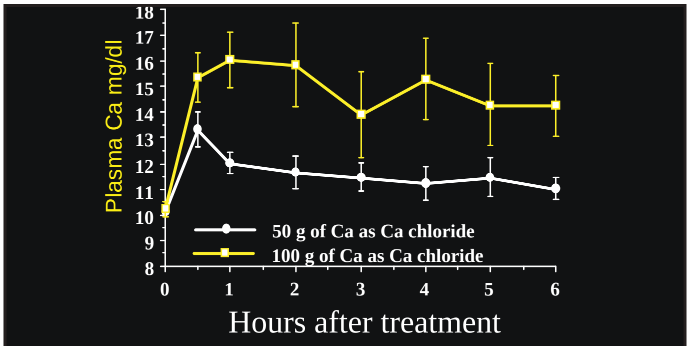
1. Avoid very high potassium forages for close-up cows; practiced by most dairies in US.
2. Add anions (Cl or Sulfate) to diet to reduce blood and urine pH; various forms practiced.
3. Diet Mg ~ 0.4% , Diet P < 0.35%
4. Reduce diet Ca to stimulate parathyroid hormone release well before calving. Zeolite?
5. **Vitamin D administration – too dangerous at effective doses**

41

Milk Fever & Hypocalcemia Prevention

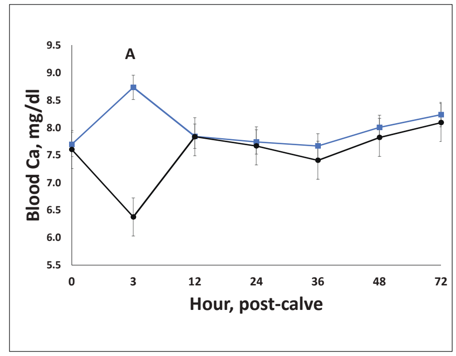
1. Avoid very high potassium forages for close-up cows; practiced by most dairies in US.
2. Add anions (Cl or Sulfate) to diet to reduce blood and urine pH; various forms practiced.
3. Diet Mg ~ 0.4% , Diet P < 0.35%
4. Reduce diet Ca to stimulate parathyroid hormone release well before calving. Zeolite?
5. Vitamin D administration – too dangerous at effective doses
6. **Oral Calcium drench, bolus, gels.**
7. **IV calcium to each cow??**

42



Goff et al., 1993. J. Dairy Sci

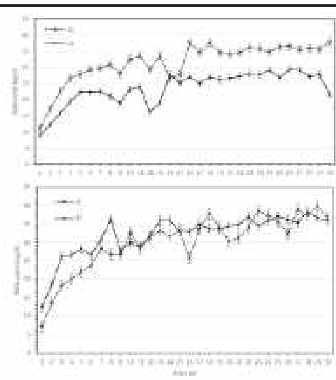
43



44

Melendez et al., 2021
Livestock Sci

Oral Ca boluses at calving and 24 hrs improved milk production in 3+ lactation cows but not in 2[nd] lactation cows fed a partially acidifying diet



45

Roberts, et. al. N Zeal Vet J 2018

First Ca bolus (41 g Ca) at 1[st] milking
Urine collected 12 hours after calving

5/13 (41%) treated cows had urine pH <7

0/12 (0%) control cows (p<0.001)

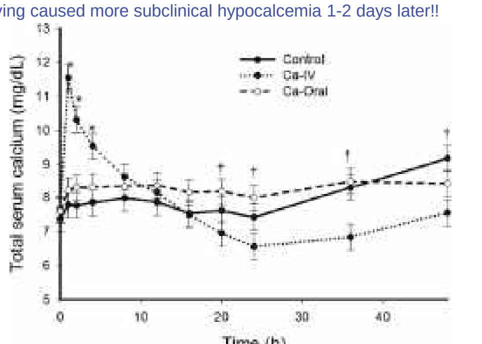
Second bolus given ~12 hrs after calving
24 hr Urine

13/13 (100%) treated cows had urine pH <7

0/12 (0%) control cows (p<0.001).

46

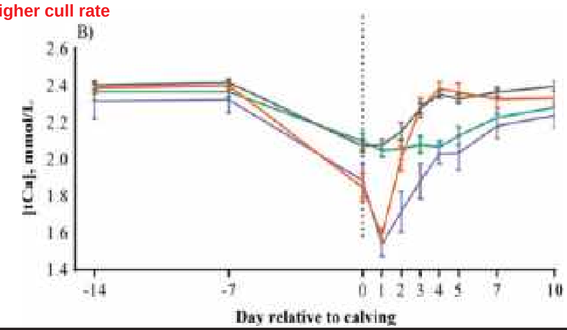
IV Calcium at calving caused more subclinical hypocalcemia 1-2 days later!!



Blanc et al., JDS 2014

47

McArt et al., 2020 J D S Transient hypocalcemia (red) associated with higher milk production. Persistent hypocalcemia (purple) associated with higher cull rate



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Four-State Dairy Nutrition & Management Conference

Perturbations in Calcium Around Calving

Dr. Laura Hernandez
University of Wisconsin

Department of Animal & Dairy Sciences
UNIVERSITY OF WISCONSIN-MADISON

Perturbations in Calcium Around Calving

Laura L. Hernandez, Ph.D., Department of Animal and Dairy Sciences

1

Calcium loss associated with pregnancy and lactation

• Growing Fetus ⇨	3-6 g/d
• Colostrum ⇨	~ 23 g/d
• Early Milk ⇨	30-50 g/d
• Peak Milk ⇨	~ 80 g/d

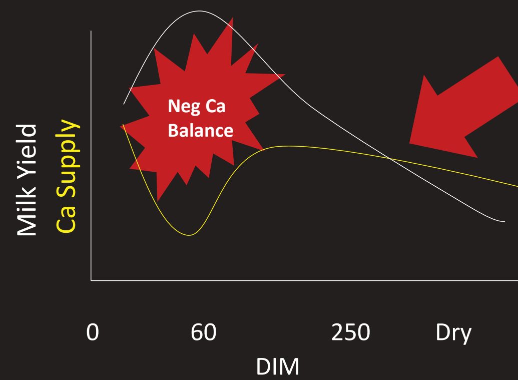
5 g

⇨

80 g

2

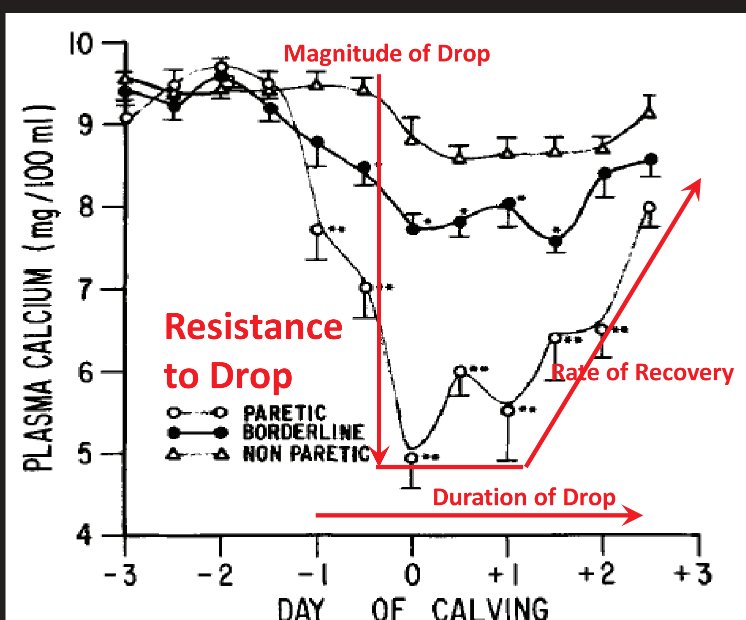
Skeletal Ca is required → 7.8 – 8.5 kg



Dietary Ca solely meets fetal and maintenance requirements

3

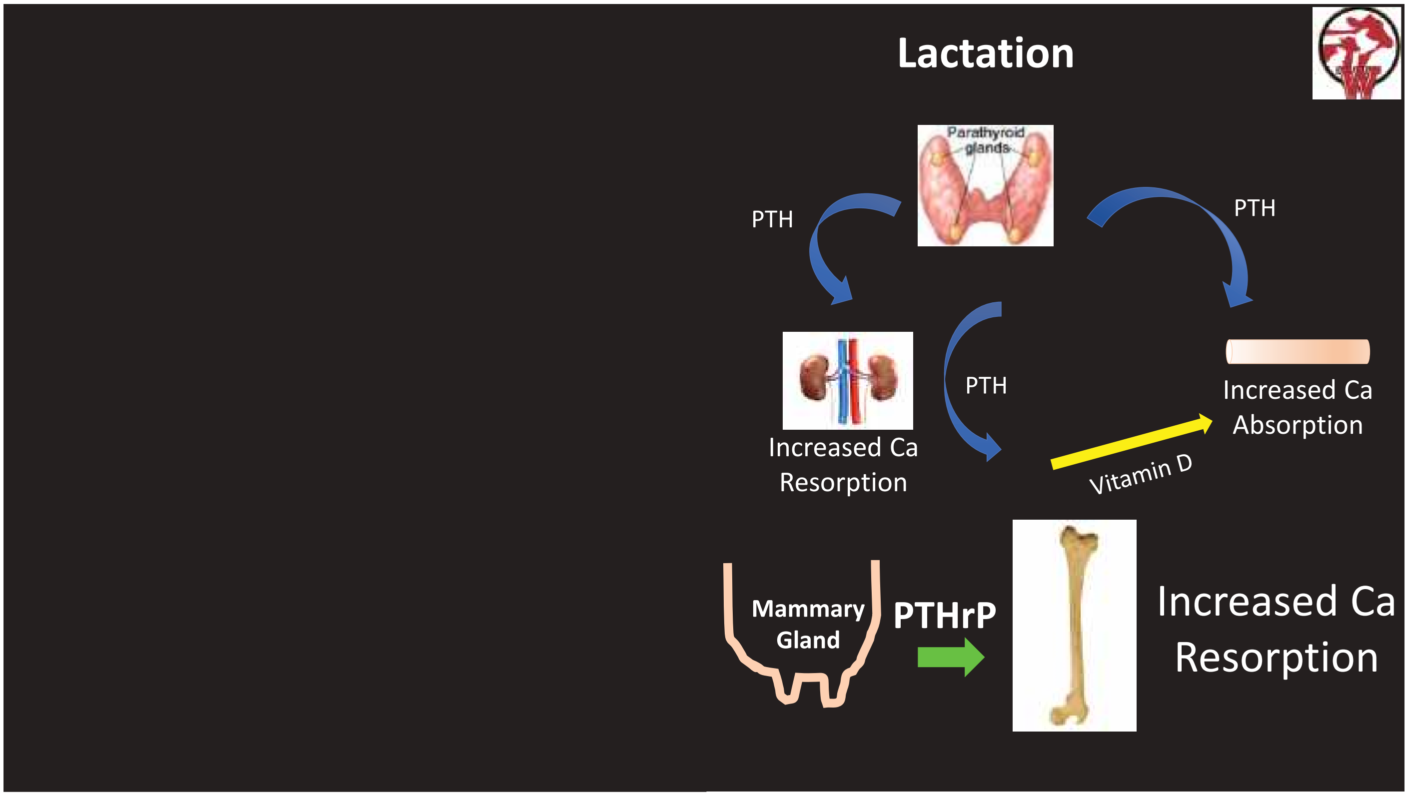
Calcium Status of Periparturient Dairy Cows based on Serum Calcium Concentrations



- Several factors contribute to regulating calcium homeostasis:
  - *Resistance to Drop*
  - *Magnitude of Drop*
  - *Duration of Drop*
  - *Rate of Recovery*

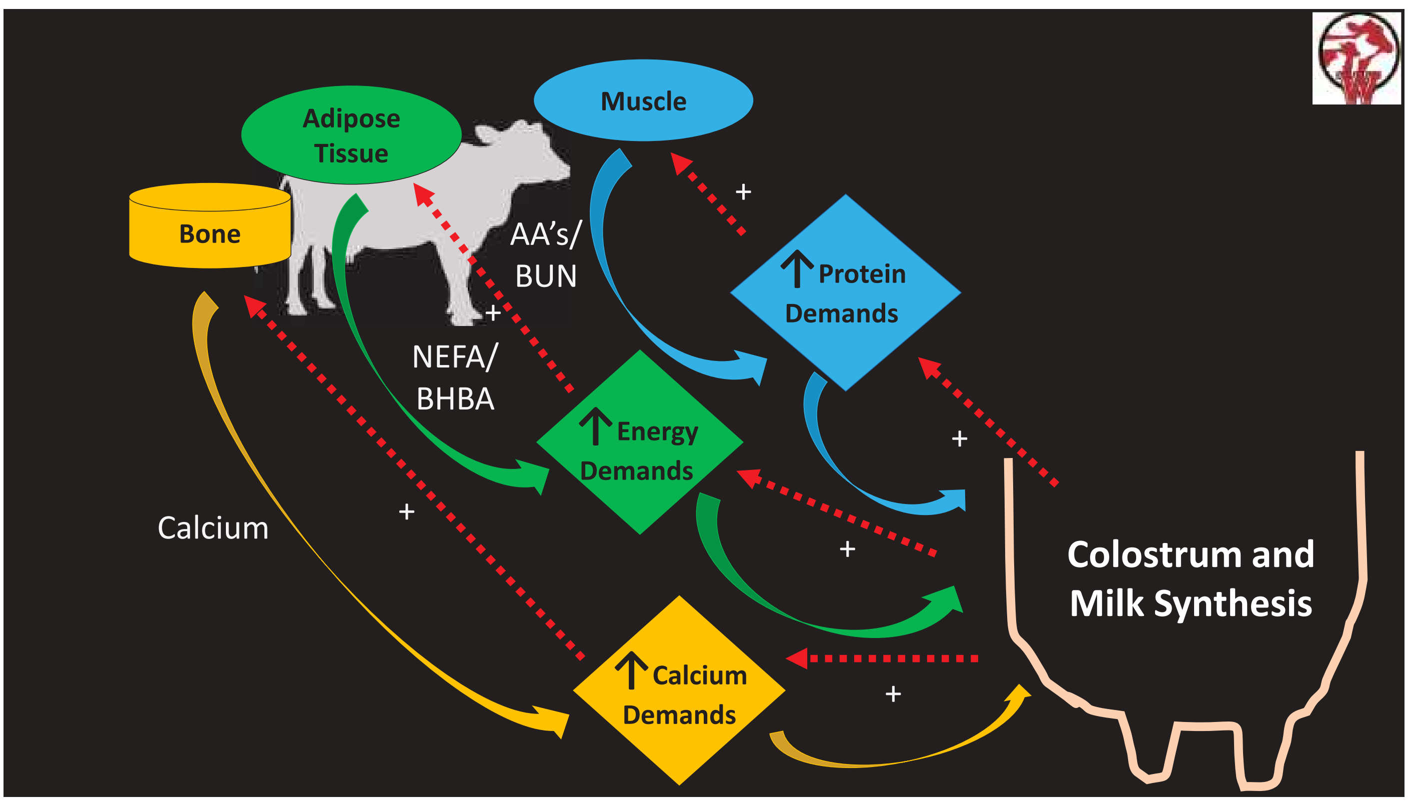
Horst and Jorgensen, 1982

4



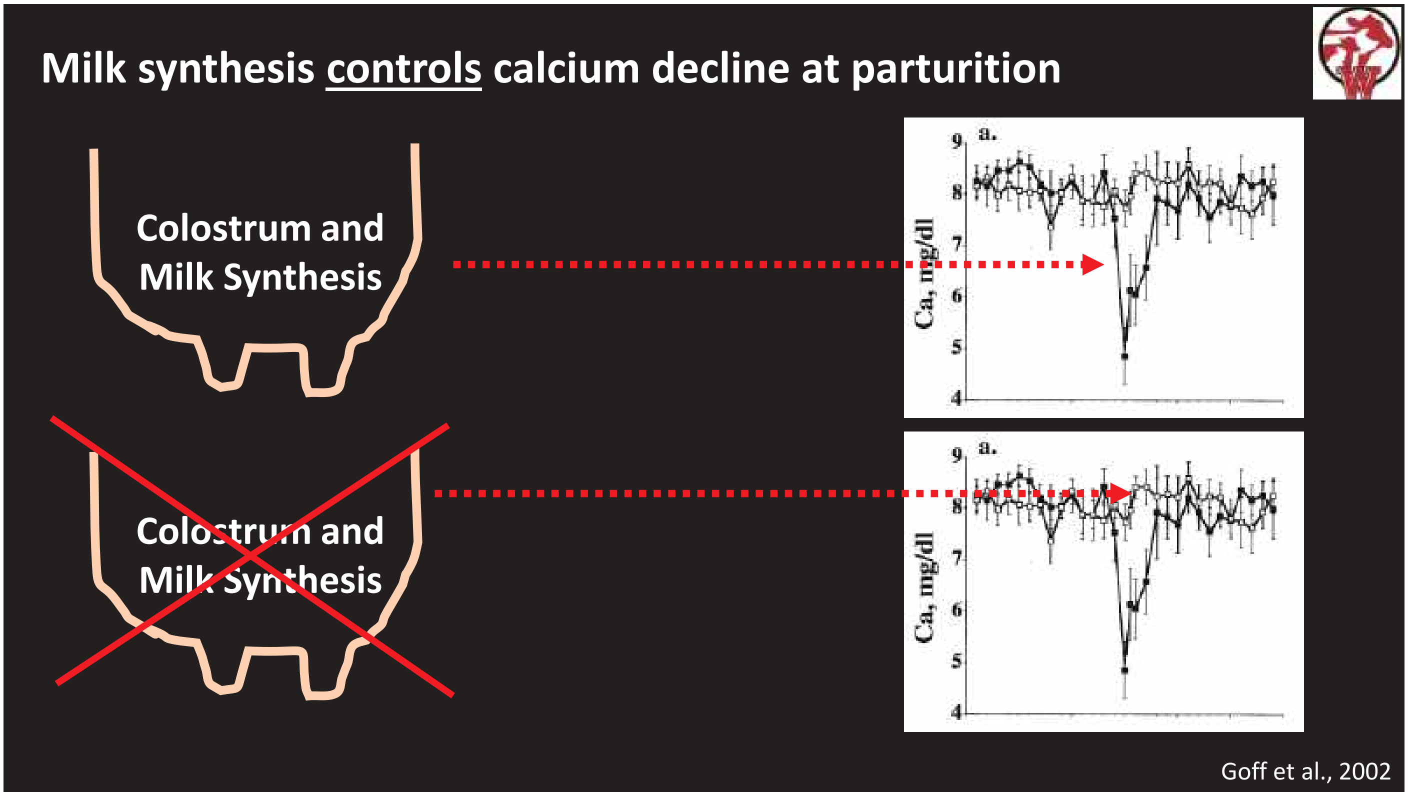
Lactation
Parathyroid glands
PTH
PTH
PTH
Increased Ca Resorption
Increased Ca Absorption
Vitamin D
Mammary Gland
PTHrP
Increased Ca Resorption

5



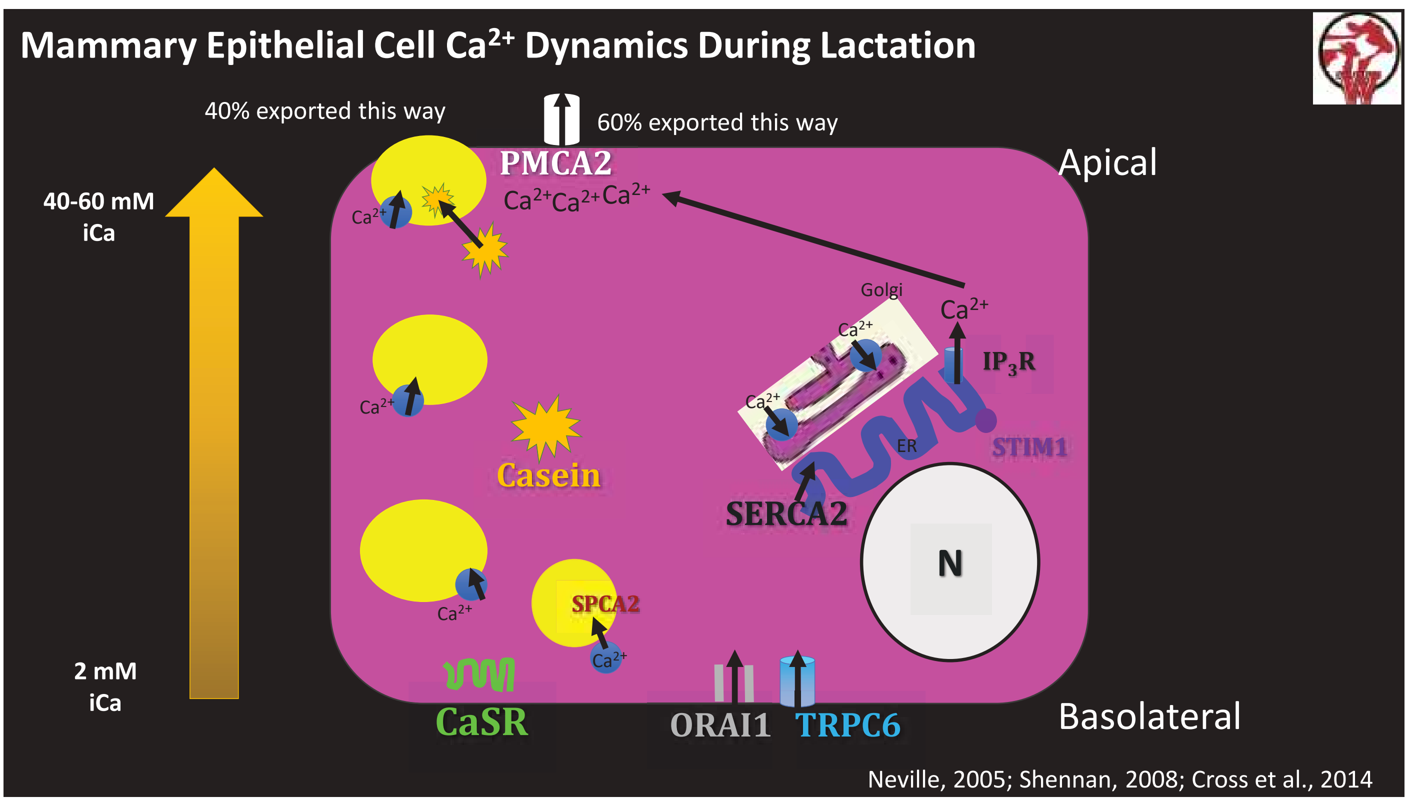
Adipose Tissue
Muscle
Bone
AA's/ BUN
NEFA/ BHBA
+
+
↑ Protein Demands
↑ Energy Demands
+
+
Calcium
+
↑ Calcium Demands
+
Colostrum and Milk Synthesis

6



Milk synthesis controls calcium decline at parturition
Colostrum and
Milk Synthesis
Colostrum and
Milk Synthesis
Ca, mg/dl
a.
Ca, mg/dl
a.
Goff et al., 2002

7



Mammary Epithelial Cell Ca2+ Dynamics During Lactation
40% exported this way
60% exported this way
PMCA2
Ca2+Ca2+Ca2+
Apical
40-60 mM
iCa
Golgi
Ca2+
IP3R
STIM1
ER
Casein
SERCA2
N
SPCA2
2 mM
iCa
CaSR
ORAI1
TRPC6
Basolateral
Neville, 2005; Shennan, 2008; Cross et al., 2014

8

How do early lactation cows respond to calcium challenges?

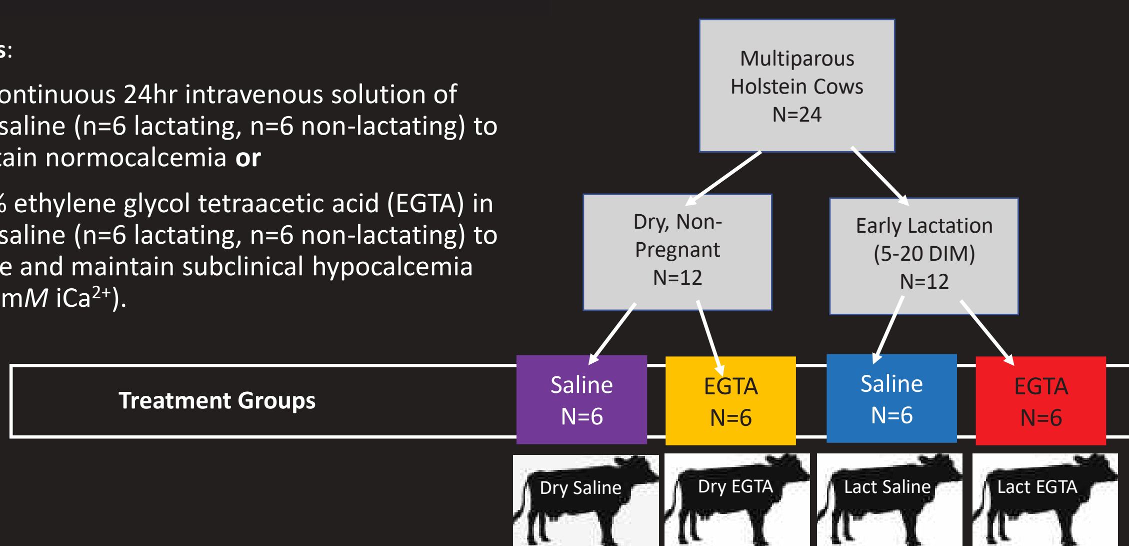
9

Experimental Treatments

Infusions:

i.) a continuous 24hr intravenous solution of 0.9% saline (n=6 lactating, n=6 non-lactating) to maintain normocalcemia **or**

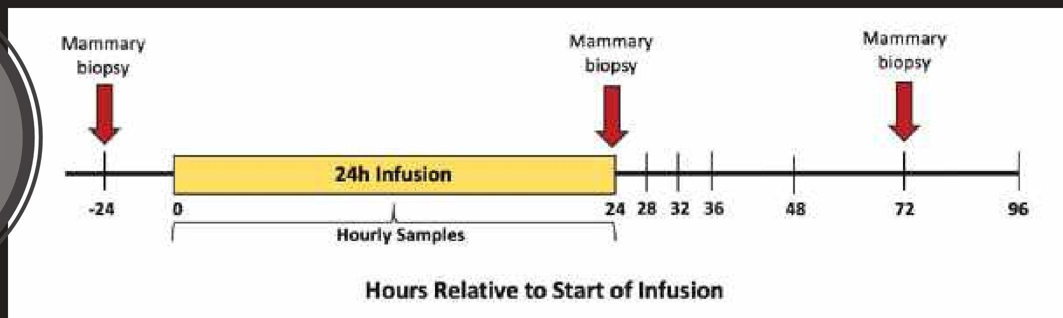
ii.) 5% ethylene glycol tetraacetic acid (EGTA) in 0.9% saline (n=6 lactating, n=6 non-lactating) to induce and maintain subclinical hypocalcemia (<1.0 m*M* iCa^{2+}).



