Four-State Dairy Nutrition and Management Conference

Wednesday, June 10, 2020
Virtual Conference

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

2020
## Table of Contents

### Pre-Conference Symposium

**Sponsored by Adisseo**  
**All Systems Go! Amino Acid Balancing to Take Cows Farther**

Amino Acid Balancing for the Transition Cow: Old and New Stories from a Molecular Perspective  
Dr. Johan Osorio, South Dakota State University ................................................................................................................................................................................................. 1

Yes, Met and Lys are Important, But There are Several Others That are Also Important in Lactating Cow Diets  
Dr. Mark Hanigan, Virginia Tech ................................................................................................................................................................................................. 8

Functional Amino Acids: The Concept, Present Reality, and Future Prospects using Reproduction as an Example  
Dr. Milo Wiltbank, University of Wisconsin ................................................................................................................................................................................................. 13

### 4-State Dairy Nutrition and Management Conference

#### General Session

**Improving Herd Health**

Taking Steps to Prevent Lameness in Dairy Herds  
Dr. Nigel Cook, University of Wisconsin ................................................................................................................................................................................................. 24

How Daily and Seasonal Rhythms Impact Cows  
Dr. Kevin Harvatin, Penn State University ................................................................................................................................................................................................. 39

Nutritional Regulation of Gut Health and Development: Colostrum and Milk  
Dr. Mike Steele, University of Guelp ................................................................................................................................................................................................. 49

**Maximizing Profit from your Bull Calves**

Realizing Full Value for Full- and Half-blood Holstein Steers  
Dr. Dan Schaefer, University of Wisconsin ................................................................................................................................................................................................. 59

The Commercial Science Behind Purebred Holstein Beef  
Bill Munns, JBS USA ................................................................................................................................................................................................................................................................. 68

A Data Driven Approach to Sourcing Profit Focused Beef Bulls for a Holstein Based Dairy  
Chip Kemp, American Simmental Assn. ................................................................................................................................................................................................................................................................. 72

#### Breakout Sessions

Clean Feed: Optimizing Health and Nutrition  
Dr. Keith Bryan, Chr Hansen ................................................................................................................................................................................................................................................................. 81

Lessons Learned From the 2019 Growing Season  
Dr. Mike Hutjens, University of Illinois  
Dr. Steve Woodford, Nutrition Professionals ................................................................................................................................................................................................................................................................. 90

Don’t Underestimate the Cost of Milk Quality  
Dr. Derek Nolan, University of Illinois ................................................................................................................................................................................................................................................................. 96

Effect of Timing of Induction of Ovulation Relative to Timed AI Using Sexed Semen on Pregnancy Outcomes in Primiparous Holstein Cows  
Dr. Paul Fricke, University of Wisconsin ................................................................................................................................................................................................................................................................. 103
Challenges of Barn Design and Performance in Automated Milking Systems
Dr. Nigel Cook University of Wisconsin ................................................................. 110

Maximizing Milk Fat Yield
Dr. Kevin Harvatine, Penn State University ............................................................ 123

Nutritional Regulation of Gut Health and Development: Weaning and Beyond
Dr. Mike Steele, University of Guelph ...................................................................... 131

The High Fertility Cycle
Dr. Milo Wiltbank, University of Wisconsin ............................................................ 140

Using MUN to Manage Protein Feeding
Dr. Mark Hanigan, Virginia Tech .............................................................................. 149

Rumen-Protected Amino Acids Fed to Dairy Cows During Stressful Periods: Does it work?
Dr. Phil Cardoso, University of Illinois ..................................................................... 154
<table>
<thead>
<tr>
<th>Advertiser</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adisseo</td>
<td>7</td>
</tr>
<tr>
<td>Ag Processing, Inc.</td>
<td>37</td>
</tr>
<tr>
<td>Alflorex Seeds</td>
<td>47</td>
</tr>
<tr>
<td>Alltech</td>
<td>66</td>
</tr>
<tr>
<td>Amelicor</td>
<td>70</td>
</tr>
<tr>
<td>Anpario</td>
<td>88</td>
</tr>
<tr>
<td>Arm &amp; Hammer</td>
<td>94</td>
</tr>
<tr>
<td>Balchem</td>
<td>108</td>
</tr>
<tr>
<td>Canola Council of Canada</td>
<td>129</td>
</tr>
<tr>
<td>Central Life Sciences</td>
<td>152</td>
</tr>
<tr>
<td>Dairy Nutrition Plus</td>
<td>152</td>
</tr>
<tr>
<td>Dairyland Labs</td>
<td>12</td>
</tr>
<tr>
<td>Diamond V</td>
<td>164</td>
</tr>
<tr>
<td>Elanco</td>
<td>70</td>
</tr>
<tr>
<td>Feed Components</td>
<td>139</td>
</tr>
<tr>
<td>Fermented Nutrition</td>
<td>38</td>
</tr>
<tr>
<td>GLC Minerals</td>
<td>47</td>
</tr>
<tr>
<td>International Stock Food</td>
<td>48</td>
</tr>
<tr>
<td>Jefo</td>
<td>71</td>
</tr>
<tr>
<td>Kemin Animal Nutrition &amp; Health</td>
<td>80</td>
</tr>
<tr>
<td>Kent</td>
<td>139</td>
</tr>
<tr>
<td>Lallemand Animal Nutrition</td>
<td>67</td>
</tr>
<tr>
<td>Micronutrients</td>
<td>67</td>
</tr>
<tr>
<td>Multimin USA</td>
<td>89</td>
</tr>
<tr>
<td>Natural Biologics</td>
<td>89</td>
</tr>
<tr>
<td>Novita Nutrition</td>
<td>95</td>
</tr>
<tr>
<td>Olmix</td>
<td>95</td>
</tr>
<tr>
<td>Origination LLC</td>
<td>109</td>
</tr>
<tr>
<td>Papillon Agricultural Co.</td>
<td>148</td>
</tr>
<tr>
<td>Peak Forage Solutions Inc.</td>
<td>153</td>
</tr>
<tr>
<td>Phileo by Lesaffre</td>
<td>148</td>
</tr>
<tr>
<td>PMI</td>
<td>109</td>
</tr>
<tr>
<td>Provita Supplements</td>
<td>130</td>
</tr>
<tr>
<td>Quali Tech Inc.</td>
<td>165</td>
</tr>
<tr>
<td>Quality Liquid Feeds</td>
<td>58</td>
</tr>
<tr>
<td>Quality Roasting</td>
<td>102</td>
</tr>
<tr>
<td>Rock River Laboratory</td>
<td>57</td>
</tr>
<tr>
<td>Timab USA</td>
<td>58</td>
</tr>
<tr>
<td>Virtus Nutrition</td>
<td>122</td>
</tr>
<tr>
<td>Zinpro Performance Minerals</td>
<td>165</td>
</tr>
</tbody>
</table>
Amino Acid Balancing for the Transition Cow: Old and New Stories from a Molecular Perspective

Johan Osorio, Assistant Professor
Dairy and Food Science Department
South Dakota State University, Brookings, USA
Amino acid balancing for the transition cow: Old and new stories from a molecular perspective

Johan Osorio
Assistant Professor
Dairy and Food Science Department
South Dakota State University, Brookings, USA

June 10, 2020

Peripartal or Transition period

Energy balance
Body condition score
Energy intake
4% Fat corrected milk

Cow in negative energy balance

VLDL
NEFA
Insulin
NE
Epi
TG

Feed
Intake
Decrease
Increase

Body fat and protein mobilization

0 50 100 150 200 250

Fat Protein

Week relative to parturition

-2 5 12

16% Crude protein
19% Crude protein

Peripartal protein mobilization

Body protein (kg)

-14 40 120

97.2 88.9 88.5

3-Methylhistidine (μM)

-7 7 14 21 28

17.8 10.6 6.4 6.7 7.8

Metabolizable protein and amino acids likely limiting around calving

Metabolizable Protein

Needed for milk protein, glucose synthesis, synthesis of other compounds (e.g. SAM, glutathione, taurine)
Net liver uptake of Methionine and Histidine increases after calving

(Larsen and Kristensen, 2013)

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

Methionine and the Peripartal Period

<table>
<thead>
<tr>
<th>Dietary component</th>
<th>Osorio et al., 2013</th>
<th>Zhou et al., 2016</th>
<th>Batistel et al., 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP, % of DM</td>
<td>17.4</td>
<td>17.2</td>
<td>17.7</td>
</tr>
<tr>
<td>MP supplied (g/d)</td>
<td>1.563</td>
<td>1.840</td>
<td>2.090</td>
</tr>
<tr>
<td>MP balance (g/d)</td>
<td>-574</td>
<td>-616</td>
<td>-434</td>
</tr>
<tr>
<td>Lys (% of MP)</td>
<td>6.17</td>
<td>6.07</td>
<td>6.33</td>
</tr>
<tr>
<td>Met (% of MP)</td>
<td>1.81</td>
<td>2.15</td>
<td>1.79</td>
</tr>
<tr>
<td>lys:Met</td>
<td>3.43:1</td>
<td>2.82:1</td>
<td>3.54:1</td>
</tr>
</tbody>
</table>

Methionine and the Peripartal Period

Milk Yield

Adapted from Osorio et al., 2013

Adapted from Zhou et al., 2016

Adapted from Batistel et al., 2017

Liver Function

Methionine

Milk yield & Performance

Antioxidant

Liver function

DNA & Histone methylation

Reduced immunosuppression

Fatty liver on milk yield

Actual TG mean:
- Mild = 3.3 ± 1.0
- Moderate = 6.5 ± 1.5
- Severe = 11.1 ± 0.9

Actual Milk yield:
- Mild = 41.9 ± 0.84
- Moderate = 41.6 ± 1.5
- Severe = 36.9 ± 2.9

Correlation:
- r = 0.2
- P = 0.06

Osorio et al., 2013; Zhou et al., 2016; Batistel et al., 2017
Methionine plays several roles in liver

Phospholipid synthesis

Apolipoprotein synthesis

Glutathione (antioxidants)

Taurine

Amino acids (Met, et al.)

Albumin

Major secretory protein synthesized by liver

Peripartum

NEFA

Esterification

TG

VLDL, secreted from liver

Liver function

Carnitine metabolism

Carnitine

Acyl-CoA from cytosol to the mitochondrial matrix

Matrix

Cytoplasm

Acyl-CoA

Carnitine

Acyl-carnitine

Carnitine

CPT I (Carnitine Palmitoyl Transferase I)

CPT II (Carnitine Palmitoyl Transferase II)

Liver function

VLDL = Very low density lipoproteins

Adapted from Sun et al., 2016

Adapted from Osorio et al., 2013

Inflammatory response

Metritis

Mastitis

Acute Phase Proteins

Liver

Potential Pathogen Infection

Kuby Immunology, 2007
Fat or Adipose Tissue

Cow in negative energy balance

Liver

NEFA

Inflammatory Response Signal

NEFA

Liver

Inflammation

Fat or Adipose Tissue

Liver

NEFA

TG

Insulin NE, Epi

Liver

Insulin NE, Epi

Liver

Inflammatory response

Metritis

Mastitis

Potential Pathogen Infection

Milk yield +6.5 kg/d in Upper

Diet, P = 0.28

Time, P = 0.04

D × T, P = 0.20

Control, P = 0.15

Milk yield +6.5 kg/d in Upper

Glutathione

Methionine supplementation alters the liver transcriptome

2,663 genes with diet × time effect

Liver function

Glutathione Priming Effect

Dietary methyl-donors in dairy cows

Methionine

SAM

DA methylation

Liver Function

Glutathione

Met

P = 0.04

Diet

Met

P = 0.04

Antioxidants

Methionine

Control

Methionine

Zhou et al., 2016

Batistel et al., 2018

Osorio et al., 2014

Glutathione (mM)

Zom et al., 2011

5-MTHF

Diet

Folate

Cysteine

Diet

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine

SAM

Dietary methyl-donors in dairy cows

Methionine
Histone Methylation

**Relative Histone Methylation**

- Milk protein

**Total protein**

<table>
<thead>
<tr>
<th>Diet</th>
<th>Methionine?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Control</td>
</tr>
<tr>
<td>500</td>
<td>0</td>
</tr>
<tr>
<td>250</td>
<td>0</td>
</tr>
</tbody>
</table>

**Epigenetic regulation**

- Euchromatin
- Heterochromatin

**Dietary Methionine?**

Bionaz et al., 2012; PLoS ONE 7:333268

---

**Conclusions**

- Methionine
- Performance
- Metabolism
- Gene expression
- Methionine Model
- Gene Regulation

**Prepartum**

**Postpartum**

---

**Thanks!**

Johan.Osorio@sdstate.edu
METHIONINE
More Than Milk

Optimal performance, day in and day out, requires that all essential nutrient requirements be met.

Talk with your Adisseo representative today!

More milk, milk protein, and milkfat
More relief from metabolic disorders at transition
More timely breed backs and full-term pregnancies

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

Dr. Mark Hanigan
Virginia Tech
Yes, Met and Lys are Important, but there are Several Others that are also Important in Lactating Cow Diets

Dr. Mark Hanigan, Virginia Tech

Ohio Dairy Nutrient Values – 5-year Average

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Cost/unit</th>
<th>Daily Supply</th>
<th>Cost/cow/d</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEL (kcal, NRC 2001)</td>
<td>$0.06</td>
<td>35.4 Mcal</td>
<td>$2.83</td>
</tr>
<tr>
<td>Metabolizable Protein (NRC)</td>
<td>$0.43</td>
<td>8.44 lbs</td>
<td>$2.34</td>
</tr>
<tr>
<td>Effective NDF (forage NDF)</td>
<td>$0.14</td>
<td>104 lbs</td>
<td>$1.46</td>
</tr>
<tr>
<td>Non-effective NDF (Total NDF – Forage NDF)</td>
<td>$-0.02</td>
<td>7.3 lbs</td>
<td>$0.15</td>
</tr>
<tr>
<td>Total Cost for Energy, Protein and Fiber</td>
<td>$0.48</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* NEL to cow, 60 lbs milk, 3% protein, 3.5% fat

Milk Protein vs Metabolizable Protein

For this much protein

Feed this much MP

4

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

How do we achieve this?