Ethylene glycol tetraacetic acid (EGTA) is a selective calcium chelator

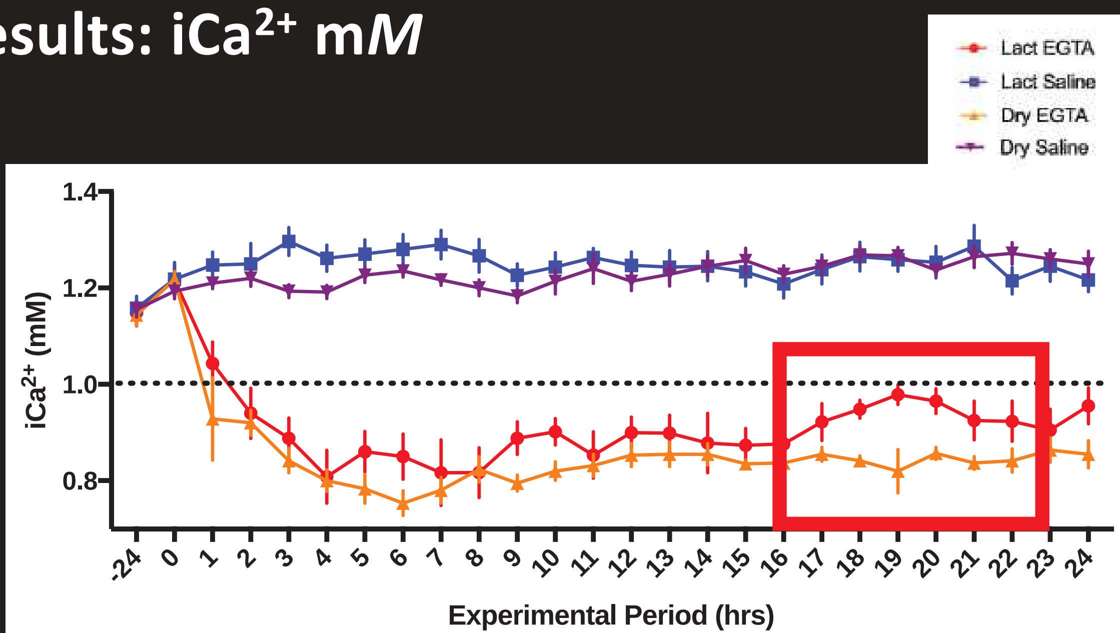
10

Experimental Timeline



11

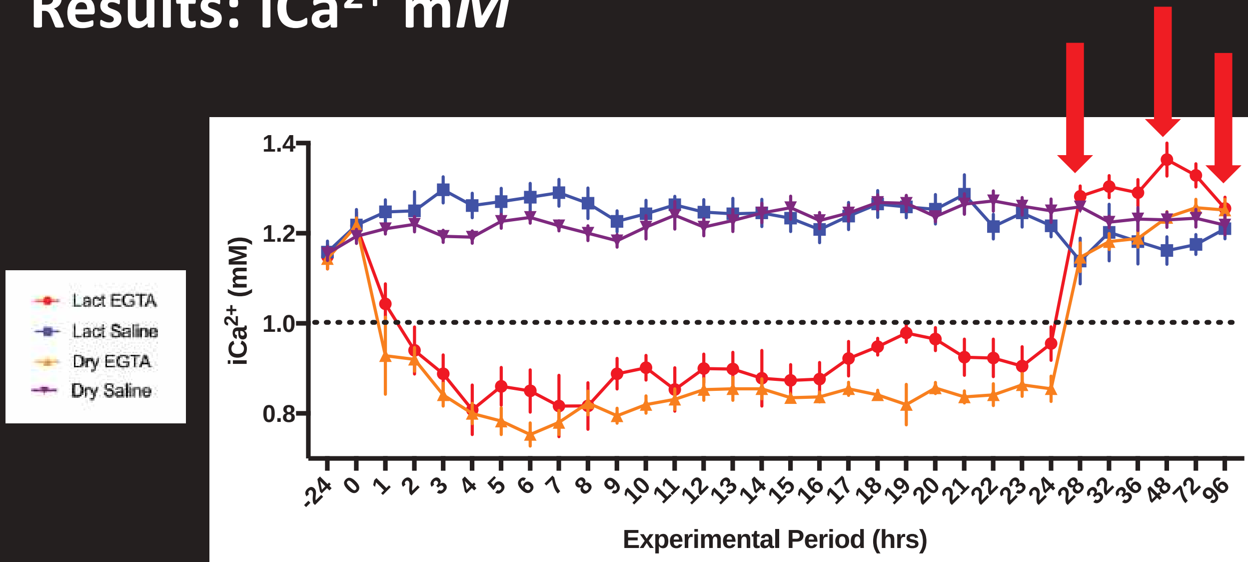
Results: iCa^{2+} m*M*



Connelly, unpublished results

12

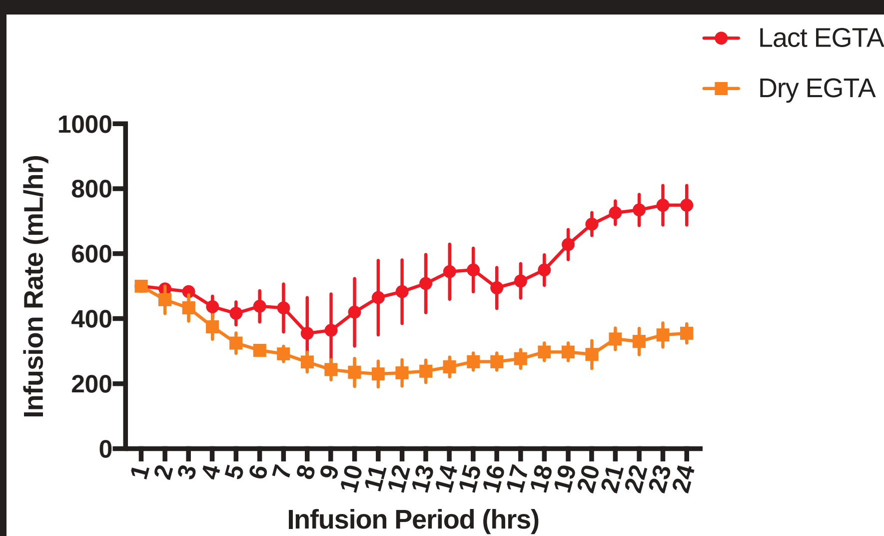
Results: iCa^{2+} m*M*



Connelly, unpublished results

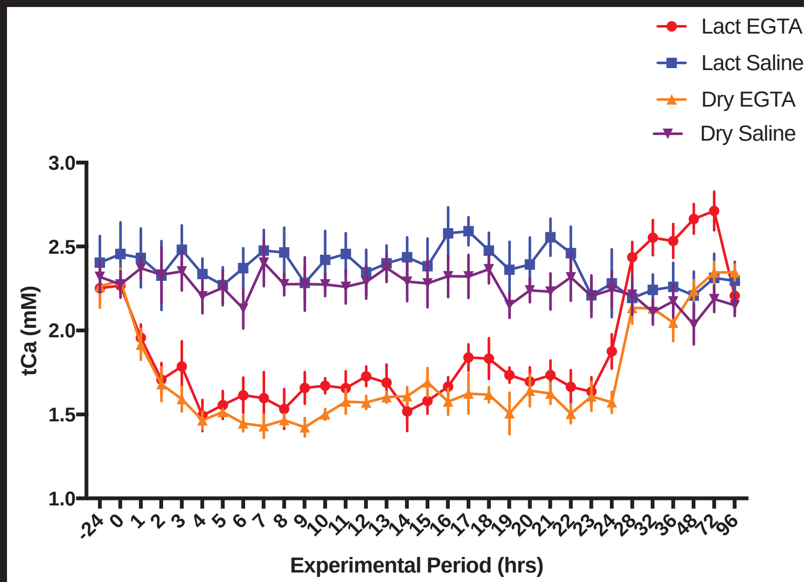
13

Results: iCa^{2+} m*M*



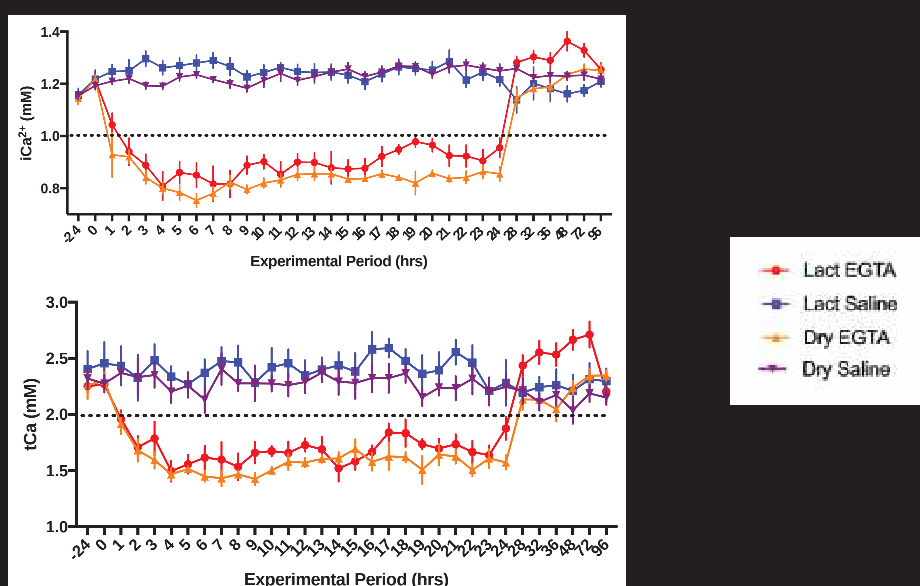
14

Results: tCa m*M*



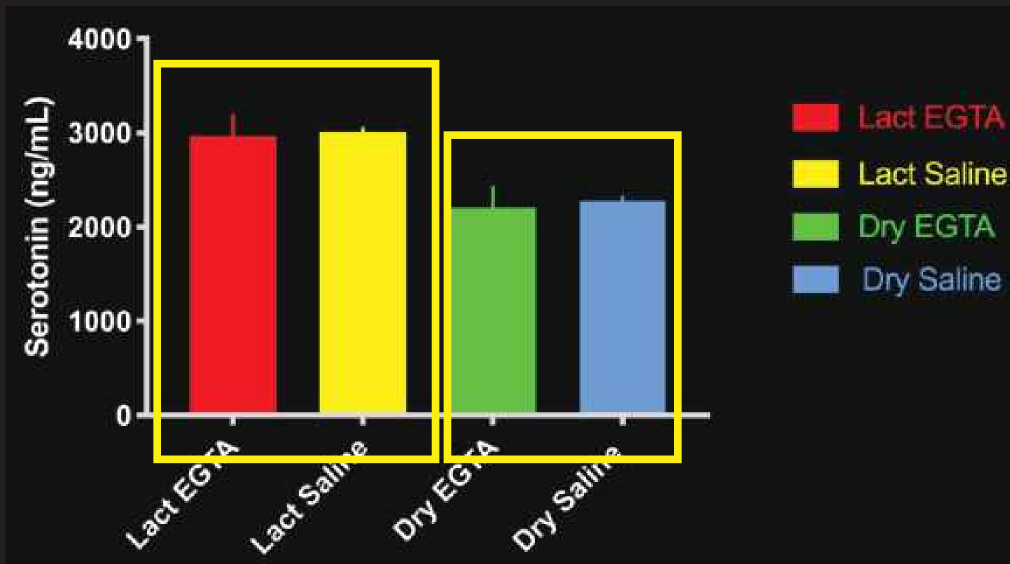
15

Results: iCa^{2+} mM v. tCa m*M*



16

Results: Serotonin

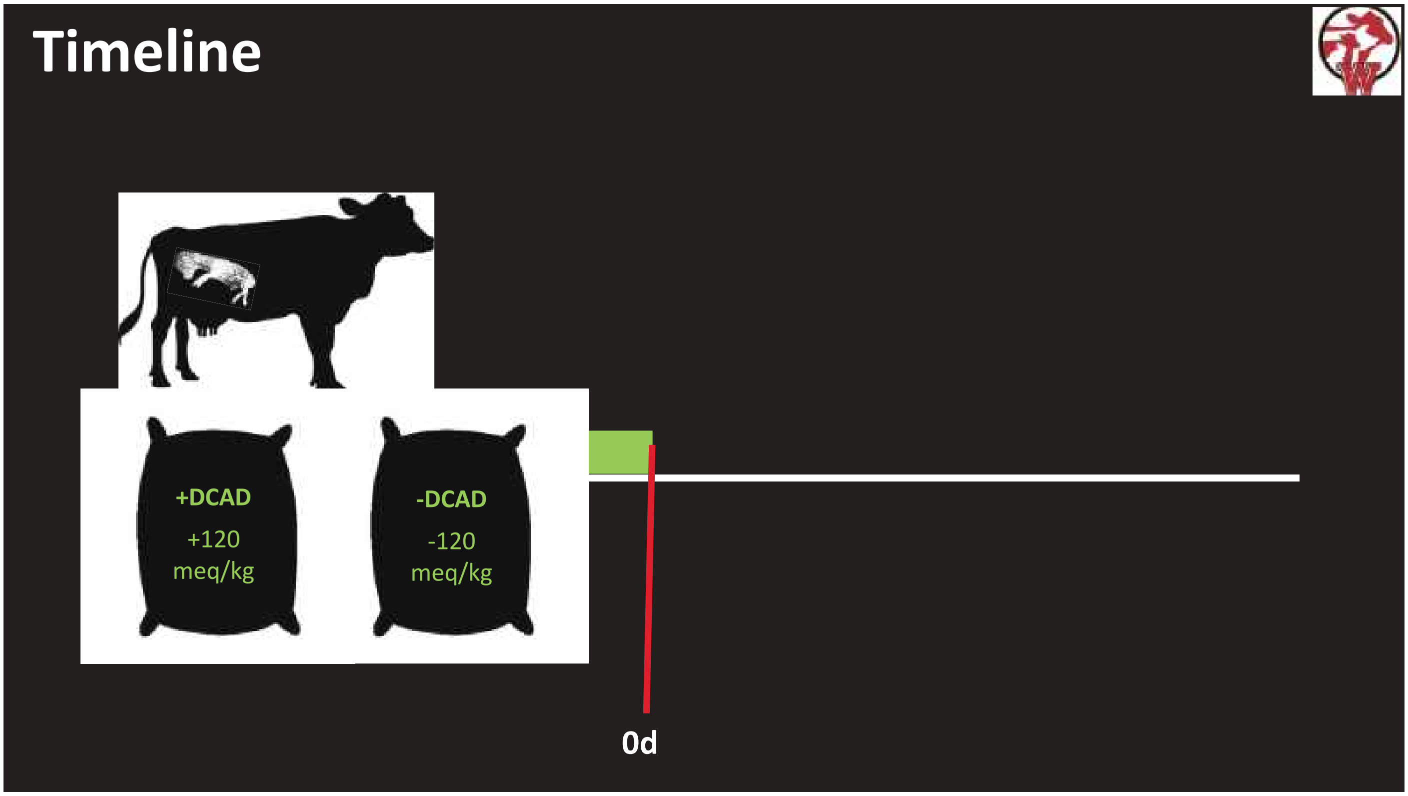


Connelly, unpublished results

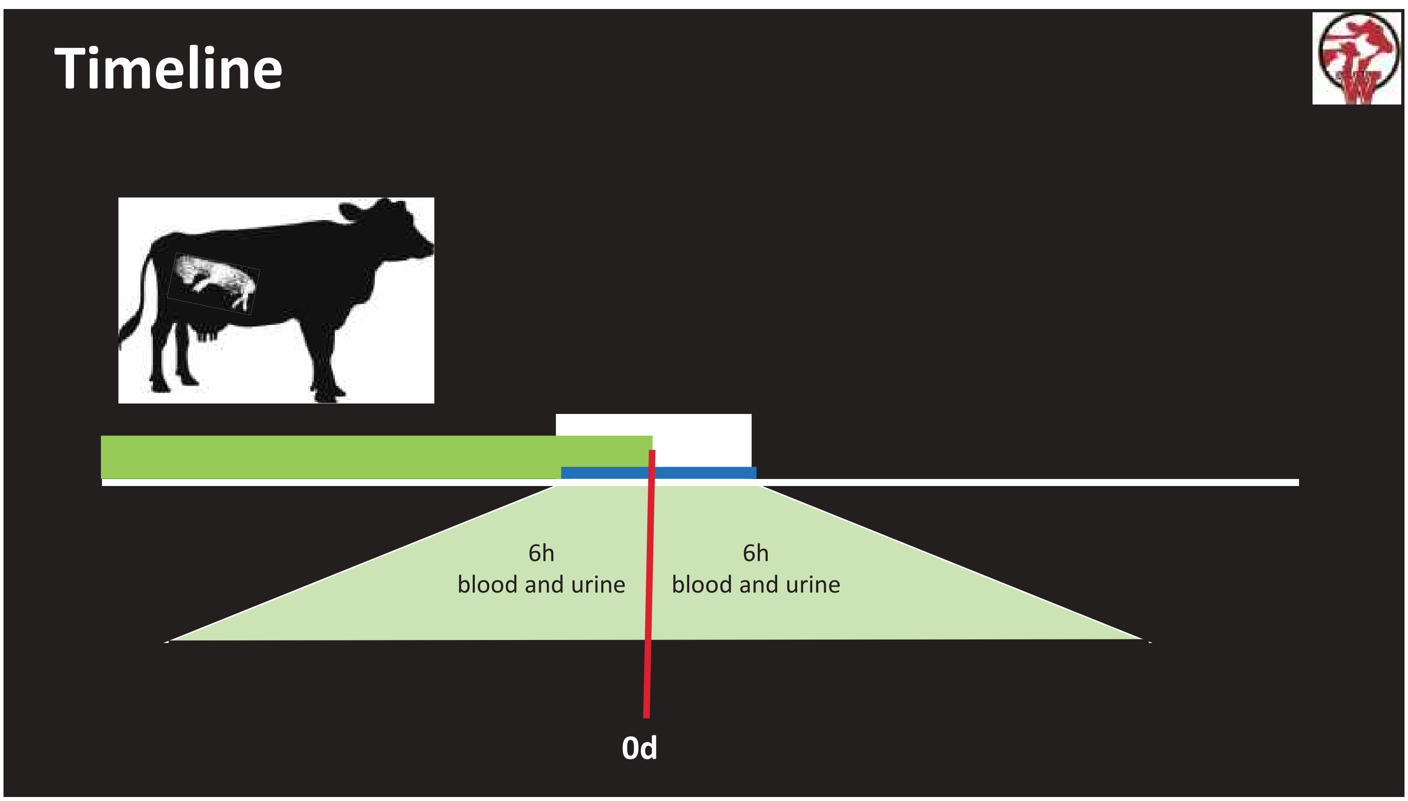
17

What is a "normal" hypocalcemia needed to activate calcium homeostasis at parturition?

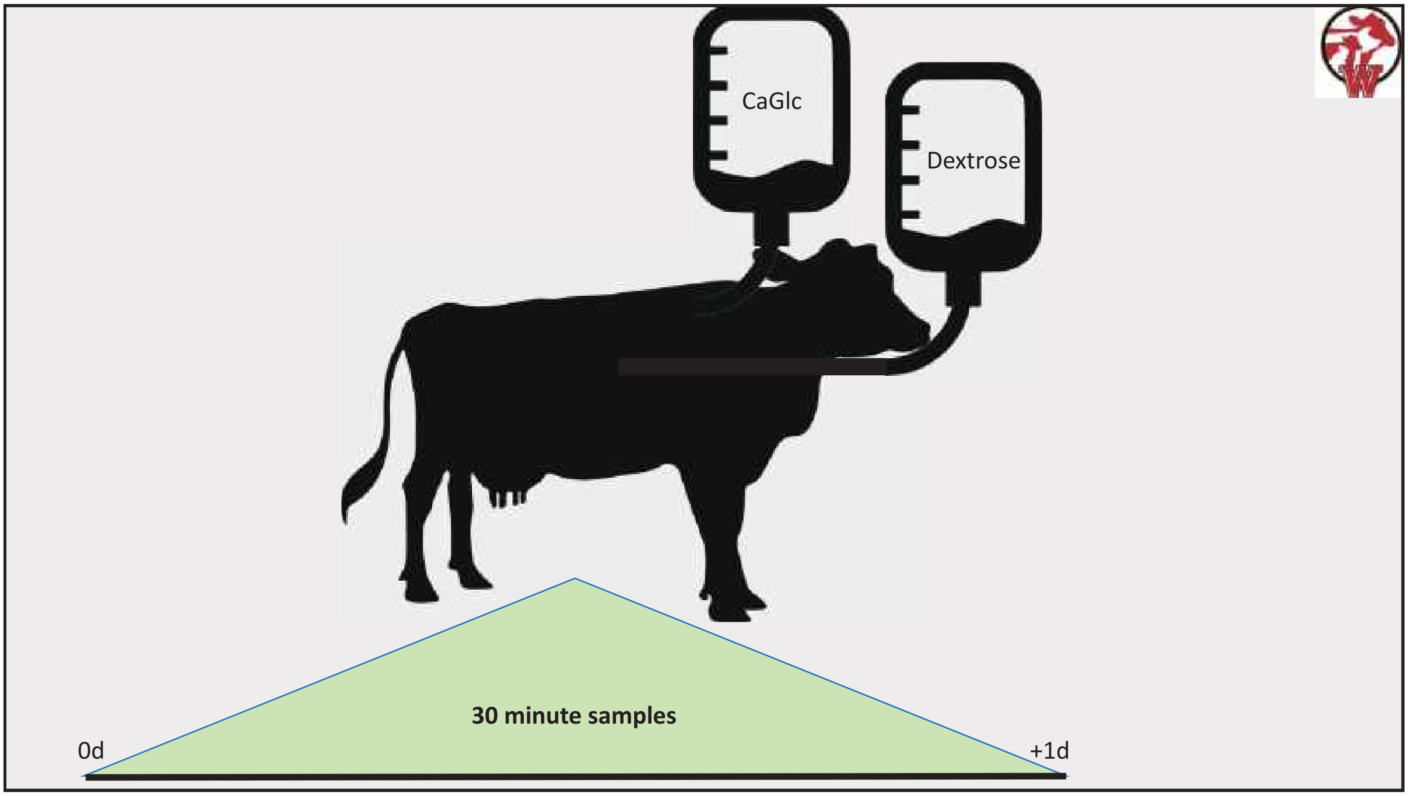
18


Timeline
+DCAD
+120
meq/kg
-DCAD
-120
meq/kg
0d

19

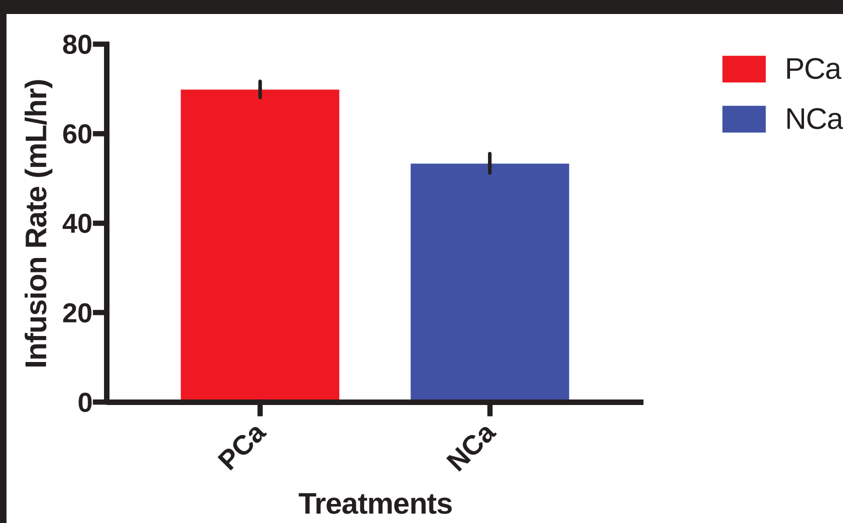

Timeline
6h
blood and urine
6h
blood and urine
0d

20

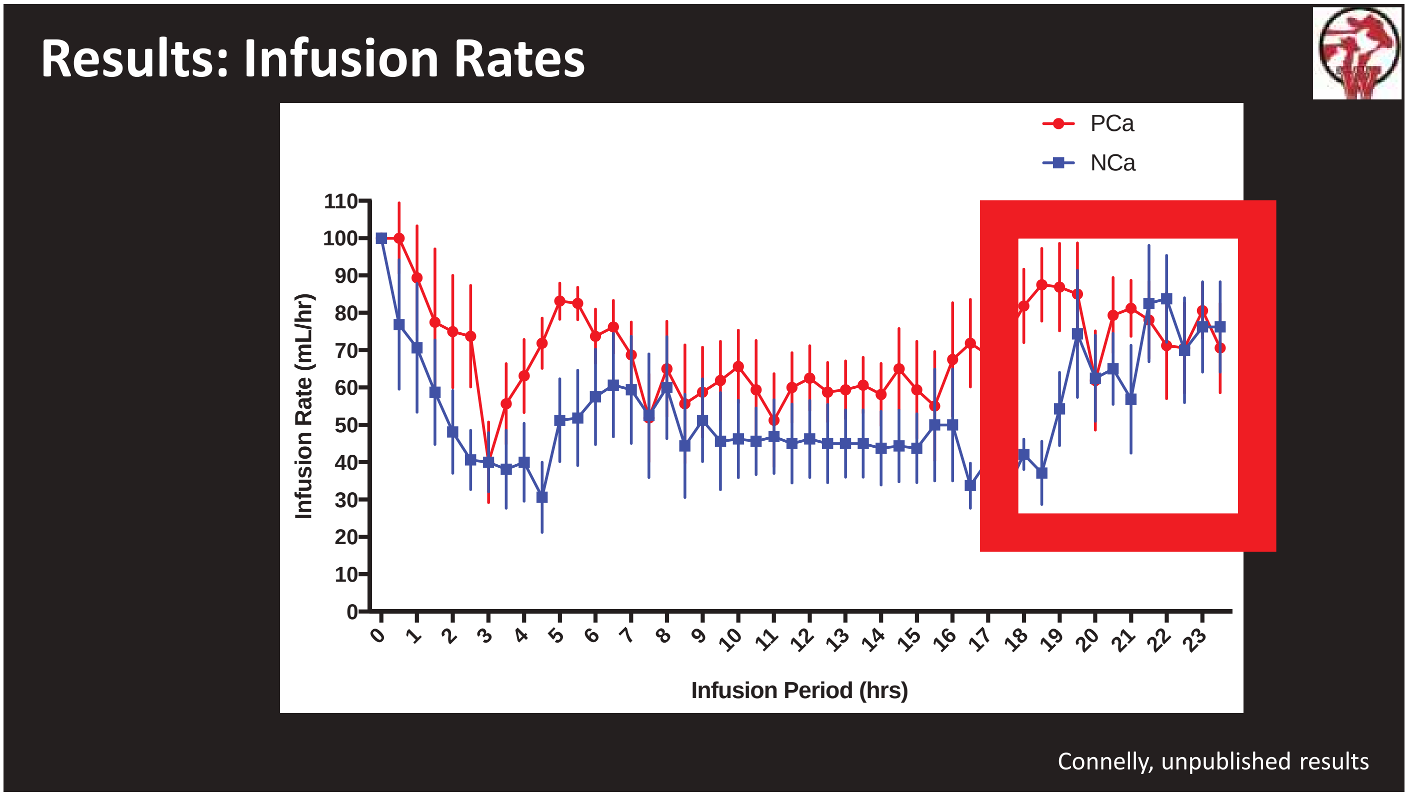


21

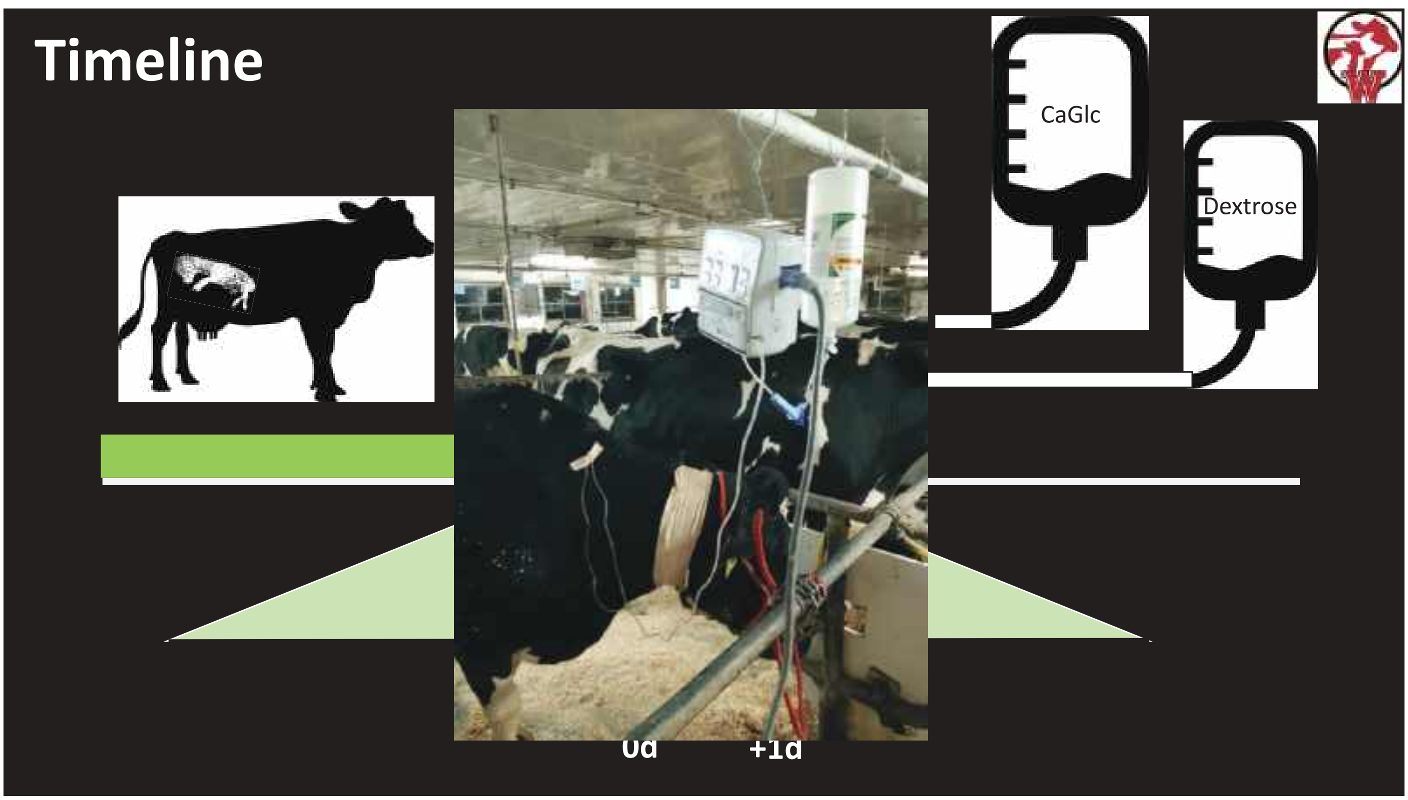
Results: Infusion Rates



22

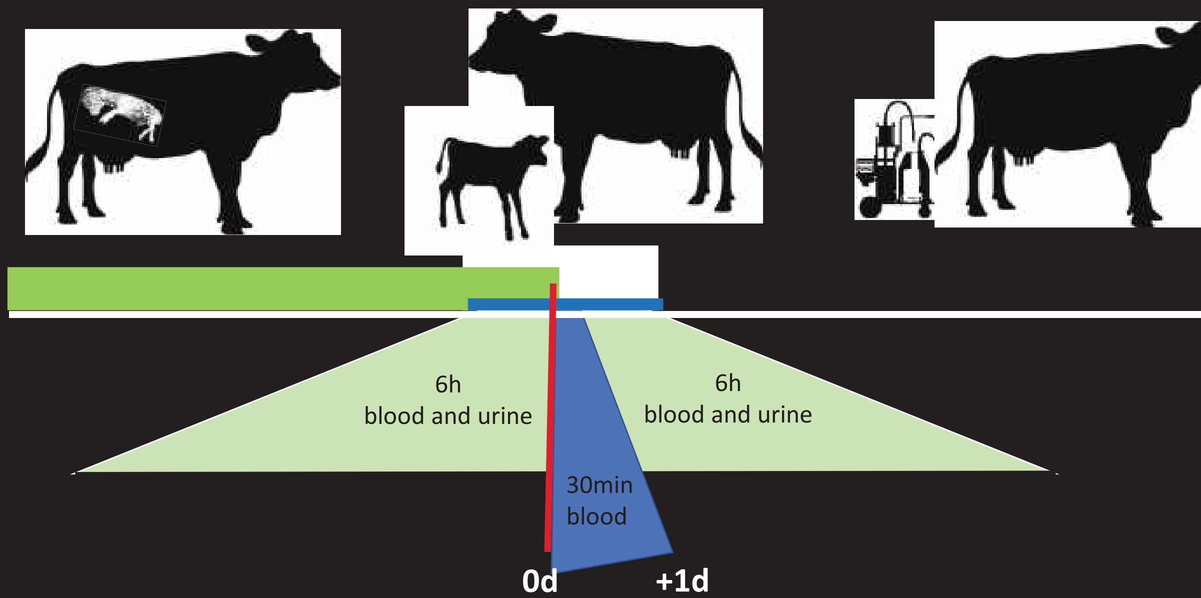

Results: Infusion Rates
PCa
NCa
Infusion Rate (mL/hr)
Infusion Period (hrs)
Connelly, unpublished results

23


Timeline
CaGlc
Dextrose
+1d

24

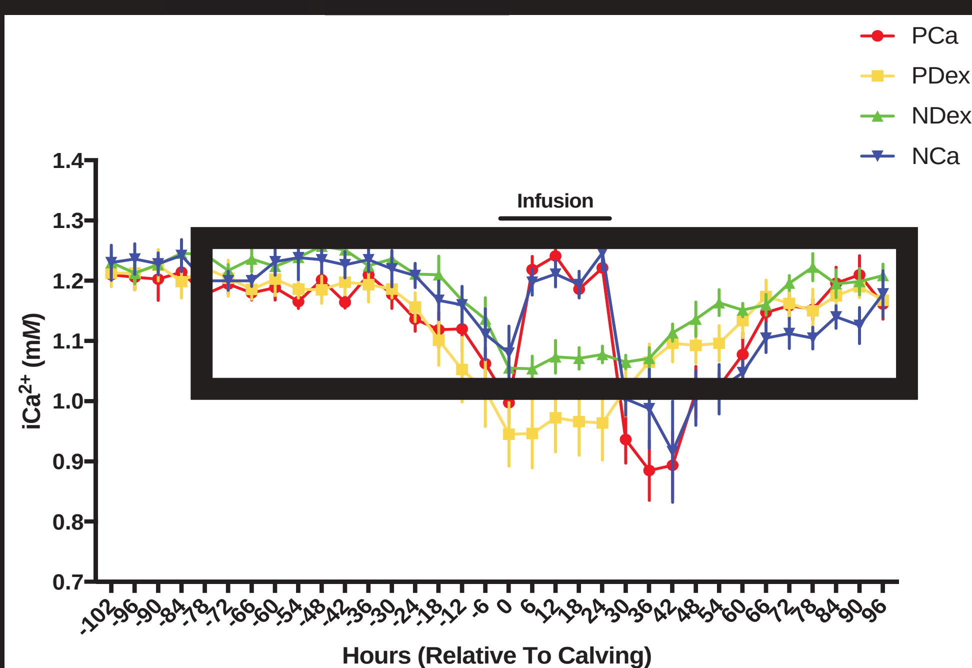
Timeline



iCa measured via iStat Analyzer

25

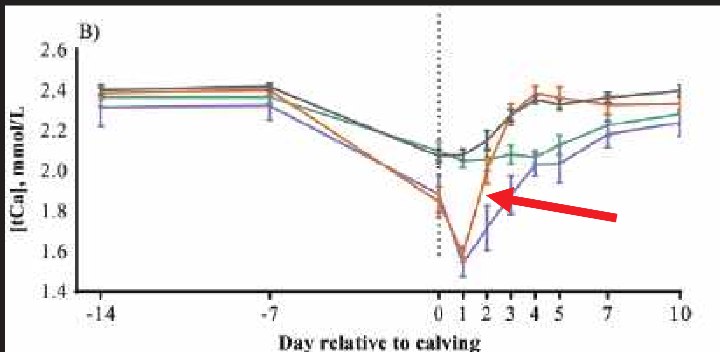
Results: iCa^{2+} mM

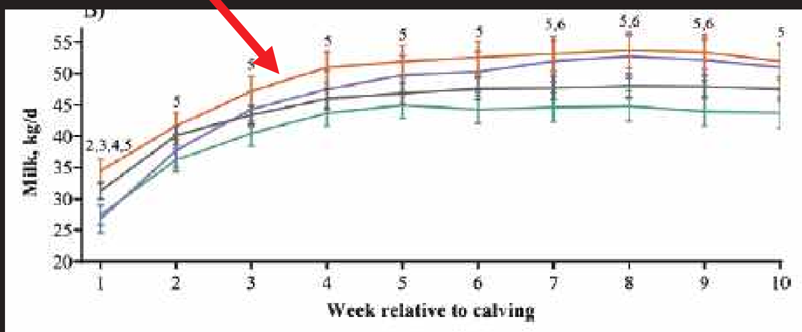


Negative Feedback is Necessary?

Negative Feedback is Important?

26



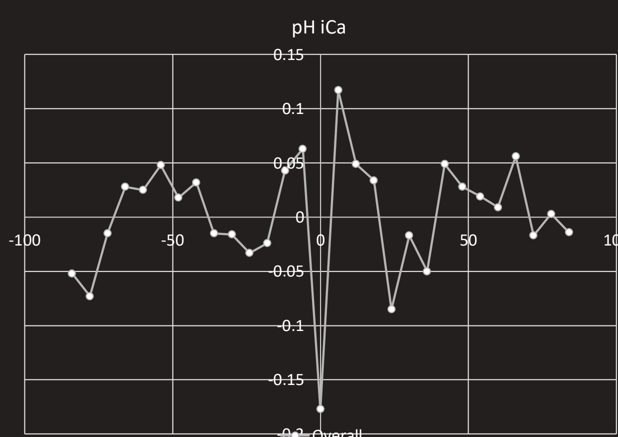


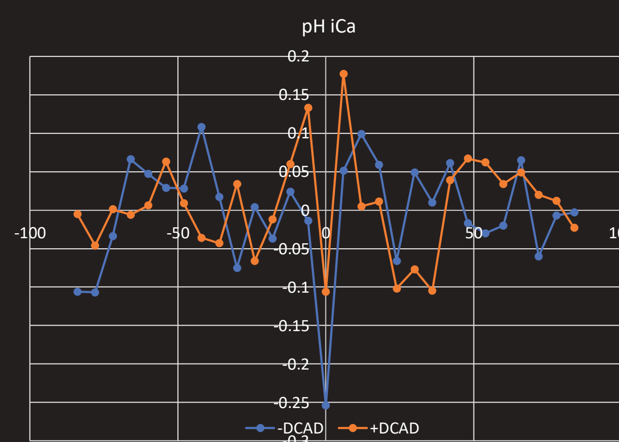
Red=transient hypocalcemia
Black=normocalcemia
Green=persistent hypocalcemia
Blue=delayed hypocalcemia

McCart and Neves, 2019

27

Homeostatic (6hr) and homeorhetic (day-day) relationship between two metabolites





28

Determination of effects of feeding DCAD and X-Zelit on transition cows

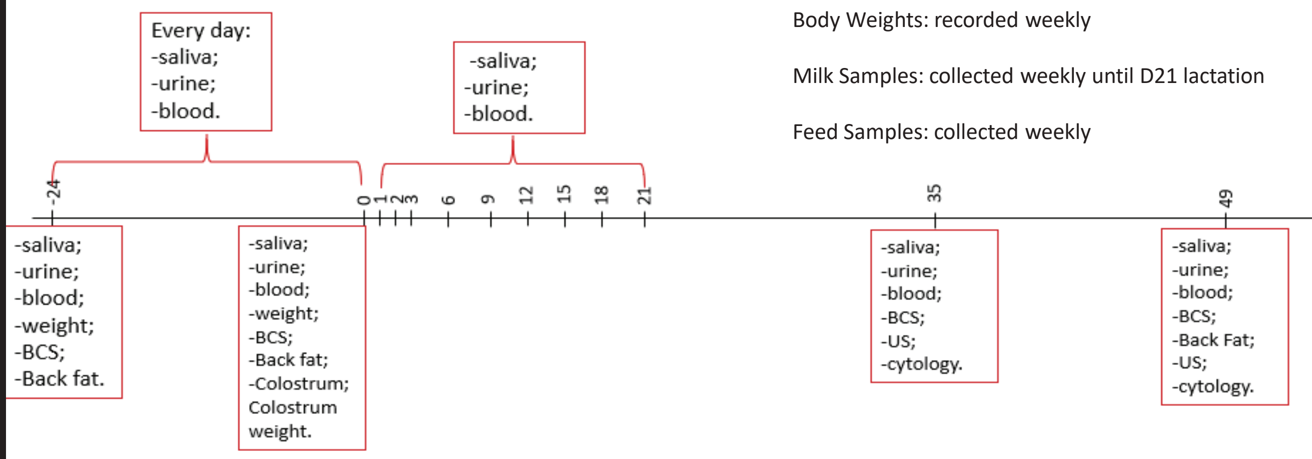
BCS: D0, D7, D14, D21, D35 and D49

Metricheck: D3, D7 and D10 post partum

Body Weights: recorded weekly

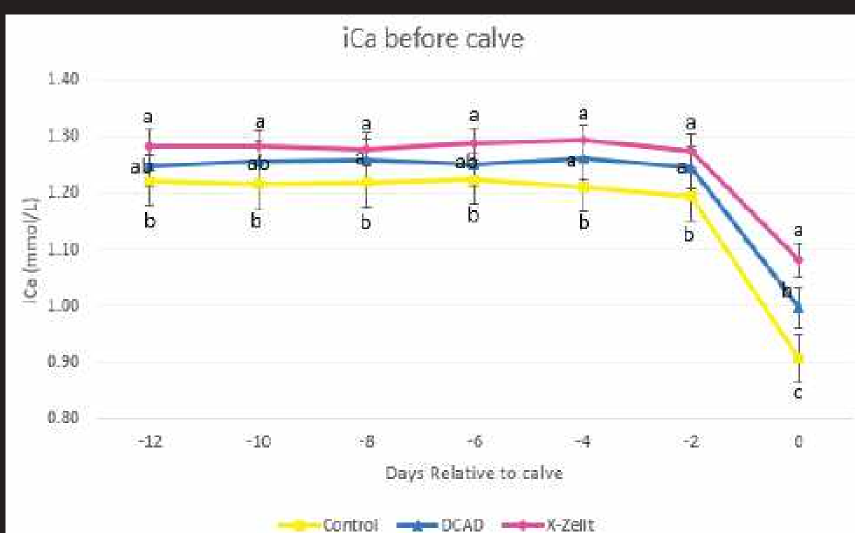
Milk Samples: collected weekly until D21 lactation

Feed Samples: collected weekly



29

Ionized Calcium



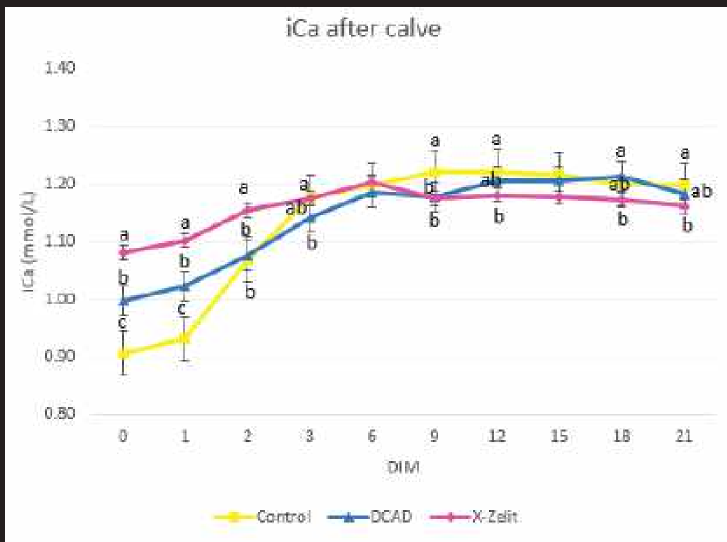
Treatment: $p < 0.01$;

Time: $p < 0.01$;

Treatment*Time: $p < 0.01$.

30

Ionized Calcium



Treatment: $p < 0.01$; Time: $p < 0.01$;

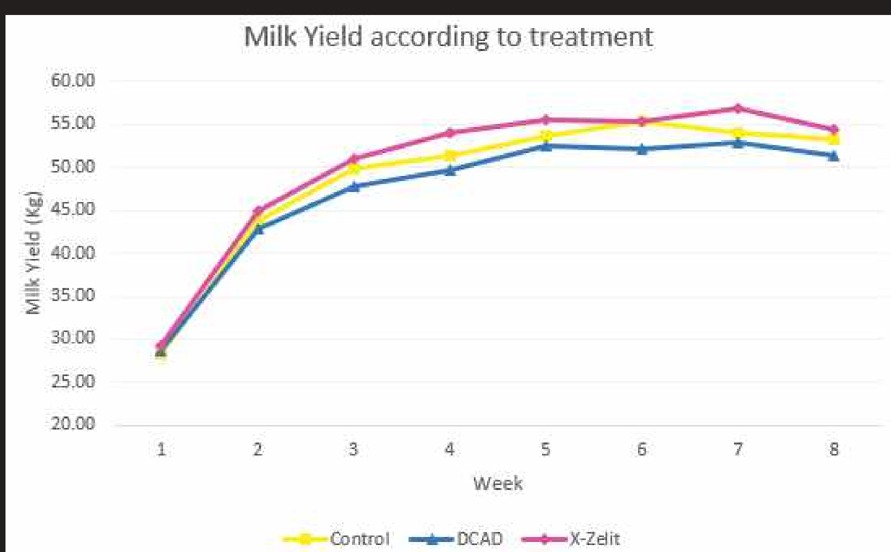
Treatment*Time: $p < 0.01$.

Between D-2 and D0:

- Control: ↓ 24.1%;
- DCAD: ↓ 19.89%;
- X-Zelit: ↓ 15.17%.

31

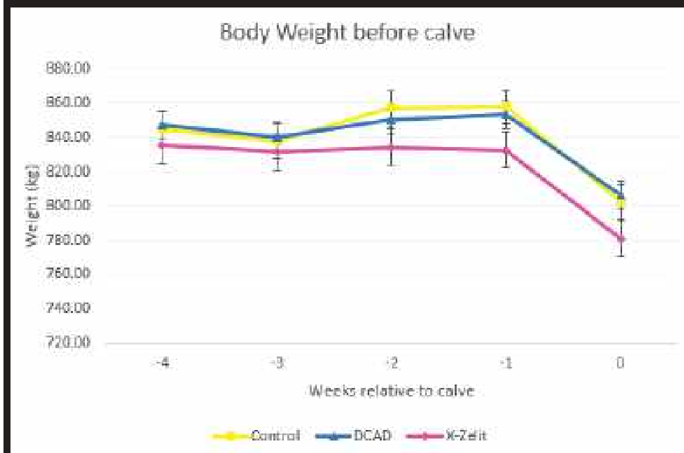
Milk Yield



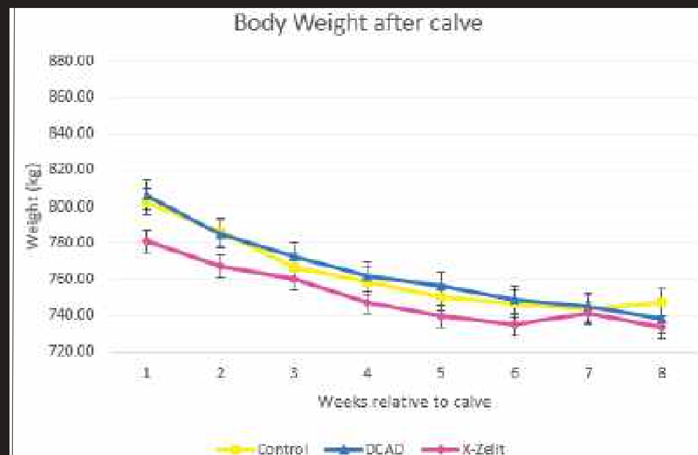
- Treatment: $p = 0.09$;
- Time: $p < 0.01$;
- Treatment*Time: $p = 0.61$.

32

Body Weight



Treatment: p = 0.0760; Treatment*Time: p = 9979.
Time: p < 0.01;



Treatment: p = 0.0660; Treatment*Time: p = 1.00.
Time: p < 0.01;

33

Anovulation Rate

Treatment	Number of cows	Number Anovulation cows	% Anovulation
Control	43	6	13.95
DCAD	41	9	21.95
X-Zelit	42	10	23.81
Total	126	24	19.05

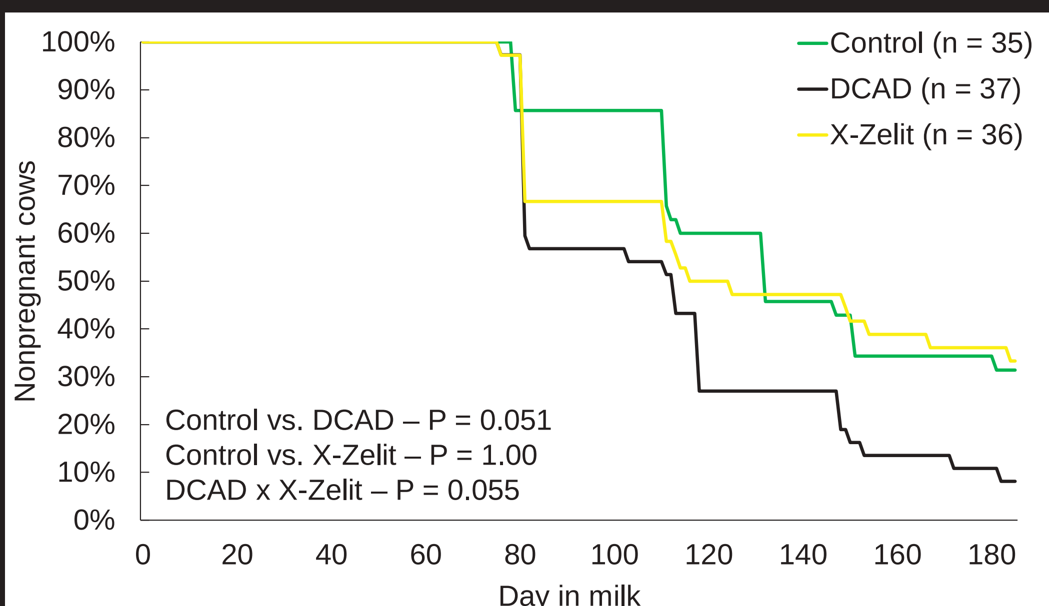
34

Pregnancy/AI according to treatments

Treatment	Number of cows	Number Pregnant Cows	Pregnancy/AI
Control	20	5	25.00%
DCAD	19	8	42.11%
X-Zelit	19	10	52.63%
Total	58	23	39.66%

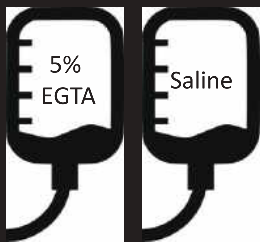
35

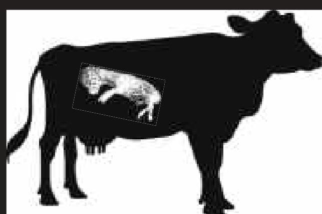
Nonpregnant cows according to DIM

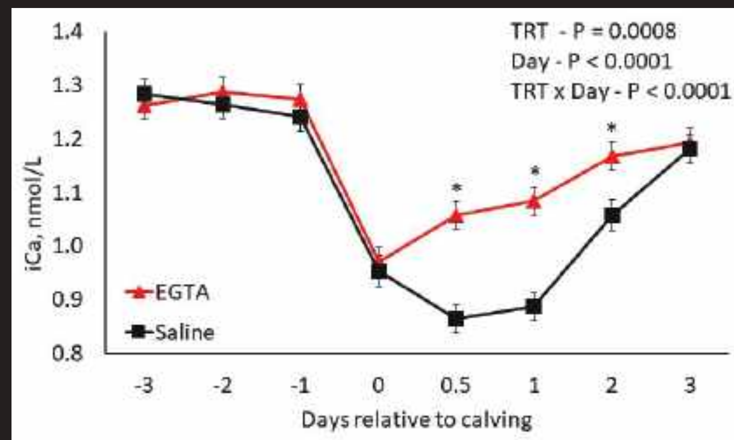


36

Can EGTA treatment improve calcium homeostasis postpartum and how does that effect energy and immune status?







Treatments for 7 days prepartum

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Conclusions

- Early lactation cows are equipped to maintain their calcemic status when challenged with hypocalcemia
- A certain level of decreased calcium around parturition is necessary to activate homeostatic mechanisms related to maintenance of adequate calcium concentrations
- It is critical to manage the prepartum cow to ensure proper calcium homeostasis post-partum
- We aim to determine the homeostatic relationships surrounding calving that are indicative of a healthy transition into lactation and the interactions with immune and energy status

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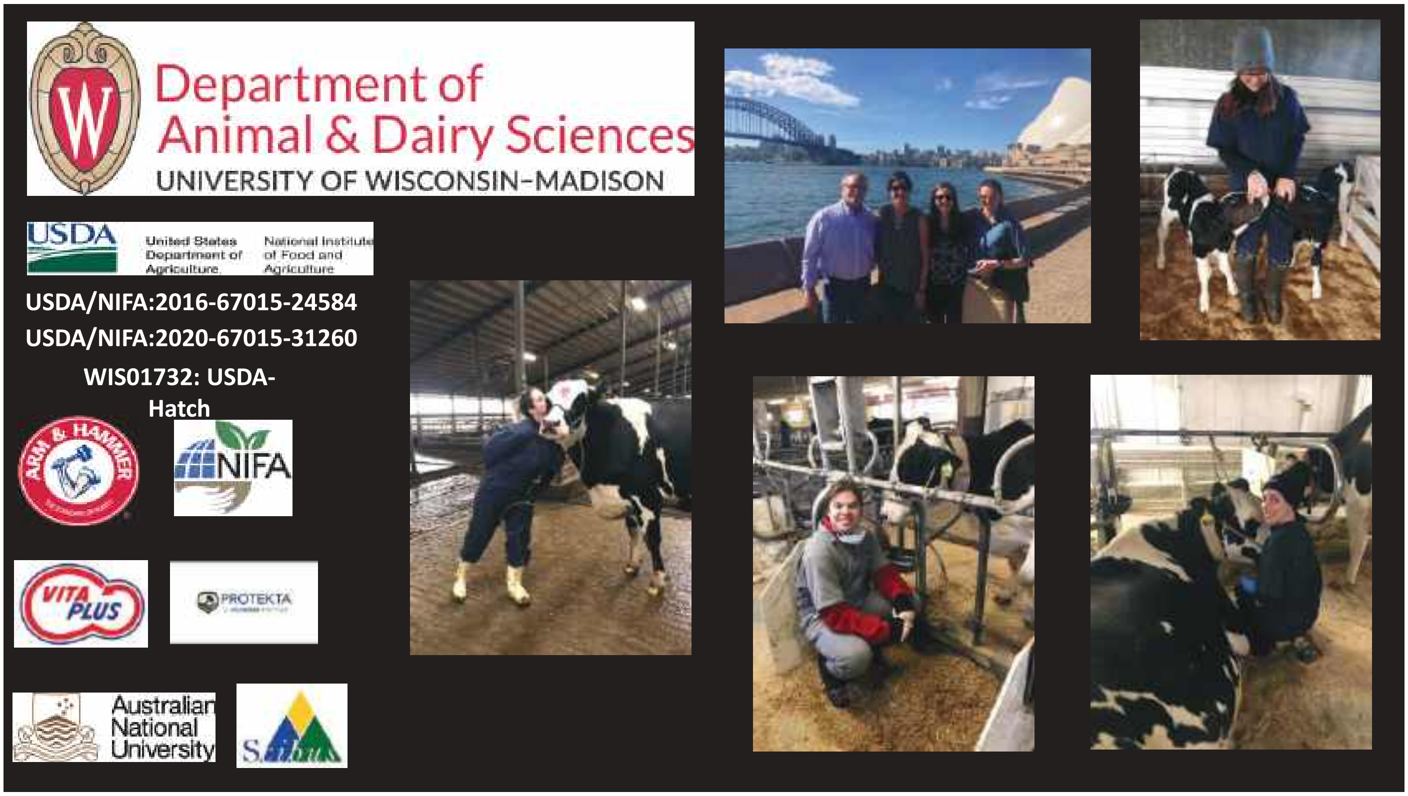

Department of Animal & Dairy Sciences
UNIVERSITY OF WISCONSIN-MADISON
USDA
United States Department of Agriculture
National Institute of Food and Agriculture
USDA/NIFA:2016-67015-24584
USDA/NIFA:2020-67015-31260
WIS01732: USDA-Hatch
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Four-State Dairy Nutrition & Management Conference

Using Reduced-Lignin Alfalfa in Lactating Dairy Cow Diets

Dr. Ken Kalscheur
USDA Forage Research Center

Using Reduced-Lignin Alfalfa in Lactating Dairy Cow Diets

Hannah C. Wilson and Kenneth F. Kalscheur
USDA-ARS Dairy Forage Research Center, Madison, WI
kenneth.kalscheur@usda.gov

SUMMARY

- Increasing fiber digestion leads to improved milk production
- Reduced-lignin alfalfa offers flexibility for harvest dates while maintaining forage quality
- Reduced-lignin alfalfa can be harvested at greater intervals than conventional alfalfa and maintain lactating cow performance

INTRODUCTION

Maintaining forage crop sustainability for perennial legumes is largely dependent on increasing fiber digestibility (Martin et al., 2017). Alfalfa (Medicago sativa L.) is a regularly grown forage fed to ruminants in the U.S. with approximately 11.5 million acres (42 million dry tons) harvested in 2020 (NASS, 2021). Alfalfa is commonly credited for its high nutritional value. However, alfalfa is often limited on its nutritive value because of the indigestible lignin components in the cell wall, which continue to accumulate as the plant matures (Albrecht et al. 1987). Utilizing technology to improve fiber digestibility in alfalfa provides opportunities for increased flexibility and improved animal production.

INCREASING FIBER DIGESTIBILITY

Incomplete fiber digestion reduces the profitability and performance of a dairy operation mainly by limiting intake and increasing manure production leading to overall reduced animal productivity. Compared with substrates from starch, ruminal fermentation of fiber generates more hydrogen ions that reduce carbon dioxide to methane (Adesogan et al, 2019). By improving fiber digestion, additional energy may go towards the cow's energy supply and reduce the enteric methane production which is an environmental concern. Thus, it is critically important to maximize fiber digestibility to take full advantage of the nutrients in forage sources. Increases in forage NDF digestibility (NDFD) are associated with a 0.17 kg/d increase in DMI and a 0.25 kg/d increase in milk production (Oba and Allen, 1999). Additionally, each percentage unit increase in lignin concentration in forage cell walls severely constrains DMI and milk production.

LIGNIN

Lignin, a complex structural polymer, provides strength and rigidity for the plant, leading to decreased digestibility as the concentration of lignin increases with maturity. During the thickening of secondary cell walls in plants during maturity, lignin is responsible for providing structural integrity to hold the plant upright and protect against environmental and pest stresses (Jung and Engels, 2002). Lignin content can also be directly related to cell wall digestibility by forming cross-linkages with other cell wall constituents, notably cellulose and hemicellulose, that would otherwise be more digestible without these cross-linkages (Moore and Jung, 2001).

REDUCED LIGNIN ALFALFA

A multitude of alfalfa varieties with reduced-lignin content have achieved significantly greater fiber digestibility due to less lignification of the plant cell wall (Baucher et al., 1999; Reddy et al., 2005; Chen et al., 2006; Zhou et al., 2010 Cherney et al., 2020). One such specific variety, marketed as HarvXtra, has demonstrated to be successful in improving forage digestibility by downregulation of caffeic acid 3-O-methyltransferease and caffeoyl CoA 3-O-methyltransferase (Guo et al., 2001).

Other alfalfa varieties attempt to manipulate the leaf:stem ratio utilizing conventional breeding, one marketed under the name Hi-Gest. Fiber digestibility of alfalfa declines as the stem lignifies with advancing maturity and the leaves fall off. This can also occur with leaf loss during harvest (Albrecht, 1987). Alfalfa leaves maintain high NDF digestibility throughout the growth cycle, while the stem material becomes increasingly lignified as the plant approaches full bloom (Buxton and Hornstein, 1986). Conventionally bred, reduced-lignin alfalfa, offers a slight improvement in the digestibility of alfalfa stems compared to conventional alfalfa and an increase in the rate of digestion of NDF.

HARVEST FLEXIBILITY

Alfalfa has environmental and sustainability advantages when compared to corn silage, another popular forage source. However, because corn silage is harvested one time in the fall it has a perceived economical advantage over alfalfa which must be cut 4 to 5 times in a season, requiring more labor and machinery costs. Alfalfa is often cut more frequently, sacrificing yield, to maximize quality and fiber digestibility. Harvest timing is critical for obtaining optimal forage nutritive value, yet harvest decisions are often made without knowledge of forage nutritive value due to the time constraint of obtaining laboratory test results (Arnold et al. 2019).

In addition to improved nutritive value, reduced-lignin alfalfa can also offer an advantage to harvest management flexibility. The reduced-lignin concentration and increased digestibility may lengthen the time window when alfalfa has suitable nutritive value, allowing for wider optimal harvest windows. This would allow for alfalfa growers to accumulate larger amounts of forage by delaying harvest but still maintaining acceptable nutritive value (Grev et al., 2017; Undersander et al., 2009). A field experiment conducted at 6 locations (KS, MI, OH, PA, CA, and WI) over 2 years reported that reduced-lignin alfalfa (HarvXtra) contained consistently lower neutral detergent fiber (NDF; -3.5 to -7.5%), reduced acid detergent lignin (-8.4%) and an increase in neutral detergent fiber digestibility (5.3 to 7.7%) compared to two other varieties of alfalfa which represented at 7-to-10-day advantage in nutritive value using a 38-day cutting schedule (Arnold et al., 2019). Another study reported no differences in yield or nutrient quality when harvested at 28-day intervals (Getachew et al., 2018). However, in the same study extending harvest to a 35-day cutting interval led to increased yield but also maintained nutritional quality compared to a control alfalfa which sacrificed quality for greater yields. Figure 1, adapted from Barros et al. (2019), illustrates the relationship of increased yield as cutting interval increases in exchange for a dramatic decrease in NDF digestibility (NDFD). However, the HarvXtra variety had a similar rise in yield but a 12-15% advantage in digestibility.

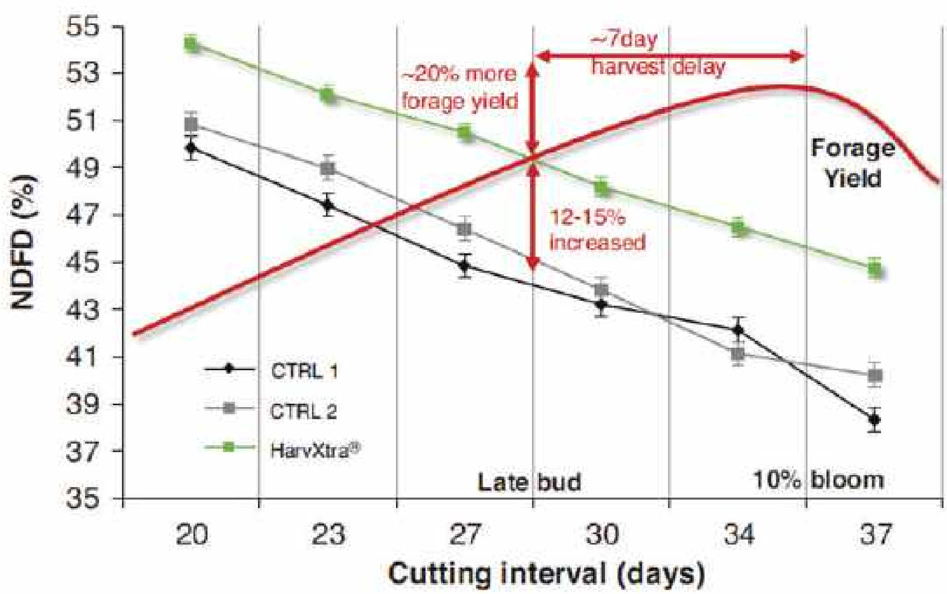

Figure 1. Relationship of cutting interval and neutral detergent fiber digestibility (NDFD) in addition to forage yield for 2 control varieties of alfalfa (CTRL 1, CTRL 2) compared to a reduced-lignin alfalfa (HarvXtra). Adapted from Barros et al. (2019).

REDUCED-LIGNIN ALFALFA AND ANIMAL PERFORMANCE

Feeding increasingly digestible alfalfa, despite the reduced-lignin variety, is primarily a response of increased intake. Improving the nutritive value of alfalfa, subsequently by increasing fiber digestibility, could lead to increased milk production (Oba and Allen, 1999). It is important to consider harvest intervals simultaneously. Improved fiber digestibility or increased milk production may not be expected if reduced-lignin alfalfa is being utilized from delayed harvest, or increased harvest intervals to increase tonnage. If a normal cutting schedule is maintained a higher quality reduced-lignin alfalfa may lead to an increase in milk production. However, research utilizing reduced-lignin alfalfa in lactating dairy cow diets is limited.

The first study conducted at the U.S. Dairy Forage Research Center evaluated the inclusion of reduced-lignin alfalfa silage as a replacement for soyhulls and supplemental protein in dairy cow diets. Forty-eight lactating Holstein cows (24 multiparous, 24 primiparous) averaging 141 DIM at the beginning of the experiment. The experiment had a 2-wk covariate period where cows were fed a common diet, followed by an 8-wk treatment period were cows were assigned randomly to 4 treatments in a randomized complete block design. Diets consisted of 40% BMR corn silage, 10% conventional alfalfa silage (AS) and either 0, 6, 12, or 18% high quality (reduced lignin) alfalfa silage (0AS, 6AS, 12AS, 18AS, respectively) on a DM basis.

Increasing AS in the diets linearly decreased DMI from 26.3 kg/d (0% AS) down to 24.9 kg/d (18% AS; $P \leq 0.05$). Milk production was unaffected ($P > 0.10$) by AS inclusion but feed conversion efficiency (ECM/DMI) increased linearly from 1.63 to 1.83 when AS was incrementally increased in the diets. Milk fat % and yield increased linearly as AS replaced concentrate feedstuffs (3.35 to 3.90% fat, 1.48 to 1.65 kg/d fat). Percentage and yield of both milk protein and lactose did not differ among the treatments. Substitution of protein and non-forage fiber feedstuffs up to 18% of the diet (DM basis) with reduced-lignin AS did not reduce milk production and increased milk fat yield, milk fat % and feed conversion efficiency.

A second study conducted at the U.S. Dairy Forage Research Center evaluated two different harvest intervals to determine retention of nutritive value during later harvests in both conventional and reduced-lignin alfalfa. It was hypothesized that reduced-lignin alfalfa may either increase milk production or feed conversion efficiency because of greater fiber digestibility (and increasing DM intake) if harvested at similar intervals as the conventional alfalfa. Conversely, if harvest is delayed (late), utilizing reduced-lignin alfalfa may maintain milk production compared to possible losses in efficiency when feeding late harvested conventional alfalfa.

A lactation study was conducted utilizing 55 lactating Holstein cows (16 primiparous and 39 multiparous cows) averaging 89 DIM at the start of the experiment. After all cows were fed a common covariate diet for 2 weeks, cows were assigned randomly to 1 of 4 alfalfa silage treatments and fed for 8 weeks. The four alfalfa silage treatments were an early harvest (EH) conventional alfalfa (CA; 28-day interval from previous cutting), late harvest (LH) conventional alfalfa (35-day interval from previous cutting), early harvest reduced-lignin alfalfa (RLA), and late harvest reduced-lignin alfalfa (both harvested on the same day as the respective conventional alfalfa). Alfalfa used in the experiment was 3rd cutting alfalfa harvested in August 2019. The basal diet consisted of 30% BMR corn silage, 19% high-moisture corn, 6% canola meal, 8% soybean hulls, 4.5% Soyplus, 2.5% mineral and vitamins, and 30% of 1 of 4 treatment alfalfa silages.

Cows fed EH-RLA and LH-CA had the greatest DMI (27.9 and 27.2 kg/d, respectively) compared to EH-CA and LH-RLA (26.7 and 26.4 kg/d respectively; Table 1). There was a tendency for milk production to be greater for EH regardless of alfalfa hybrid. There were no differences in milk protein (%) or lactose (%). However, milk fat (%) tended to be least for cows fed LH-CA, intermediate for EH-RLA and LH-RLA, and greatest for EH-CA. There was a tendency for TS (%) to be least (12.8) for LH-CA and EH-RLA, but greater (12.9) for EH-CA and LH-RLA). There was no effect of alfalfa hybrid on FCM, however, EH led to greater ECM and FCM compared to cows fed LH alfalfa. When compared on a DMI basis, FCM/DMI was least for LH-CA, intermediate for EH-RLA and LH-RLA, and greatest for EH-CA.

As expected, cows fed the LH-CA resulted in the poorest feed conversion efficiency because it took greater intake to produce similar yields of milk. Because this alfalfa was likely of poorer quality (further analysis pending), cows consumed more feed to meet energy requirements to produce milk. The additional digestibility in the EH-RLA allowed cows to eat more and produce numerically more milk, but the cows were not as efficient as EH-CA on a fat-corrected basis.

CONCLUSIONS

Reduced-lignin alfalfa can be a useful tool to improve harvest flexibility compared to conventional alfalfa. Delayed harvest using reduced-lignin alfalfa may reduce total milk production compared to harvesting at shorter intervals. However, delaying harvest using reduced-lignin varieties allows for greater tonnage to be procured with minimal sacrifices in forage quality while maintaining feed conversion efficiency.

Table 1. Milk production and components for 55 lactating Holstein cows fed conventional or reduced-lignin alfalfa at two harvest intervals.1

	CA		RLA			*P*-value		
Item	EH	LH	EH	LH	SEM	H × A	H	A
DMI, kg/d	26.7[a]	27.2[ab]	27.9[b]	26.4[a]	0.35	<0.01	0.12	0.52
Milk, kg/d	47.0	46.6	48.1	46.7	0.54	0.29	0.08	0.23
Fat, %	4.08[a]	3.92[b]	3.97[ab]	4.00[ab]	0.05	0.06	0.20	0.73
Protein, %	3.06	3.07	3.07	3.04	0.02	0.27	0.67	0.58
Lactose, %	4.79	4.78	4.79	4.78	0.01	0.85	0.32	0.90
TS, %	12.9	12.8	12.8	12.9	0.06	0.08	0.19	0.97
MUN, mg/dL	13.0[a]	12.9[ab]	12.2[b]	13.0[a]	0.20	<0.01	0.08	0.08
FCM	46.9	45.4	47.5	46.5	0.68	0.68	0.05	0.17
ECM[2]	49.8	48.5	50.7	49.5	0.67	0.96	0.05	0.13
FCM/DMI	1.77[a]	1.65[c]	1.71[bc]	1.75[ab]	0.03	<0.01	0.13	0.47
ECM/DMI	1.88[a]	1.77[b]	1.83[ab]	1.86[ab]	0.03	<0.01	0.14	0.38

[abc] indicated significant differences between treatment means

[1]CA = Conventional alfalfa, RLA = Reduced-lignin alfalfa, EH = Early harvest, LH = late harvest, H = effect harvest interval, A = effect of alfalfa hybrid

[2]ECM = [0.327 × milk yield (kg)] + [12.95 × fat yield (kg)] + [7.2 × protein yield (kg)]

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Four-State Dairy Nutrition & Management Conference

Corn Silage Fiber Digestibility - Why Do Cows Care?

Luiz F. Ferraretto, Ph.D., PAS
Assistant Professor and Ruminant Nutrition Extension Specialist
University of Wisconsin

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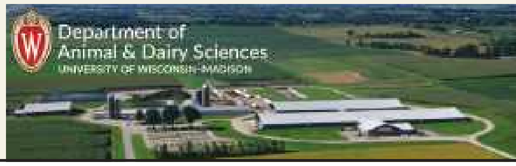

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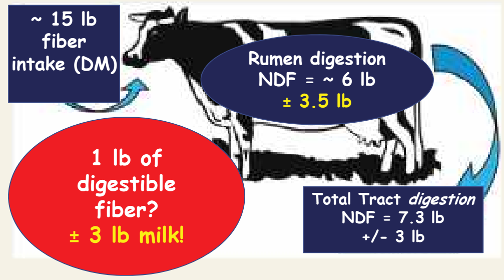
Speaking "Fiber"



Adapted from slide courtesy of Dr. John Goeser, RRL

2

Objectives

- Review the importance of fiber digestibility
- Introduce indicators of forage/diet nutritive value
- Highlight the use and application of these indices

3

US Fiber Quality Summary

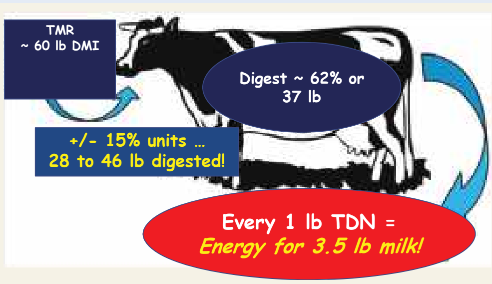
Parameter	Indicates Better Quality	n	Normal Range
NDF (% DM)	↓	384,715	36 - 46
Lignin (% DM)	↓	344,134	3 - 4
$uNDF_{240}$ (% DM)	↓	81,418	8 - 13
$NDFD_{30}$ (% NDF)	↑	170,634	48 - 60
TTNDFD (% NDF)	↑	27,954	36 - 46

Summary of combined multi-year, multi-lab (CVAS, DairyOne, RRL, DLL) data, except TTNDFD only from RRL

Adapted from slide courtesy of Dr. Randy Shaver, UW-Madison

4

What holds cows back?



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5

Why do we care about these assays?

- Prediction models
- Forage ranking
- To standardize laboratory assays

6

Fiber Quality Indicators

Indicator	Practical Implication
NDF (% DM)	▪ Intake limitation through rumen fill
Lignin (% DM)	
uNDF$_{240}$ (% DM)	▪ Impact milk yield and the establishment of high-forage diets
NDFD$_{30}$ (% NDF)	
TTNDFD (% NDF)	

Methods vary across laboratories and may include calculation of pools and rates of digestion.