Predictions always off in an unpredictable manner
- High RMSE
- Low CCC
- High mean bias
- High slope bias
- May be useful but difficult calibration
- NRC 2001
Subsequent NRC Committee Work

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

Prediction Errors for Duodenal CP and AA Flows
- All Amino Acids are Required

Protein Synthesis Regulated by Multiple AA
- Dietary and Microbial Protein
- mRNA
- Ribosome
- ATP

AA Effects on αS1-Casein Synthesis
- Arrows indicate high cow in vivo concentrations (Swanepoel et al., 2016 and Yoder, 2019)
Lactational Responses to Individual Essential AA in Mice

Liu et al., 2017

<table>
<thead>
<tr>
<th>AA</th>
<th>50</th>
<th>55</th>
<th>60</th>
<th>65</th>
<th>70</th>
<th>75</th>
<th>80</th>
<th>85</th>
<th>90</th>
<th>95</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>21% CP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15% CP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15% + Ile</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15% + Leu</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15% + Met</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15% + Thr</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Litter Weight Gain, g

15% CP Diet
38% N Efficiency

Yoder et al., 2020

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

Integrated Milk Protein Predictions from Meta-analysis

Predictors: Intercept His Ile Leu Lys Met Thr DEInp dNDF BW
g/d

Estimates 6.3 2.44 1.05 0.99 1.10 1.80 2.01 –

SE 102 0.76 0.51 0.29 0.30 0.39 0.75 0.0004 0.68 0.94 0.14

Cross Evaluation Results – 500 Iterations

How Low Can We Go?

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

<table>
<thead>
<tr>
<th>MP, g/d</th>
<th>16.5% CP</th>
<th>14.5% CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>2280</td>
<td>2000</td>
<td></td>
</tr>
<tr>
<td>EAA, g/d</td>
<td>1170</td>
<td>1026</td>
</tr>
<tr>
<td>Milk Pr, g/d</td>
<td>1010 (2.38)</td>
<td>1010 (2.34)</td>
</tr>
<tr>
<td>Abs His, g/d</td>
<td>56</td>
<td>49</td>
</tr>
<tr>
<td>Abs Leu, g/d</td>
<td>214</td>
<td>188</td>
</tr>
<tr>
<td>Abs Lys, g/d</td>
<td>173</td>
<td>157</td>
</tr>
<tr>
<td>Abs Met, g/d</td>
<td>94</td>
<td>47</td>
</tr>
<tr>
<td>MP, $/d</td>
<td>$2.20</td>
<td>$1.93</td>
</tr>
<tr>
<td>Milk Pr, $/d</td>
<td>$4.76</td>
<td>$4.69</td>
</tr>
<tr>
<td>Net, $/d</td>
<td>$0.20</td>
<td>$0.36</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>MP, g/d</th>
<th>16.5% CP</th>
<th>14.5% CP</th>
<th>12.5% CP</th>
<th>12.5% + rpAA</th>
</tr>
</thead>
<tbody>
<tr>
<td>2280</td>
<td>2000</td>
<td>1725</td>
<td>1885</td>
<td></td>
</tr>
<tr>
<td>EAA, g/d</td>
<td>1170</td>
<td>1026</td>
<td>895</td>
<td>1027</td>
</tr>
<tr>
<td>Milk Pr, g/d</td>
<td>1010 (2.38)</td>
<td>1010 (2.34)</td>
<td>1010 (2.30)</td>
<td>1114 (2.45)</td>
</tr>
<tr>
<td>Abs His, g/d</td>
<td>56</td>
<td>49</td>
<td>42</td>
<td>56 (+14)</td>
</tr>
<tr>
<td>Abs Leu, g/d</td>
<td>214</td>
<td>188</td>
<td>162</td>
<td>214 (+52)</td>
</tr>
<tr>
<td>Abs Lys, g/d</td>
<td>173</td>
<td>157</td>
<td>135</td>
<td>179 (+44)</td>
</tr>
<tr>
<td>Abs Met, g/d</td>
<td>94</td>
<td>47</td>
<td>47</td>
<td>94 (+13)</td>
</tr>
<tr>
<td>MP, $/d</td>
<td>$2.20</td>
<td>$1.93</td>
<td>$1.66</td>
<td>&gt;$1.66</td>
</tr>
<tr>
<td>Milk Pr, $/d</td>
<td>$4.76</td>
<td>$4.69</td>
<td>$4.59</td>
<td>$4.91</td>
</tr>
<tr>
<td>Net, $/d</td>
<td>$0.20</td>
<td>$0.36</td>
<td>$0.68</td>
<td>$0.18</td>
</tr>
</tbody>
</table>

How Low Can We Go?

15% CP Diet
38% N Efficiency

Metabolic Representation

Real Facts: A Leaky Barrel

• Leaks define efficiency
• Size of each leak depends on the mix of nutrients
  – AA and Energy Supply
  – AA partitioning to Mammary
  – Mammary responses to AA and energy
• Additive, independent milk protein responses
• Understanding requires a change in thought!
Diet Optimization Using Different Strategies
RP His, Lys, Ile, Leu, Met, and Thr offered

<table>
<thead>
<tr>
<th>Least Cost</th>
<th>Maximum IOFC</th>
<th>IOFC + N Penalty</th>
<th>IOFC MILK</th>
<th>D2 MILK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diet Cost, $/d/c</td>
<td>$6.38</td>
<td>$3.72</td>
<td>$7.81</td>
<td>$3.44</td>
</tr>
<tr>
<td>Milk Value, $/lb</td>
<td>$14.59</td>
<td>$16.74</td>
<td>$16.18</td>
<td>$12.01</td>
</tr>
<tr>
<td>Milk Protein, g/d</td>
<td>1110</td>
<td>1286</td>
<td>1210</td>
<td>1262</td>
</tr>
<tr>
<td>ME, kcal/kg</td>
<td>2.52</td>
<td>3.01</td>
<td>3.12</td>
<td>3.00</td>
</tr>
<tr>
<td>MP, g/d</td>
<td>2039</td>
<td>3067</td>
<td>2110</td>
<td>2907</td>
</tr>
<tr>
<td>Dietary CP, %</td>
<td>14.9</td>
<td>21.8</td>
<td>14.7</td>
<td>20.6</td>
</tr>
<tr>
<td>N Efficiency, %</td>
<td>29.7</td>
<td>25.8</td>
<td>33.0</td>
<td>24.5</td>
</tr>
<tr>
<td>Neutral Detergent Fiber, %</td>
<td>35.7</td>
<td>32.8</td>
<td>34.5</td>
<td>31.4</td>
</tr>
<tr>
<td>Starch, %</td>
<td>26.2</td>
<td>24.1</td>
<td>25.2</td>
<td>24.8</td>
</tr>
</tbody>
</table>

Milk protein = $4/lb and milk fat = $2/lb; assumed high potential production.
Milk protein = $3/lb and milk fat = $1.50/lb.
Milk protein = $2/lb and milk fat = $1/lb.

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

Accurate and timely analysis of feed and forages, molds and mycotoxins, soil, water, and more.

CONTACT US TODAY
For tools that can add value to your forage testing data

info@dairylandlabs.com
Phone: 608-323-2123
Fax: 608-323-2184
Functional Amino Acids: The Concept, Present Reality, and Future Prospects Using Reproduction as an Example

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

Julio Giordano, Matias Stangaferro, Michael Van Amburgh
Cornell University

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

Julio Giordano, Matias Stangaferro, Michael D. Amburgh
Cornell University

Presented during the 2020 Four State Dairy Nutrition & Management Virtual Conference. Do not reuse or reproduce without author permission.

AA Nutrition

- Over 700 AA occur in nature, but 20 are incorporated into proteins.
- Amino acids are required nutrients.
- Essential vs. Non Essential.
  - Arg
  - His
  - Ile
  - Leu
  - Lys
  - Met
  - Phe
  - Thr
  - Trp
  - Val
  - Tyr

Amino Acid Structure

Functional amino acid definition

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


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


Functions of amino acids

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

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

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

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

Reproductive effects of Arg feeding in ruminants?

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

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

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

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

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

Potential Arg effects on reproduction in dairy cows

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

<table>
<thead>
<tr>
<th></th>
<th>Singletons</th>
<th>Twins</th>
<th></th>
<th>n</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cool</td>
<td>4.6%</td>
<td>17.6%</td>
<td></td>
<td>37/805</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Warm</td>
<td>12.7%</td>
<td>53.7%</td>
<td></td>
<td>64/505</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Total</td>
<td>7.7%</td>
<td></td>
<td></td>
<td>1,310</td>
<td>&lt; 0.0001</td>
</tr>
</tbody>
</table>

Methionine

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

One-Carbon Pathway:
- DNA methylation
- Synthesis of other compounds (choline, creatine, polyamines)
- Antioxidant balance
Functional amino acids: The concept, present reality, and future prospects using reproduction as an example: Methionine

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

Present Reality:

Future Prospects:

Methionine

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

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

Reproduction?

Effect of dietary methionine supplementation in early lactation dairy cows:

I - Lactation performance & II - Embryo quality
Souza, Carvalho, Dresch, Vieira, Hackbart, Luichini, Bertics, Betzold, Wiltbank & Shaver

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

Effect of dietary methionine supplementation in early lactation dairy cows:

I - Lactation performance & II - Embryo quality
Souza, Carvalho, Dresch, Vieira, Hackbart, Luichini, Bertics, Betzold, Wiltbank & Shaver

- SUPPLEMENTAL DIETARY RUMEN-PROTECTED METHIONINE INCREASED PLASMA METHIONINE CONCENTRATIONS AND MILK PROTEIN CONCENTRATION & MILK PROTEIN YIELD.

<table>
<thead>
<tr>
<th>MET in Plasma</th>
<th>Control</th>
<th>+ MET</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.8 µM</td>
<td>22.9 µM</td>
<td></td>
</tr>
</tbody>
</table>
Embryos of superovulated cows fed MET or CON

<table>
<thead>
<tr>
<th>MET</th>
<th>CON</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CL number</td>
<td>17.0 ± 1.3</td>
<td>17.7 ± 1.5</td>
</tr>
<tr>
<td>% Fertilized ova</td>
<td>74.7 ± 5.6</td>
<td>82.2 ± 3.8</td>
</tr>
<tr>
<td>% Transferable embryos</td>
<td>56.3 ± 6.5</td>
<td>62.5 ± 6.0</td>
</tr>
<tr>
<td>% Degenerate embryos</td>
<td>18.5 ± 4.6</td>
<td>19.7 ± 4.7</td>
</tr>
</tbody>
</table>

Present Reality based on RNA-Seq trial:
- Methionine has functional effects on embryos
- Methionine supplementation of the dam changes gene expression in the embryo (Epigenetics).
- Most genes are down-regulated by methionine supplementation.

Gene Expression Is Different

Feeding treatments

TOP-DRESSING

- CONTROL = 60 g dried distillers grain
- RPM = 21.2 g of Rumen-protected MET + 38.8 g of dried distillers grain

From 30 ± 3 to 126 ± 3 DIM

Plasma methionine profile after top-dressing

**CON**

**RPM**

* P < 0.05
† 0.05 < P ≤ 0.10
∗ Treatment P < 0.001
†† Time P < 0.001
‡ Treatment Time P = 0.002

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

- CON
- RPM

Time after RPM top-dressing

Treatment P = 0.99
Time P = 0.08
Treatment*Time P = 0.71

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

Experimental design timeline

Conception

Double Ovsynch

Treatment Period

Experimental design timeline

Days in milk

Adaptation Period

Treatments continued until diagnosed non-pregnant on day 32 or 61 of pregnancy

Pregnancy Diagnosis

P/AI (%)

Treatment

P = 0.42
P = 0.32
P = 0.27
P = 0.26

No parity effect!

Fertility of synchronized cows (92.2%)

PSPB levels

Day after AI

US

US

US

US

Mateus Z. Toledo

Methionine & Embryo Size

<table>
<thead>
<tr>
<th>Trt &amp; Parity</th>
<th>n</th>
<th>Amnionic Vesicle (mm³)</th>
<th>Crown-Rump Length (mm)</th>
<th>Abdominal Diam. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pri-Con</td>
<td>36</td>
<td>617.1</td>
<td>10.5</td>
<td>5.6</td>
</tr>
<tr>
<td>Pri-RPM</td>
<td>38</td>
<td>596.0</td>
<td>10.9</td>
<td>5.7</td>
</tr>
<tr>
<td>Mul-Con</td>
<td>37</td>
<td>479.4</td>
<td>10.6</td>
<td>5.3</td>
</tr>
<tr>
<td>Mul-RPM</td>
<td>45</td>
<td>593.9</td>
<td>11.0</td>
<td>5.9</td>
</tr>
</tbody>
</table>

Multiparous Cows supplemented with RP-Methionine had larger embryos.

Embryo size

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

![Chart showing pregnancy loss by parity](image)

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


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

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

Experimental Design
- 470 multiparous Holstein cows
  - Cornell University Ruminant Center (CU; n = 235)
  - Emmons Blaine Dairy Research Center (UW; n = 235)
- Housed in replicated pens:
  - Close-up: 4 (CU) + 2 (UW) = 10 cows
  - Lactation: 6 (CU) + 12 (UW) = 18 cows
- Cows were enrolled between 3 and 4 weeks before calving
- Randomly assigned to either a control (CON; no Smartamine M) or treatment diet (MET; 12 g (Pre) and 27 g (Post) Smartamine M).