7

Effect of eating time on lactation performance

Data expressed as expected response for each min of increased eating time

Item	n	effect	*P*-value
Milk, lb/d	415	-0.053	0.001
3.5% FCM, lb/d	415	-0.024	0.03
ECM, lb/d	405	-0.035	0.001
Milk protein, %	405	-0.0005	0.04
Milk protein, lb/d	405	-0.0020	0.001

Adapted from Krentz et al., 2018; ADSA Abstract

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Forage NDF digestibility and cow performance

For every 1 percentage-unit increase in NDF digestibility
- +0.40 lb/d DMI
- +0.55 lb/d 4%FCM

(Oba and Allen, 1999)

>40% corn silage in diet
- +0.26 lb/d DMI
- +0.31 lb/d 3.5%FCM

(Jung et al., 2010)

Slide courtesy of Dr. Rick Grant, Miner Institute

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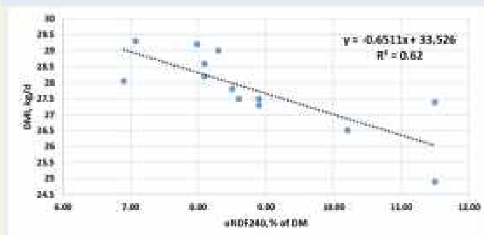
uNDF and intake



uNDF Intake – 0.25 to 0.45% of BW

Adapted from slide by Dr. Rick Grant, Miner Institute

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Fiber digestibility and chewing behavior

Study	Intake	Eating time
Grant et al., 1994	88.3	120.7
Aydin et al., 1999 Exp. 1	85.0	117.9
Aydin et al., 1999 Exp. 2	95.6	105.6
Oliver et al., 2004	95.5	114.9

Data presented as percentage of control treatment

Grant and Ferraretto, 2018; JDS

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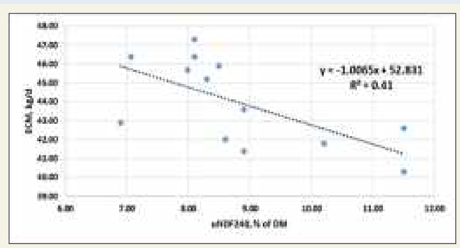
uNDF and ECM Yield



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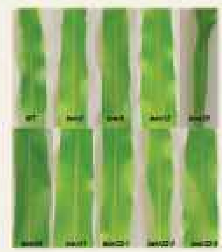
Brown mid-rib mutant hybrids

- BMR mutation reduces forage lignin
- Characteristic brown mid-rib color
- Markedly improved digestibility outweighs lower yields



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Pools and uNDF of forages

Parameter	BMR	Conventional	Alfalfa hay	Alfalfa silage	Alfalfa silage
aNDFom, % DM	43.8	41.3	38.8	38.1	40.9
uNDFom, % aNDFom	23.7	30.3	51.3	36.2	42.8
Fast pool, % aNDFom	67.8	8.8	35.7	55.2	33.4
Slow pool, % aNDFom	8.5	60.9	13.0	8.7	23.9

Adapted from Zontini and Van Amburgh

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Nutrient composition of corn hybrids

Item	BMR	CONS	*P*-value
DM, % as fed	33.7	33.9	0.27
CP, %DM	8.1	7.8	0.07
NDF, %DM	43.0	42.8	0.34
Lignin, %DM	2.0^{b}	2.9^{a}	0.001
ivNDFD, % NDF[1]	58.1	46.7	0.001
Starch, %DM	28.7^{ab}	29.7^{a}	0.05

[1]Ruminal in vitro NDF digestibility after 30 or 48 h of incubation

Ferraretto and Shaver, 2015

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Does uNDF explain intake changes?

Parameter	BMR	LFY
Diet NDF, % DM	29.4	30.1
Diet uNDF, % DM	8.4	8.9
30 h ivNDFD, % of NDF	50.9	44.1
Intake of DM, lb/d	61.9	58.1
Intake of uNDF, lb/d	5.15	5.11
Intake of uNDF, % BW	0.32	0.31
Milk, lb/d	107.9	103.1

Adapted from Lopes et al., 2015 – using diets from Ferraretto et al., 2015

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Effect of BMR corn silage on lactation performance

Item	Control	Difference
DMI, lb/d	53	+2
Milk, lb/d	82.2	+3.3
Fat, %	3.63	-0.11
MUN, mg/dL	15	-1
NDFD, % NDF	42.3	+2.5
TTSD, % Starch	92.7	-1.4

Adapted from Ferraretto and Shaver, 2015

17

Diet ingredient and nutrient composition

	Week 1 to 7		Week 8 to 14	
Ingredient, % DM	BMR	LFY	BMR	LFY
Corn Silage	41.8	41.8	41.8	44.2
Alfalfa Silage	20.6	20.6	20.6	20.6
Wheat Straw	2.4	2.4	2.4	0.0
Concentrate	35.2	35.2	35.2	35.2
Nutrient, % DM				
CP	17.3	16.6	17.6	17.0
NDF	29.4	32.0	29.4	29.1
Lignin	3.5	3.9	3.5	3.5
Starch	23.1	21.4	22.6	22.8

Ferraretto et al., 2015

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Lactation performance

Item	BMR	LFY	*P*-value
DMI, lb/d	61.9	58.1	0.01
Milk, lb/d	107.9	103.1	0.05
ECM, lb/d	111.2	107.9	0.07
Fat, %	3.83	4.05	0.01
Protein, %	3.27	3.27	0.98
MUN, mg/dL	15.6	16.8	0.001

No interactions between treatment and week or period were detected.

Ferraretto et al., 2015

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Interaction with forage concentration?

	Control Silage		BMR Silage		*P*-value		
Item	Low	High	Low	High	H	F	Int
Eating time, min/d	273	301	250	273	0.01	0.01	0.73
Rumination time, min/d	514	543	463	536	0.08	0.01	0.17
Meal length, min/meal	29.2	31.3	27.5	28.4	0.11	0.28	0.64
Meal bout, bouts/d	11.8	12.1	11.5	11.9	0.45	0.33	0.95

Miller et al., 2021

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Interaction with forage concentration?

	Control Silage		BMR Silage	
Nutrient, % DM	Low	High	Low	High
CP	17.0	17.0	16.7	16.7
aNDFom	30.8	33.7	30.7	33.5
ADL	3.1	3.6	2.7	2.9
Starch	28.0	21.2	27.8	23.8
24 h ivNDFD, % NDF	56.3	54.0	62.0	60.0
uNDFom	8.2	9.6	6.9	7.6

Miller et al., 2021

21

Predicting the benefits of CH

- Several studies have evaluated the influence of cutting height corn silage yield and quality
- However, an evaluation across multiple studies has yet to be conducted
- Our objective was to assess the influence of cutting height on nutrient composition and yield of whole-plant corn silage through a meta-analysis

22

Interaction with forage concentration?

	Control Silage		BMR Silage		*P*-value		
Item	Low	High	Low	High	H	F	Int
DMI, lb/d	63.9	58.4	64.5	64.3	0.01	0.01	0.02
uNDFom, lb/d	19.4	19.8	19.2	20.9	0.07	0.01	0.02
uNDFom, %BW	0.35	0.38	0.29	0.32	0.01	0.01	0.97
Milk, lb/d	103.5	94.9	107.0	104.0	0.01	0.01	0.15
ECM, lb/d	109.0	101.1	111.9	110.4	0.02	0.05	0.16
Milk fat, %	3.82	4.02	3.76	3.94	0.27	0.01	0.84
Milk protein, %	3.06	2.92	3.10	3.02	0.01	0.01	0.05

Miller et al., 2021

23

Cutting Height Equations

Data expressed as expected response for each 10-inches of increased chop height

Item	n	Effect	*P* - value
DM, % of as fed	62	2.18	0.02
Starch, % of DM	55	2.08	0.01
NDF, % of DM	64	-2.48	0.001
Lignin, % of DM	25	-0.29	0.08
NDFD[1], % of NDF	49	2.02	0.01
DM yield, ton/acre	52	-0.52	0.001

[1]NDFD = ruminal in vitro or in situ NDF digestibility at 30 or 48 h

Adapted from Paula et al., 2019; ADSA Abstract

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Simulation

	CS	High-cut CS	High-cut simulation
Cutting height, inches	10	25	25
NDF, % of DM	38.9	34.6	35.1
Starch, % of DM	39.0	44.1	42.1
NDFD, % of NDF	65.2	69.0	68.2

Data adapted from Diepersloot et al., unpublished
Simulation performed with equations by Paula et al., 2019

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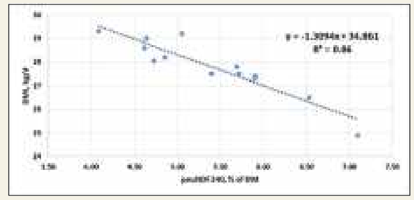
peuNDF and intake



Adapted from slide by Dr. Rick Grant, Miner Institute

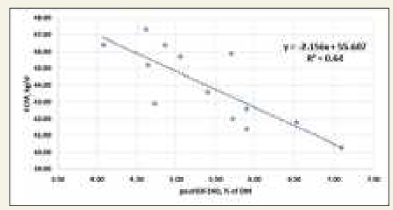
26

Particle Size

The PSPS procedure is conducted manually using 3 sieves (19-mm, 8-mm, and 1.18-mm) and a pan (Kononoff et al. (2003)

27

peuNDF and ECM Yield



Adapted from slide by Dr. Rick Grant, Miner Institute

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Particle Size

Sieve	Why does it matter?
19 mm	Sortable particles, may affect silage density and eating time
8 mm	Physically effective fiber
1.18 or 4 mm	May provide physical effective fiber / intact kernels
Pan	Broken kernels / small fiber fraction

If using specific theoretical length of cut – why do we need to measure particle size?

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Conclusions

- Many factors alter fiber digestibility of whole-plant corn silage
- Initial data evaluating uNDF is promising, but interactions with other factors (i.e. forage NDF, starch, particle size) may play a major role
- Fiber digestibility modulate feeding behavior patterns

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Questions

ferraretto@wisc.edu

Linkedin.com/in/luiz-ferraretto-7a726731

ferraretto_ruminant_nutrition

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Four-State Dairy Nutrition & Management Conference

Dairy Heifer Coccidiosis Research With Novel Egg

Dr. Matt Akins
University of Wisconsin

Dairy Heifer Coccidiosis Research With Novel Egg Antibodies

Matt Akins, Abbey Niebuhr, Cherrie Nolden,
Dan Schaefer, Mark Cook
UW-Madison Animal and Dairy Science

This project was supported by the USDA National Institute of Food and Agriculture, Hatch project 1013011.

Extension

1

Overview

- Coccidiosis lifecycle
- Development of egg-based antibodies at UW
- Recent UW research with dairy heifers

2

What is Coccidiosis?

Disease caused by the protozoa of the genus *Eimeria* (coccidia) that invade the animal's intestinal lining

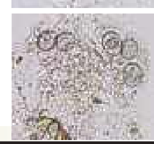
- Certain species pathogenic to cattle
  - E. *bovis* and E. *zurnii*
- Common from 1 month to 1 year old
  - Especially during stress events
  - Develop immunity with exposure

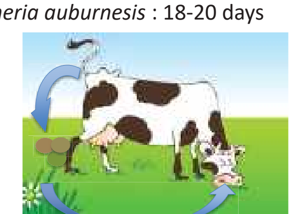
- Recent US NAHMS study in weaned beef calves reported over a 60% prevalence from 99 operations (Stromberg et al., 2015)

3

Bovine Eimeria species

Common species and incubation times:
Eimeria zurnii: 15-20 days
Eimeria bovis: 15-20 days
Eimeria auburnesis : 18-20 days





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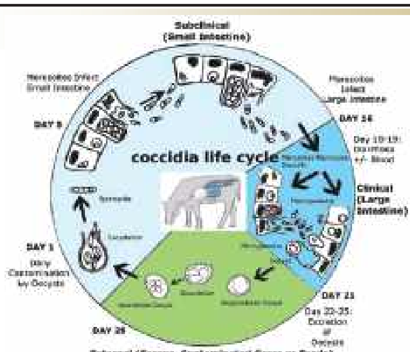


https://www.corid.com/Coccidia.html

5

Coccidiosis Symptoms

- Variable signs depending on ingested oocyst load
- Small % typically clinical; high portion sub-clinical
  - Decreased feed intake and growth

Clinical signs

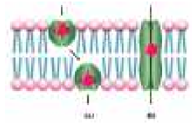
- Condition loss; anorexia
- Severe, watery diarrhea
- Straining to defecate
- Damage to intestinal cells can cause bloody feces
- Death (due to electrolyte loss/dehydration)

https://www.vetent.co.nz/dairy-disease-management/coccidiosis.html

6

Coccidiostats

- Monensin/Lasalocid - ionophores
  - -act by increasing transfer of ions into cell
  - -cell use energy to transport ions out of cell
  - -Also acts on rumen bacteria to improve efficiency



en.wikipedia.org/wiki/ionophore

- Decoquinate
  - -Disrupts energetic functions in the cell

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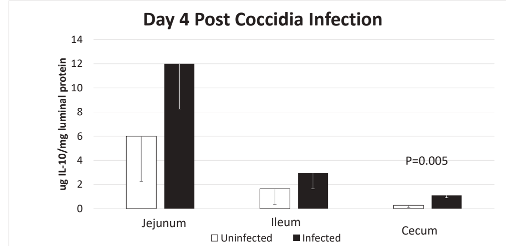
UW Research – Egg-based antibodies

-Mark Cook's lab found that *Eimeria* infected chickens had elevated levels of interleukin-10 in the intestines



Cook et al., 2016

8

Interleukin 10

- Anti-inflammatory cytokine
  - Immune system communication molecule
- Inhibits activity of immune cells that attack pathogens
- IL-10 is secreted from regulatory T cells after infection cleared
- IL-10 suppresses other inflammatory cytokines

Couper et al., 2008

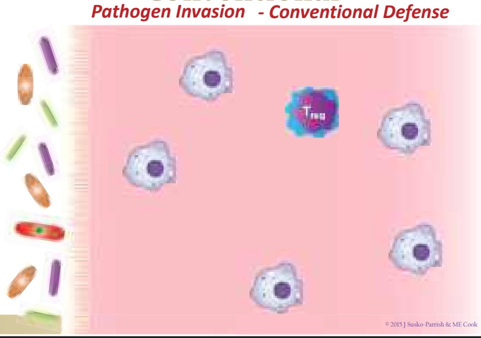
9

Mucosal Microenvironment

10

Conventional

Pathogen Invasion - Conventional Defense



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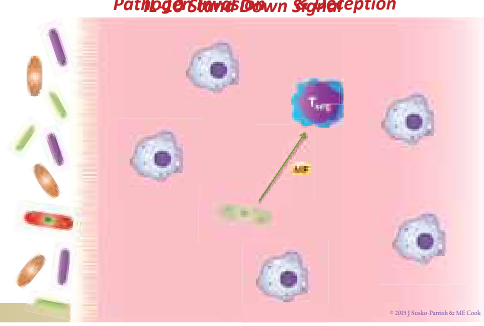
Deception

Pathogen Invasion & Deception

IL-10 Stand Down Signal



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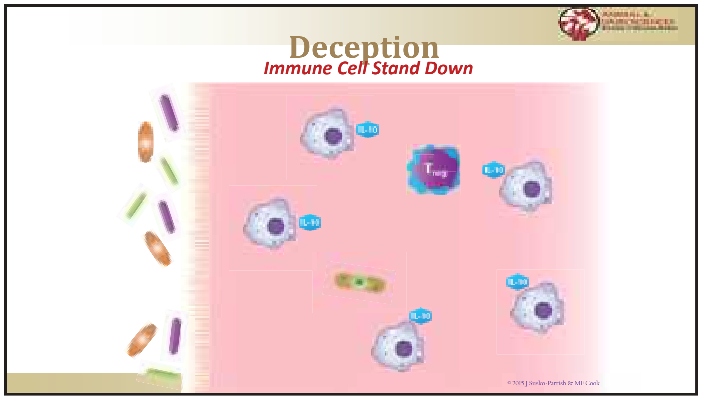

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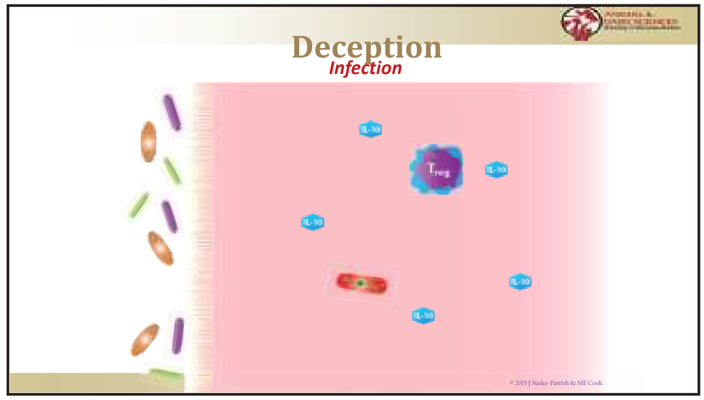

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Anti IL-10 Current thinking

- **By binding IL-10:**
- Pathogens are no longer able to suppress an adaptive immune response
- Adaptive immunity is initiated at onset of infection and pathogen is cleared by normal immune processes
- Animal is able to generate long term immunity to a certain pathogen

Cook et al., 2016

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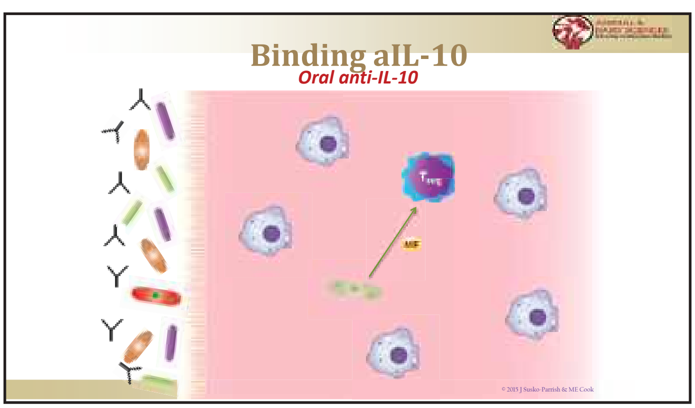
Where/How is Anti IL-10 made?

- Made by immunized laying hens
- aIL-10 is found in the egg yolks
  - Not found in egg albumen
  - Can be pasteurized
- Developed by Dr. Mark Cook

16



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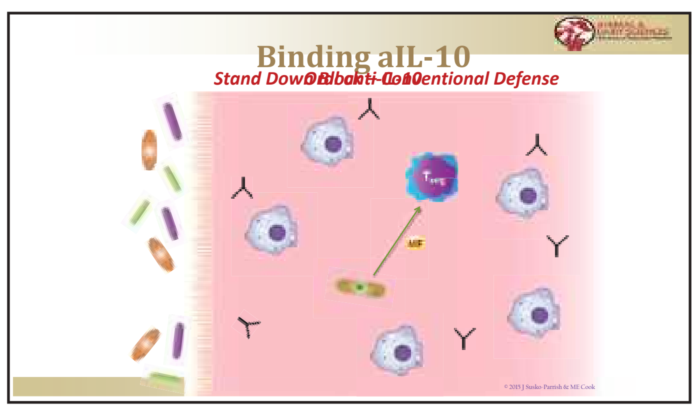

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IL-10 antibody in *Eimeria*-infected broilers

Table 1. Experiment 1. Effects of anti-IL-10 on performance of chicks challenged with *Eimeria* spp.

Diet	Weight (Grams) Control	Weight (Grams) *Eimeria*	Feed Conversion[1] Control	Feed Conversion[1] *Eimeria*	Oocyst/Gram Excreta Control	Oocyst/Gram Excreta *Eimeria*
Control	670[a]	611[b]	1.82	1.75	3,890	119,700
Anti-IL-10	629[ab]	659[ab]	1.65	1.6	6,030	41,600
SEM	27.8		0.157		12,210	
P Values						
Antibody	0.78		0.19		0.06	
Eimeria	0.12		0.41		0.008	
Antibody × *Eimeria*	0.0341		0.94		0.0715	

[1]Feed conversion was calculated by divided the feed consumption by the total cage weight n = 10.

[a,b]Means with different superscript in the same column were significantly different ($P < 0.05$).

Sand et al., 2016

20

Previous Research – Beef Cattle

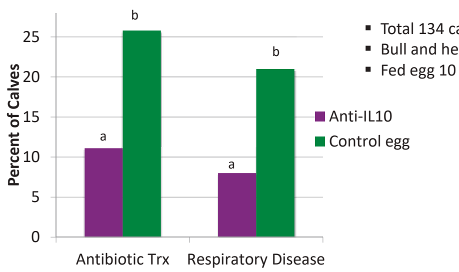
Feeding aIL-10 to newly arrived feedlot steers and effects on growth performance and antibiotic usage

	Control	aIL-10	SEM	*P*- value
No. of pens (steers)	9 (56)	9 (57)	-	-
Initial wt, lb	653	653	16.6	0.77
Final wt, lb	860	873	19.1	0.14
ADG, lb	3.26	3.48	0.11	0.13
DMI, lb	17.8	18.0	0.44	0.84
G:F	0.182[b]	0.193[a]	0.003	0.04
BRD treatment, %				
1X	16	16	5.4	0.97
2X	7	0	2.6	0.09

Schaefer et al.,2016

21

UW Vet School Calf Research



- Total 134 calves
- Bull and heifer calves
- Fed egg 10 days

Rabbis et al., 2018

22

UW Dairy Heifer Research

- Evaluate the use of aIL-10 in newly relocated dairy heifers and its effect on:
  - disease incidence
  - growth
  - feed conversion

<u>Hypothesis:</u>
Feeding aIL-10 will allow heifers to more quickly develop immunity to *Eimeria*

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2018 Dairy Heifer Research

20 pens of heifers with 8 animals per pen
<u>4 Treatments</u>:
- Ionophore (sodium monensin; 150 mg/hd/d)
- Anti IL-10 (egg yolk with IL-10 antibodies)
  - Fed for 14 days after arrival
- Egg Control (egg yolk without IL10 antibodies)
- Negative control

- Heifers transported from Arlington to Marshfield at 3 Months of age

- Tracked intakes, growth, and sampled blood and feces
  - Fecal floats to measure coccidia
  - Blood immunoglobulins

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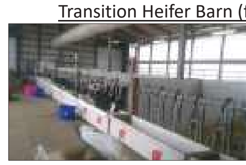
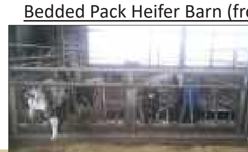
Marshfield ARS Heifer Facilities

<u>Transition Heifer Barn (from 3 to 4 months of age)</u>



<u>Bedded Pack Heifer Barn (from 4 months of age until bred)</u>



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Extension

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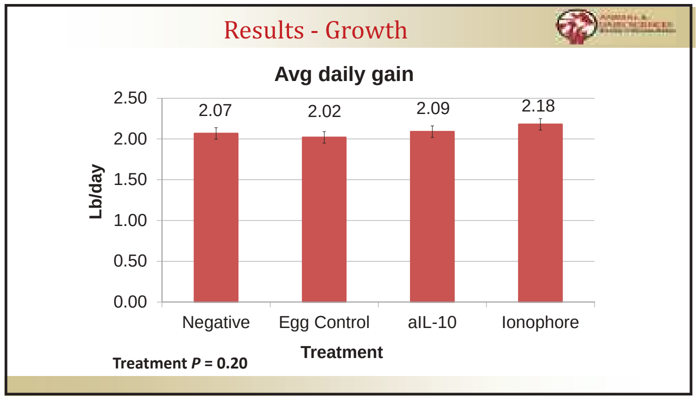

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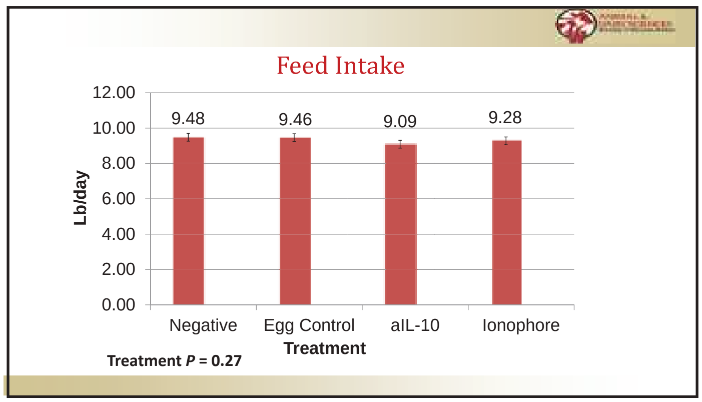

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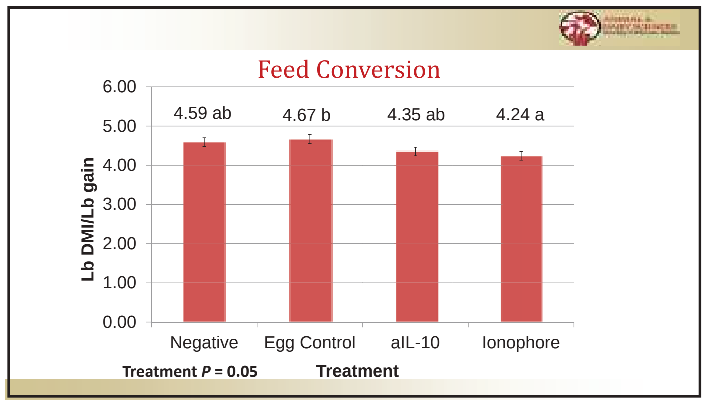

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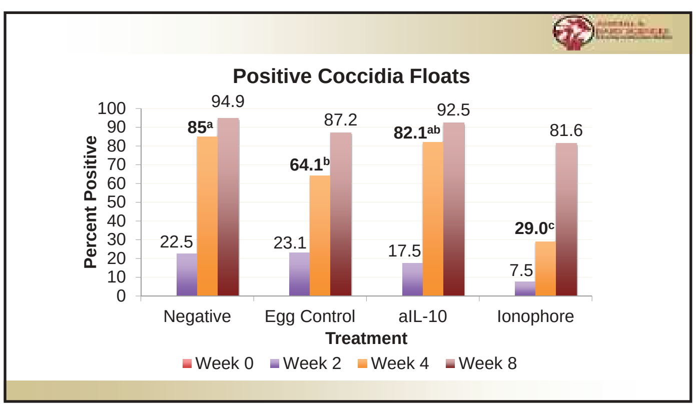

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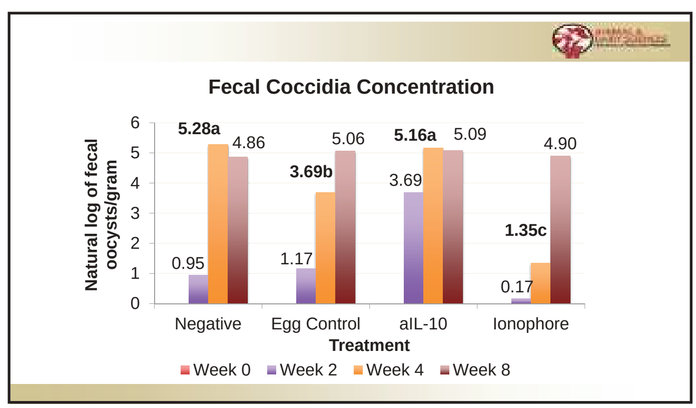

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Extension

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2019 Dairy Heifer Research

20 pens of heifers with 8 animals per pen

4 Treatments:

- Ionophore (sodium monensin; 150 mg/hd/d)
- Anti IL-10 (egg yolk with IL-10 antibodies)
  - ***Fed for 14 days from week 2 to week 4 after arrival***
- Egg Control (egg yolk without IL10 antibodies)
- Negative control

- Heifers transported from Arlington to Marshfield at 3 months of age

- Tracked intakes, growth, and sampled blood and feces
  - Fecal floats to measure coccidia
  - Blood immunoglobulins

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2019 Results

- No difference in daily gain across treatments but ionophore numerically higher growth
- Feed efficiency tended to be improved for ionophore
- Similar trends in fecal oocysts prevalence/concentrations as previous study
- Lower clinical digestive treatments for ionophore
- Higher respiratory treatments for Egg Control

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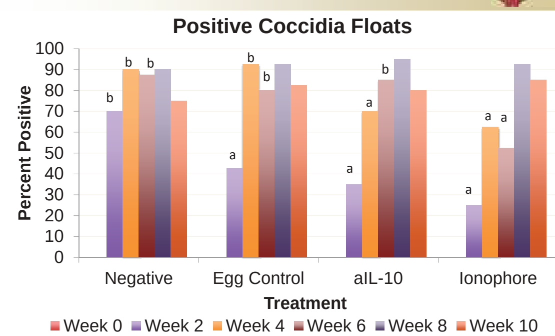

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Summary

- Cleanliness and management critical to control
- Coccidiostats delayed oocyst shedding and reduced treatments
  - Similar oocyst shedding by end of trial
- Anti IL-10 has not shown improved growth or efficiency compared to Control or Ionophore
  - Impact of feeding rate or rumen degradation?

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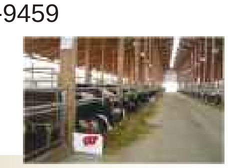
Thank You!
Questions?

www.fyi.uwex.edu/heifermgmt
msakins@wisc.edu
715-384-9459



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Four-State Dairy Nutrition & Management Conference

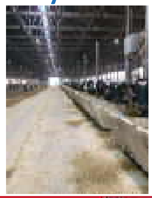
Opportunities to Combine Genetics with New Technologies to Improve Feed Efficiency in Dairy Cattle

Dr. James Koltes
Iowa State University

IOWA STATE UNIVERSITY

Opportunities to combine genetics with new technologies to improve feed efficiency in dairy cattle

Dr. James E Koltes
Assistant Professor
Dairy Genetics
jekoltes@iastate.edu



1

The dairy industry continues to improve sustainability

2

Feed Intake is a major part of sustainability

- Feed accounts for upwards of 40% - 50% of production costs (USDA - ERS, 2017).
- Improving feed efficiency is an opportunity to continue to reduce the environmental footprint of dairy cattle.
- Equipment to measure individual feed intake is expensive and requires additional labor.
  - Precision livestock technologies may provide lower cost opportunities as feed intake proxies
- A 1% genetic gain in feed efficiency = ~$4.5 million/year to the U.S. dairy industry (VanRaden, 2017.)

3

Genetic tools to enhance feed efficiency

4

A national effort to boost feed efficiency in Holstein Dairy cattle (2019-2024)

Improving dairy feed efficiency, sustainability and profitability by impacting farmer's breeding & culling decisions.

Feed Efficiency Team: Mike Vandehaar, Rob Tempelman, Kent Weigel, Heather White, Jose Santos, Francisco Penigaricano, James Koltes, Randy Baldwin, Paul Van Raden, Kristen Gaddis

CDCB FFAR USDA AGIL

5

Objectives of the FFAR Dairy Feed Efficiency Project

Project Aims:

1) Increase reliability of genomic predictions for feed efficiency→ Collect feed intake on 3600 cows

2) Implement a plan to update the feed intake reference population → with CDCB

3) Develop sensor-based analytics to predict dry matter intake → ID indicators of feed intake

4) Study associations between feed efficiency and methane emissions

FFAR CDCB USDA

6

Development of feed efficiency genetic selection tool: PTA Feed Saved

- Feed Saved predicted transmitting ability (PTA) represents the expected pounds of feed saved per lactation by accounting for differences in individual body weight and dry mater intake.
- Larger, positive values are more favorable.
- Feed Saved $h^2 = 0.14$
- Feed Saved is calculated to be unrelated (correlation ~0) with other traits.
  - Adjusted for : milk energy traits and body weight (factors impacting maintenance)
  - Combines information about residual feed intake and maintenance energy estimates

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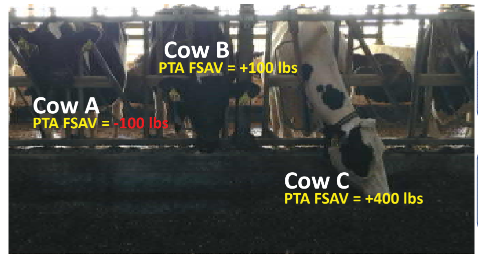
7

What Does Feed Saved (FSAV) look like in practice?



Positive Values are better!

Cow B vs. A:
100 - -100 = 200lbs * 2 = **400lbs less feed consumed per lactation on average by Cow B.**

Calves from cow C vs. A:
400 - -100 = **500lbs less feed consumed per lactation on average by heifers of Cow C.**

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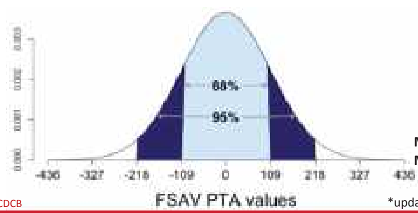
What are the typical differences we will expect in PTA Feed Saved (FSAV) for bulls?

68% bulls: +109 and -109 lbs PTA FSAV:
up to 218lbs feed/ lactation daughter differences expected for these bulls



218 lbs. feed/ lactation X 3 lactations=
654 lbs. feed less/ lifetime

Maximum PTA FSAV: 633 lbs.*
Minimum PTA FSAV: -822 lbs.

Data courtesy CDCB

*update: 2021: 1700 lbs PTA difference!

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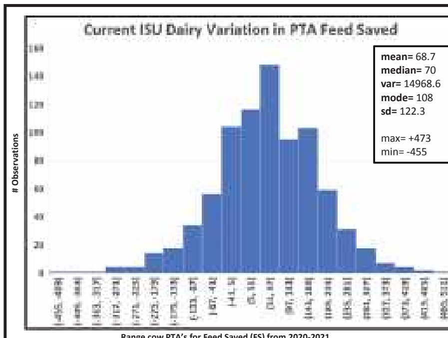

Genetics Impact
- Offspring difference: 923lbs less feed *(adjusted by milk prod. & body weight.)*

Feed Intake Impact
923 x 2 = 1846lbs less / lactation

Profitability Impact
- Extreme cows eat $461.00 **more feed** per lactation at the same milk production.

Bottom Cows Compared to Average
- Bottom 20 cows cost us about $2,555.00/ year more in feed than the average cow.

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10

How is Feed Saved related to other important traits?

Trait	Genetic Correlation
Milk yield	0.002
Protein yield	0.02
Fat yield	-0.02
SCS	-0.02
Productive Life	0.04
Livability	0.15
Daughter Pregnancy Rate	0.10
Health Traits	0.10

Uncorrelated (Independent) from production traits

Data courtesy CDCB- bulls born since 2000 with NM$ > 90%

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11

Data Collection for the Feed Saved PTA

- Collecting Feed Intake is expensive!
- Each cow: 28-42days of feed intake data
- >5200 cows have contributed data (May 2021)

Funder 1 USDA
2010-2015
$5,000,000
4753 cows

Funder 2 FFAR CDCB
2019-2024
$2,000,000
3600 cows

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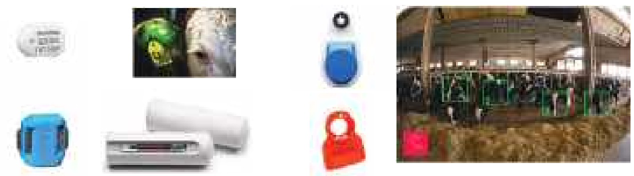
Expected Economic Impact of Feed Saved (FSAV)

- $8 million / year estimated savings based on FSAV variation, reliability, feed costs.
- FSAV could be 3rd most important trait in $NM index in August 2021
- Because REL is lower for PTA FSAV, $NM REL will be lower when FSAV is included.
  - FSAV will increase profitability over current $NM index version.

13

Precision technologies as proxies for feed intake

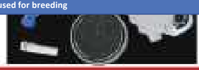


14

Goals for Precision Technologies in Predicting Feed Efficiency

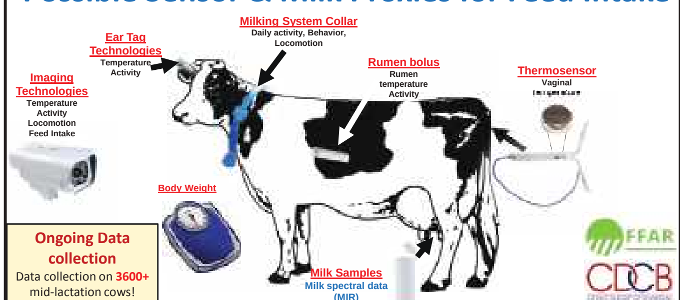
Goal: Increase the accuracy of predicting feed intake* by adding *sensor data* to feed intake, body weight, production traits and genomic data

*PTA Feed Saved = new feed efficiency trait used for breeding



15

Possible Sensor & Milk Proxies for Feed Intake

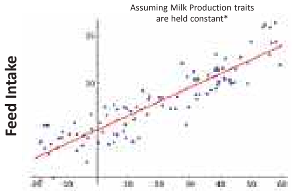


Ongoing Data collection
Data collection on 3600+ mid-lactation cows!

16

How do we know if a sensor was a good indicator of feed intake?

Consistent association with Feed Intake



Favorable relationship with other traits of interest under selection

Reduced incidence of Health problems

Increased sensor measure (increased feed efficiency)

*Assumes specific milk components do not require a lot more feed

17

Experiment 1: Are sensor measures associated with feed intake in lactating Holstein cows?

18

Are sensor measures associated with adjusted dry matter intake?

Sensor Measures associated with feed intake (p<0.05)

- Ear tag activity[1]
- Rumen Bolus activity[2]
- Rumen temperature[3]

Sensors that may be associated with feed intake (0.05<p<0.10)

Rumen pH



[1] = 107 cows
[2] = 57 cows
[3] = 41 cows

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Does temperature (THI) impact sensor relationships with feed intake?



Sensor Measures impacted by THI(p<0.05)

- Ear tag activity
- Ear tag temperature
- Rumen Bolus activity
- Rumen temperature
- Rumen pH

Sensors who's relationship with feed intake may change with heat stress (p<0.05)

- Ear tag activity
- Ear tag temperature

THI calculated as described: Johnson, 1965

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Does health status affect sensor associations?

Questions considered:

- How do health events* impact the ability of a sensor to detect differences in feed intake?
- What's the impact of health events on feed intake/ efficiency?

Possible Health event categories:

Lameness
Mastitis
Multiple
Other (injury)

*35 cows with health events

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How do health events impact sensor associations with feed intake?

Sensor Measures impacted by health(p<0.05)

- All activity and temperature measures
- Rumen pH
- Rumination

Sensors who's relationship with feed intake change with different health events (p<0.05)

- All sensor measurements

Health events evaluated: Lameness, Mastitis, Other (injury), Multiple events

- Health event evaluated during the clinical illness event only

Lameness (N = 11 animals; 154 days)
Mastitis (N = 17 animals; 291 days)

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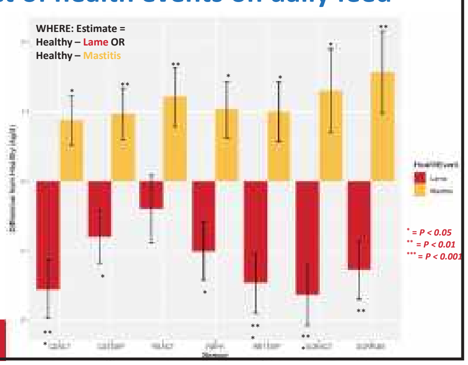
Estimated impact of health events on daily feed efficiency

1kg = 2.2 lbs



Lameness (N = 11 animals; 154 days)
Mastitis (N = 17 animals; 291 days)

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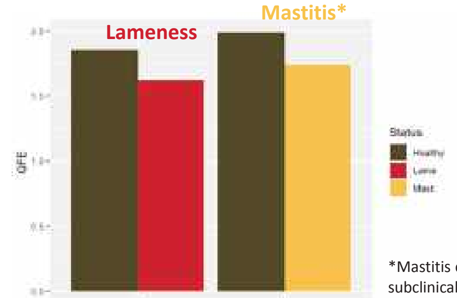
Health events appear to decrease Gross Feed Efficiency



*Mastitis cases were subclinical in this study.

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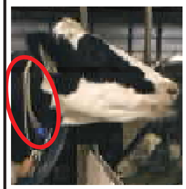
Is Milk Collar Activity Associated With Dry Mater Intake ?



N = 676 cows

- $Y_{ijk} = \mu + Activity_k + CG_i + Parity_j + Cow_k + \varepsilon_{ijk}$

Variable	Estimate (kg DMI)	P-value
Log Activity	0.362	<0.05

- Increase in daily activity → increase in intake

Boumatic/ Nedap activity monitors

25

Next Question: If you can relate sensors to feed intake, can we predict feed intake?

Sensor	Base Model r^2 (MSE)	Sensors Added r^2 (MSE)
Ear tag	0.4477 (12.50)	0.4576 (12.32)
Rumen bolus	0.4298 (13.25)	0.4635 (12.53)

Change in Prediction Accuracy
+1% boost from ear tags*
+4% boost from rumen bolus

*Currently being replicated with larger datasets

26

Milk Spectral Data also appears promising

J. Dairy Sci. 101:5878–5889
https://doi.org/10.3168/jds.2017-13997
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Mining data from milk infrared spectroscopy to improve feed intake predictions in lactating dairy cows

J. R. R. Dórea, G. J. M. Rosa, K. A. Weld, and L. E. Armentano

J. Dairy Sci. 101:6232–6243
https://doi.org/10.3168/jds.2017-13874
© American Dairy Science Association®, 2018.

Milk mid-infrared spectral data as a tool to predict feed intake in lactating Norwegian Red dairy cows

S. E. Wallén, E. Prestløkken, T. H. E. Meuwissen, S. McParland, and D. P. Berry

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Take home points

- *PTA feed saved* is a new genetic tool to select more feed efficient cattle
- Multiple sensors are being investigated as potential predictors of feed intake in Holstein dairy cows
- Sensor measurements have been associated with feed intake and health
- Heat stress and illness (mastitis and lameness) impact how sensor measures relate to feed intake
- Mild mastitis and lameness are costing 2 to 6 lbs. lost feed efficiency/cow/day.
- FFAR/CDCB Project Plan: test if sensor measurements & milk spectral data are useful to improve the accuracy of feed intake prediction tools
- **Sensor data appears promising for predicting feed intake**

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Acknowledgements

Improving dairy feed efficiency, sustainability and profitability by impacting farmer's breeding & culling decisions.

FFAR

CDCB

The Dairy Feed Efficiency Team

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Four-State Dairy Nutrition & Management Conference

Using Summer to Winter Ratios to Evaluate Summer Slump

Dr. Derek Nolan
University of Illinois

Using Summer : Winter Ratios to Evaluate Summer Slump

Four-State Dairy Nutrition & Management Conference

Dairy Extension

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Derek T. Nolan, Ph.D
4-State Dairy Nutrition and Management Conference
June 9 and 10, 2021

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Battling Heat Stress

- Temperature humidity index above 68
- Risks of increased disease incidence and lower milk production
- Somatic cell count, body condition scoring, lameness scoring
- Summer to winter ratio to measure effectiveness of heat abatement strategies

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2

What is a summer to winter ratio?

- Extension Service of the Ministry of Agriculture and Israel Cattle Breeders Association
- Metric used to quantify seasonal effects on cow performance

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What is a summer to winter ratio?

- Summer production value divided by winter production value
- A ratio under 1 = reduced performance in summer
- SCC or SCS – higher ratios = higher SCC in summer
- $\frac{\text{summer performance variable}}{\text{winter performance variable}} = \frac{25}{25} = 1.00$

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4

Ratio Examples

- $\frac{\text{summer milk production}}{\text{winter milk production}} = \frac{23 \text{ kg (51 lb)}}{28 \text{ kg (62 lb)}} = 0.82$
- $\frac{\text{summer SCS}}{\text{winter SCS}} = \frac{3.5}{3.0} = 1.17$

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5

J. Dairy Sci. 102:11777–11785
https://doi.org/10.3168/jds.2018-16170
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Comparing dairy farm milk yield and components, somatic cell score, and reproductive performance among United States regions using summer to winter ratios

Jenna M. Guinn,[1] D. T. Nolan,[1] P. D. Krawczel,[2] C. S. Petersson-Wolfe,[3] G. M. Pighetti,[2] A. E. Stone,[1,4] S. H. Ward,[4,5] J. M. Bewley,[6] and Joao H. C. Costa[1]
[1]Department of Animal and Food Sciences, University of Kentucky, Lexington 40506
[2]Department of Animal Science, University of Tennessee, Knoxville 37996
[3]Department of Dairy Science, Virginia Polytechnic Institute and State University, Blacksburg 24061
[4]Department of Animal and Dairy Science, Mississippi State University, Starkville 39762
[5]Department of Animal Science, North Carolina State University, Raleigh 27607
[6]Alltech, Nicholasville, KY 40356

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- Collected from 2007 to 2016
- Summer = June 21 to September 21
- Winter = December 21 to March 19

7

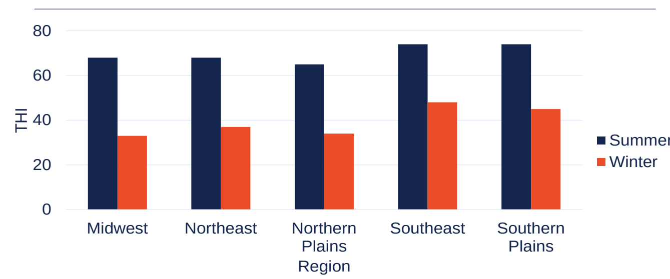
- Energy corrected milk (ECM)
- Fat percent
- Protein percent
- Somatic cell score
- Conception rate
- Pregnancy rate
- Heat detection rate

8

US Regions

9

Summer and winter THI by region



10

Milk Production Variables

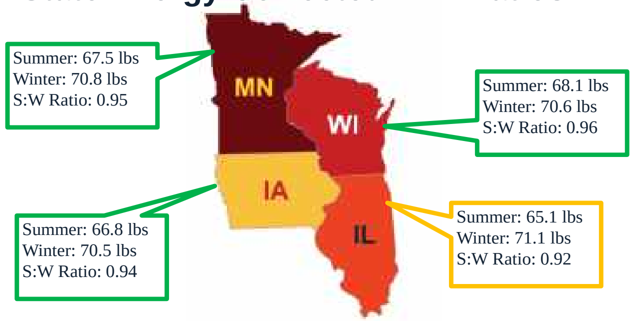
11

Regional Benchmarks – ECM

Percentile	Midwest	Northeast	Northern Plains	Southeast	Southern Plains	Total
75th	0.99	0.99	0.97	0.94	0.93	0.99
50th	0.94	0.94	0.93	0.89	0.88	0.94
25th	0.89	0.89	0.88	0.84	0.82	0.89

12

4-State Energy Corrected Milk Ratios



13

Regional Benchmarks – SCS

Percentile	Midwest	Northeast	Northern Plains	Southeast	Southern Plains	Total
75th	1.14	1.17	1.09	1.15	1.18	1.15
50th	1.04	1.06	1.00	1.05	1.07	1.05
25th	0.95	0.96	0.91	0.97	0.97	0.95

14

4-State Somatic Cell Score Ratios

15

Regional Benchmarks – Fat %

Percentile	Midwest	Northeast	Northern Plains	Southeast	Southern Plains	Total
75th	0.98	0.97	0.97	0.99	0.99	0.98
50th	0.95	0.95	0.93	0.95	0.95	0.94
25th	0.91	0.91	0.90	0.91	0.91	0.90

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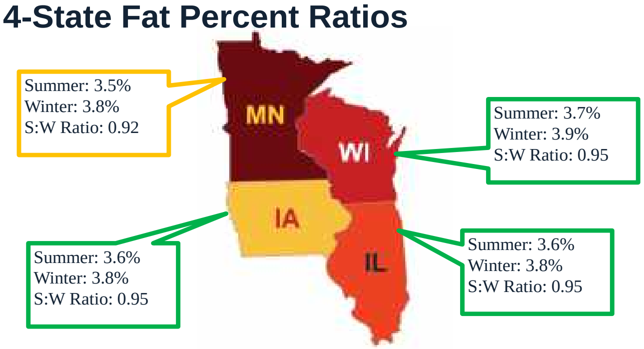
4-State Fat Percent Ratios



17

Regional Benchmarks – Protein %

Percentile	Midwest	Northeast	Northern Plains	Southeast	Southern Plains	Total
75th	0.98	0.99	0.97	0.99	0.99	0.98
50th	0.96	0.97	0.95	0.97	0.96	0.97
25th	0.94	0.95	0.93	0.95	0.94	0.94

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4-State Protein Percent Ratios

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Reproduction Variables

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Regional Benchmarks – CR

Percentile	Midwest	Northeast	Northern Plains	Southeast	Southern Plains	Total
75th	1.06	1.09	1.05	1.00	1.02	1.07
50th	0.89	0.89	0.87	0.81	0.80	0.88
25th	0.73	0.72	0.71	0.64	0.64	0.71

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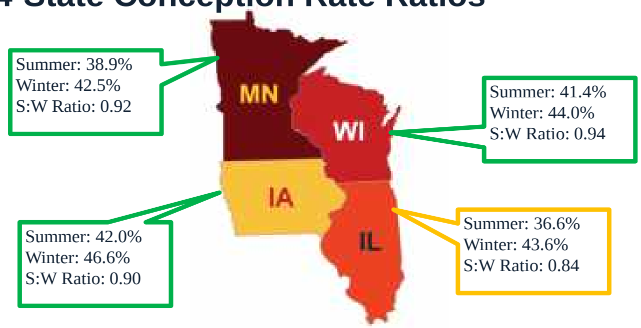
4-State Conception Rate Ratios



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Regional Benchmarks – HDR

Percentile	Midwest	Northeast	Northern Plains	Southeast	Southern Plains	Total
75th	1.09	1.12	1.10	1.06	1.02	1.10
50th	0.95	0.96	0.95	0.91	0.86	0.95
25th	0.80	0.82	0.78	0.76	0.70	0.81

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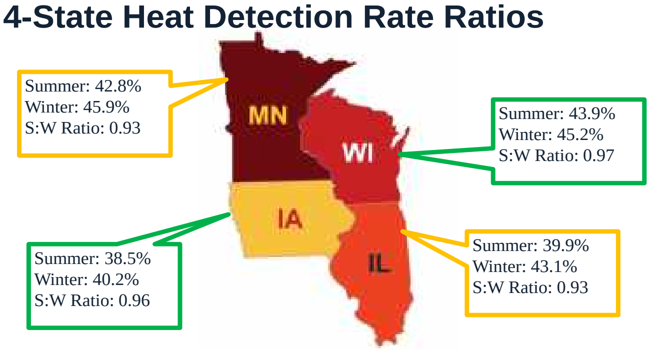
4-State Heat Detection Rate Ratios



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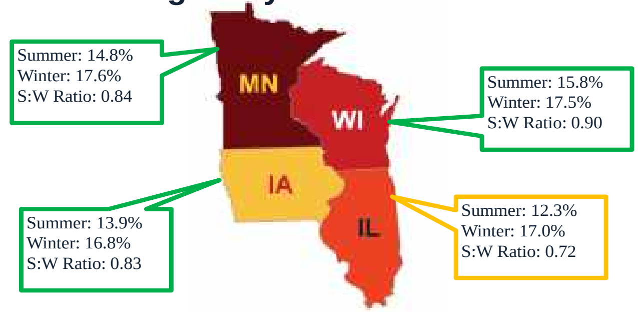
Regional Benchmarks – PR

Percentile	Midwest	Northeast	Northern Plains	Southeast	Southern Plains	Total
75th	1.04	1.09	1.03	0.86	0.79	1.06
50th	0.81	0.84	0.79	0.64	0.59	0.81
25th	0.62	0.63	0.58	0.47	0.45	0.61

25

4-State Pregnancy Rate Ratios



26

What strategies are effective for increasing (or decreasing) S:W Ratio?

27


J. Dairy Sci. 102:11777–11785
https://doi.org/10.3168/jds.2019-16170
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Comparing dairy farm milk yield and components, somatic cell score, and reproductive performance among United States regions using summer to winter ratios

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[4]Department of Animal and Dairy Science, Mississippi State University, Starkville 39762
[5]Department of Animal Science, North Carolina State University, Raleigh 27607
[6]Alltech, Nicholasville, KY 40356

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Southeast Quality Milk Initiative

- Completed over 122 farm assessments on farms in Southeast region
- A single on-farm assessment was conducted over 2014 to 2015
  - Survey
  - Housing assessment

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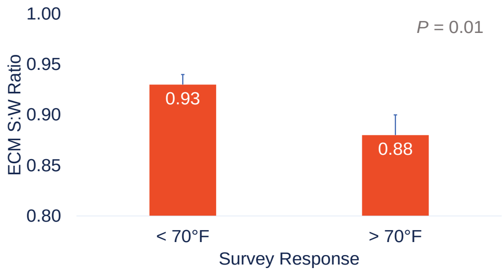
Milk Production Variables

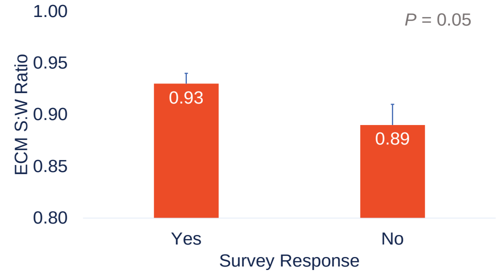
30

Herds that turned on fans at lower temperatures had higher ECM S:W Ratios



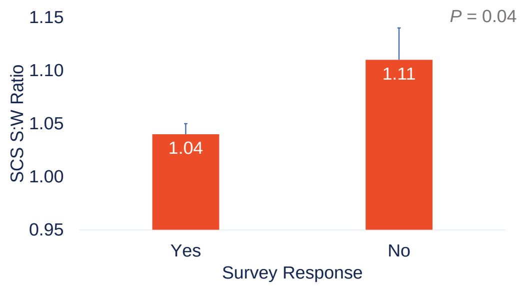
31

Herds that had fans in the holding pen had higher ECM S:W Ratios



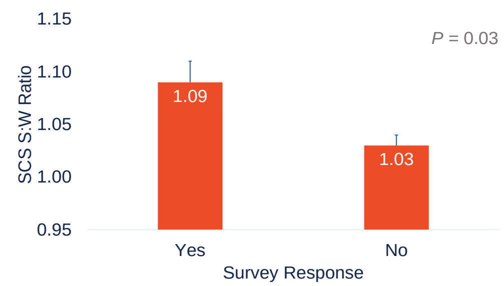
32

Herds that had fans in the holding pen had lower SCS S:W Ratios



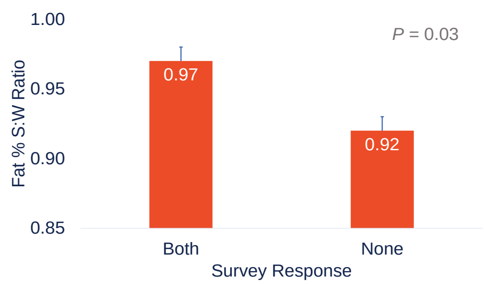
33

Herds that had sprinklers in the holding pen had higher SCS S:W Ratios



34

Herds that had fans + sprinklers had higher Fat % S:W Ratios than herds with none

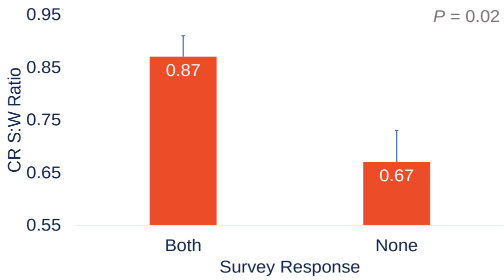


35

Reproduction Variables

36

Herds that had fans + sprinklers in the holding pen had higher conception rate S:W Ratios than herds with none



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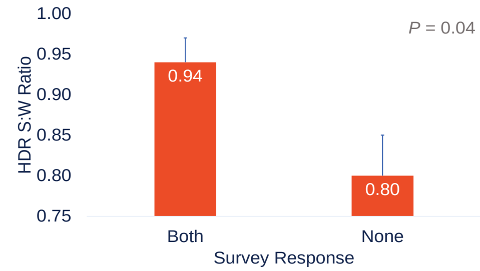
Herds that had fans + sprinklers in the holding pen had higher HDR S:W Ratios than herds with none



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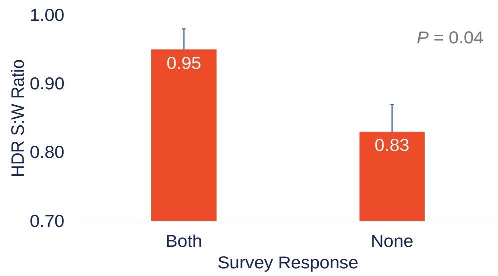
Herds that had fans + sprinklers had higher HDR S:W Ratios than herds with none



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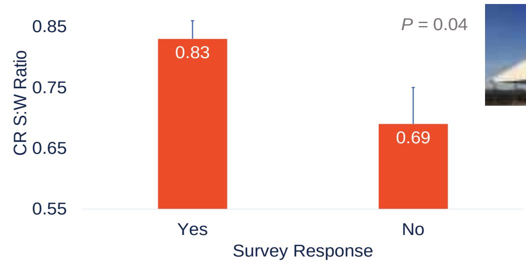
Herds that had ridge vents in lactating cow facilities had higher conception rate S:W Ratios than herds with none



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Take Home Messages

- Summer : Winter Ratios can be used to determine effectiveness of heat abatement
- Goals depend on farms and regions – optimal would be a ratio of 1
- See more of an impact of reproductive performance

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Take Home Messages

- Turning fans on at lower temperatures associated with higher S:W Ratios
- Heat abatement in holding pin associated with higher S:W Ratios
- Using fans and sprinklers associated with higher reproductive S:W Ratios

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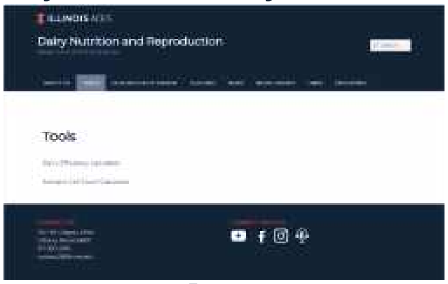
Coming Soon!

- **University of Illinois Dairy Decisions Suite**



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Thank You

- Four State committee
- Four State Sponsors
- Jenna Guinn

Four-State Dairy Nutrition & Management Conference

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Thank you

Derek T. Nolan
Teaching Assistant Professor
Dairy Extension Specialist
University of Illinois
217-244-7637
dtnolan@Illinois.edu

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Lackluster Calves – Using Lung Ultrasound to Identify a "Calories-out" Problem

Dr. Terri Ollivett
University of Wisconsin

Lackluster calves

using lung ultrasound to identify a “calories-out” problem

TL Ollivett, DVM, PhD, DACVIM
Assistant Professor
UW School of Veterinary Medicine

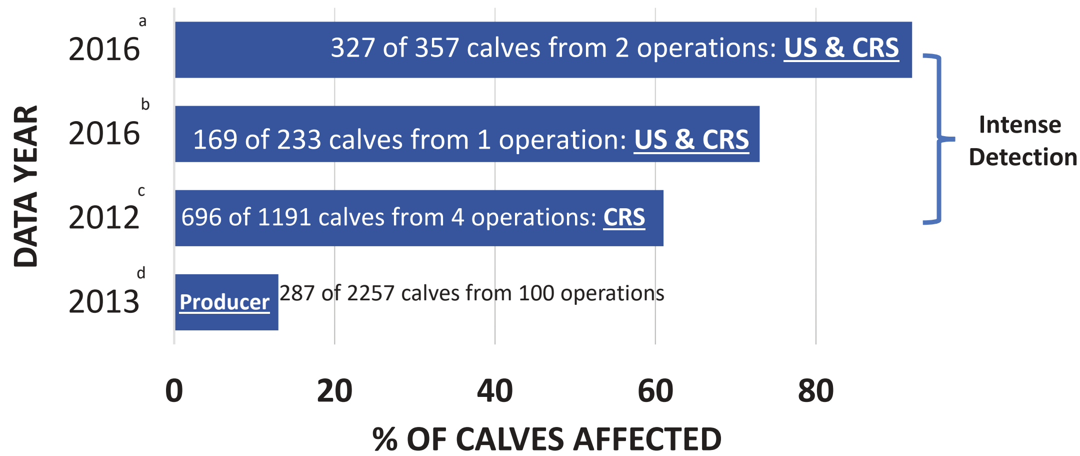
1

Respiratory disease is a symptom – rarely occurs in isolation

2

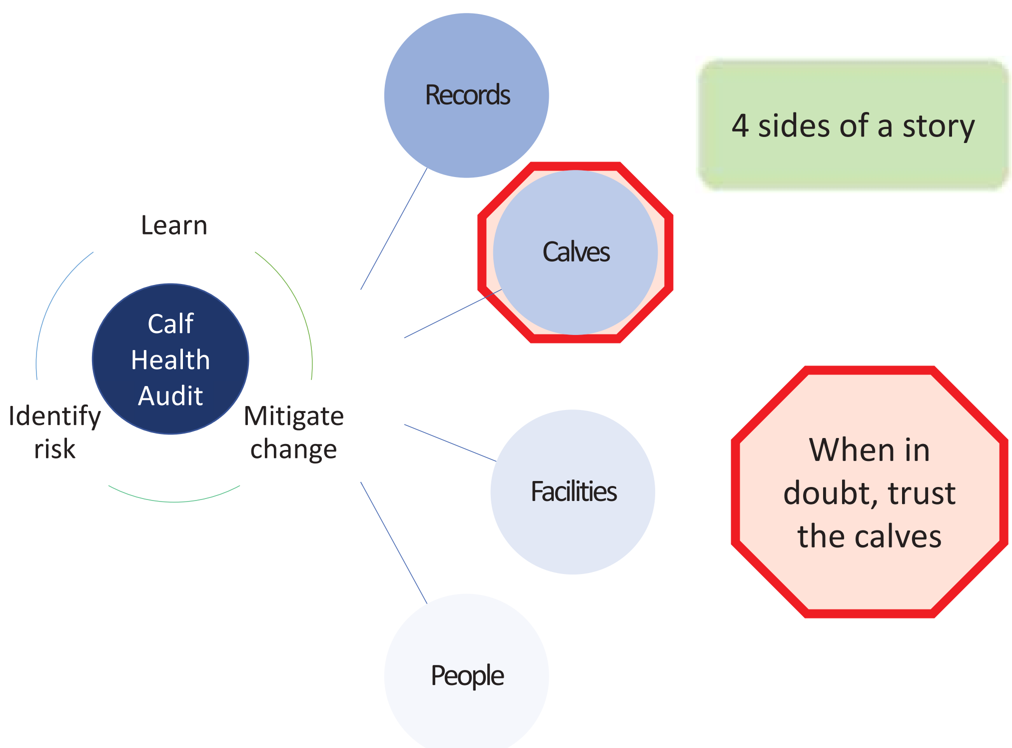
Respiratory Disease in Dairy Calves

- variable occurrence, 13 – 92%
- depends on method of detection
- catastrophic for some operations



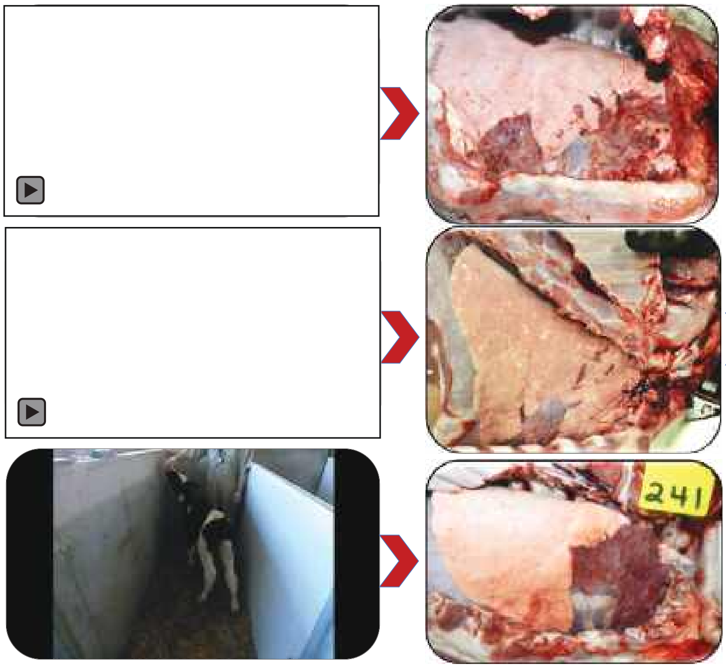
[a] Binversie et al., 2020 [b] Cramer et al., 2019 [c] Heins et al., 2014 [d] Urie et al., 2018
US: lung ultrasound CRS: UW clinical respiratory score Producer: producer defined disease

3



4

Spectrum of clinical signs…

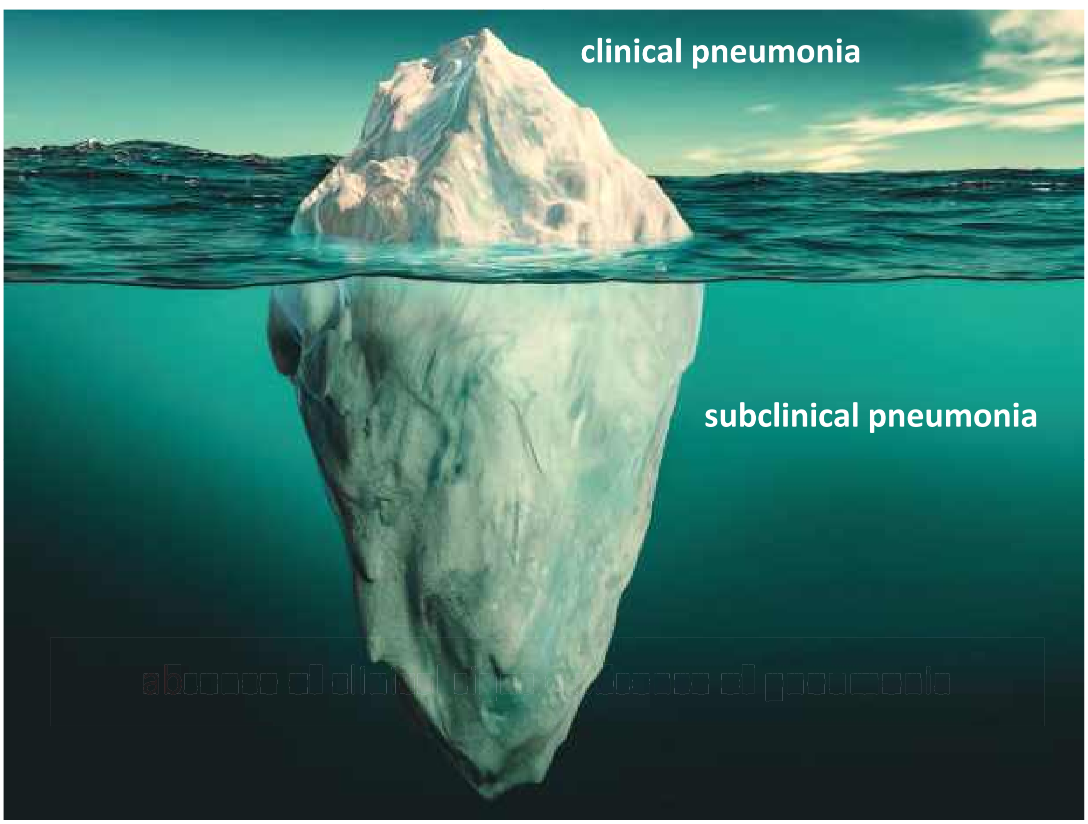


≥ 50% of **new** cases are **subclinical**

severity of **lung disease NOT well correlated** to severity of **clinical signs**

2 – 4 subclinicals for every **clinical case**

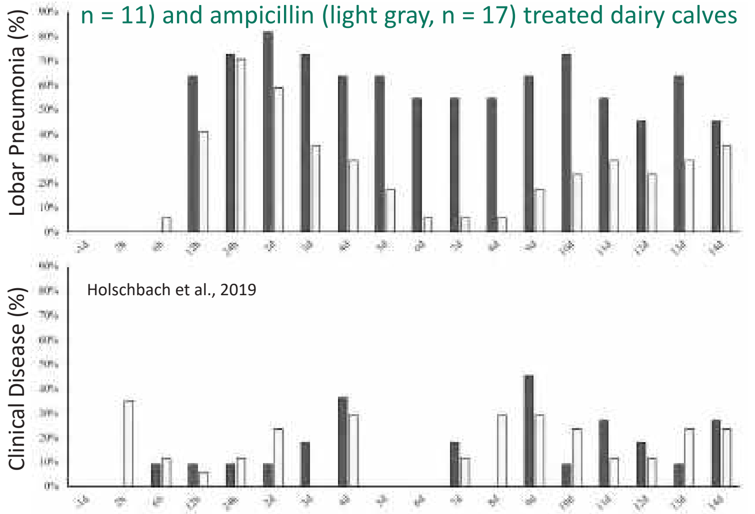
5



6

absence of clinical signs ≠ absence of pneumonia

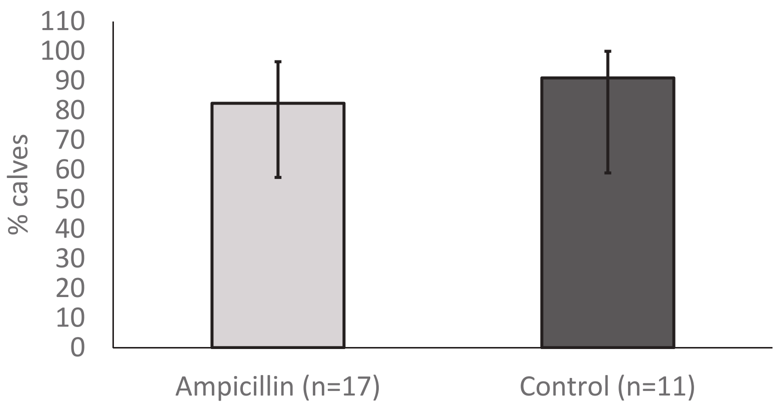
Respiratory health after **bacterial challenge** in saline (dark gray, n = 11) and ampicillin (light gray, n = 17) treated dairy calves



Holschbach et al., 2019

7

School of Veterinary Medicine



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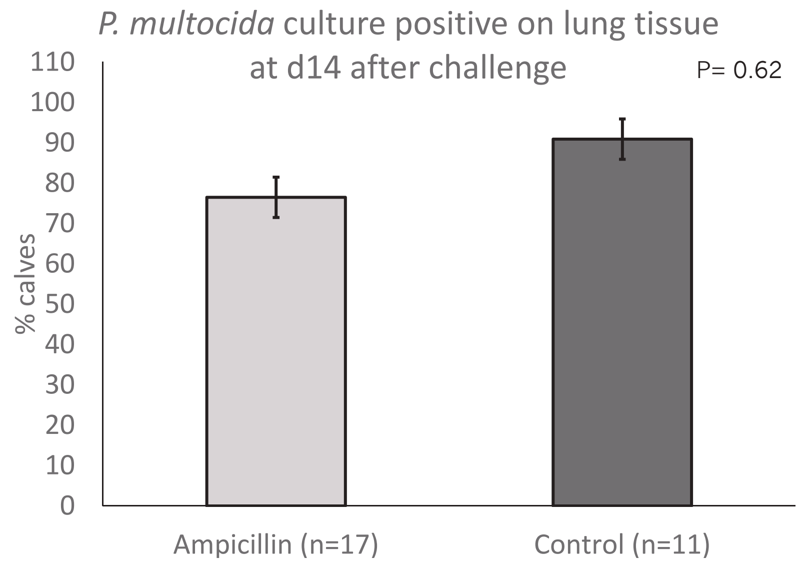
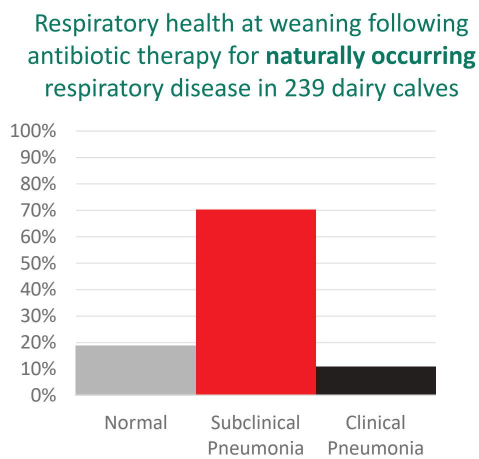


9

absence of clinical signs ≠ absence of pneumonia



Binversie et al., 2020

10

Calf lung ultrasound…

Fast (less than 1 minute)

Sensitive (>88%)

- Better than clinical exam (~60%) or auscultation (<10%)

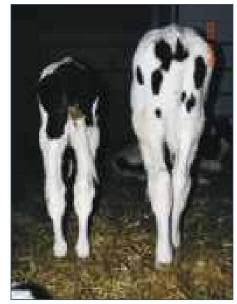
Associated with short term outcomes

- **Growth**
- **Vaccine, antibiotic response**

Associated with long term outcomes

- **Death**
- **Removal**
- **Decreased pregnancy** risk
- Decreased milk production **(1200# L1)**

Attitude scores and Feeding behavior – clinical pneumonia not subclinical pneumonia



Heritability estimates at 3 wk (0.21) were higher than estimates at 6 wk (0.08), suggesting greater influence of management and environmental conditions over time.