Methionine Crew Acknowledgments
- University of Wisconsin-Madison
- Cornell University
- Blaine Dairy Cattle Center
- Dairy Unit of the Cornell University Ruminant Center
Does feeding RPM increase plasma Met?
- Blood samples collected from 72 cows [0 – 3 h after feeding (UW=24; CU= 48) only; 80 DIM] and individually analyzed for free AA by LC-MS

![Plasma Met CV](image)

\[ CV = 22.2\% \]

\[ CV = 29.5\% \]

\[ 21.6 \mu M \]

\[ 35.7 \mu M \]

\[ P_{Trt} < 0.01 \]

\[ P_{Farm} = 0.04 \]

\[ P_{Trt*Farm} = 0.28 \]

Does plasma Met vary during the day?
- Blood samples collected from 16 cows (UW only; 60-85 DIM) every 3 h and analyzed for free AA by LC-MS

![Plasma Met variation](image)

\[ Treatment P = 0.02 \]

\[ Time P = 0.11 \]

\[ Treatment*time P = 0.86 \]

Outline
- Background
  - Amino acids (AA) nutrition in dairy cattle
  - Met importance and functions
  - Studies feeding Met during pre- and postpartum and evaluating health and productive performance?

- Does feeding RPM pre- and postpartum improve:
  - Production?, Health?, Reproduction?, HealthXReproduction?

Lactation performance: 0-112 DIM

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

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

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

Productive performance: 16 weeks

<table>
<thead>
<tr>
<th></th>
<th>CON</th>
<th>MET</th>
<th>Trt</th>
<th>Farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMI, Kg/d</td>
<td>28.0</td>
<td>27.9</td>
<td>0.96</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Milk yield, Kg/d</td>
<td>49.2</td>
<td>48.7</td>
<td>0.36</td>
<td>0.61</td>
</tr>
<tr>
<td>Fat, %</td>
<td>3.77</td>
<td>3.87</td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>Fat, kg</td>
<td>1.83</td>
<td>1.86</td>
<td>0.36</td>
<td>0.11</td>
</tr>
<tr>
<td>Protein, %</td>
<td>2.95</td>
<td>3.07</td>
<td>&lt; 0.01</td>
<td>0.17</td>
</tr>
<tr>
<td>Protein, kg/d</td>
<td>1.43</td>
<td>1.48</td>
<td>0.02</td>
<td>0.04</td>
</tr>
<tr>
<td>Lactose, %</td>
<td>4.88</td>
<td>4.86</td>
<td>0.22</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Lactose, kg/d</td>
<td>2.41</td>
<td>2.37</td>
<td>0.32</td>
<td>0.34</td>
</tr>
<tr>
<td>SCC x 10³, cells/ml</td>
<td>76.3</td>
<td>68.5</td>
<td>&lt;0.01</td>
<td></td>
</tr>
<tr>
<td>MUN, mg/dl</td>
<td>10.3</td>
<td>10.5</td>
<td>0.44</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Milk:DMI</td>
<td>1.79</td>
<td>1.79</td>
<td>0.96</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>CON</th>
<th>MET</th>
<th>Trt</th>
<th>Farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMI, Kg/d</td>
<td>28.0</td>
<td>27.9</td>
<td>0.96</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Milk yield, Kg/d</td>
<td>49.2</td>
<td>48.7</td>
<td>0.36</td>
<td>0.61</td>
</tr>
<tr>
<td>Fat, %</td>
<td>3.77</td>
<td>3.87</td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>Fat, kg</td>
<td>1.83</td>
<td>1.86</td>
<td>0.36</td>
<td>0.11</td>
</tr>
<tr>
<td>Protein, %</td>
<td>2.95</td>
<td>3.07</td>
<td>&lt; 0.01</td>
<td>0.17</td>
</tr>
<tr>
<td>Protein, kg/d</td>
<td>1.43</td>
<td>1.48</td>
<td>0.02</td>
<td>0.04</td>
</tr>
<tr>
<td>Lactose, %</td>
<td>4.88</td>
<td>4.86</td>
<td>0.22</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Lactose, kg/d</td>
<td>2.41</td>
<td>2.37</td>
<td>0.32</td>
<td>0.34</td>
</tr>
<tr>
<td>SCC x 10³, cells/ml</td>
<td>76.3</td>
<td>68.5</td>
<td>&lt;0.01</td>
<td></td>
</tr>
<tr>
<td>MUN, mg/dl</td>
<td>10.3</td>
<td>10.5</td>
<td>0.44</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Milk:DMI</td>
<td>1.79</td>
<td>1.79</td>
<td>0.96</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>CON</th>
<th>MET</th>
<th>Trt</th>
<th>Farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMI, Kg/d</td>
<td>28.0</td>
<td>27.9</td>
<td>0.96</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Milk yield, Kg/d</td>
<td>49.2</td>
<td>48.7</td>
<td>0.36</td>
<td>0.61</td>
</tr>
<tr>
<td>Fat, %</td>
<td>3.77</td>
<td>3.87</td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>Fat, kg</td>
<td>1.83</td>
<td>1.86</td>
<td>0.36</td>
<td>0.11</td>
</tr>
<tr>
<td>Protein, %</td>
<td>2.95</td>
<td>3.07</td>
<td>&lt; 0.01</td>
<td>0.17</td>
</tr>
<tr>
<td>Protein, kg/d</td>
<td>1.43</td>
<td>1.48</td>
<td>0.02</td>
<td>0.04</td>
</tr>
<tr>
<td>Lactose, %</td>
<td>4.88</td>
<td>4.86</td>
<td>0.22</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Lactose, kg/d</td>
<td>2.41</td>
<td>2.37</td>
<td>0.32</td>
<td>0.34</td>
</tr>
<tr>
<td>SCC x 10³, cells/ml</td>
<td>76.3</td>
<td>68.5</td>
<td>&lt;0.01</td>
<td></td>
</tr>
<tr>
<td>MUN, mg/dl</td>
<td>10.3</td>
<td>10.5</td>
<td>0.44</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Milk:DMI</td>
<td>1.79</td>
<td>1.79</td>
<td>0.96</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>CON</th>
<th>MET</th>
<th>Trt</th>
<th>Farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMI, Kg/d</td>
<td>28.0</td>
<td>27.9</td>
<td>0.96</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Milk yield, Kg/d</td>
<td>49.2</td>
<td>48.7</td>
<td>0.36</td>
<td>0.61</td>
</tr>
<tr>
<td>Fat, %</td>
<td>3.77</td>
<td>3.87</td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>Fat, kg</td>
<td>1.83</td>
<td>1.86</td>
<td>0.36</td>
<td>0.11</td>
</tr>
<tr>
<td>Protein, %</td>
<td>2.95</td>
<td>3.07</td>
<td>&lt; 0.01</td>
<td>0.17</td>
</tr>
<tr>
<td>Protein, kg/d</td>
<td>1.43</td>
<td>1.48</td>
<td>0.02</td>
<td>0.04</td>
</tr>
<tr>
<td>Lactose, %</td>
<td>4.88</td>
<td>4.86</td>
<td>0.22</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Lactose, kg/d</td>
<td>2.41</td>
<td>2.37</td>
<td>0.32</td>
<td>0.34</td>
</tr>
<tr>
<td>SCC x 10³, cells/ml</td>
<td>76.3</td>
<td>68.5</td>
<td>&lt;0.01</td>
<td></td>
</tr>
<tr>
<td>MUN, mg/dl</td>
<td>10.3</td>
<td>10.5</td>
<td>0.44</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Milk:DMI</td>
<td>1.79</td>
<td>1.79</td>
<td>0.96</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>CON</th>
<th>MET</th>
<th>Trt</th>
<th>Farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMI, Kg/d</td>
<td>28.0</td>
<td>27.9</td>
<td>0.96</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Milk yield, Kg/d</td>
<td>49.2</td>
<td>48.7</td>
<td>0.36</td>
<td>0.61</td>
</tr>
<tr>
<td>Fat, %</td>
<td>3.77</td>
<td>3.87</td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>Fat, kg</td>
<td>1.83</td>
<td>1.86</td>
<td>0.36</td>
<td>0.11</td>
</tr>
<tr>
<td>Protein, %</td>
<td>2.95</td>
<td>3.07</td>
<td>&lt; 0.01</td>
<td>0.17</td>
</tr>
<tr>
<td>Protein, kg/d</td>
<td>1.43</td>
<td>1.48</td>
<td>0.02</td>
<td>0.04</td>
</tr>
<tr>
<td>Lactose, %</td>
<td>4.88</td>
<td>4.86</td>
<td>0.22</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Lactose, kg/d</td>
<td>2.41</td>
<td>2.37</td>
<td>0.32</td>
<td>0.34</td>
</tr>
<tr>
<td>SCC x 10³, cells/ml</td>
<td>76.3</td>
<td>68.5</td>
<td>&lt;0.01</td>
<td></td>
</tr>
<tr>
<td>MUN, mg/dl</td>
<td>10.3</td>
<td>10.5</td>
<td>0.44</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Milk:DMI</td>
<td>1.79</td>
<td>1.79</td>
<td>0.96</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

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

0.11 % units of milk fat
0.12 % units of milk protein
40 g of milk protein yield
Outline

Amino acids (AA) nutrition in dairy cattle
- Met importance and functions
- Studies feeding Met during pre- and postpartum and evaluating health and productive performance?

Does feeding RPM pre- and postpartum improve:
- Productive performance?
- Health disorders and herd exit dynamics?
- Reproductive performance and herd exit dynamics?

Proportion of health disorders

<table>
<thead>
<tr>
<th>Number of health disorders</th>
<th>Proportion, % (n)</th>
<th>SEM</th>
<th>Trt</th>
<th>Farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>49.4 (117)</td>
<td>2.8</td>
<td>0.86</td>
<td>0.63</td>
</tr>
<tr>
<td>Single</td>
<td>28.3 (67)</td>
<td>3.0</td>
<td>0.61</td>
<td>0.69</td>
</tr>
<tr>
<td>Multiple</td>
<td>22.3 (53)</td>
<td>2.7</td>
<td>0.65</td>
<td>0.93</td>
</tr>
<tr>
<td>Displaced abomasum</td>
<td>2.9 (8)</td>
<td>1.1</td>
<td>0.81</td>
<td>0.12</td>
</tr>
<tr>
<td>Ketosis</td>
<td>13.9 (33)</td>
<td>2.1</td>
<td>0.18</td>
<td>0.58</td>
</tr>
<tr>
<td>Retained placenta</td>
<td>7.8 (19)</td>
<td>3.0</td>
<td>0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>Respiratory problems</td>
<td>11.3 (27)</td>
<td>2.3</td>
<td>0.95</td>
<td>0.16</td>
</tr>
</tbody>
</table>

Cytological endometritis: cows with ≥ 10% in the uterine smear at 35 DIM. There was no Trt*n Farm interaction (P ≥ 0.10, except lameness and cytological endometritis). Multiple health disorders include cytological endometritis.

The Effect of Feeding Met on Health

<table>
<thead>
<tr>
<th>Author</th>
<th>Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grief et al.</td>
<td>not evaluated</td>
</tr>
<tr>
<td>Overton et al.</td>
<td>not evaluated</td>
</tr>
<tr>
<td>Xu et al.</td>
<td>Blood TG levels</td>
</tr>
<tr>
<td>Phillips et al.</td>
<td>Body protein mobilization</td>
</tr>
<tr>
<td>Piepenbrink et al.</td>
<td>NS</td>
</tr>
<tr>
<td>Socha et al.</td>
<td>NS</td>
</tr>
<tr>
<td>Johnson-Van Wieringen et al.</td>
<td>not evaluated</td>
</tr>
<tr>
<td>Ordway et al.</td>
<td>not evaluated</td>
</tr>
<tr>
<td>Preynat et al.</td>
<td>NS</td>
</tr>
<tr>
<td>Preynat et al.</td>
<td>NS</td>
</tr>
<tr>
<td>Osorio et al. I, II</td>
<td>Ketonemia, immune response, liver function, oxidative stress</td>
</tr>
<tr>
<td>Zhou et al. I, II</td>
<td>Ketonemia, LP, liver function, immune response</td>
</tr>
<tr>
<td>Batistel et al. I, II</td>
<td>NEFA, liver function, immune response, oxidative stress</td>
</tr>
</tbody>
</table>

Uterine Health

Endometrial cells
Polymorphonuclear cell (PMN)

Cut-off 10% for PMN

Culling

Pregnancy/AI and pregnancy loss

Double-Ovsynch

PG 32 d
PG 67 d

Reproductive performance and herd exit dynamics?
### Pregnancies per AI and pregnancy loss

**Synchronized cows (84%)**

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

### Pregnancy loss

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

### Embryonic Size

**Embryo:**
- Crown-rump length
- Abdominal diameter

**Amniotic vesicle:**
- Volume

<table>
<thead>
<tr>
<th>Day 32</th>
<th>Day 39</th>
</tr>
</thead>
<tbody>
<tr>
<td>CON</td>
<td>MET</td>
</tr>
<tr>
<td>Amniotic vesicle volume (mm³)</td>
<td>559.8</td>
</tr>
<tr>
<td>Crown-rump length (mm)</td>
<td>10.8</td>
</tr>
<tr>
<td>Abdominal diameter (mm)</td>
<td>5.7</td>
</tr>
</tbody>
</table>

*Interaction treatment by time P > 0.10

### Time to pregnancy

**Hazard Ratio:** 1.14

P = 0.20

All cows

<table>
<thead>
<tr>
<th>CON (n = 212)</th>
<th>MET (n = 214)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median: 130 d</td>
<td>Median: 119 d</td>
</tr>
</tbody>
</table>

### Environment (Stress, overcrowding)

**Amino acid profile**

**Plasma Met, μM**

Hours after feeding

**Hours after RPM by top-dressing**

Differences between studies?
Health disorders and time to pregnancy

![Graph showing the proportion of cows with health disorders and time to pregnancy for None, Single, and Multiple categories.](image)

- None: Median = 83 d, HR: 1.05, P = 0.71
- Single: Median = 151 d, HR: 2.11, P < 0.01

Cows with at least one health disorder and time to pregnancy

![Graph showing the proportion of cows with health disorders and time to pregnancy for CON and MET.](image)

- CON: Median = 148 d
- MET: Median = 125 d

Productive Performance by Health Status Category

<table>
<thead>
<tr>
<th>Item</th>
<th>None</th>
<th>Single</th>
<th>Multiple</th>
<th>None</th>
<th>Single</th>
<th>Multiple</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk yield, kg/d</td>
<td>50.3</td>
<td>50.1</td>
<td>50.8</td>
<td>49.4</td>
<td>49.7</td>
<td>49.4</td>
</tr>
<tr>
<td>ECM, kg/d</td>
<td>50.5</td>
<td>50.8</td>
<td>50.8</td>
<td>49.8</td>
<td>49.1</td>
<td>49.4</td>
</tr>
<tr>
<td>NEL in milk, Mcal/d</td>
<td>29.9</td>
<td>30.1</td>
<td>30.4</td>
<td>29.8</td>
<td>29.8</td>
<td>29.8</td>
</tr>
<tr>
<td>Milk components yield, kg/d</td>
<td>1.86</td>
<td>1.88</td>
<td>1.85</td>
<td>1.95</td>
<td>1.87</td>
<td>1.92</td>
</tr>
</tbody>
</table>

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

Herd Exit Dynamics

Cows that were sold during lactation (350 DIM)

<table>
<thead>
<tr>
<th>Item</th>
<th>Proportion, % (n)</th>
<th>SEM</th>
<th>Trt</th>
<th>Farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sold</td>
<td>20.6 (49)</td>
<td>13.4 (32)</td>
<td>2.6</td>
<td>0.06</td>
</tr>
<tr>
<td>Died</td>
<td>6.6 (5)</td>
<td>7.1 (10)</td>
<td>1.5</td>
<td>0.85</td>
</tr>
<tr>
<td>Left (Sold + Died)</td>
<td>22.8 (54)</td>
<td>17.8 (42)</td>
<td>2.3</td>
<td>0.13</td>
</tr>
</tbody>
</table>

Mean: 310 d

Had one or more health disorders

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

- **Concept:** Increased Met is needed for optimal milk production but feeding higher amounts of Met may improve reproduction and health traits.
- **Present Reality:** There are physiologic effects of Met: Change in gene expression in embryo when dam is fed Met. Reduced pregnancy loss in multiparous with Met feeding. Improved reproductive efficiency with Met for unhealthy cows.
- **Future Prospects:** Large, randomized, controlled studies are needed to determine effects of functional amino acids on economically important traits of dairy cattle.

Summary & Conclusions

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

**Pre- and postpartum RPM**

- Improved lactation performance: Milk protein % and yield, and milk fat %
- No effects on health disorders, embryo development and 1st service P/AI and pregnancy loss
- May reduce time to pregnancy, particularly in cows with at least one health disorder, and appears to decrease likelihood of cows being sold.

Mean: 315 d

HR: 1.53 P = 0.06

67% (54/81)
Future Prospects: Amounts and timing of RPM feeding still needs to be optimized.

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

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

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

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

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

Preliminary data
44 cows (20 %)

Loading…

Four State Pre-Conference

Thank you for your attention!
Questions?
Taking Steps to Prevent Lameness in Dairy Cattle

Nigel B. Cook MRCVS
School of Veterinary Medicine
University of Wisconsin-Madison
Taking Steps to Prevent Lameness in Dairy Cattle

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

Presented during the 2020 Four State Dairy Nutrition & Management Virtual Conference. Do not reuse or reproduce without written permission.

Lameness – A Global Problem!

Worldwide average ~ 23%

Factors Reducing Lameness Risk

Literature 2006-2020

- Less time standing on concrete (Bell et al., 2009)
- Deep bedded comfortable stalls rather than mats or mattresses (Chapinal et al., 2013; Cook, 2003; Dipple et al., 2009; Espejo et al., 2006; Rouha-Mulleder, et al., 2009; Solano et al., 2015).
- Less restrictive neck rail locations, low near curb heights, and absence of lunge obstructions (eg. Chapinal et al., 2013; Dipple et al., 2009; Rouha-Mulleder, et al., 2009; Westin et al., 2016).
- Wider stalls (Westin et al., 2016).
- Use of manure removal systems other than automatic scrapers (Barker et al., 2019).
- Use of non-slippery, non-traumatic flooring rather than slats (Barker et al., 2010; Saripkari et al., 2013; Solano et al., 2015).
- Access to pasture or an outside exercise lot (Chapinal et al., 2013; Hernandez-Mendo et al., 2007; Popescu et al., 2013; Rouha-Mulleder, et al., 2009).
- Use of a divided feed barrier (rather than a post and rail system) (Saripkari et al., 2013).
- Wider feed alleys (Saripkari et al., 2013; Westin et al., 2016).
- Access to a trim-chute for treatment and use of an effective footbath program (eg. Pérez-Cabal and Alenda. 2014).
- Prompt recognition and treatment of lameness (Barker et al., 2010).

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

Locomotion Score Targets

Lame

<10%

Altered cadence of movement, weight transfer of affected limb with shortened stride, joint stiffness with arched back and head held in stilted stance.

Severe Lame

<1%

Altered weight to bear weight on the affected limb, pronounced back arch, associated signs of pain and poor body condition.

Failed to Prevent!

Failed to Prevent and Treat!
Hoof Trimming

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

Provide Facilities and Equipment

Avoid Doing Harm!
Foot Rot (Phlegmon)

Hygiene
- Genetics
  - Schopke et al., JDS 98:1-11, 2015
- Nutrition
  - Gomez et al. JDS 97:6211, 2014
- Infectious agents – Treponeme spp
  - Gomez et al. JDS 95:1821, 2012

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

<table>
<thead>
<tr>
<th>DD during the rearing period</th>
<th>No DD</th>
<th>1 DD case</th>
<th>&gt;1 DD case</th>
</tr>
</thead>
<tbody>
<tr>
<td>% First Lactation</td>
<td>13.7</td>
<td>45.6*</td>
<td>67.6*</td>
</tr>
</tbody>
</table>

Source: JDS 98:1-11, 2015
The Ideal Footbath – 2-3 immersions per foot

**Do Longer footbaths improve efficacy?**
(Logee et al., Vet. J. 190:664, 2012)

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

<table>
<thead>
<tr>
<th>Reduction in DD lesions Score Effect</th>
<th>OR (95% CI)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>5% copper sulfate + test product</td>
<td>1.6 (1.14-2.32)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Longer footbaths vs shorter footbaths</td>
<td>3.39 (2.37-5.19)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>parity</td>
<td>1.13 (1.02-1.25)</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

**Footbath Best Management Practice**

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

The big question is why?

Poor cow comfort and increased standing time on hard surfaces was recognized as a secondary factor increasing severity.

It is now becoming increasingly probable that standing up alone could be the primary cause of claw horn disruption pathogenesis… not just a secondary factor.
Increased load bearing from insufficient rest is the most likely cause of the inflammation!

Injury to corium below the pedal bone (third phalanx)

Lamellar hypopsia at the claw

Inflammation creating bone exostoses

Changes to digital fat pad

Leaking of the connection between the pedal bone and the horn capsule of the claw

Activation of gelatinases in the suspensory apparatus of the claw

Stress from wearing the hoof

Calving Changes – Hormonal/metabolic

Sole Ulcers

Standing Up Disease

Get Lame – Stay Lame: The Dual Roles of Cow Comfort

Healthy

1

Get Lame

2

Stay Lame

Decreased lying time

Hoof overload

Abnormal resting behavior

Poor treatment

Bed Surfaces and Lying Time

(Wilson et al., 2014; Furr 2008, 2016; Broderick et al., 2016)

Water bed

Concrete

Cement Solutions

Mol

Sand

Well designed stalls appropriately sized to provide sufficient resting space

Cow Comfort

Feeding and drinking

Adequate sleep

Optimized resting behavior

Shelter from climate extremes

Walking and exercise

Definition: “Contented Well-being”
Cushion, traction and support to facilitate rising and lying movements.

There are mattress herds with low levels of lameness!

Mattress Herds and Lameness

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

Ventilating the cow space vs. the barn space.

Rate of Temperature Change by Position

Cows cool while standing in the pen at half the rate that they accumulate heat while lying down.
Aim to achieve Minimum Cooling Air Speeds of >200 ft/min (1 m/s)

Growing interest in mechanically ventilated, climate-controlled barns
An Achievable Target for Rest

- Based upon:
  - Healthy, non-lame cows
  - Deep bedded comfortable freestalls
  - TMR fed
  - >21 h/d in the pen
  - 1 cow per stall
  - Favorable resting area microenvironment

- Aim for mean lying times of 11.5 to 12.5 h/d, with mean lying bout durations of 1.2 h
Thin Soles and Toe Lesions

Direction of movement
Handler moves from side to side applying gentle pressure to the outlying cows behind the point of balance in their pressure zone

Zip-zagging when moving cattle to the milking center

Better Concrete

Some flooring surfaces are too slippery because grooves are too shallow or too far apart

$\frac{3}{4}$” (1.9cm) wide
$\frac{1}{5}$” (1.3cm) deep
3 1/4” (8.25cm) OC
Cut grooves into preformed concrete
http://www.trakriteglobal.com/

Some of the cows, some of the time

Rubber transfer lanes will reduce hoof wear to and from the parlor

...... Something unexpected!

Corkscrew Claw Syndrome In Heifers

Permanent skeletal changes already present in heifers in early lactation
**Type of Heifer Housing and Bedding**

![Graph showing percentages of different types of housing and bedding for heifers.]

**Use of Feed Bunk Headlocks**

![Graph showing percentages of use of feed bunk headlocks.]

**Pressure at the bunk**

Creates hoof growth/wear issues during heifer development

**Heifer Housing Recommendations (Different from Cows!)**

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

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

<table>
<thead>
<tr>
<th>Management Characteristic</th>
<th>% Herds or Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep bed or bedded pack stall (layer)</td>
<td>78</td>
</tr>
<tr>
<td>Headlocks at the feedbunk</td>
<td>70</td>
</tr>
<tr>
<td>Solid floor (vs slats)</td>
<td>97</td>
</tr>
<tr>
<td>Manual manure removed from alleys (vs scraper)</td>
<td>43</td>
</tr>
<tr>
<td>Rubber freestall alley flooring</td>
<td></td>
</tr>
<tr>
<td>Fans over resting area</td>
<td>36</td>
</tr>
<tr>
<td>Feedline soakers in the pen</td>
<td>73</td>
</tr>
<tr>
<td>Trim cows feet at least once per lactation</td>
<td>83</td>
</tr>
<tr>
<td>Footbath frequency (mean times per week)</td>
<td>4.5</td>
</tr>
</tbody>
</table>
Hoof Care
Disinfection
Comfort

Steps To Lameness Prevention

Thank you!
TOP SELLING U.S. BYPASS SOYBEAN PROTEIN

With AminoPlus natural soy protein in your ration, you can maintain production on a lower protein ration, increase milk production, improve nitrogen efficiency, and reduce nitrogen excretion.

Calculate your profitability at AminoPlus.com.
Improving Lactation Performance Starts with GlucoBoost

GlucoBoost is a high energy/high protein feed ingredient that improves early lactation performance. Its proprietary formulation – including ammonium lactate – is a powerful source of energy that helps cows manage the period of negative energy balance.

University research and extensive field application demonstrated that GlucoBoost:

Enhanced Early Lactation Performance – by increasing the cow’s supply of two important precursors used to make up to 90% of the cow’s glucose.

Improved Liver Function and Overall Health – while reducing metabolic disorders such as fatty liver and subclinical ketosis.

Increased Feed Efficiency by 10.7% – by producing the same amount of milk from less feed while also maintaining body weight, body condition score and milk composition and yield.

Learn how to start feeding GlucoBoost to your herd today.
Call 920.845.5564
How Daily and Seasonal Rhythms Impact Cows

Kevin Harvatine, Ph.D.
Associate Professor of Nutritional Physiology
Penn State University
KJH182@psu.edu
How Daily and Seasonal Rhythms Impact Cows

Presented during the 2020 Four State Dairy Nutrition & Management Virtual Conference. Do not reuse or reproduce without author permission.