Resolution of disease following treatment – not guaranteed

11

Lung disease and average daily gain

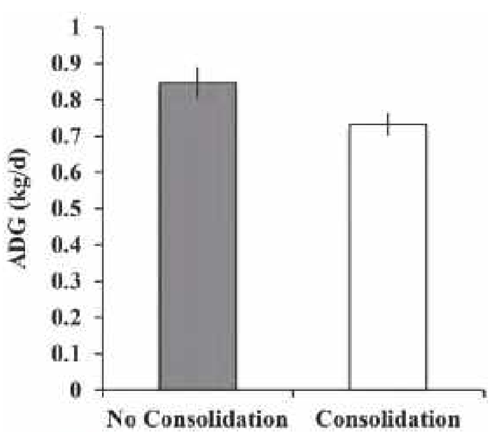


Figure 1. Least squares means (±SE) estimates for ADG (kg/d) for 233 preweaned, group-housed calves with no lung consolidation (<1 cm^2 of consolidation at all ultrasound exams) or with lung consolidation (≥1 cm^2 of consolidation for at least one ultrasound exam; $P = 0.01$). This simplified ultrasound score was adapted from Ollivett and Buczinski (2016). Estimates were obtained from a multivariable linear model that controlled for clinical respiratory disease status of the calf, cohort, and breed.

Cramer et al., 2019

What drives the impact on gain?

- Reduced intakes?
- Metabolic cost of disease?

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Lung disease and feeding behavior

Table 2. Raw values for feeding behaviors, by Bovine Respiratory Disease (BRD) status, over the 3 d before, the d of, and the 3 d after BRD detection. Calves were enrolled in the study at 21 ± 6 (mean ± SD) d of age and underwent twice weekly health exams.

Feeding Behavior	BRD Status		
	Clinical BRD (CBRD) (n = 18)	Subclinical BRD (SBRD) (n = 73)	Without BRD (NOBRD) (n = 12)
Average daily drinking speed (mL/min; mean ± SD)	716 ± 230	827 ± 221	879 ± 250
Average daily milk intake (L/d; mean ± SD)	10 ± 2.9	10.6 ± 4.0	10.3 ± 3.4
Average meal size (L/meal; mean ± SD)	1.8 ± 0.9	1.7 ± 0.8	1.6 ± 0.8
Number of rewarded visits (no./d; median; 1st quartile, 3rd quartile)	6 (5, 9)	6 (4, 9)	7 (4, 9)
Number of unrewarded visits (no./d; median; 1st quartile, 3rd quartile)	0 (0, 1)	0 (0, 1)	0 (0, 2)

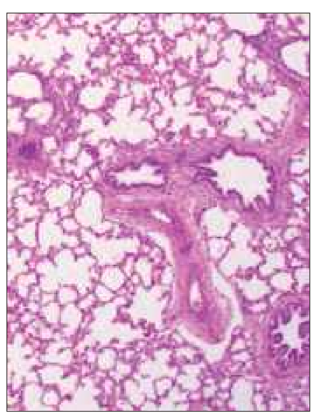
Calves with CBRD drank slower than both calves with SBRD (687 ± 42 vs. 782 ± 25 mL/min $p = 0.02$) and calves with NOBRD (687 ± 42 vs. 844 ± 51 mL/ min; $p = 0.01$; Table 3). There was no difference in drinking speed between calves with SBRD and calves with NOBRD (782 ± 25 vs 844 ± 51 mL/min; $p = 0.26$). There was no effect of BRD status on milk intake ($p = 0.64$), average meal size ($p = 0.79$), rewarded visits ($p = 0.26$), or unrewarded visits ($p = 0.19$; model results not shown).

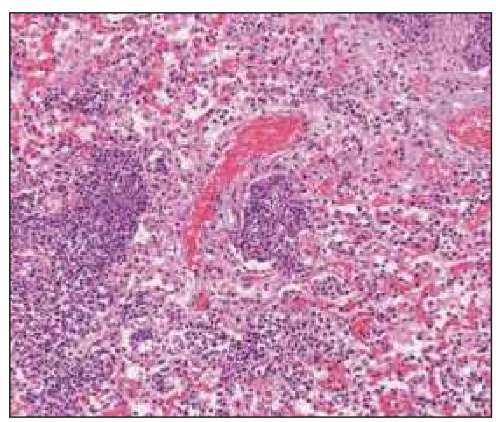
Cramer et al., 2020

13

Lung lesion pathophysiology

- Bacterial infection
  - Bronchopneumonia
  - Neutrophils in the airways





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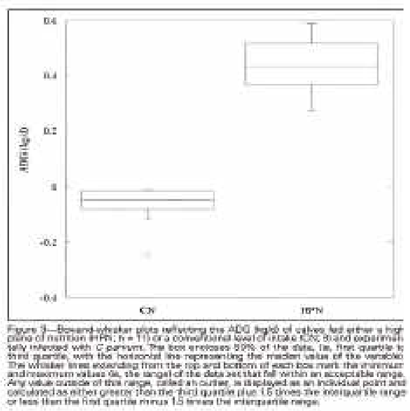
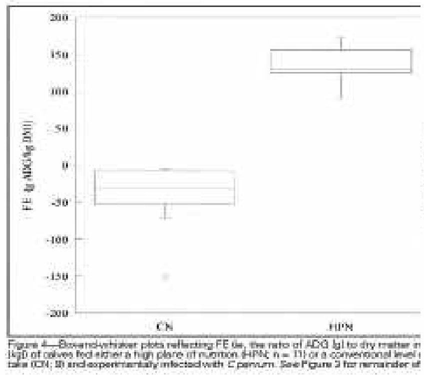
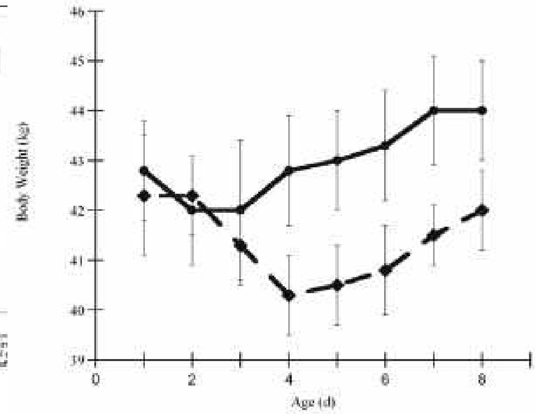
Constant recruitment of neutrophils into the airways - WEEKS not days

14

Early life plane of nutrition & growth







HPN: 28/22% MR: 1.8 lb/d DM x 7d; then 2.4 lb/d
CN: 20/20% MR: 1 lb/d DM

Ollivett et al., 2010; 2012

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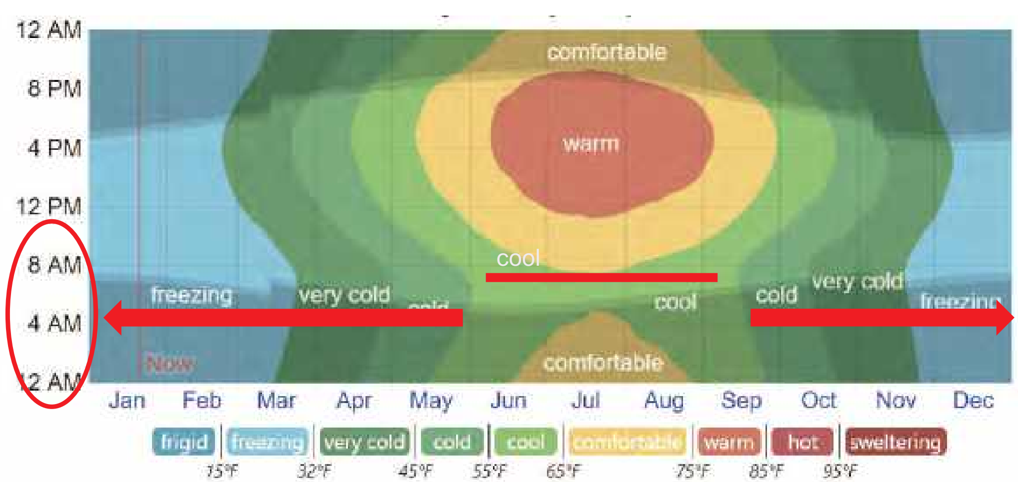
When will cold stress happen?

Consider the <u>lower critical temperature</u> for newborn and young calves: <u>< 60°F</u>

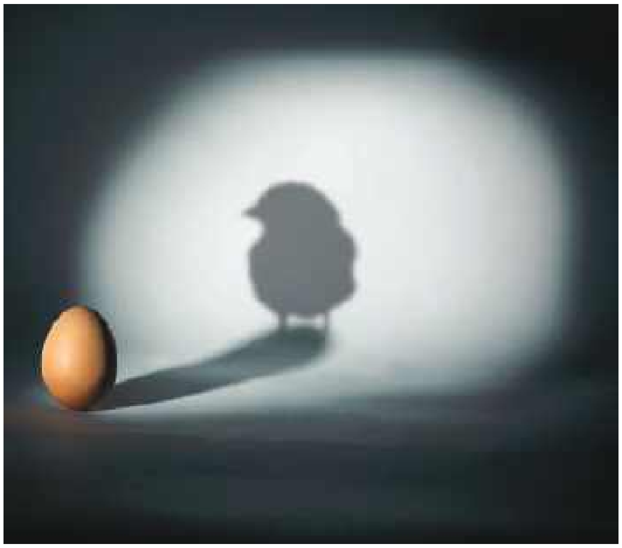


https://weatherspark.com/y/12796/Average-Weather-in-Madison-Wisconsin-United-States-Year-Round#Sections-Temperature

Wisconsin, USA: weather throughout the year

16

Chicken or Egg – Growth and BRD



- Subclinical pneumonia = calorie sink
- Confirm onset, severity with ultrasound
- Feed calves to grow in week 1
- Keep gut healthy in week 2

No growth = No lungs = No growth

17

18

Why is pneumonia subclinical?

1) Prey species: 60-80%* subclinical for ~ 7d before we see them

2) Failure to cure and relapse of subclinical/clinical disease

*Salmonella changes this relationship...

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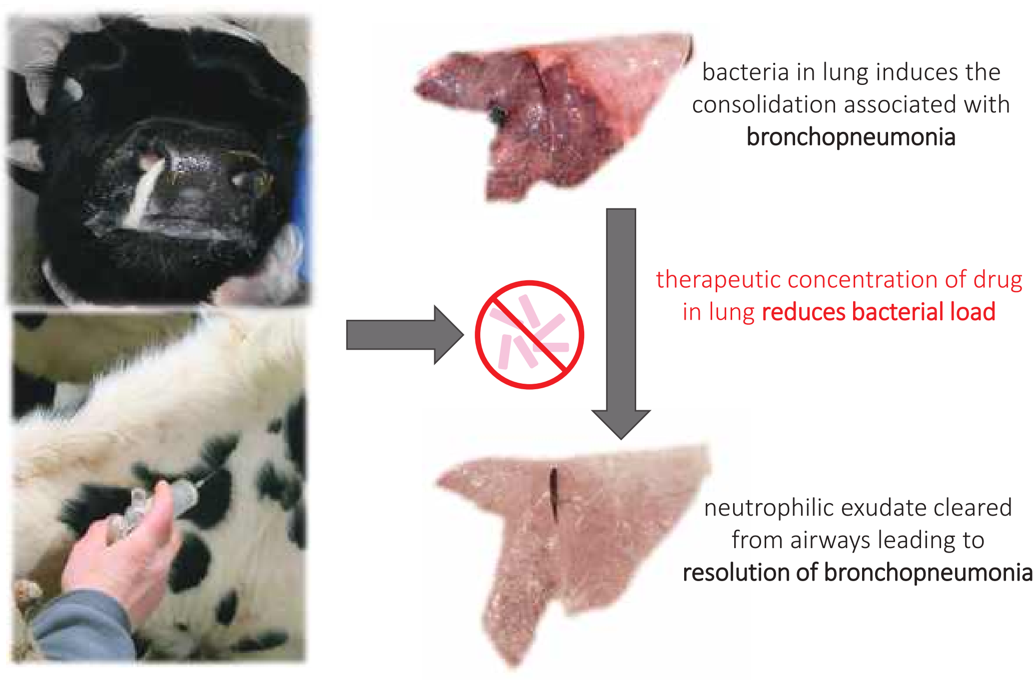
Respiratory disease and antibiotic therapy



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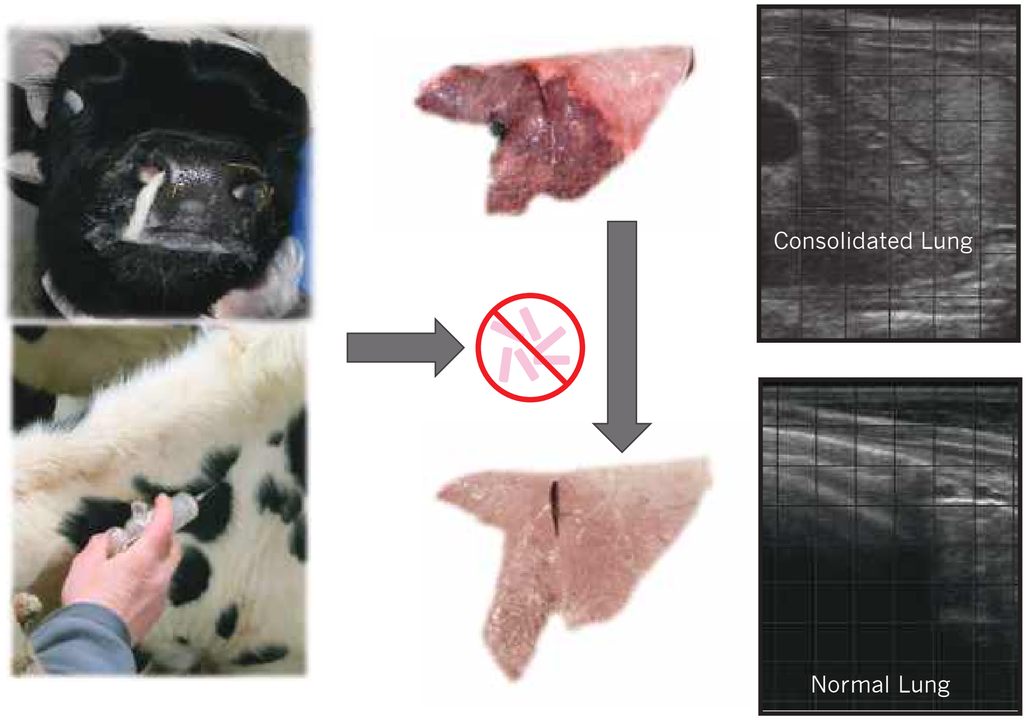
Respiratory disease and antibiotic therapy



21

Approved dosing strategies are based on PK data.

Efficacy is characterized by:

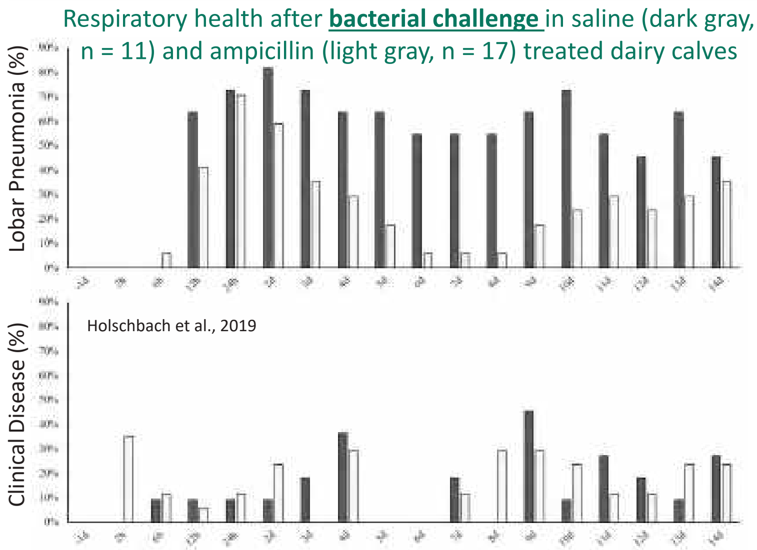
survival
rectal temperature < 104°F
lack of depression
lack of heavy breathing or increased rate

Two common misconceptions based on this information:
1) Approved dosing strategies are best, or optimal
2) Resolution of severe clinical signs = resolution of pneumonia

DeDonder and Apley, 2015

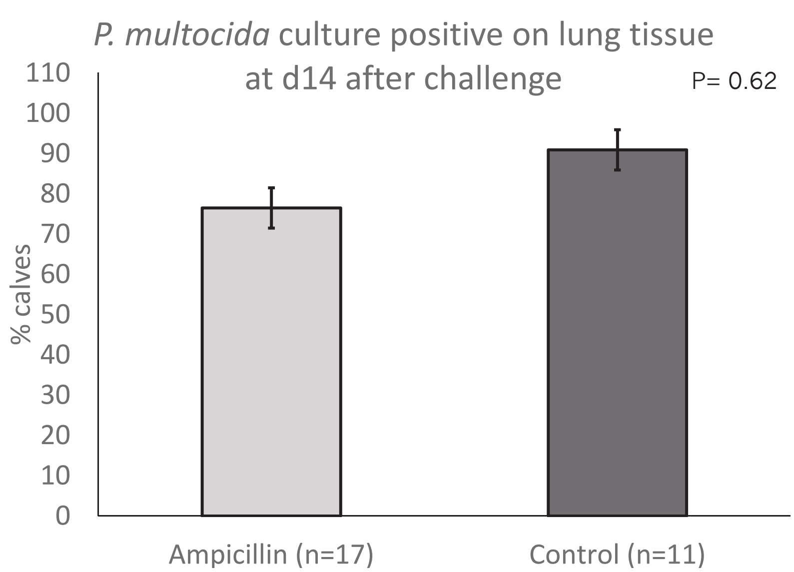
22

absence of clinical signs ≠ absence of pneumonia



Holschbach et al., 2019

23



24

Why does treatment efficacy matter? Exposure time

	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
# new cases	5	5	5	5	5	
# cures – good (80%)	4	4	4	4	4	5
# cures- bad (40%)	2	2	2	2	2	15

25

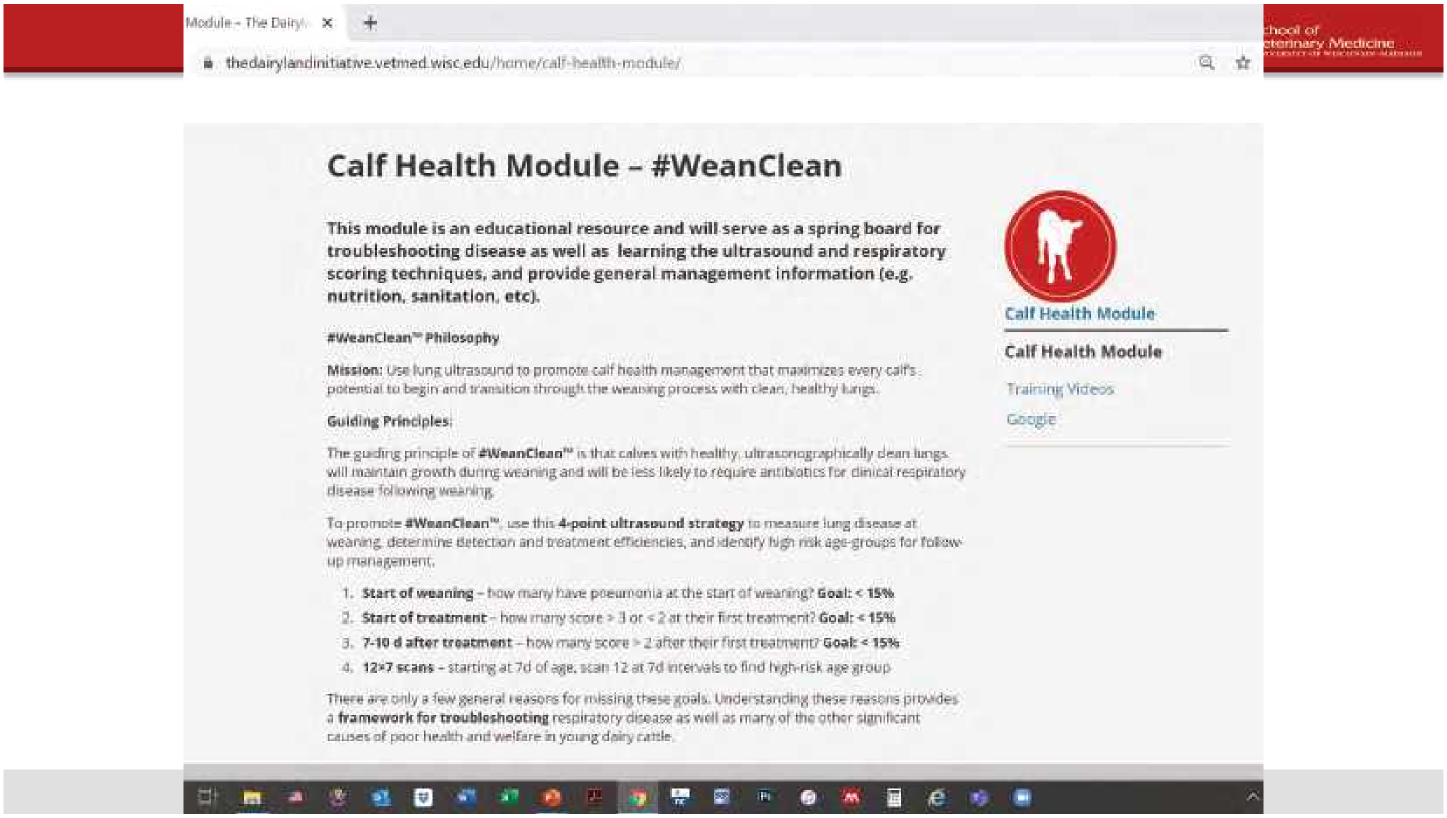
Age (d)
<9
10-19
20-27
28-34
49-54

ID	28-Nov	6-Dec	13-Dec	30-Dec	7-Jan
22179			0	3	
22178			0	0	
22177			0	0	
22176			0	0	
22175			2	0	
22174			0	0	
22173			0	2	
22172		0	2	3	
22171		2	2	4	
22170		0	0	0	
22169		0	0	0	
22168		2	0	2/3	
22167		0	2	3	
22165		0	3	3	
22164		0	0		
22159	1	2	3		
22158	0	2	0		
22157	0	2	2/4		
22156	0	2	5		
22155	2	2	2/3		4
22154	0	3	2/3		3
22153	2	2	3		4
22152	3	4	5		5
22151	0	3	5		3
22150	0	4	3		3
22149		0	0		0
22148		0	3		4
22147		2	3		4

Routine **12x7 weekly scans** at 2200 cow Holstein dairy in WI

These calves did NOT #WeanClean™

26



Module – The Dairyl...

thedairylandinitiative.vetmed.wisc.edu/home/calf-health-module/

Calf Health Module – #WeanClean

This module is an educational resource and will serve as a spring board for troubleshooting disease as well as learning the ultrasound and respiratory scoring techniques, and provide general management information (e.g. nutrition, sanitation, etc).

#WeanClean™ Philosophy

Mission: Use lung ultrasound to promote calf health management that maximizes every calf's potential to begin and transition through the weaning process with clean, healthy lungs.

Guiding Principles:

The guiding principle of **#WeanClean™** is that calves with healthy, ultrasonographically clean lungs will maintain growth during weaning and will be less likely to require antibiotics for clinical respiratory disease following weaning.

To promote **#WeanClean™**, use this **4-point ultrasound strategy** to measure lung disease at weaning, determine detection and treatment efficiencies, and identify high risk age-groups for follow-up management.

1. **Start of weaning** – how many have pneumonia at the start of weaning? **Goal: < 15%**
2. **Start of treatment** – how many score > 3 or < 2 at their first treatment? **Goal: < 15%**
3. **7-10 d after treatment** – how many score > 2 after their first treatment? **Goal: < 15%**
4. **12×7 scans** – starting at 7d of age, scan 12 at 7d intervals to find high-risk age group

There are only a few general reasons for missing these goals. Understanding these reasons provides a **framework for troubleshooting** respiratory disease as well as many of the other significant causes of poor health and welfare in young dairy cattle.

Calf Health Module

Calf Health Module

Training Videos

Google

27

#WeanClean™ Philosophy

When calves **don't wean clean**, we **failed them not once but twice**

- We let her get pneumonia (many reasons why this happens)
- We didn't treat her effectively (fewer reasons why this happens)

Scan lungs at **4 strategic points** to promote **#WeanClean** philosophy

1. **Start of weaning** – how many have pneumonia at the start of weaning? Goal: < 15%
2. **Start of treatment** – how many score > 3 or < 2 at their first treatment? Goal: < 15%
3. **7-10 d after treatment** – how many have lesions after first treatment? Goal: < 15%
4. **12x7 scans** – starting at 7d old, scan 12 calves at 7d intervals to find high-risk ages

(Ollivett, 2019)

28

#WeanClean™ Philosophy

- Too many calves **weaning with lung lesions**? **3 reasons** - weren't treated, weren't treated right, or they have poor **immune function**

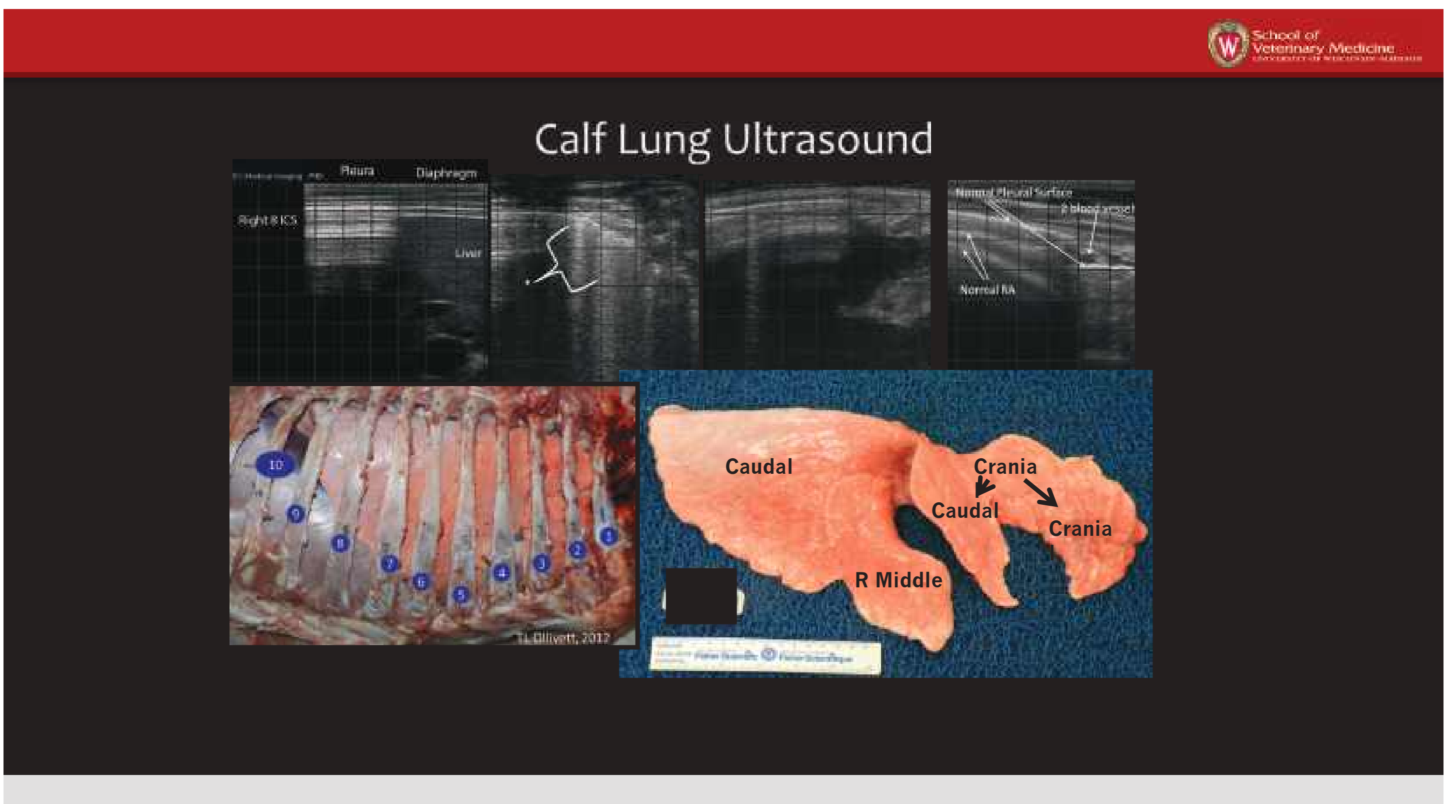
- Too many calves with **high lung scores at first treatment**? **2 reasons** – don't spend enough time looking at the right group of calves, and/or don't recognize early signs

- Too many calves with **normal lung at first treatment**? **2 reasons** – misdiagnosing toxemia or septicemia, and/or don't recognize early signs of pneumonia

- Too many calves with **high lung scores after first treatment**? **3 reasons** – used right drug in wrong way (late, wrong dose, duration, frequency), used wrong drug (wrong class, resistant bug), or they have poor **immune function**

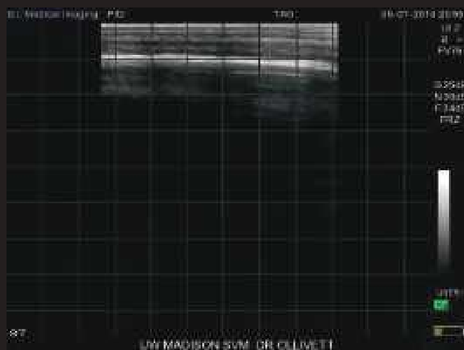
- Does **age at first treatment reflect reality**? Use **12x7 scans** to confirm onset of disease, train treaters to focus on the right calves, treat subclinicals (Ollivett, 2019)

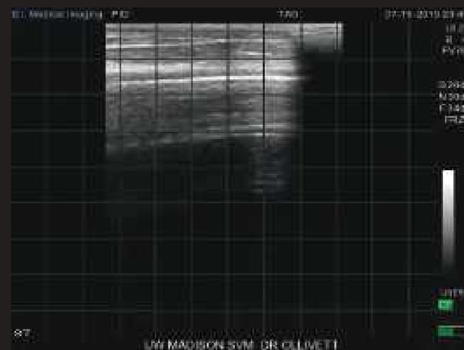
29



30

Pneumonia





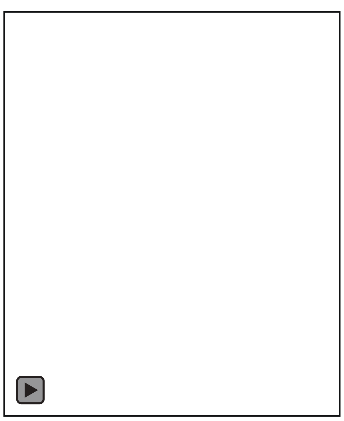
Severe pneumonia

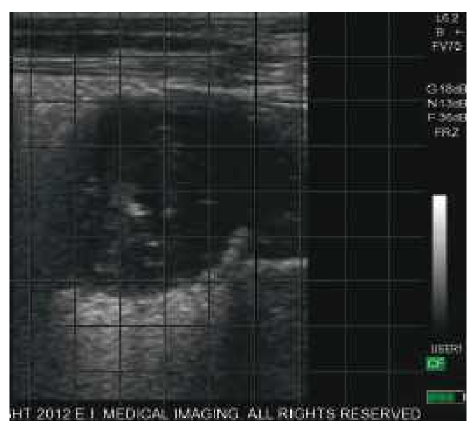
Normal lung

31

Abscesses…

- Abscesses have fluid inside a capsule, occasionally gas
- **Pics left to right:** 6 week old Holstein bull **caudal lobe abscess**, 3 month old Jersey heifer **caudal lobe abscess**, 4 week old Holstein bull **caudal lobe abscess**.