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

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

Migration
Hibernation

Seasonal Breeding in Sheep

Daily rhythms coordinate metabolism with changes across the day

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

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

Key Principles

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

Milk fat and protein are affected by many factors

<table>
<thead>
<tr>
<th>Nutritional Factors</th>
<th>Non-nutritional Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreased by milk fat depression</td>
<td>Genetics</td>
</tr>
<tr>
<td>- Unsaturated fat</td>
<td>Season</td>
</tr>
<tr>
<td>- Fermentability</td>
<td>Time of day</td>
</tr>
<tr>
<td>- Acidosis</td>
<td>Stage of lactation</td>
</tr>
<tr>
<td>- Feeding strategies</td>
<td>Parity</td>
</tr>
<tr>
<td>- Ionophores</td>
<td></td>
</tr>
<tr>
<td>Increase by additional substrate</td>
<td></td>
</tr>
<tr>
<td>- Acetate from forages</td>
<td></td>
</tr>
<tr>
<td>- Fat supplement</td>
<td></td>
</tr>
<tr>
<td>- Palmitic acid</td>
<td></td>
</tr>
</tbody>
</table>

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

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

Environmental Cues
Light/Dark

Master Clock
(SCN- Brain)

Other Environmental Cues
 Other Environmental Cues
 e.g. Feeding Times

Peripheral Clocks

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

Asher, Schibler 2011
We know “Photoperiod” has a large impact on milk yield

Constant 16 to 18 h vs. 8 to 10 h light
- ~5 to 10% increase in milk yield and no change in milk composition
- Additional effect of short days in dry period
- Eliminated by constant light

Basic mechanism of photoperiod is through same signaling as circadian rhythms

Dahl and Petitclerc., 2003

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

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

Auchtung et al., 2005

Seasonal rhythms are common in many animals

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

Some Amazing Examples in Biology

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

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

Salfer et al. 2019

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

Salfer et al. 2020
Milk fat percent peaks at end of year, but milk fat yield peaks in March and differ by region

There is an annual pattern to milk protein!

The seasonal pattern is consistent by parity

What does heat stress do to milk yield and composition?

What do I think is going on?

Two seasonal time-keepers:

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

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

- No data on how to manage out of this. Managing photoperiod probably best chance
Is there a daily pattern of feed intake?

**Pasture Fed Cows**

Peak Lact.

Late Lact.

---

TMR fed cows: Feeding time is most important

Feeding and milking commonly both near dawn & dusk

---

Eating and Ruminating tend to be inverse

Eating

Ruminating

Rumination pattern is maintained even during heat stress

---

PSU Feeding Behavior System

MooMonitor+ Dairymaster

(Image Dairymaster.ie)

---

Rate of feed intake is variable over the day

---

Sheanhan, Kolver, and Roche, 2011

DeVries et al. 2005

Sorani et al. JDS 2014

Ying et al. 2015
What is the impact of the daily pattern of intake?

\[
\text{Intake} = \text{Entrance of fermentable feed into the rumen for microbes to digest}
\]

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

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

Evening feeding • Fed • Intake = VFA

Fermentable feed = vs. PM

How is feeding 1x/d 1x/d 2x/d 2x/d at 0830 and 2030 h (AMPM)

What is the impact of the daily pattern of intake?

• Feeding stimulates intake, but what is the impact of feeding time

• Fed TMR:
  • 1x/d at 0830 h (AM)
  • 1x/d at 2030h (PM)
  • 2x/d at 0830 and 2030 h (AMPM)

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

<table>
<thead>
<tr>
<th>Item</th>
<th>AM</th>
<th>PM</th>
<th>AMPM</th>
<th>SE</th>
<th>Trt</th>
<th>AM vs. PM</th>
<th>AM vs. AMPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield, lbs/d</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.69</td>
<td>0.59</td>
</tr>
<tr>
<td>Milk</td>
<td>110.0</td>
<td>111.1</td>
<td>111.8</td>
<td>5.7</td>
<td></td>
<td>0.84</td>
<td>0.99</td>
</tr>
<tr>
<td>Milk fat</td>
<td>3.78</td>
<td>3.78</td>
<td>3.85</td>
<td>0.09</td>
<td></td>
<td>0.77</td>
<td>0.78</td>
</tr>
<tr>
<td>Milk protein</td>
<td>3.26</td>
<td>3.28</td>
<td>3.30</td>
<td>0.13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk composition, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fat</td>
<td>3.51</td>
<td>3.49</td>
<td>3.48</td>
<td>0.15</td>
<td></td>
<td>0.90</td>
<td>0.83</td>
</tr>
<tr>
<td>Protein</td>
<td>2.97</td>
<td>2.95</td>
<td>2.96</td>
<td>0.07</td>
<td></td>
<td>0.80</td>
<td>0.52</td>
</tr>
<tr>
<td>DMI, lbs/d</td>
<td>71.7</td>
<td>69.1</td>
<td>70.2</td>
<td>2.0</td>
<td></td>
<td>0.40</td>
<td>0.18</td>
</tr>
<tr>
<td>Feed Efficiency</td>
<td>1.54</td>
<td>1.58</td>
<td>1.57</td>
<td>0.05</td>
<td>0.43</td>
<td>0.21</td>
<td>0.37</td>
</tr>
</tbody>
</table>

• Also no difference in milk FA profile

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

ANOVA

Circadian Parameters

Treatment Phase/Amplitude/Frequency

AM 1524 2.2 <0.01
AMP 1568* 0.6* <0.01

*Significantly (P < 0.01) different from AM

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

Increase intake in the evening spikes insulin

ANOVA

Circadian Parameters

Treatment Phase/Amplitude/Frequency

AM 1544 1.3 0.07
AMP 1503* 0.1* <0.01
AMP 2220* 4.8* <0.01

*Significantly (P < 0.01) different from AM

• AM vs. PM (\( P < 0.01 \), and \( P < 0.05 \)); AM vs. AMP (\( P < 0.01 \), and \( P < 0.05 \))

• Fresh feed delivery at night resulted in greater insulin secretion
• Morning feeding moderately increased insulin in the early afternoon
Milk synthesis is variable over the day
2x Milked Herds

Milk yield is variable over the day
3x Milked Herds

Theoretical de-synchronization of intake and mammary metabolism

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

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

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

Rhythm of milk fat yield also modified by 4x feeding

Rottman et al. 2014
When do cows prefer to be milked?!
Automated Milking System

Hogeveen et al., 2001

How Can We Use This Information??

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

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

1st... Think of the rumen

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

How do we do this?

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

What else can we do?

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

Interesting Call From the Field

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

Key Principles

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

Lab Members:

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

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

Thank You
Make the Switch!

Learn why so many growers are switching to Alforex™ varieties with Hi-Gest® alfalfa technology.

1. **Higher Digestibility**
   - 5-10% increased rate of fiber digestion
   - 22% reduction in indigestible fiber at 240 hours (uNDF240)
   - 3-5% more crude protein

2. **More Tonnage**
   Alforex varieties with Hi-Gest alfalfa technology provide farms flexibility to adjust to aggressive harvest systems to maximize yield and quality or to a more relaxed schedule focused on tonnage.

3. **More Milk**
   If your ration contains a higher percentage of alfalfa you could expect 2.5 lbs. more milk per cow, per day. And while not every producer experiences this level of improvement, some producers report even better results.

Ready to bring higher digestibility, more tonnage and more milk to your farm?
Visit us at www.alforexseeds.com or call us at 1-800-824-8585

---

**Higher Digestibility**

*The increased rate of fiber digestion, extent of digestion and crude protein data was developed from replicated research and on-farm testing. During the 2015 growing season at West Salem, WI and Woodland, CA, the following commercial dormant, semi-dormant, and non-dormant alfalfa varieties were compared head-to-head in trials with Alforex varieties with Hi-Gest alfalfa technology for rate of digestion, extent of digestion and percent crude protein: America’s Alfalfa Brand AmeriStand 427TQ; Croplan Brands LegenDairy XHD and Artesia Sunrise; Fertizona Brand Fertilac; S&W Seed Brands SW6330, SW7410 and SW10; and W-L Brands WL 319HQ and WL 354HQ. Also, during the 2015 growing season, 32 on-farm Alforex varieties with Hi-Gest alfalfa technology hay and silage samples were submitted to Rock River Laboratories, Inc, for analysis. The resulting data for rate of digestion, extent of digestion and percent crude protein were compared to the 60-day and four-year running average for alfalfa in the Rock River database which includes approximately 1,700 alfalfa hay and 3,800 silage 60-day test results and 23,000 hay and 62,000 silage test results for the four-year average.

**More Tonnage**

**More Milk**

If your ration contains a higher percentage of alfalfa you could expect 2.5 lbs. more milk per cow, per day. And while not every producer experiences this level of improvement, some producers report even better results.

---

**Your Mineral Solution**

Partner For Your Animal Nutrition Needs

Our all-natural products include:
- Calcium Sulfate
- Calcium Carbonate
- Calcium Magnesium Carbonate

Call us today to place your order! 1 (800) 236 7737
Nutritional Regulation of Gut Health and Development: Colostrum and Milk

Dr. Michael Steele
University of Guelph
“Early Life Programming”

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

Patel and Srinivasan, 2002

Adapted from Conrad’s Waddington epigenetic landscape

---

**Early Life Nutrition**

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

Soberon et al., 2012

---

**Gut Health and Dairy Calves**

- Mortality and Morbidity:
  - 5% mortality, 32% due to digestive disorders
    - Mean age: 18.3 ± 2.3 d old
  - 38% morbidity, 56% due to digestive disorders

- Immune Status:
  - 12.1% of calves failed passive transfer

- Antibiotic Use:
  - 26.8% of calves receive antibiotics
  - 48.4% for digestive disorders

(Sheley et al. 2018) (Urie et al. 2018)

---

**NSERC Industry Research Chair**

Colostrum  Plane of Nutrition

Industry Concerns

Maternal  Antimicrobial
Colostrum Intake

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

Inadequate colostrum intake reduces lifetime production

Colostrum - Is it all the same?

<table>
<thead>
<tr>
<th>Pros</th>
<th>Fresh Pasteurized Dried</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tailored for the calf</td>
<td>Can assess the quality</td>
</tr>
<tr>
<td>All bioactive molecules and cells</td>
<td>Reduce bacterial load</td>
</tr>
<tr>
<td>Can assess the quality</td>
<td>Convenient</td>
</tr>
<tr>
<td>Reduce bacterial load</td>
<td>Clean and consistent</td>
</tr>
</tbody>
</table>

Failure in passive immune transfer...

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

Evaluating colostrum absorption in calves

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

Brix refractometer is a good start but has limitations

Failure of Passive Transfer

But is it accurate for all neonatal programs?
What’s in colostrum?

<table>
<thead>
<tr>
<th>Component</th>
<th>Ratio</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immunoglobulins</td>
<td>&gt;100:1</td>
<td>immune function</td>
</tr>
<tr>
<td>Lactoferrin</td>
<td>&gt;25:1</td>
<td>local immunity in gut</td>
</tr>
<tr>
<td>IGF-I</td>
<td>80:1</td>
<td></td>
</tr>
<tr>
<td>IGF-II</td>
<td>20:1</td>
<td></td>
</tr>
<tr>
<td>Epidermal growth factor</td>
<td>2:1</td>
<td></td>
</tr>
<tr>
<td>Insulin</td>
<td>100:1</td>
<td>local gut effects</td>
</tr>
<tr>
<td>Interleukines</td>
<td>&gt;100:1</td>
<td></td>
</tr>
<tr>
<td>Relaxin</td>
<td>19:1</td>
<td>reproductive development</td>
</tr>
<tr>
<td>Prolactin</td>
<td></td>
<td>little data</td>
</tr>
<tr>
<td>TGFα and TGFβ</td>
<td>&gt;100:1</td>
<td></td>
</tr>
<tr>
<td>Leptin</td>
<td></td>
<td>hypothalamic pituitary axis</td>
</tr>
<tr>
<td>Leucocytes</td>
<td></td>
<td>immune function</td>
</tr>
</tbody>
</table>

Slide Courtesy of Dr. VanAmburgh

Components of Colostrum Management

- Cleanliness
- Quantity
- Quickness
- Quality

Successful Colostrum Feeding

Colostrum Feeding Method

- Bottle
- Tube

Colostrum Feeding Method

- IgG
- Acetaminophen

Delayed Colostrum Feeding

E. Coli entering intestine epithelial cell
Destruction of microvilli

Colostrum deprived calf
Colostrum fed calf

Dark areas represent absorbed Ig

Slide Courtesy of Dr. James
**Delayed Colostrum Feeding**

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

---

**Bacterial Contamination of Colostrum**

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

<table>
<thead>
<tr>
<th>Total Bacterial Count</th>
<th>% of Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 100,000</td>
<td>54.8</td>
</tr>
<tr>
<td>100,000 - 300,000</td>
<td>12.1</td>
</tr>
<tr>
<td>300,000 - 500,000</td>
<td>6.3</td>
</tr>
<tr>
<td>500,000 - 1,000,000</td>
<td>9.9</td>
</tr>
<tr>
<td>&gt;1,000,000</td>
<td>16.9</td>
</tr>
</tbody>
</table>

---

**Cleanliness of Colostrum Handling**

Mean log10 total plate count and mean log10 total coliform count for colostrum samples collected from the udder, milking bucket and esophageal feeder tube within bacteria type group.

---

**Heat Treatment of Colostrum**

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

---

**Colostrum Oligosaccharides**

Heat-treatment may cleave prebiotic oligosaccharides from colostral proteins and lipids.
Oligosaccharides – Transition

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

From Colostrum to Milk

<table>
<thead>
<tr>
<th>From Colostrum to Milk</th>
<th>Colostrum Milking</th>
<th>Mature Milk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unit</td>
<td>1</td>
</tr>
<tr>
<td>Dry Matter</td>
<td>%</td>
<td>24.5</td>
</tr>
<tr>
<td>Fat</td>
<td>%</td>
<td>6.4</td>
</tr>
<tr>
<td>Protein</td>
<td>%</td>
<td>13.3</td>
</tr>
<tr>
<td>Essential Amino Acids</td>
<td>mM</td>
<td>2.2</td>
</tr>
<tr>
<td>Lactoferrin</td>
<td>g/L</td>
<td>1.85</td>
</tr>
<tr>
<td>Lactose</td>
<td>g/L</td>
<td>0.85</td>
</tr>
<tr>
<td>Growth Hormone</td>
<td>μg/L</td>
<td>3.5</td>
</tr>
<tr>
<td>Insulin</td>
<td>μg/L</td>
<td>210</td>
</tr>
<tr>
<td>Insulin-like growth factor</td>
<td>μg/L</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Improved health status in calves fed transition milk

Conneely et al., 2014

From Colostrum to Milk

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

Connery et al., 2014

From Colostrum to Milk

First Feeding

Colostrum

Wk 1

First Feeding

Transition

Wk 1

Milk

From Colostrum to Milk

Passive Transfer

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

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

**Larger Meal Size and Insulin Sensitivity**

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

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

**Feeding Large Meals**

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

**Normal Pre-Weaning Milk Intake**

*Jasper and Werny, 2013*

**Normal Pre-Weaning Milk Intake**

*de Passille et al., 2016*
Gastric Emptying and Glucose-Insulin Dynamics

Gastric emptying rate will influence glucose appearance in blood

Gut Hormones

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

Best innovation in calf feeding in recent years:

- 3-L and 4-L nursing bottles!

Allows us to design feeding system to meet calf requirements.

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

<table>
<thead>
<tr>
<th>BW kg</th>
<th>Temperature, °C</th>
<th>Milk Replacer/Milk Dry Matter Required (kg/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>20</td>
<td>0.27</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>0.36</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0.41</td>
</tr>
<tr>
<td></td>
<td>-10</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>-15</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>-20</td>
<td>0.54</td>
</tr>
<tr>
<td></td>
<td>-30</td>
<td>0.64</td>
</tr>
<tr>
<td>36</td>
<td>20</td>
<td>0.36</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>0.41</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>-10</td>
<td>0.59</td>
</tr>
<tr>
<td></td>
<td>-15</td>
<td>0.64</td>
</tr>
<tr>
<td></td>
<td>-20</td>
<td>0.68</td>
</tr>
<tr>
<td></td>
<td>-30</td>
<td>0.77</td>
</tr>
<tr>
<td>45</td>
<td>20</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0.59</td>
</tr>
<tr>
<td></td>
<td>-10</td>
<td>0.73</td>
</tr>
<tr>
<td></td>
<td>-15</td>
<td>0.77</td>
</tr>
<tr>
<td></td>
<td>-20</td>
<td>0.82</td>
</tr>
<tr>
<td></td>
<td>-30</td>
<td>0.91</td>
</tr>
<tr>
<td>55</td>
<td>20</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>0.59</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0.68</td>
</tr>
<tr>
<td></td>
<td>-10</td>
<td>0.77</td>
</tr>
<tr>
<td></td>
<td>-15</td>
<td>0.86</td>
</tr>
<tr>
<td></td>
<td>-20</td>
<td>0.91</td>
</tr>
<tr>
<td></td>
<td>-30</td>
<td>1.05</td>
</tr>
</tbody>
</table>

Milk Replacer vs Whole Milk

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

- Hypertonic MR increases gut permeability
- Higher lactose results in increased gastric emptying and lower glucose tolerance in the first week of life

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

Take Home Messages
- An abrupt transition from colostrum to milk can compromise gut development
- Calves can consume large quantities of milk in early life when starter intake is depressed
- If feeding times per day is limited, the calf can regulate by decreasing abomasal emptying
- The environmental temperature has a large impact on milk feeding regimens

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

Academic Collaborators
- University of Guelph
- Dairy at Guelph

Colostrum and Milk Collaborators
- University of Saskatchewan
- INRA
- Dairy NZ
WE WEAR MANY HATS.

AND CUSTOMER SERVICE IS ALWAYS ONE OF THEM.

In these times of uncertainty, this hat is more important than ever. We’re here to help and we’re working - to support, provide stability, and offer confidence to carry you and your customers through to the other side. Whether you’re 6 feet or 400 miles away, contact us and check out our resources:

@FIELD_UPDATES
ROCKRIVERLAB.COM
QLF liquid supplements are superior carriers of urea or nonprotein nitrogen (NPN), making them a valuable tool to achieve your protein supplementation needs. With the recent shortages of other protein ingredients, such as distillers grains, NPN can help offset a significant portion of your protein needs. Natural protein is still an important component of the diet but achieving optimal rumen and performance efficiency is best achieved by incorporation both true and NPN sources of protein.
Realizing Full Value for Full- and Half-blood Holstein Steers

Dan Schaefer
Emeritus Professor
University of Wisconsin-Madison
Significance of Holstein steers to U.S. beef production?

Assumptions
- Calving interval: 13.1 months
- Dairy calf component of U.S. calf crop: 26%
- Heifer component of dairy calf crop: 53%
- Dairy calf death loss: 8.1%
- Dairy feeder cattle deaths and realizers: 3.77%
- Holstein component of dairy cow herd: 86%
- Fed Holstein carcasses, USDA Prime: 12.9%

Results of Calculations
- Holstein steer component of fed steer & heifer supply: 13.8%
- Holstein steer component of USDA Prime carcasses: 33%

1 Native carcasses, 2.1% Prime (2016)

The Ideal Holstein Steer

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

Ron Mayer – JBS Packerland

Holstein Steer Packing Plants

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

Target for Marketing

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

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

Weaning and Post-weaning

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

Grower Phase – Role for Forages?

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

Finisher Phase

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

Net Energy<sub>gain</sub> (NEg) Concentrations in Feedlot Diets

<table>
<thead>
<tr>
<th>Gross Silage Proportion (%)</th>
<th>Corn, high-moisture Proportion (%)</th>
<th>NEg&lt;sub&gt;gain&lt;/sub&gt;</th>
<th>Mcal/lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td></td>
<td>60</td>
<td>0.65</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>55</td>
<td>0.64</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>50</td>
<td>0.63</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>45</td>
<td>0.61</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>40</td>
<td>0.60</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td>30</td>
<td>0.57</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>20</td>
<td>0.54</td>
</tr>
</tbody>
</table>

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

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

Summary across 25 Closeouts

<table>
<thead>
<tr>
<th>Variable</th>
<th>Overall Ave</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head, Ave</td>
<td>346 (n=25)</td>
</tr>
<tr>
<td>Initial wt, lb</td>
<td>487</td>
</tr>
<tr>
<td>Harvest wt, lb</td>
<td>1437</td>
</tr>
<tr>
<td>Duration, d</td>
<td>321</td>
</tr>
<tr>
<td>DMI, lb/hd*  d</td>
<td>20.5</td>
</tr>
<tr>
<td>ADG, lb/hd*  d</td>
<td>2.95</td>
</tr>
<tr>
<td>DMI/ADG</td>
<td>6.97</td>
</tr>
<tr>
<td>Grade</td>
<td>80+% Choice &amp; Prime</td>
</tr>
</tbody>
</table>

Consistent Holstein Steer Performance

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

Commercial Diets Self-fed (as-fed basis)

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Diet 1</th>
<th>Diet 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn, cracked, %</td>
<td>67</td>
<td>65</td>
</tr>
<tr>
<td>Corn gluten feed, pelleted %</td>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td>Distillers grain, %</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>Balancer pellets, %</td>
<td>6</td>
<td>5</td>
</tr>
</tbody>
</table>

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

Closeouts 1-5 with Self-feeders

<table>
<thead>
<tr>
<th>Group</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Mean</th>
<th>S.dev.</th>
<th>C.V.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head, n</td>
<td>294</td>
<td>310</td>
<td>314</td>
<td>310</td>
<td>310</td>
<td>306</td>
<td>534</td>
<td>338</td>
</tr>
<tr>
<td>Implants*</td>
<td>E+FO</td>
<td>E+IS</td>
<td>E+FO</td>
<td>E+FO</td>
<td>E+FO</td>
<td>E+FO</td>
<td>E+FO</td>
<td></td>
</tr>
<tr>
<td>Housing</td>
<td>Bedded</td>
<td>Confinement</td>
<td>Outside lots with sheds</td>
<td>Outside lots with sheds</td>
<td>Outside lots with sheds</td>
<td>Outside lots with sheds</td>
<td>Outside lots with sheds</td>
<td></td>
</tr>
<tr>
<td>Begin wt, lb</td>
<td>565</td>
<td>593</td>
<td>594</td>
<td>610</td>
<td>541</td>
<td>581</td>
<td>27.4</td>
<td>4.7%</td>
</tr>
<tr>
<td>Kill wt, lb</td>
<td>1461</td>
<td>1458</td>
<td>1426</td>
<td>1440</td>
<td>1442</td>
<td>1445</td>
<td>14.3</td>
<td>1.0%</td>
</tr>
<tr>
<td>Duration, d</td>
<td>323.5</td>
<td>293</td>
<td>305</td>
<td>307</td>
<td>315</td>
<td>309</td>
<td>11.2</td>
<td>3.7%</td>
</tr>
<tr>
<td>DMI, lb/hd*d</td>
<td>323.5</td>
<td>293</td>
<td>305</td>
<td>307</td>
<td>315</td>
<td>309</td>
<td>11.2</td>
<td>3.7%</td>
</tr>
<tr>
<td>ADG, lb/hd*  d</td>
<td>2.77</td>
<td>2.95</td>
<td>2.73</td>
<td>2.7</td>
<td>2.86</td>
<td>2.80</td>
<td>0.10</td>
<td>3.7%</td>
</tr>
<tr>
<td>DMI/ADG</td>
<td>7.48</td>
<td>7.11</td>
<td>8.00</td>
<td>7.76</td>
<td>7.34</td>
<td>7.54</td>
<td>0.35</td>
<td>4.6%</td>
</tr>
<tr>
<td>Death &amp; Culls, %</td>
<td>4.85</td>
<td>2.74</td>
<td>5.0</td>
<td>2.7</td>
<td>2.9</td>
<td>3.64</td>
<td>1.18</td>
<td>32%</td>
</tr>
<tr>
<td>Choice &amp; Prime, %</td>
<td>- 78.33</td>
<td>81.25</td>
<td>79.75</td>
<td>80.01</td>
<td>79.84</td>
<td>79.84</td>
<td>1.20</td>
<td>1.5%</td>
</tr>
</tbody>
</table>

Aim for Dry, Draft-free Housing

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

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

Quality of Holstein Beef

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

Finished Holstein Steer

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body wt</td>
<td>1388 lb</td>
</tr>
<tr>
<td>Dress</td>
<td>58.6%</td>
</tr>
<tr>
<td>Carcass</td>
<td>81.4 lb</td>
</tr>
<tr>
<td>Fat thickness</td>
<td>0.28 in</td>
</tr>
<tr>
<td>Loin muscle area</td>
<td>12.2 in²</td>
</tr>
<tr>
<td>Kidney, pelvic, heart fat</td>
<td>3.0%</td>
</tr>
<tr>
<td>USDA Yield Grade</td>
<td>A</td>
</tr>
<tr>
<td>USDA Maturity</td>
<td>A</td>
</tr>
<tr>
<td>USDA Marbling</td>
<td>Modest ²</td>
</tr>
<tr>
<td>USDA Quality Grade</td>
<td>Choice</td>
</tr>
</tbody>
</table>

What are the goals for half-blood dairy steers?

- Note the difference in frame size.
**Beef Sire Selection for Dairy Matings**

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

**Certified Angus Beef**

(as stds apply to dairy-beef crossbreds)

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


---

**Traits of Importance**

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

**Beef Sire Selection Criteria for Holstein Matings**

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

---

**Beef Sire Selection Criteria for Jersey Matings**

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

---

**Cattle Performance Estimates**

<table>
<thead>
<tr>
<th>Enterprise</th>
<th>ADG lb/d</th>
<th>Feed:Gain</th>
<th>Days on Feed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holstein, birth to 400</td>
<td>2.0</td>
<td>3.5</td>
<td>150</td>
</tr>
<tr>
<td>Dairy x beef, birth to 400</td>
<td>2.0</td>
<td>3.5</td>
<td>150</td>
</tr>
<tr>
<td>Holstein 400-1450</td>
<td>3.9</td>
<td>7.2</td>
<td>362</td>
</tr>
<tr>
<td>Dairy x beef 400-1400</td>
<td>3.2</td>
<td>6.9</td>
<td>312</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Diet NEL (Mcal/1.14t DM)</th>
<th>Holstein</th>
<th>Half Holstein</th>
<th>Native</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start finishing by 100 lb</td>
<td>62-65</td>
<td>62-65</td>
<td>62-65</td>
</tr>
<tr>
<td>Harvest ready, lb</td>
<td>1450</td>
<td>1375</td>
<td>1300</td>
</tr>
<tr>
<td>Daily gain, lb/day</td>
<td>2.9</td>
<td>3.2</td>
<td>3.5</td>
</tr>
<tr>
<td>Days to finish</td>
<td>240</td>
<td>165</td>
<td>100</td>
</tr>
</tbody>
</table>

1 Assumes anabolic implant inserted as follows:
- Holstein – Revalor XS (200 days)
- Half-Holstein – Revalor 5 (last 100 days)
- Native – Revalor 5 (last 100 days)

### Nutritional Recommendations

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Growing</th>
<th>Finishing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude protein</td>
<td>14%</td>
<td>13%</td>
</tr>
<tr>
<td>Calcium</td>
<td>0.65</td>
<td>0.65</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>Potassium</td>
<td>0.60</td>
<td>0.60</td>
</tr>
<tr>
<td>Sulfur</td>
<td>0.15-0.40</td>
<td>0.15-0.40</td>
</tr>
<tr>
<td>Magnesium</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Salt</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Trace mineral premix</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Vitamins</td>
<td>IU/lb DM</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>1,000</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td>Cu</td>
<td>62</td>
<td></td>
</tr>
</tbody>
</table>

### Trace Mineral Premix

<table>
<thead>
<tr>
<th>Mineral</th>
<th>NRC Recommen.</th>
<th>TM Premix</th>
<th>Premix/Recomm.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca</td>
<td>230,000 mg/kg</td>
<td>230,000 mg/kg</td>
<td>230,000 mg/kg</td>
</tr>
<tr>
<td>Fe</td>
<td>50 mg/kg</td>
<td>10,000 mg/kg</td>
<td>200 mg/kg</td>
</tr>
<tr>
<td>Mn</td>
<td>20 mg/kg</td>
<td>40,000 mg/kg</td>
<td>2,000 mg/kg</td>
</tr>
<tr>
<td>Zn</td>
<td>30 mg/kg</td>
<td>60,000 mg/kg</td>
<td>2,000 mg/kg</td>
</tr>
<tr>
<td>Co</td>
<td>0.15 mg/kg</td>
<td>300 mg/kg</td>
<td>2,000 mg/kg</td>
</tr>
<tr>
<td>Cu</td>
<td>10 mg/kg</td>
<td>20,000 mg/kg</td>
<td>2,000 mg/kg</td>
</tr>
<tr>
<td>I</td>
<td>0.5 mg/kg</td>
<td>1,000 mg/kg</td>
<td>2,000 mg/kg</td>
</tr>
<tr>
<td>Se</td>
<td>0.1 mg/kg</td>
<td>200 mg/kg</td>
<td>2,000 mg/kg</td>
</tr>
</tbody>
</table>

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

### Summary

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

### Early Results are Encouraging

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

Note variation in frame size. She's not pretty, but she’s finished.