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Scoring lungs

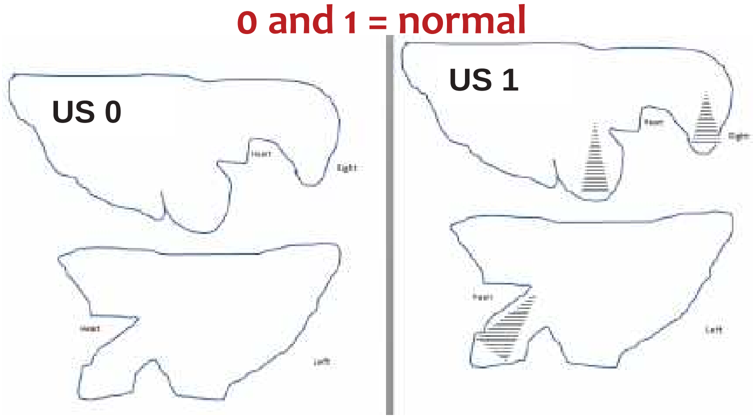
- Staff competency – yes
- Treatment response – yes
- Culling – yes
- Purchasing – yes
- Metaphylaxis – yes
- Diagnostic sampling – yes
- Onset of disease – yes

- Overall Prevalence – NO, use 1 cm cut off

33

0 – 5 TUS scoring system

0 and 1 = normal



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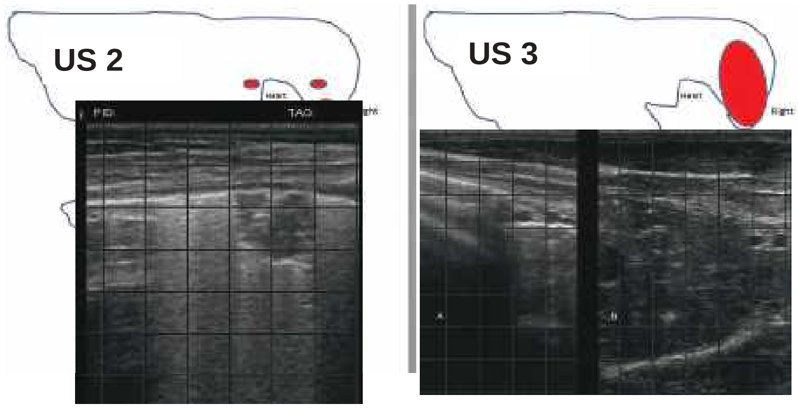
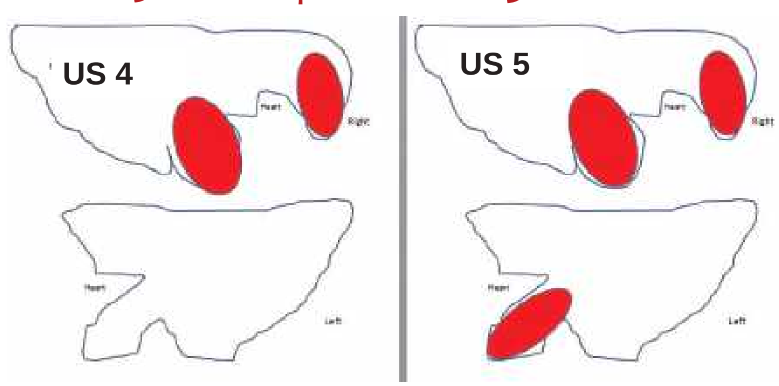
2 = **lobular** pneumonia
3 = **lobar** pneumonia **1 lobe**

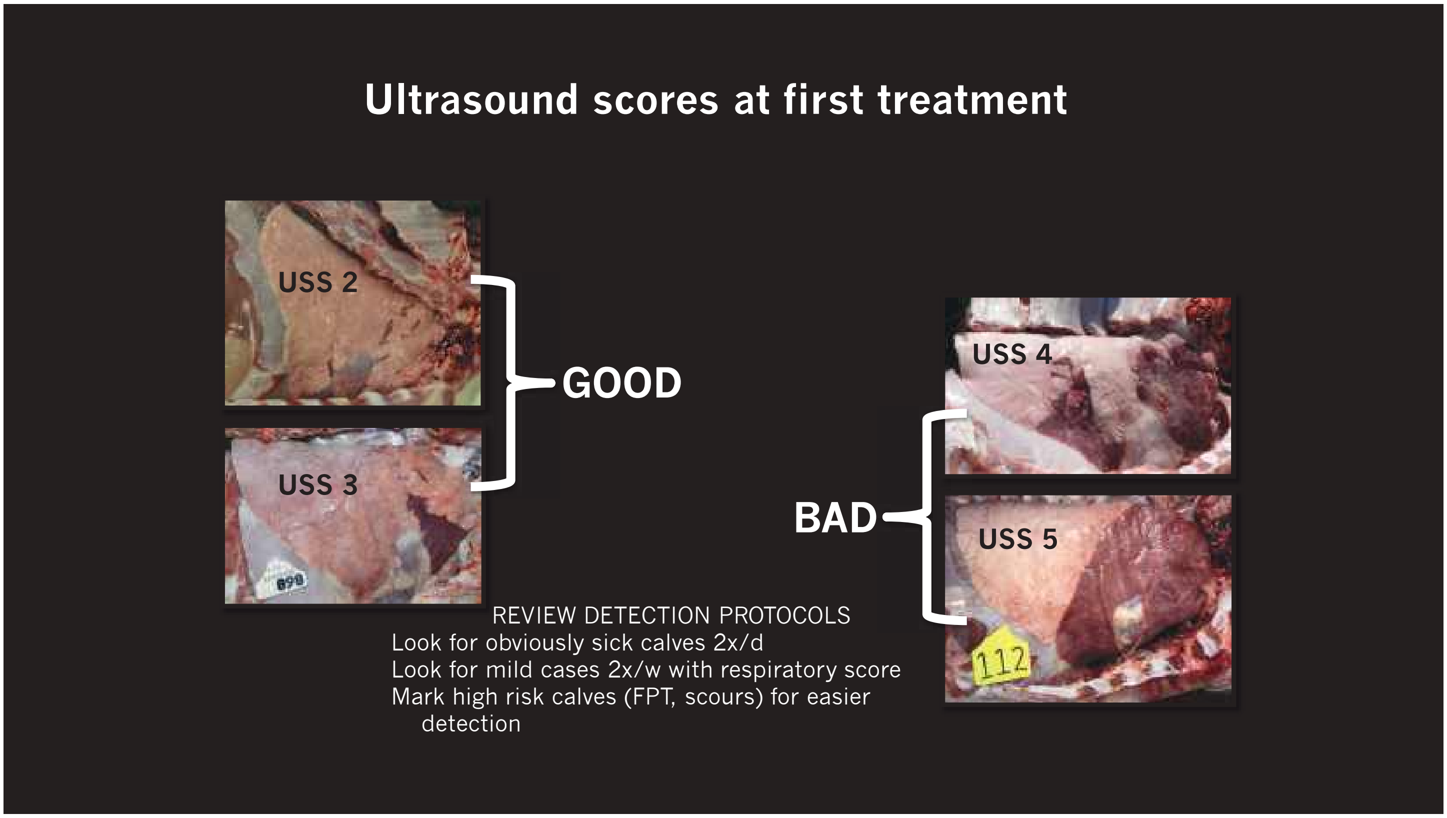


35

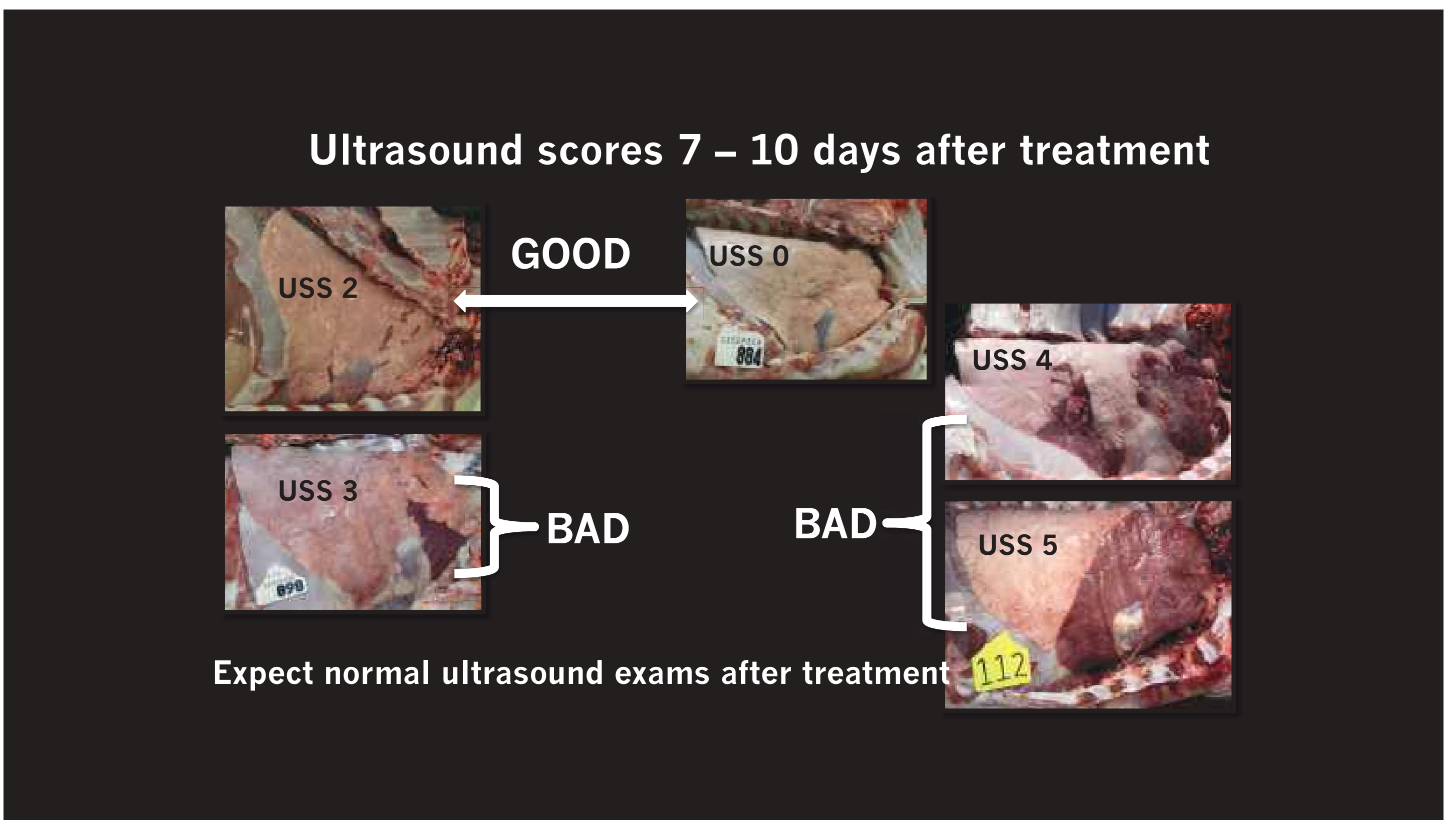
4 = **lobar** pneumonia **2 lobes**
5 = **lobar** pneumonia **3 + lobes**



36


Ultrasound scores at first treatment
USS 2
USS 3
GOOD
USS 4
USS 5
BAD
REVIEW DETECTION PROTOCOLS
Look for obviously sick calves 2x/d
Look for mild cases 2x/w with respiratory score
Mark high risk calves (FPT, scours) for easier detection
112

37


Ultrasound scores 7 – 10 days after treatment
USS 2
GOOD
USS 0
884
USS 4
USS 3
BAD
BAD
USS 5
Expect normal ultrasound exams after treatment
112

38

Ultrasound scores 7 – 10 days after treatment

GOOD

BAD

39

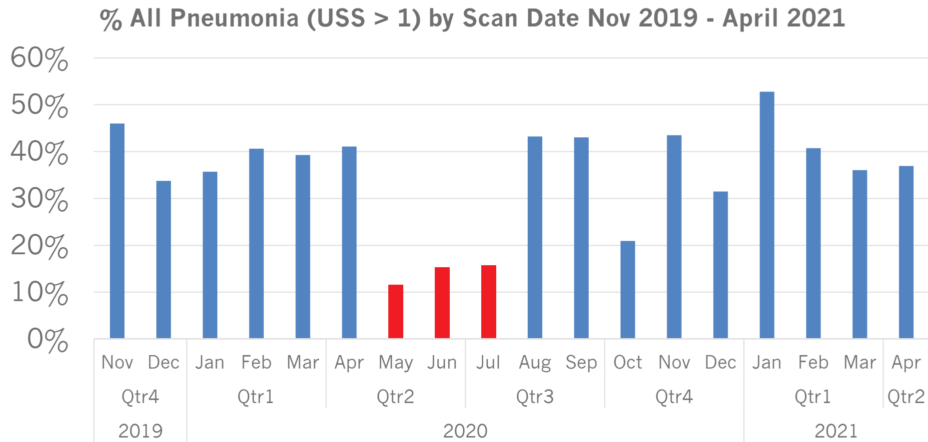
After implementing lung ultrasound to treat subclinical pneumonia:

- detection and treatment happens earlier now
- rare to treat a calf for the first time after weaning
- **Better growth, fewer deaths from untreated/late treated pneumonia**

Year	% of calves treated for the first time after weaning
2019	**42%**
2020	**10%**
2021 (Jan - Apr)	**0%**

age at first treatment **before scanning**	**35 d**	350 calves
age at first treatment **after starting scanning**	**21 d**	1140 calves

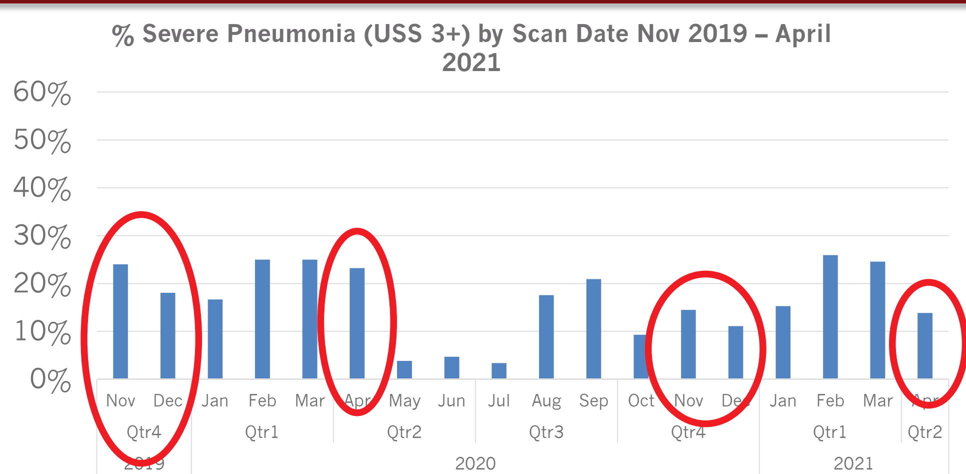
40



Warm weather big reduction in disease

1272 calves scanned
since Nov. 2019

41

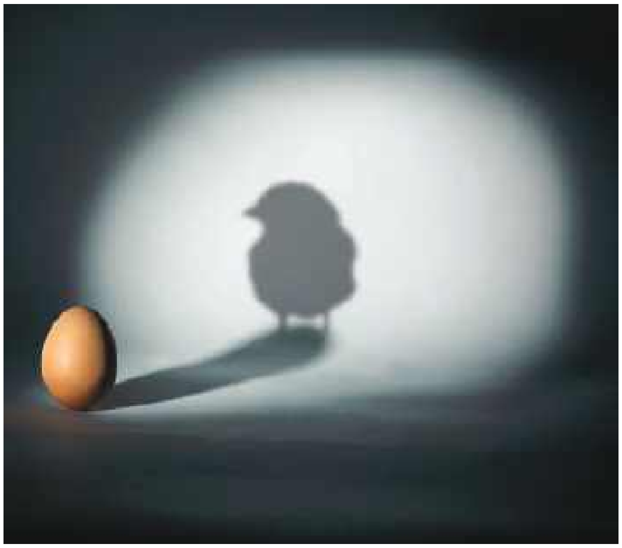


Seeing drops in severe pneumonia during second year of scanning

1272 calves scanned
since Nov. 2019

42

Chicken or Egg – Growth and BRD



- Subclinical pneumonia = calorie sink
- Confirm onset, severity with ultrasound
- Feed calves to grow in week 1
- Implement routine scanning to address SCP

No growth = No lungs = No growth

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School of Veterinary Medicine

Questions?

ollivett@wisc.edu
608.358.1640

#WeanClean™

https://thedairylandinitiative.vetmed.wisc.edu/home/calf-health-module/

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Four-State Dairy Nutrition & Management Conference

What is Happening in the Gut in the Scouring Calf and Effective Fluid Therapy

Jesse Goff, DVM, PhD
Iowa State University
College of Veterinary Medicine

What is Happening in the Gut in the Scouring Calf and Effective Fluid Therapy

Jesse Goff DVM, PhD
Iowa State University

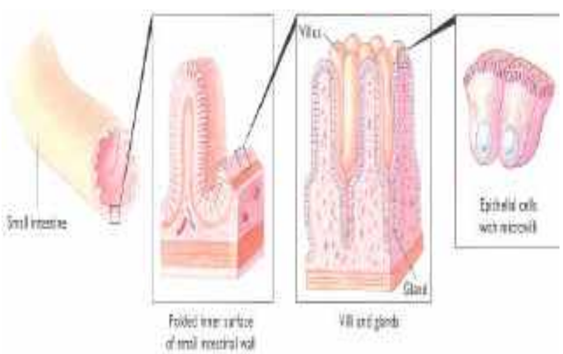
1

How the intestines are supposed to work!

Need to absorb water, electrolytes and the simple sugars, short chain fatty acids, and amino acids left after digestion of milk proteins, fats, and lactose.

Microscopic Anatomy
Physiology of absorption
3 Forms of Diarrhea
How electrolytes work to rehydrate calves

2



Folds & villi & microvilli greatly increase surface area

Sjaastad Hove, Sand: Physiology of Domestic Animals

3

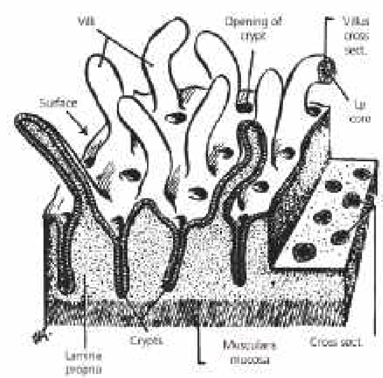
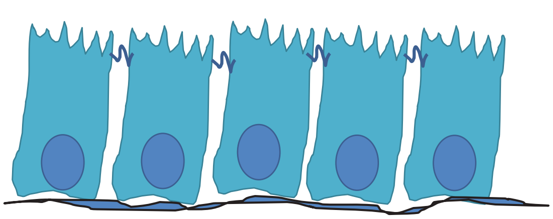


Figure 43.11 Three-dimensional representation of the small intestine lining. The villi are finger-like processes with cores of lamina propria that extend into the lumen. The crypts of Lieberkühn are depressions in the lamina propria (Lp). From Ham, A.W. (1974) Histology, 7th edn. J.B. Lippincott, Philadelphia. Reproduced with permission from Lippincott Williams & Wilkins.

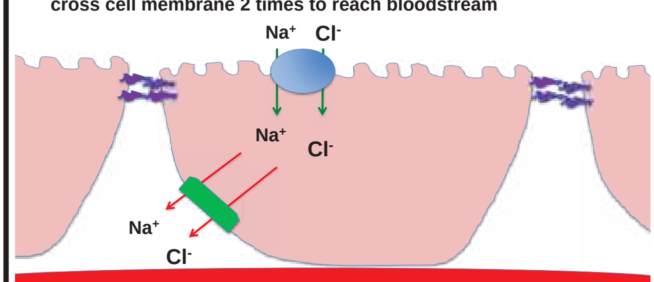
4

Single layer of cells attached to each other by tight junction proteins forms a barrier to keep bacteria and most toxins out of body!!
Nutrients need to get across this barrier to reach bloodstream



5

Nutrients (example Salt) require various Transporter proteins to cross cell membrane 2 times to reach bloodstream



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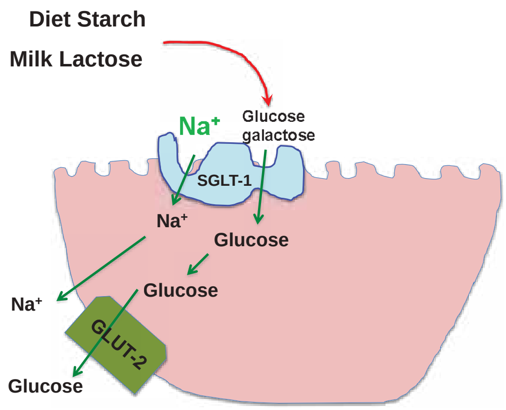

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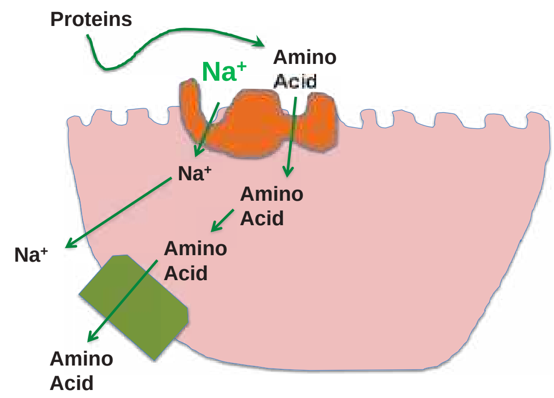

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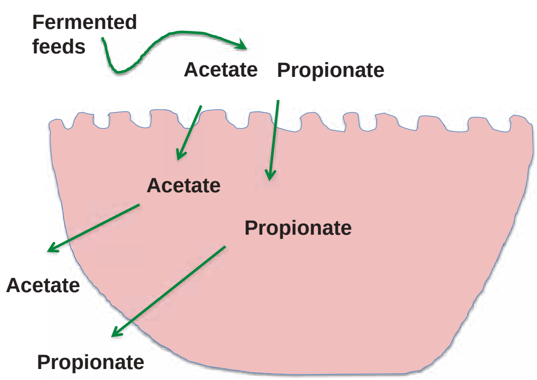
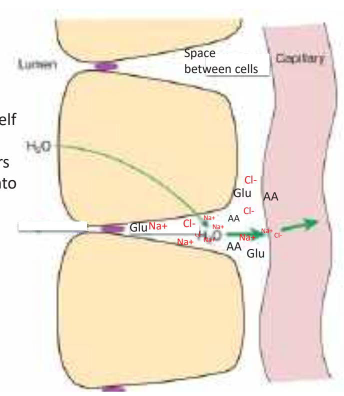


9

Water cannot be absorbed by itself

Water follows electrolytes , sugars or amino acids across cells and into blood
= OSMOSIS



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No Na^+ = No absorption of sugar, AA, or Cl- !!!!!

No Absorption of sugar, AA, or salts = NO ABSORPTION OF H_2O

Where does the needed Na^+ come from??

It is NOT the diet!!!

Intestinal cells in crypts secrete Cl, Na and water

11

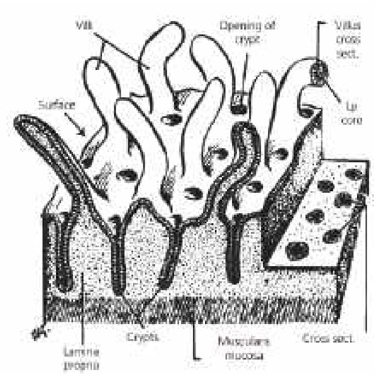


Figure 43.11 Three-dimensional representation of the small intestine lining. The villi are finger-like processes with cores of lamina propria that extend into the lumen. The crypts of Lieberkühn are depressions in the lamina propria (Lp). From Ham, A.W. (1974) *Histology*, 7th edn. J.B. Lippincott, Philadelphia. Reproduced with permission from Lippincott Williams & Wilkins.

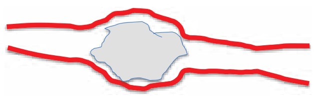
12

13

NORMALLY

Crypt cells secrete Na, Cl and water needed for sugar and amino acid absorption by villus cells **only when it is needed**!!!!!

Locally controlled by stretch of gut to stimulate secretion in that section of intestine only



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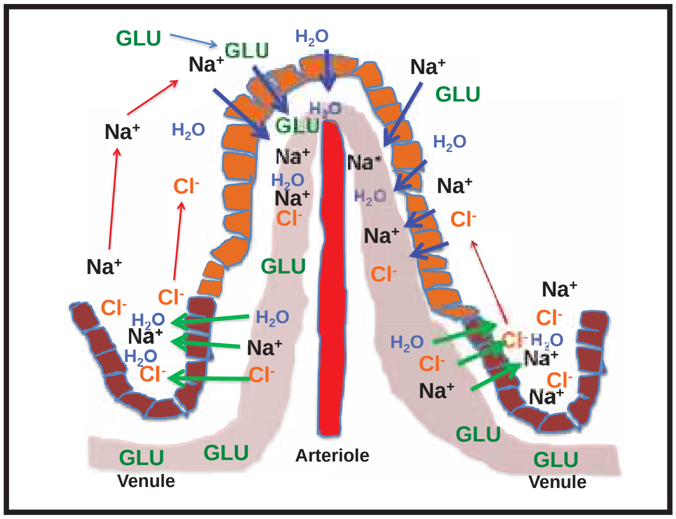

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Diarrhea

Classically broken into 3 ”Causes”

1. **Secretory** **Excessive** secretion of Na, Cl and water
2. **Malabsorption** of solutes and water
3. **Osmotic** diarrhea

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General Diarrhea Timetable

First 5 days of life

E.coli predominate.

Enterotoxigenic produce toxins→ extreme secretory diarrhea , Rarely starts beyond day 7 of life

Effacing E.coli - latch onto surface and destroy microvilli and cells → malabsorptive bloody diarrhea. Can occur up to 2 months of life

Days 5-14

Viral diarrheas common - Rotavirus, coronavirus, Breda (torovirus)- malabsorptive tinged with blood

Cryptosporidium parasite- takes at least 7 days to reproduce so diarrhea first seen after 8 days of age – watery diarrhea tinged with blood

Onset After week 2

Salmonella – fever, bloody diarrhea, septicemia (Dublin)

Clostridia perfringens – abomasum and gut hemorrhage. Can die before diarrhea is observed!!!

Campylobacter – inflammation → watery diarrhea, some blood

Onset after weaning

Coccidiosis parasite- moderate watery diarrhea in most. Heavily loaded calves show bloody diarrhea as well.

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Inflammation Causes Prostaglandin Release

Intestinal Cells damaged by bacteria, viruses or parasites release prostaglandins

Prostaglandins stimulate hypersecretion of salt and water by crypt cells in a local area of cell damage.

A protective mechanism ???

Flushes toxins, bacteria, viruses, parasites further out with feces

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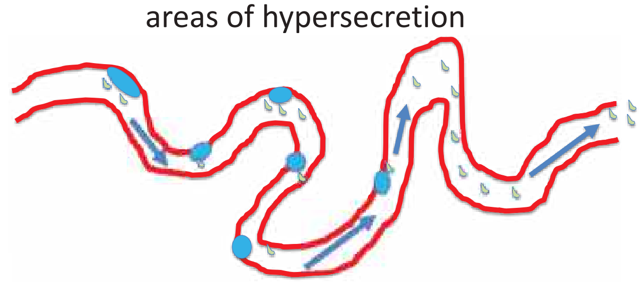
Local inflammation causes localized areas of hypersecretion



Enterotoxigenic E Coli Diarrhea

Some Strains of E. Coli secrete Toxin into gut

Toxin binds directly to small intestine cells and **activates extreme hypersecretion of Na and Cl**

→ **SEVERE WATERY DIARRHEA**

This toxin spreads throughout small intestine

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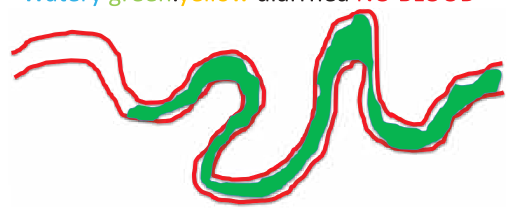
E.Coli toxin causes widespread areas of hypersecretion.
Watery green.yellow diarrhea NO BLOOD



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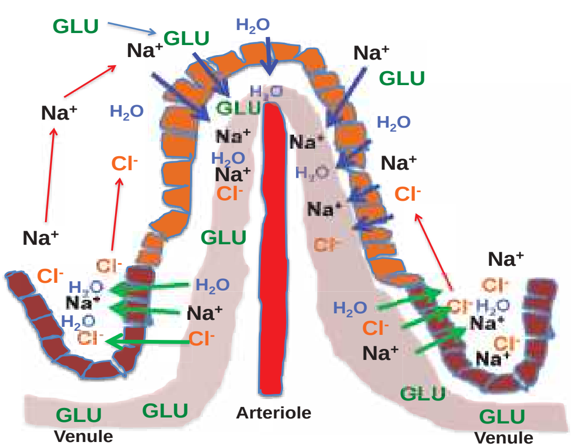

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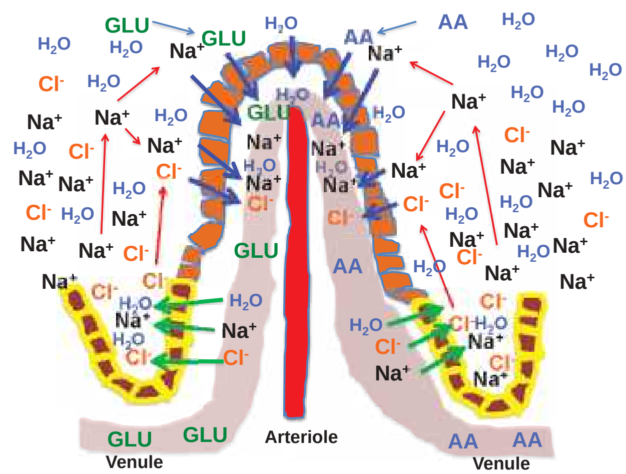

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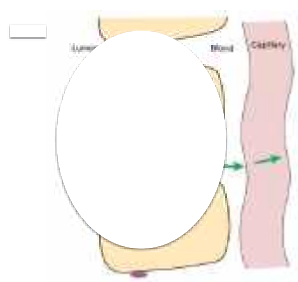
Malabsorptive Diarrhea

Pathogens or toxins can destroy gut lining cells breaking barrier

Salmonella
E. Coli
Rotavirus
Coronavirus
Campylobacter
Clostridia
Cryptosporidium



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Gut pathogens may also invade blood vessels under the surface cells

= BLOODY DIARRHEA!!

Hallmark of a Severe Malabsorptive diarrhea!!!!

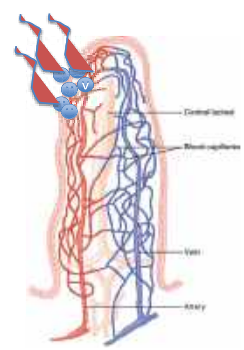

Figure 62-8; Guyton & Hall

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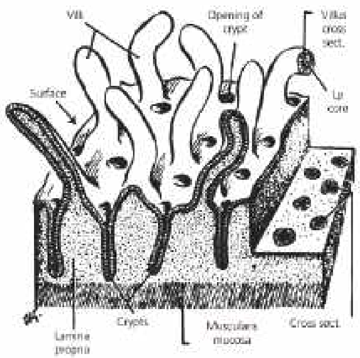

Figure 43.11 Three-dimensional representation of the small intestine lining. The villi are finger-like processes with cores of lamina propria that extend into the lumen. The crypts of Lieberkühn are depressions in the lamina propria (Lp). From Ham, A.W. (1974) *Histology*, 7th edn. J.B. Lippincott, Philadelphia. Reproduced with permission from Lippincott Williams & Wilkins.

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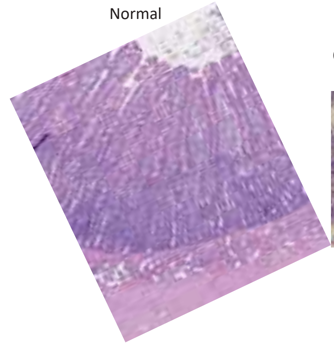
Normal



Corona Virus – Villi destroyed,

Darin Madson, ISU

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Parasitic Malabsorptive Diarrhea

Cryptosporidiosis

Takes 7 days for life cycle of parasite to be completed so diarrhea day 8-15.
Lifelong immunity generally develops after an attack.

Coccidiosis –single cell eukaryote parasite

Attacks colon and cecum !!
Takes 21 days for the life cycle of the parasite to be completed so diarrhea generally after day 25

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Cryptosporidiosis

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Malabsorptive Diarrhea – general truths

Small Intestine

Pathogens affecting small intestine cause more severe dehydration than diseases of colon.

Small intestine pathogens will often leave the colon intact.

Large intestine

Colon pathogens often result in blood and lots of mucus in feces.

But since colon does not have same secretory capability as small intestine, dehydration tends to be less severe.