### Market Comments

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

- Market for Holstein bull calves will persist as long as there is a
  - market demand
  - packer(s) with a market for Holstein beef
  - packer profit in the carcass cut-out value

- When the supply of Holstein bull calves shrinks relative to market demand,
  - market will induce more Holstein beef production
    - price incentive for forward-contracted Holstein steers & heifers
    - price incentive for newborn Holstein bull and heifer calves

Take Home Message

- Health, growth, cost of production, and carcass value of Holstein steers have become consistently predictable.

- Much will need to be learned about dairy x native crossbreds so that the price premium in these commodity calves can be preserved.
Helping your dairy save time and money.

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

For more information about the Alltech On-Farm Support program, please contact DairyOnFarmSupport@Alltech.com or visit Alltech.com/on-farm-support
We are committed to optimizing animal performance and well-being with specific natural microbial product and service solutions. Using sound science, proven results and knowledge from experience, Lallemand Animal Nutrition:

- Develops, manufactures and markets high value yeast and bacteria products including probiotics, silage inoculants and yeast derivatives.
- Offers a higher level of expertise, leadership and industry commitment with long-term and profitable solutions to move our partners Forward.

Lallemand Animal Nutrition
Specific for your Success

Are your trace minerals causing digestive interference?

Switch to IntelliBond® hydroxy trace minerals and improve NDF digestibility by 1.4 to 3.4 points.¹⁻⁵

Unlike sulfate trace minerals, IntelliBond® trace minerals hold together in the rumen, avoiding negative reactions with rumen microbes and antagonists. Without this digestive interference, more beneficial microbes can go to work digesting fiber that’s critical to milk production.

Learn more about avoiding digestive interference at micro.net/species/dairy.


IntelliBond® is a registered trademark of Micronutrients, a Nutreco company. © 2020 Micronutrients USA, LLC. All rights reserved.
The Commercial Science Behind Purebred Holstein Beef

Bill Munns
Head of Sales & Supply Chain
JBS Regional Beef
**The Commercial Science Behind Purebred Holstein Beef**

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

---

**B2B MARKETING APPROACH**

**PUREBRED FED HOLSTEINS**
- Holstein steers comprise 30-40% of total fed cattle forwarded. Approximately 300K head/year
- 95% of industry USDA Prime is Holstein®
- Cattled from an early age
- Consistent genetic base delivers uniform across weights, primal confirmation, meat quality, tenderness & flavor

**HOLSTEIN PERFORMANCE**
- More average USDA quality grades – 90% Prime, 70% Choice
- Delivers a more visually & tender eating experience consumers prefer
- Over 90% feed Grade 1 & 2
- Superior quality yields deliver a retail gross margin advantage

**PROVEN PROGRAMS**
- Only young & Mature cattle qualify into JBS branded Holstein brands
- No dark cuts allowed in JBS programs
- Various programs available across USDA Prime, Choice & Select

---

**HOLSTEIN BEEF**

**CARCASS WEIGHTS**
- Holstein sustainability offer consistent sizing throughout each year, YOY

---

**HOLSTEIN BEEF**

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

---

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

CARCASS CHARACTERISTICS

On the tests we have run so far, results are inconclusive

- 25% Black/w/Holstein Type Attributes
- 25% Black w/Breed Type Attributes
- 50% Somewhere in Between

1.5-2.0% Lower Hot Carcass Yield vs Conventional Beef Type

- Lower Quality Grading than Pangwed Holsteins, on par with Conventional Beef Type

Upcoming tests with Penn State

- Limousine/Holstein Cross
- Angus/Holstein Cross
- SimAngus/Holstein Cross

CLEAR RIVER FARMS

USDA INSPECTED UPGRADED BEEF

- Minimum packaging requirement 6 oz
- Equipped to cut beef to high

- Lean & Fat color specification to ensure premium visual appearance

- No dark cuts, no yellow fat allowed

- Minimum cross weight & cross area cut to ensure product sizing &
  consistency

- Comprehensive offering all upgraded rib products

- Customer not meeting quality specifications are offered as four filler

- Produced at all 50 USDA inspected plants

FOUR STAR BEEF

USDA INSPECTED UTILITY PRODUCTS

- 1x1 spb, 100% No cross

- Crosses offering include: Ribeye, loin, eye, & 100% lean 0%
If you know the problem, you’ll know how to fix it.

**EZfeed does that.**

www.amelicor.com/feed-management

Feed your cattle accurately

Talk to EZfeed Support Today. 800-453-9400 x6711

MY FIRST EXPERIENCE IN DAIRY FARMING WAS ON THE DAY I WAS BORN. My dad had to get back home to milk cows before I even got my name. It takes **DETERMINATION, COMMITMENT** and **TEAMWORK** to make it in this business. You have to take the good with the bad. But if you **LOVE WHAT YOU DO**, you’re going to keep going and **SEE IT THROUGH**. I admire my father and grandfather for showing me that. I want that to be **MY LEGACY**.

– CORY BROWN, Sunburst Dairy, Belleville, Wisconsin

WHAT WILL YOUR LEGACY BE?
Tell us your story at TrustedByGenerations.com
Is heat stress affecting your herd?

Jefo’s specific blends of protected B-Vitamins are designed to help dairy cows cope with stressful situations that affect production.

Move your business forward
CA Data Driven Approach to Sourcing Profit Focused Beef Bulls for Holstein Based Dairy Industry

Chip Kemp
International Genetic Solutions
American Simmental Association
A Data Driven Approach to Sourcing Profit Focused Beef Bulls for Holstein Based Dairy Industry

Chip Kemp
International Genetic Solutions
American Simmental Association

Presented during 2020 Four State Dairy Nutrition & Management Virtual Conference. Do not reuse or reproduce without author permission.

Transforming Frustration to Leverage!

What is IGS?

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

IGS is a tech company

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

A little background...

Feeder Profit Calculator
A simple look at semen sales numbers...
Excluding import numbers which are small and export numbers that don’t directly impact US beef market.

Combined Dairy Domestic Sales & Custom

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Holstein</td>
<td>21645443</td>
<td>21421445</td>
<td>21368838</td>
<td>20474167</td>
<td>21287608</td>
<td>19976216</td>
<td>17162654</td>
</tr>
<tr>
<td>Jersey</td>
<td>3048823</td>
<td>3333879</td>
<td>30493907</td>
<td>3072640</td>
<td>3703766</td>
<td>3630467</td>
<td>5074001</td>
</tr>
<tr>
<td>Red Factor</td>
<td>416575</td>
<td>703441</td>
<td>782435</td>
<td>390038</td>
<td>343857</td>
<td>314176</td>
<td>500270</td>
</tr>
<tr>
<td>AOB</td>
<td>404464</td>
<td>395828</td>
<td>391795</td>
<td>390462</td>
<td>605660</td>
<td>306804</td>
<td>262564</td>
</tr>
<tr>
<td>TOTAL</td>
<td>25511905</td>
<td>25851347</td>
<td>25764944</td>
<td>24373707</td>
<td>25644491</td>
<td>24227665</td>
<td>2099368</td>
</tr>
</tbody>
</table>

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

Combined Beef Domestic Sales & Custom

<table>
<thead>
<tr>
<th>Total Beef Semen (Sales &amp; Custom)</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019 % Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angus</td>
<td>2249074</td>
<td>2595931</td>
<td>3090752</td>
<td>3180929</td>
<td>2881182</td>
<td>3480149</td>
<td>4111331</td>
</tr>
<tr>
<td>Simmental</td>
<td>356369</td>
<td>386278</td>
<td>450136</td>
<td>493057</td>
<td>537386</td>
<td>596978</td>
<td>1412403</td>
</tr>
<tr>
<td>Limousin</td>
<td>229878</td>
<td>299106</td>
<td>483099</td>
<td>434565</td>
<td>279856</td>
<td>1238743</td>
<td>807181</td>
</tr>
<tr>
<td>Red Angus</td>
<td>207734</td>
<td>266282</td>
<td>308861</td>
<td>316277</td>
<td>291410</td>
<td>347441</td>
<td>228691</td>
</tr>
<tr>
<td>Hereford</td>
<td>246881</td>
<td>271536</td>
<td>296837</td>
<td>274465</td>
<td>258375</td>
<td>249125</td>
<td>236462</td>
</tr>
<tr>
<td>Charolais</td>
<td>89880</td>
<td>119202</td>
<td>111198</td>
<td>103386</td>
<td>95619</td>
<td>136891</td>
<td>364647</td>
</tr>
<tr>
<td>Gelbvieh</td>
<td>66901</td>
<td>78724</td>
<td>84033</td>
<td>98394</td>
<td>76792</td>
<td>110185</td>
<td>51484</td>
</tr>
<tr>
<td>AOB</td>
<td>932400</td>
<td>895105</td>
<td>889525</td>
<td>735164</td>
<td>810837</td>
<td>1142369</td>
<td>1438536</td>
</tr>
<tr>
<td>TOTAL</td>
<td>4371207</td>
<td>4921264</td>
<td>5715341</td>
<td>5636237</td>
<td>5238457</td>
<td>7710881</td>
<td>8956635</td>
</tr>
</tbody>
</table>

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

Combined Beef Domestic Sales & Custom

<table>
<thead>
<tr>
<th>Combined Beef Domestic Sales &amp; Custom</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holstein</td>
<td>2249074</td>
<td>2595931</td>
<td>3090752</td>
<td>3180929</td>
<td>2881182</td>
<td>3480149</td>
</tr>
<tr>
<td>Jersey</td>
<td>356369</td>
<td>386278</td>
<td>450136</td>
<td>493057</td>
<td>537386</td>
<td>596978</td>
</tr>
<tr>
<td>Red Factor</td>
<td>229878</td>
<td>299106</td>
<td>483099</td>
<td>434565</td>
<td>279856</td>
<td>1238743</td>
</tr>
<tr>
<td>Hereford</td>
<td>246881</td>
<td>271536</td>
<td>296837</td>
<td>274465</td>
<td>258375</td>
<td>249125</td>
</tr>
<tr>
<td>Charolais</td>
<td>89880</td>
<td>119202</td>
<td>111198</td>
<td>103386</td>
<td>95619</td>
<td>136891</td>
</tr>
<tr>
<td>Gelbvieh</td>
<td>66901</td>
<td>78724</td>
<td>84033</td>
<td>98394</td>
<td>76792</td>
<td>110185</td>
</tr>
<tr>
<td>AOB</td>
<td>932400</td>
<td>895105</td>
<td>889525</td>
<td>735164</td>
<td>810837</td>
<td>1142369</td>
</tr>
<tr>
<td>TOTAL</td>
<td>4371207</td>
<td>4921264</td>
<td>5715341</td>
<td>5636237</td>
<td>5238457</td>
<td>7710881</td>
</tr>
</tbody>
</table>

NOTE: Beef on Dairy

Beef on Dairy

Figure 1: Trend in beef sires sold for insemination of Holstein

Canadian Dairy Network

73
WHY?

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

Beef breeds used in the beef x dairy model

**Angus**
- Large Supply
- Marbling Genetics
- High Growth
- Less REA
- High BF
- Large Frame Size

**Charolais**
- High REA
- High Growth
- High Retail Yield
- Less Marbling
- Large Frame Size
- Calf Color is Limiting

**Limousin & LimFlex**
- High REA
- High Cutability
- Moderate Growth/Size
- Lower Marbling
- Lower Growth
- Particularly Popular for Jersey

**Simmental & SimAngus**
- High REA & Cutability
- Moderate Size & Mod/High Growth
- More Marbling than LM or CH
- Have to avoid excessive white mark
Semen purchase
What are the producer’s expectations

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

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

Most have grown to accept:
• Cheap
• Easy
• Fertility

We can do more!

Dollars, convenience, and fertility are crucial.

BUT, shouldn’t that be a given??

You are buying semen to breed a cow after all.

Where is the value add?

Adding a Profit Center to Dairy Business

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

Precision Agriculture – or lack there of

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

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

Let’s study the Beef X Holstein model...

Step 1

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

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

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

I digress...

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

$28.15 Choice/Select Spread.

That is over $250 difference on 900 lb carcass!

I digress...

- Marbling
  - Economic import of intramuscular fat
  - Jersey vs. Holstein
  - Very Economic
  - Not

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

Step 1

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

The Answer

- Searched IGS database (and the second largest beef database) for sires in:
  - Top 25% REA, MARB, CE, Mid level YW & CW
- Results:
  - 3.125% were straight British
  - 6.25% were straight Continental
  - 90.6% were Composite bulls that were a mix of British & Continental
- Of the list of Composite Bulls – 89.7% were SimAngus.
- So roughly 80% of all bulls that populated were SimAngus.