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Osmotic Diarrhea

Diet ingredients are not absorbed to an adequate extent or are non-absorbable
- their presence draws water into gut

Examples
- Milk of magnesia ($MgOH_2$) , epsom salts ($MgSO_4$)
- Prune juice – has sorbitol which is not absorbed well

CALVES- Inadequate absorption of nutrients due to

Overfeeding

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Neonates and Osmotic diarrhea

Natural suckling = small meals many times/day

Dairy calves – fed milk or MILK REPLACERS 2X/day.
- Milk – casein protein forms curd to slow passage from abomasum.
- Milk replacer – whey proteins do not form curd. Speeds rate at which they leave abomasum and reach intestine

Worsened if you try to compensate for cold weather and feed more milk replacer – but still feed 2x day!!

Or when you add more powder than called for → hypertonic and draws water into gut from blood

Overwhelm ability to digest lactose

→ osmotic diarrhea

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Calves with diarrhea die from:

Dehydration

Acidosis and High blood potassium
- loss of suckle reflex, recumbency

Starvation (hypoglycemia)

Low Body Temperature (Hypothermia)

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What can the calf with diarrhea absorb orally??

I will focus on calves less than 2 weeks of age

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100 lb calf with diarrhea

Calf Health	% Dehydrated	Daily Milk	Oral Fluids	qts
Healthy calf	0%	4.4 kg	0 kg per day	
Mild diarrhea	2%	4.4 kg	1.1 kg per day	1
Mild diarrhea	4%	4.4 kg	2.2 kg per day	2
Depressed	6%	4.4 kg	3.3 kg per day	3
Very ill	8%	4.4 kg	4.4 kg per day	4.5
Recumbent	>10%	4.4 kg	Need intravenous fluids	

Geof Smith, UNC vet college

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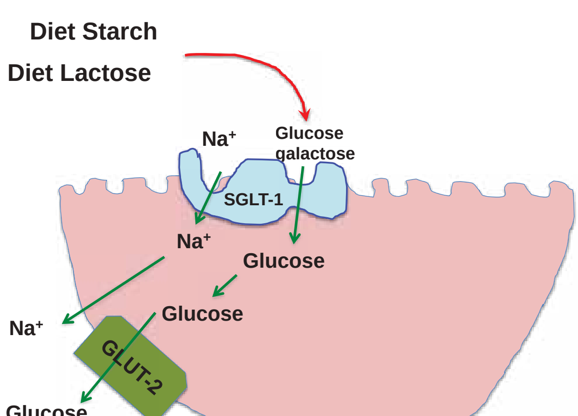

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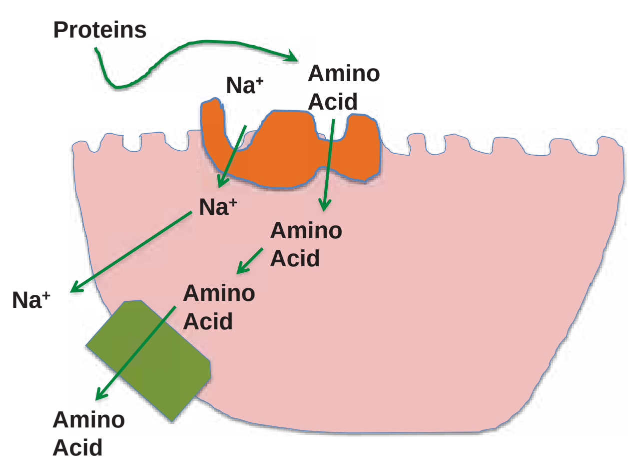

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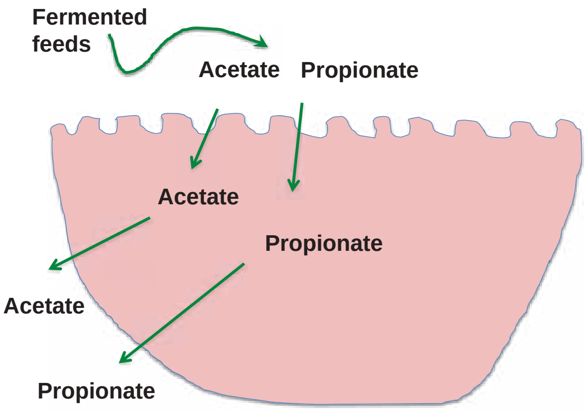

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COLON COMPENSATION

Colon is usually intact - most viruses fairly specific for small intestine cells.

Colon can absorb some Na, Cl, K, HCO_3^- and water will follow.
Colon absorbs acetate and propionate very well!!

Absorb electrolytes, acetate and propionate and water follows

BUT Colon has No ability to absorb sugars or amino acids .

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Oral Rehydration Therapy

Na, K, Cl - Electrolytes to restore circulation if absorbed. Colon absorption still working!!

- Water
- Sodium (4-5%) (100 meq/L) - as NaCl, sodium bicarb, sodium citrate, sodium acetate
- Potassium (2-3%) (20-25 meq/L) - KCl
- Chloride (4-5%) (70-75 meq/L)

Glucose (60-70 g /L) & Amino Acid (glycine) (30-60 g / L)

Take advantage of Na-sugar and Na-amino acid transport mechanisms which are intact to get Na and chloride (and water) back into circulation

Also provides energy .

Needs to have an alkalinizer to combat acidosis of blood

Sodium Bicarbonate- fast acting but raises pH of gut

Sodium acetate or sodium propionate → raise pH of blood only also provide energy

acetate and propionate may slow Salmonella growth

Should be mildly Hypertonic – 400-450 mOsm

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Gel type Oral ReHydration products

Usually have **psyllium** in them to increase thickening of manure
- Manure looks good, but is it effective?

Blocks glucose absorption (Cebra et al., 1998)
So calf isn't getting energy it needs

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Eyes sunken in = Dehydration

Geof Smith, UNC Vet college

Normal

5-6% Dehydrated

6-8% Dehydrated

9-12% Dehydrated

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Tenting of skin

Pinch up skin in area of neck and release

Normal – returns to flat position within 2 seconds

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Table 1: Assessing Dehydration

Clinical Sign	Percent Dehydrated
Few clinical signs	<5%
Sunken eyes, skin tenting for 3-5 seconds	6-7%
Depression, skin tenting for 8-10 seconds, dry mucous membranes	8-10%
Recumbent, cool extremities, poor pulse	11-12%
Death	>12%

Source: Sheila M. McGuirk, DVM, PhD, and Pamela Ruegg, DVM, MPVM, University of Wisconsin-Madison

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100 lb calf with diarrhea

Calf Health	% Dehydrated	Daily Milk	Oral Fluids	qts
Healthy calf	0%	4.4 kg	0 kg per day	
Mild diarrhea	2%	4.4 kg	1.1 kg per day	1
Mild diarrhea	4%	4.4 kg	2.2 kg per day	2
Depressed	6%	4.4 kg	3.3 kg per day	3
Very ill	8%	4.4 kg	4.4 kg per day	4.5
Recumbent	>10%	4.4 kg	Need intravenous fluids	

Geof Smith, UNC vet college

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Feed milk???

Maybe we should give the intestine a break from milk digestion??

- seems like milk makes diarrhea worse
- giving bacteria food to grow
- milk slows intestinal healing

NO EVIDENCE SUPPORTING ANY OF THESE REASONS

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Feed Milk along with oral electrolytes

Ideal

Feed milk and oral electrolytes several hrs apart

Most effective when fed in smaller and more frequent amounts!!!!

Withhold milk → calf starves!!!!

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electrolytes into milk?

ten raises osmolarity (saltiness) of the milk to the point that it akes scouring worse –> osmotic diarrhea.

/perosmolarity can slow abomasal emptying → abomasal bloat (I l Constable, 2006)

sodium bicarbonate is main alkalinizer – it can interfere with milk otein digestion.

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Probiotics ?
Mannan oligosaccharides?
Other support?
-antibiotics, NSAIDs

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Four-State Dairy Nutrition & Management Conference

The Use of Canola Meal in the Diets of Early Lactation Dairy Cows

Dr. Ken Kalscheur
USDA Forage Research Center

The Use of Canola Meal in the Diets of Early Lactation Dairy Cows

Jordan M. Kuehnl, University of Wisconsin, Madison, WI
Kenneth F. Kalscheur, USDA-ARS Dairy Forage Research Center, Madison, WI
kenneth.kalscheur@usda.gov

TAKE-HOME MESSAGES

SUMMARY

- Early lactation presents a unique set of challenges when formulating diets fed to dairy cows as they recover from calving, fend off numerous metabolic disorders, and increase milk production towards peak lactation
- Canola meal contains an amino acid profile with more methionine than other protein sources, such as soybean meal, making it an ideal protein source for early lactation diets
- 3.9 to 9.8 lb/d increase in milk yield for cows consuming diets supplemented with canola meal compared to soybean meal, based on 4 early-lactation studies
- Canola meal supplementation increases production efficiency, as evidenced by increased feed efficiency and decreased MUN

EARLY LACTATION

Early lactation is unquestionably the most challenging time period of the lactation cycle for dairy cows from a metabolic standpoint. Generally regarded as the first 100 days of milk production, critical events such as the recovery from calving, weeks of negative energy balance, and peak milk production all occur during early lactation. Following parturition, the postpartum dairy cow is challenged with the task of supporting a rapid increase in milk production while concurrently burdened by heightened metabolic stressors, putting her at increased risk for metabolic disorders such as displaced abomasum, ketosis, mastitis, metritis, and milk fever. While these burdens are occurring, cows are also in a period of negative energy balance. This typically occurs during the first few weeks postpartum when the energetic and nutrient demands of milk production outpace nutrients provided via dry matter intake (Bauman and Currie, 1980). To remedy this nutritional deficiency, dairy cows mobilize adipose and skeletal muscle tissue to supply nutrients required for milk production. Approximately 18 to 46 pounds of skeletal muscle during the first 5 to 6 weeks of lactation (Komaragiri and Erdman, 1997; Komaragiri et al., 1998; Overton and Burhans, 2013) and 110 to 154 pounds of adipose tissue during the first 5 to 12 weeks of lactation (Komaragiri and Erdman, 1997) have been estimated to be mobilized. Moreover, the demand for glucose increases by more than 2 pounds per day during the first few days postpartum (Bertics et al., 1992; Reynolds et al., 2003). Considering the dramatic increase in nutrient demands to support milk production during early lactation, at the same time when dry matter intake is depressed, improved dietary formulations may alleviate these demands by affording the dairy cow a more favorable nutrient profile to utilize. Rapidly gaining popularity in dairy cow diets, canola meal (CM) is a protein supplement that holds potential towards achieving this goal. This paper will explore the utilization of CM in diets fed to early lactation dairy cows.

AMINO ACIDS AND METHIONINE AS A METHYL DONOR

Historically, soybean meal (SBM), and to a lesser extent dried distillers grains and cottonseed meal, have been the predominant protein sources used to formulate diets fed to dairy cows. In recent years, however, CM has rapidly gained popularity as an alternative protein source. Between the crop years 2014/2015 and 2017/2018, the total meal export from Canada, the world's leading canola producer, to the United States and China increased by more than 25% (Canola Council of Canada, 2019). These protein sources differ in their overall nutrient profile, with special consideration given to their respective amino acid profiles when formulating diets. An optimal balance of amino acids supplied via the diet is critical to optimize milk protein production. Of the 20 amino acids used to synthesize milk protein, lysine and methionine are generally recognized as the two most limiting. Therefore, incorporation of protein sources that contain ideal amounts of lysine and methionine for milk protein production is advantageous. The crude protein in cow's milk contains 7.7% lysine and 2.7% methionine, which equates to a ratio of approximately 2.85:1 lysine to methionine (NRC, 2001). On a crude protein basis, CM contains 5.62% lysine and 1.87% methionine (3.01:1 ratio), whereas SBM (48% CP, solvent extracted) contains 6.29% lysine and 1.44% methionine (4.37:1 ratio; NRC, 2001). From these calculated values, it is clear that CM contains a ratio of lysine to methionine that is more ideal for milk protein synthesis compared to SBM. Furthermore, it is the increased methionine content of CM that is contributing to this more ideal ratio.

While methionine is one of the two amino acids generally recognized as most limiting for milk protein synthesis, the benefits of increased methionine concentration in the diet reach far beyond this. These far-reaching effects stem from methionine's role as a methyl donor and its ability to alter DNA and proteins in the cow. As a methyl donor, methionine is known to improve liver and immune function (Osorio et al., 2013; Zhou et al., 2017), decrease the risk of ketosis (Osorio et al., 2013), decrease inflammation (Batistel et al., 2018), decrease oxidative stress (Batistel et al., 2018), and positively alter pregnancy and offspring metabolism and growth (Acosta et al., 2016; Toledo et al., 2017). Given these benefits, the overall well-being of the periparturient and early lactation dairy cow, under the concurrent stressors of recovering from calving while increasing milk production, should improve from increased methionine concentration in the diet. This can be achieved by substitution of protein sources in the diet, i.e. CM in the place of SBM.

EARLY LACTATION STUDIES

Due to the various challenges of early lactation dairy cow studies, only a handful of CM feeding studies have been conducted thus far. Utilizing 79 multiparous Holstein cows from calving through 16 weeks of lactation, Moore and Kalscheur (2016) tested the effects of low (16.2%) and high (18.1%) crude protein diets formulated with either SBM or CM as the main protein source. The diets contained a 55:45 forage to concentrate ratio, with 39.6% corn silage and 15.4% alfalfa silage. Canola meal was included at 11.9% and 19.4% DM, whereas SBM was included at 8.9% and 14.5% DM for the low and high CP diets, respectively. Cows consuming diets formulated with CM increased milk yield compared to cows consuming diets formulated with SBM (mean ± SEM; 122.5 vs. 112.7 ± 2.13 lb/d). Furthermore, ECM and FCM were both increased in cows consuming the CM diets compared to the SBM diets (126.7 vs. 117.9 ± 3.04 lb/d and 120.9 vs. 112.2 ± 3.00 lb/d, respectively). While the cows consuming the CM diets tended to have increased DMI compared to the cows consuming the SBM diets (56.8 vs. 55.0 ± 0.75 lb/d), this increase is not enough to support the level of increased milk production. Furthermore, there was no difference in body weight or body condition score throughout the experiment to compensate for this discrepancy. These data suggest that cows consuming CM-based diets utilized dietary nutrients more efficiently for milk production compared to the cows consuming SBM-based diets. This is reflected in the increased feed efficiency (ECM/DMI) for cows consuming the CM diets compared to the SBM diets (2.27 vs. 2.16 ± 0.06). Furthermore, cows consuming CM-based diets decreased MUN compared to cows consuming SBM-based diets (10.9 vs. 11.4 ± 0.2 mg/dL). This indicates a more efficient use of nitrogen in the diets. There was no difference in milk fat, protein, or lactose percentage between cows consuming the CM-based or SBM-based diets. However, cows consuming the CM diets had increased milk fat, protein, and lactose yields over cows fed the SBM-based diet because of the increase in milk yield.

After observing a production increase of 9.8 lb/d for cows consuming diets formulated with CM compared to diets formulated with SBM in Moore and Kalscheur (2016), a subsequent study by Kuehnl and Kalscheur (2021) further explored CM supplementation during early lactation. However, Kuehnl and Kalscheur (2021) additionally sought to determine the effect of CM supplementation during the close-up dry period on milk production and related measurements. Eighty multiparous Holstein cows were fed isonitrogenous diets containing either SBM or CM as the primary protein source from 3 weeks prepartum through 16 weeks of lactation. From 3 weeks prepartum through calving, 40 cows consumed the diet containing SBM, whereas the other 40 cows consumed the diet containing CM. At calving, half of the cows consuming each of the prepartum diets switched to the postpartum diet containing the other protein source, whereas the other half remained on the diet with the same protein source. There were 4 treatment groups of 20 cows each, 1) SBM pre- and postpartum, 2) SBM pre- and CM postpartum, 3) CM pre- and SBM postpartum, and 4) CM pre- and postpartum. A transition diet was fed for the first three weeks postpartum, with the objective of this diet being to include more crude protein to support milk production and less starch to minimize the possibility of metabolic disorders. Canola meal was included at 19.4%, 16.5%, and 13.5% of the diet (DM basis), whereas SBM was included at 14.2%, 12.1%, and 9.9% in the close-up, transition, and lactating diets, respectively. The close-up, transition, and lactating diets contained 14.5%, 17.7%, and 17.2% crude protein on a DM basis, respectively. Cows consuming the CM diet postpartum tended to have increased milk yield compared to cows consuming the SBM diet postpartum (116.2 vs. 112.2 ± 1.58 lb/d). Cows consuming the CM diets had increased dry matter intake both prepartum (33.7 vs. 31.9 ± 0.57 lb/d) and postpartum (57.6 vs. 55.0 ± 0.79 lb/d). There was no difference in ECM, FCM, or feed efficiency between diets. Prepartum supplementation of CM had no effect on milk yield despite the prepartum increase in dry matter intake. Unlike Moore and Kalscheur (2016), Kuehnl and Kalscheur (2021) observed no difference in milk fat, protein, or lactose yields. Moreover, there was no difference in milk fat, protein, or lactose percentages. However, cows consuming CM postpartum had decreased MUN compared to cows consuming SBM postpartum (12.9 vs. 13.7 ± 0.22 mg/dL), which is in agreement with Moore and Kalscheur (2016) and other CM feeding studies (Maxin et al., 2013; Acharya et al., 2015).

A study by Gauthier et al. (2019) examined the role of CM supplementation on a 5,000 Holstein cow dairy farm in California. In Gauthier et al. (2019), three pens of early lactation, multiparous Holstein cows were used to test the effects of three isonitrogenous diets containing increasing concentrations of CM. Cows were eligible to move into one of the three pens at 12 DIM and to move out of the pen at 160 DIM. The three diets contained 3.5% and 7% (diet 1), 8.2% and 3.5% (diet 2), and 13.0% and 0% (diet 3) CM and SBM, respectively, on a dry matter basis. Corn dried distillers grain with solubles was included at a constant rate of 7.5% of diet DM. Interestingly, while dry matter intake was not different between diets, cows consuming diets 2 and 3 had increased milk yield compared to diet 1 (98.6 vs. 97.9 vs. 93.1 lb/d). Milk fat, true protein, and lactose yields were all increased in cows consuming diets 2 and 3 compared to diet 1 as well. Similar to the data set from Moore and Kalscheur (2016), these results suggest more efficient nutrient utilization in the cows consuming diets 2 and 3, i.e. the diets containing 8.2% and 13.0% CM, compared to diet 1, i.e. the 3.5% CM diet. Furthermore, body condition score and change in body condition score (units/30 days) were both highest in diet 3 compared to diets 1 and 2. Considering the milk production and body condition score data together, it may be inferred that the cows consuming diet 3 (the 13.0% CM diet) were in a less negative energy balance compared to cows consuming diets 1 and 2 (the 3.5% and 8.2% CM diets).

Following up the study of Gauthier et al. (2019), Swanepoel et al. (2020) sought to further determine the effects of CM supplementation during early lactation in a commercial setting. Similar to the previous study, Swanepoel et al. (2020) utilized three pens of early lactation, multiparous Holstein dairy cows. Cows were assigned to one of the pens beginning at 13 DIM and remained on study until 160 DIM. There were three isonitrogenous diets tested, which included a diet with 14.5% CM (CM), a diet with 6.5% each of CM and SBM (SBM), and a diet with 6.5% each of CM and SBM supplemented with rumen protected methionine at a rate of 7.9 g/cow/day (SBM+M). There was no difference in dry matter intake between the three diets. Despite no difference in dry matter intake, milk yield was increased in the cows consuming the CM diet compared to cows consuming the SBM diet (112.9 vs. 109.0 ± 1.04 lb/d). Interestingly, there was no difference in milk production between the cows consuming the SBM and SBM+M diets. This suggests that either the amount of rumen protected methionine supplemented was not enough to elicit a production difference or that another intrinsic factor of CM was responsible for the increase in milk yield in this experiment. Furthermore, milk fat, true protein, and lactose yields were all increased in the cows consuming the CM diet compared to the SBM diet. There was no difference in body condition score or body condition score change in this experiment, potentially indicating no difference in energy balance between diets.

CONCLUSION

Early lactation is the most challenging period of the lactation curve for dairy cows. Factors such as recovery from calving, a prolonged period of negative energy balance, and the rapid increase of milk yield all occur during this time. Improved ration formulation, by utilizing protein sources such as CM that better match the amino acid profile for milk production, is one time-tested approach to successfully overcoming this challenge. The limited number of CM feeding studies conducted during early lactation arrive at the consensus that milk yields are improved when CM is incorporated into the ration. Other benefits of CM supplementation include increased production efficiency, which is achieved through increased feed efficiency and decreased MUN. Further research is necessary to determine how to best incorporate CM into early lactation dairy cow rations.

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2021 Speakers

Matt Akins

Matt Akins is an extension dairy specialist and assistant scientist at the University of Wisconsin Madison. Matt's work focuses on dairy heifer nutrition and health including the use of sorghum forages, roughage sources, grazing and coccidiosis control. He is originally from Sussex, WI and obtained a BS in Animal Science from UW-Platteville, MS in Animal Science from University of Arkansas, a PhD in Dairy Science from UW-Madison.

Dr. Phil Cardoso

Dr. Phil Cardoso is an associate professor at the University of Illinois at Urbana-Champaign. He received his D.V.M., and M.S. degrees from the Universidade Federal Do Rio Grande do Sul in Brazil, and his Ph.D. from the University of Illinois. Since 2012, Cardoso has established a unique program that seamlessly blends his teaching, extension, and research efforts. Phil's Dairy Science program impact by placing students in applied positions and academia. Phil and his students have published over 75 peer-reviewed manuscripts (original research and invited reviews) and 3 invited book chapters to date. The program builds from dairy producers' questions and focuses on having the dairy cow's diet as a medical prescription for performance, health, and reproduction. That is achieved by understanding the impact of nutrition on metabolism, reproduction, and health in dairy cows and mechanisms of metabolic adaptation to stressors and forage quality.

Dr. Devan Paulus Compart

March 1st, 2021, Dr. Devan Paulus Compart joined the North American Animal Nutrition team as Ruminant Business Development Manager. In this capacity she will support Evonik's Animal Nutrition business by working with farmers, nutritionists, feed producer and distributors on the concepts and use of feed additives in dairy and beef cattle diets. This includes the coordination of sales, marketing, technical services and communication activities with respect to Evonik's ruminant business.

Dr. Paulus Compart obtained her Bachelor's degree from the University of California Davis in the area of animal science with a focus on ruminant nutrition. Her Master's and PhD were both obtained from the University of Minnesota in ruminant nutrition. While attending the University of Minnesota, she was also an active member of the state-wide beef extension team.

James K. Drackley, Ph.D.

Dr. Drackley is Professor of Animal Sciences at the University of Illinois at Urbana-Champaign, USA. His research program has focused on nutrition and metabolism of dairy cows during the transition from pregnancy to lactation, fat utilization and metabolism, and aspects of calf nutrition and management. Dr. Drackley has published extensively, has supervised more than 45 post-graduate students to MS or PhD degrees, and has received numerous professional awards. Drackley is widely sought by the global dairy industry for speaking and consulting services. He is currently serving on the National Academies of Science, Engineering, and Medicine committee to prepare the 8th edition of Nutrient Requirements of Dairy Cattle.

Dr. Luiz Ferraretto

Dr. Luiz Ferraretto is originally from Brazil where he earned his B.S. in Animal Science from São Paulo State University in 2008. Immediately after the completion of his B.S. Degree, Luiz joined University of Wisconsin-Madison for an internship (2009) followed by a M.S. (2011) and Ph.D. (2015) in dairy science with focus on applied dairy nutrition and forage quality. After the completion of his Ph.D., Luiz joined The William H. Miner Agricultural Research Institute as a Post-doctoral Research Associate. From 2016 to 2020, he worked as Assistant Professor of Livestock Nutrition at University of Florida. Currently, Luiz is an Assistant Professor and Ruminant Nutrition Extension Specialist in the Department of Animal and Dairy Sciences at University of Wisconsin-Madison and his research interests are applied dairy cattle nutrition and management with emphasis on starch and fiber utilization by dairy cows, corn silage and high-moisture corn quality and digestibility, the use of alternative by-products as feed ingredients, and supplementation of feed additives to lactating cows.

Dr. Paul Fricke

Dr. Paul Fricke was raised on his family's row crop and dairy farm located near Papillion, Nebraska where his father and uncle continue to farm today. After receiving a B.S. degree in Animal Science in 1988 from the University of Nebraska, Paul went on to complete a M.S. degree in 1992 and a Ph.D. degree in 1996 in Reproductive Physiology from the department of Animal Sciences at North Dakota State University. Paul joined the faculty at the University of Wisconsin-Madison in 1998. His current position includes 70% Extension and 30% research appointments in dairy cattle reproduction. Dr. Fricke's research program focuses on understanding the biology underlying the many reproductive problems of dairy cattle. The goal of Dr. Fricke's extension program is to improve reproductive efficiency of dairy cattle by applying scientific research to develop practical management strategies and assess new reproductive technologies.

Dr. Brian Gerloff

Brian Gerloff was born and grew up on a small dairy farm in Woodstock, Illinois, where he currently lives. He attended Michigan State University and earned degrees in dairy science and veterinary medicine. After working in Ohio for several years, he returned to Michigan State and received a PhD in dairy nutrition, while concurrently working as a resident in the Large Animal Department.

He then established a veterinary practice in his home area of Illinois providing both veterinary and nutritional services to much of his clientele. After 25 years, in 2012 he transitioned to a full time position as a nutritional consultant, working with Renaissance Nutrition in southern Wisconsin, northern Illinois and eastern Iowa.

He has been active and held leadership positions locally in his church and community and nationally in the American Association of Bovine Practitioners. He has been honored with awards from the American Association of Bovine Practitioners, Michigan State University, the University of Illinois, and the Illinois Association of School Boards and has maintained a passion for working with dairies for his entire career that continues today. He is married to Carole, a kindergarden teacher, with twin sons Robert and Joseph who are still in high school and thinking they are likely not going to be dairy veterinarians.

Dr. Jesse Goff

Goff received his BS from Cornell University, and MS,DVM, and PhD degrees from Iowa State University. He worked for the USDA at the National Animal Disease Center in IA for 23 years, studying causes, treatments and prevention of milk fever and other metabolic and mineral disorders of cattle hogs and poultry. In addition Goff studied the immune responses of cattle, especially how the immune system was affected by metabolic diseases. Goff worked for the West Central Farmer's co-operative to help them refine Soychlor and Soyplus products and work with their clients as a nutritional consultant. In 2008, Goff started teaching and doing research at the Iowa State University College of Veterinary Medicine, where he taught Physiology courses and a Veterinary Nutrition course and took part in clinical rotations with the 4th year veterinary students. Goff is now professor emeritus at Iowa State and runs his veterinary consulting practice out of his barn in Gilbert IA, where he and wife Sandy have one child at home and 3 more grown-up children.

Dr. Mark Hanigan

Dr. Hanigan began his career as a dairy farmer in Western Iowa followed by a B.S. in Dairy Science from Iowa State University, an M.S. in Animal Science from UC-Davis, a Ph.D. in Nutrition from UC-Davis, and post-doctoral work in Biochemistry and Biophysics at UC-Davis. He joined the Dairy Research group at Purina Mills in 1993 and moved to the Dept. of Dairy Science at Virginia Tech in 2005.

He works in the area of nutrient metabolism using experimental and mathematical modeling approaches focusing on protein and energy metabolism. The long-term objective of his work is to improve animal efficiency and reduce the impact of animal-based production systems on the environment while maintaining a viable industry.

He is a member of the current NRC Nutrient Requirements of Dairy Cattle rewrite committee, and the chair of the National Animal Nutrition Program Modeling Subcommittee. He is an author or co-author of more than 120 peer-reviewed research publications.

Dr. Laura L. Hernandez

Dr. Laura L. Hernandez is an Associate Professor in the Department of Animal and Dairy Sciences at the University of Wisconsin-Madison. She received her Ph.D. in 2008 from the University of Arizona and completed her Post-Doctoral Fellowship at the University of Cincinnati in 2011. Laura's area of research has focused on how serotonin controls the mammary gland's ability to make milk and various aspects of lactation. Dr. Hernandez combines basic research from the cell to whole-animal level in a variety of mammalian species to broaden the focus on the importance of the mammary gland and its contributions to and regulation of a successful lactation in dairy cattle. The outcomes of her novel research are aimed at understanding how serotonin control the cow's physiology while lactating, particularly during the transition period when cows are the most metabolically and physiologically challenged. She specifically focuses on the interaction of serotonin and calcium metabolism during the transition period and how we can better manage calcium around the time of calving to optimize cow health and production. Her research has determined that serotonin is an important regulator of mammary gland and maternal calcium homeostasis during lactation.

Jay Joy

Jay Joy has spent his entire career focused on the business of agriculture. He is currently the General Manager of Pagel Family Businesses, LLC., which own/operate 2 large dairies, a calf ranch, and a large crop farming enterprise in Northeast Wisconsin. Jay is also the founder of Milk Money, LLC., a financial and management coaching practice focused exclusively on helping farmers make more profit by developing their people. Prior to starting Milk Money, Jay spent nearly 10 years in banking with several leading financial institutions where he financed and advised a number of large commercial dairies, cattle feeders, and grain companies. In addition to his banking and coaching experience, Jay has been fortunate to spend time in his career as the General Manager of 2 large dairies and a heifer ranch in Southwest Kansas, and as the CFO of a large corn and alfalfa farm in North Central Kansas. A native Kansan, Jay completed his undergraduate degree at Fort Hays State University, his MBA at the University of Nebraska-Lincoln, and executive development programs at Cornell University and the University of Wisconsin-Madison.

Dr. Kenneth Kalscheur

Kenneth Kalscheur received his B.S. in Dairy Science from the University of Wisconsin-Madison, and his M.S. and Ph.D. degrees in Animal Science from the University of Maryland. From 2001 to 2014, Kenneth F. Kalscheur was a Professor of Dairy Science at South Dakota State University. His appointment at South Dakota State University consists of teaching dairy science courses and conducting research on dairy cattle nutrition and management. Since 2014, Dr. Kalscheur is a Research Animal Scientist at USDA-Agricultural Research Service, U.S. Dairy Forage Research Center in Madison, Wisconsin. Research conducted by Dr. Kalscheur includes utilization of forages and agro-industry coproducts in dairy cattle diets to improve milk production and nutrient utilization by dairy cattle and the environmental impact of animal management and feeding practices in dairy production systems.

Lee Kloeckner

Lee's dairy experience began when he was in middle school by working on a neighbor's dairy farm and continued there through his first year of college. While attending the University of Minnesota for a degree in animal science, he had internships as an AI technician and a herdsperson on a 350-cow dairy. After graduating with his bachelor's degree in 2014, Lee stayed at the U of M for his master's degree working with Dr. Marcia Endres. His Master's project was a dairy management survey of 84 Minnesota dairy farms ranging from 150 to 2100 cows. Following the completion of his master's degree, Lee began working at Ag Partners Coop in the fall of 2016 where he works as a Dairy Nutrition and Production Specialist in Southeast Minnesota and Western Wisconsin. Lee and his wife Aly reside outside of Red Wing, MN.

Dr. James Koltes

Dr. James Koltes is an Assistant Professor in the Department of Animal Science within the Animal Breeding and Genetics group at Iowa State University. Dr. Koltes received his BS in Dairy Science and Genetics from the University of Wisconsin-Madison and PhD from Iowa State University in Genetics. His research at focuses on the use of new tools such as sensors and biomarkers in the genetic improvement of feed efficiency and health in dairy cattle. He also works on development of computational tools and resources to advance the application of genomics in livestock breeding.

Dr. Derek Nolan

Derek Nolan grew up on a dairy farm in Northeast Iowa. Derek received his BS in Dairy Science at Iowa State University and completed both his MS and Ph.D. at Kentucky with a research focus in milk quality and decision economics. He is now a Teaching Assistant Professor and Dairy Extension Specialist in the Animal Sciences Department at the University of Illinois. Derek strives to help dairy producers reach their goals by providing tools to assist them in making informed management decisions and improving milk quality. He focuses on providing hands-on experiences that help youth better understand the dairy cow and dairy production system.

Theresa Ollivett, DVM, PhD, DACVIM (Large Animal)

Assistant Professor in Food Animal Production Medicine section at UW-Madison School of Veterinary Medicine

Dr. Ollivett is a veterinary epidemiologist and board-certified large animal internist. After graduating from the College of Veterinary Medicine at Cornell University in 2004, Dr. Ollivett practiced in a predominantly mixed large animal clinic in northern NY. She returned to Cornell University in 2007 and completed a residency in Large Animal Medicine between 2008-2011. In 2014, she completed her doctoral studies at the University of Guelph by validating portable lung ultrasound as a means of diagnosing respiratory disease in dairy calves. As an assistant professor in the Food Animal Production Medicine section at the School of Veterinary Medicine at UW-Madison, Dr. Ollivett works to advance the academic, veterinary and professional dairy industry's awareness and understanding of lung ultrasound as a means to monitor preweaned calf lung health and promote a #WeanClean™ philosophy on dairy farms.

Dr. Larry Tranel

Dr. Larry Tranel grew up on a Wisconsin dairy farm and has continued his dairy farm involvement with his extended family. Larry graduated from UW-Platteville with B.S. degrees in Agricultural Economics and International Studies, an M.S. in Ag Industries. Dr. Tranel also holds a doctorate in Pastoral Psychology. He spent 10 years with University of Wisconsin-Extension as a Dairy Farm Management Agent and the past 21 years as Dairy Field Specialist with Iowa State University Extension and Outreach specializing in low cost parlors, robotic milking, financial management and comparison of conventional, grazing, organic and grass milk systems. He is the main lead on Iowa's Farm Couple Getaways and spends approximately half of his time working with farm behavioral and brain health.

Dr. Bill Weiss

Dr. Bill Weiss was a Professor and Extension Specialist of dairy cattle nutrition at The Ohio State University but after more than 33 years on faculty, he retired in early 2021. His main research areas were factors affecting digestibility by dairy cows, relationships between minerals and vitamins and health of dairy cows, and developing methods to incorporate cow and diet variability into ration formulation. Dr. Weiss has published more than 140 journal articles and 450 proceedings and extension articles. He has won several ADSA awards and was named a Fellow of the American Dairy Science Association in 2015. He is also a member of ARPAS and a Diplomat of the American College of Animal Nutrition. He was a member of the 2001 NRC Dairy Committee and is serving as co-chair on the 2020 NRC Dairy Committee.