So where is the BEEF – with Holstein?

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

Step 2

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

<table>
<thead>
<tr>
<th>Trait</th>
<th>Simmental Rank vs Major Continental Breeds</th>
<th>Angus/Red Angus Rank vs Major British Breeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marbling Score</td>
<td>First</td>
<td>Second</td>
</tr>
<tr>
<td>Carcass Weight</td>
<td>First</td>
<td>First</td>
</tr>
<tr>
<td>Lbs of Retail Product</td>
<td>Second</td>
<td>First</td>
</tr>
<tr>
<td>Weight Gain/Feed Efficiency</td>
<td>First</td>
<td>Second</td>
</tr>
<tr>
<td>Weaning Weight</td>
<td>Second</td>
<td>First</td>
</tr>
<tr>
<td>Post Weaning Gain</td>
<td>Second</td>
<td>Second</td>
</tr>
<tr>
<td>Shear Force</td>
<td>First</td>
<td>First</td>
</tr>
</tbody>
</table>

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

But...

Limitations exist to a threshold approach. We need something more sophisticated.
Indexing is the way to go!
Beef on Holstein Index
Starting with largest population – SimAngus.

Starts with the...

IGS Feeder Profit Calculator
-Highlights

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

The How...

• The SimAngus x Holstein (SAxH) index uses the IGS Feeder Profit Calculator™, the industry leader in feeder cattle evaluation, as the foundation for this effort.

• The results from the FPC are then adjusted for the unique economic situations relevant to Holstein cattle, namely, the need for added calving ease, muscle conformation, grading ability and sensitivity to carcass length.

Using the FPC as foundation for the SAxH Index

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

HOLSim Objectives...

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

AND MORE INDEXING WORK TO COME!
Interesting side note...

- Bulls that populate on the HOLSim index (e.g. look more appropriate in a Beef on Holstein model) tend to be high indexing bulls on a Whole Life Cycle index (All Purpose Index).

- Given the homogeneity of the traditional beef business, one could make a very sound argument that high API bulls are what is actually needed by overwhelming percent of beef operations. Along with strengths of responsible crossbreeding and heterosis.

- Semen companies could have the bulls that can “do both”. Be a data appropriate match for Holstein genetics and add profit to their British based beef audience.

Opportunities associated with BeefXDairy Model

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

Key difference to the SimAngus X Holstein model

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

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

Simply build better cattle and then retain ownership.

Want a better understanding? Want to maximize your return?

Become a cattle feeder!

Courage to consider the new

- The right kind of partners
- Profit-minded genetics
- The right kind of marketing
- The right kind of tools
QUALITY & SAFETY: IT’S ALL BY DESIGN.

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

THE CHROMIUM LEADER FOR 20+ YEARS

kemin.com/chromium
Clean Feed:
Optimizing Health and Nutrition

Dr. Keith A. Bryan
Technical Service Specialist, Chr. Hansen Animal Health & Nutrition
717.419.2715
uskebr@chr-hansen.com
Clean Feed: Optimizing Health and Nutrition

Presented during the 2020 Four State Dairy Nutrition & Management Virtual Conference. Do not reuse or reproduce without author permission.

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

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

The rumen microbial ecosystem (microbiota)

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

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

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

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

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

Archaea
- Methanogens
- Live in symbiotic relationship with H2 donating microbes

Forages and Forage Hygiene

Typical Epiphytic Populations on Plants Prior to Ensiling

<table>
<thead>
<tr>
<th>Group</th>
<th>Population (cfu/g)</th>
<th>Population (log cfu/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total aerobic bacteria</td>
<td>&gt; 10,000,000</td>
<td>&gt; 7</td>
</tr>
<tr>
<td>Lactic acid bacteria</td>
<td>10 - 1,000,000</td>
<td>1 - 6</td>
</tr>
<tr>
<td>Propionibacteria</td>
<td>1,000 – 5,000,000</td>
<td>3 – 5</td>
</tr>
<tr>
<td>Yeast &amp; weanling fungi</td>
<td>1,000 – 100,000</td>
<td>3 – 4</td>
</tr>
<tr>
<td>Molds</td>
<td>1,000 – 10,000</td>
<td>3 – 4</td>
</tr>
<tr>
<td>Clostridia (spores)</td>
<td>100 – 1,000</td>
<td>2 – 3</td>
</tr>
<tr>
<td>Acetic acid bacteria</td>
<td>100 – 1,000</td>
<td>2 – 3</td>
</tr>
<tr>
<td>Propionic acid bacteria</td>
<td>10 – 100</td>
<td>1 – 2</td>
</tr>
</tbody>
</table>

Typical Epiphytic Populations on Plants Prior to Ensiling
Molds and mycotoxins of concern

Pre and post-harvest

- Penicillium
- Aspergillus
- Fusarium

Post-harvest

- Penicillium
- Aspergillus
- Fusarium

Bacillus spp.

- Aerobic (facultative anaerobe), spore-formers
  - Soil
  - Silage (feed contamination)
  - Other feeds
  - Bedding material
  - Basidiomycota
  - Aspergillus, Acremonium, & Penicillium
  - Prevalence:
  - Oxygen, high pH
  - Air ingress
  - Relatively high pH (>4.5)
  - Human health concern (food-borne pathogen)

Listeria monocytogenes

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

Enterobacteriaceae (E. coli)

- Facultative anaerobe, Gram -
- Ubiquitous
- Soil
- Silage
- Epiphytic microflora of crops
- Varying degrees of pathogenicity
- Commercial
- STEC, E. coli D157:H7
- Other serogroups: O103, O26, O111 & O145
- Prevalence:
  - Oxygen, high pH
  - Poor compaction
  - Air ingress
  - Relatively high pH (>5.0)
  - Human health concern (food-borne pathogen)

Clostridium

- Obligate anaerobe, Gram +, spore-formers
- Ubiquitous
  - Soil
  - Silage
- Feces (animal)
- Clostridia:
  - C. butyricum, C. perfringens, C. beijerinckii, C. sordellii, C. tertium, C. tetani, C. difficile
- Prevalence:
  - Wilting, high pH
  - High moisture (>60%)
  - High water activity (0.952-0.971)
  - Relatively high pH (4.5+)
  - Human health concern (food-borne pathogen)

Pathogen Load in Silage: Inherent vs. Contamination

- Human health concern (food-borne pathogens)
- Found in soil, silage, feeds and bedding material
- Prevalence in silage: Oxygen & high pH
- Some spoilage microorganisms are pathogens, some are not!
  - Contamination:
    - Soil
    - Fecal
  - "Hygiene" – silage, feed TMR
Mitigation Strategies
- Proper silage making and feed-out practices:
  - Compaction
    - Min. AF or bulk density: 48-50 lbs./ft³
    - Min. DM density: 17 lbs./ft³
    - Align packing tractor weight and forage delivery rate
  - Insolvent:
    - Science-based, research-proven insolulant
    - Drives pH below 4.5 within 3 days of ensiling
    - Maximizes aerobic stability at feed-out
  - Minimize air ingress at feed-out
- Leading edge of top layer/facering
- Smooth face (rake or rotary de-facer)

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

Density & Porosity
- In order to store more feed in the same area (volume) of storage, increase DM packing density! Increasing DM packing density from 16 to 18 lbs. DM/ cu. ft. increases storage capacity by 12.5%. If you routinely store 6,000 tons of DM, you could now store 6,750 tons of DM in the same area, or an additional 2,140 tons as fed at 50% DM.
- Packing is complete when every square foot of top layer has tire tracks, having been run-over twice, and is smooth! There is no advantage to more than 30 minutes of packing after the final load has been spread.
- Bottom line: The most skilled tractor operator should be in the ‘push’ tractor. The people operating the ‘pull’ and ‘pull’ tractors could be the most valuable (and often most overlooked) team members in the entire process! Oxygen is the enemy!
Inoculant
- Patented inoculant strain to mitigate pathogenic organisms.
- Lactococcus lactis NCIMB 30117 (SLR54) with patent number 513829 that was submitted on 26 September 1997 and approved on 6 December 1999.
- Swedish patent. The patent states that the identified Lactococcus lactis subspecies strongly reduces development and growth of gram + bacteria, eg. Listeria monocytogenes, Staphylococcus aureus, Clostridium typhodermidis. Bacillus subtilis and other lactic acid bacteria. Certain Gram - bacteria are weakly inhibited. eg. Pseudomonos aeruginosa.
- The following patent claim is made:
  - Lactococcus lactis NCIMB 30117 reduces development of yeast and clostridia and Gram + bacteria and certain Gram - bacteria.

Listeria monocytogenes

Bacillus spp.

Enterobacteriaceae (E. coli)

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

We don’t feed the cow…we feed her microbiota!
- Complex symbiotic microbial ecosystem
- Continuous replenishment and perturbation
- Pathogenic & Non-pathogenic organisms within the same Genus
- Slage: Inherent vs. Contamination
- Mitigation strategies

Minimize Air Ingress at Feed-out
- Leading edge of top-layer/face
- Smooth face (rake or rotary de-facer)

Healthy rumen…healthy lower gut…healthy cow…more productive!
- Dysbiosis is the abnormal prevalence of specific microbiomorphisms in the GI tract leading to sub-optimal health and productivity of individuals within a herd or flock.
- Dysbiosis can result from:
  - Nutritional imbalances
  - Pathogen ingress
  - Sub-optimal fermentation of stored forage
  - Diet changes
  - Stress (environmental, social, etc.)
- Science-based, research proven silage inoculants and probiotics when fed daily and provide Essential Microbial Support to establish normal GI digestive and immunological function, re-establishing and maintaining normal health, consistency and optimal productivity.

HYGIENE MATTERS! Feed her microbiota CLEAN FEED!
Feed hygiene is a threat to optimal cow health and sustainable performance.

Cross Alley Tire Tracks Muddy Feed Area Mud Tracks into Barn

Water Seepage & Runoff

RRL TMR Nutrient Analysis

<table>
<thead>
<tr>
<th>TMR Nutrient Analysis</th>
<th>Tour TMR % of DM</th>
<th>Avg TMR,</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude Protein (CP)</td>
<td>17.1%</td>
<td>16.1%</td>
</tr>
<tr>
<td>Ash</td>
<td>33.4%</td>
<td>32.6%</td>
</tr>
<tr>
<td>Fat (EE)</td>
<td>5.6%</td>
<td>5.5%</td>
</tr>
<tr>
<td>Starch</td>
<td>29.9%</td>
<td>30.9%</td>
</tr>
<tr>
<td>Organic Matter (OM)</td>
<td>92.1%</td>
<td>92.0%</td>
</tr>
<tr>
<td>Net Energy (NE)</td>
<td>16.9%</td>
<td>14.8%</td>
</tr>
</tbody>
</table>

RRL TMR in vivo Analysis

<table>
<thead>
<tr>
<th>VINE Result</th>
<th>Dry Mat</th>
<th>DM %</th>
<th>DMI %</th>
<th>CAR %</th>
<th>NDF %</th>
<th>DCP %</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>34.2%</td>
<td>46.3%</td>
<td>71.6%</td>
<td>81.6%</td>
<td>84.2%</td>
<td>22.2%</td>
</tr>
</tbody>
</table>

RRL TMR Anti-Nutrients Analysis (Hygiene)

<table>
<thead>
<tr>
<th>Anti-Nutrients Analysis (Hygiene)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mold</td>
</tr>
<tr>
<td>Yeast</td>
</tr>
<tr>
<td>Vomitoxin, ppm</td>
</tr>
<tr>
<td>Aflatoxin, ppp</td>
</tr>
<tr>
<td>Zearalenone, ppp</td>
</tr>
<tr>
<td>Fusarium, ppp</td>
</tr>
<tr>
<td>T-2, ppp</td>
</tr>
<tr>
<td>Ochratoxin-A, ppp</td>
</tr>
<tr>
<td>Clostridium perfringens</td>
</tr>
<tr>
<td>Enterobacteria</td>
</tr>
</tbody>
</table>

Composite Hygiene: C. perfringens

Known Modes of Action of Probiotics
Known Modes of Action of Probiotics

Water sample report

SAMPLE DESCRIPTION:
Source: PHI Re2 Stock Tank

BACTERIA (ISOLATED): (#1 = maximum detection level)
- E. coli: >23.0 per 100 mL
- Aeromonas spp: <4.1 per 100 mL
- Enterobacter spp: <4.1 per 100 mL
- Pseudomonas aeruginosa: <4.1 per 100 mL
- Bacteroides spp: <4.1 per 100 mL

Water (hygiene) – The forgotten nutrient

Water - Coliforms (cfu/mL)

Before cleaning

After cleaning
Number of weekly health events* at a 1,400 cow dairy
Field data collected over 6 years from a large dairy

Avg: 29 events/wk

Avg: 19 events/wk

0 10 20 30 40 50 60 70 80 90

Before BOVAMINE® DAIRY

During BOVAMINE® DAIRY

* Includes deaths, metritis, pneumonia, and other miscellaneous non-metabolic illnesses.

Clean Feed:
Optimizing Health and Nutrition

Dr. Keith A. Bryan
Technical Service Specialist, Chr. Hansen Animal Health & Nutrition
717.498.2753
uskebr@chr-hansen.com

Presented during the 2020 Four State Dairy Nutrition & Management Virtual Conference. Do not reuse or reproduce without author permission.
Contains a consistent, high level of EPA and DHA

- EPA and DHA support the establishment and maintenance of pregnancy
- Improved energy balance helps to support lactation performance and growth rates
- Unique foil-lined packaging ensures freshness

For more about the many pros of Optomega Plus
visit anpario.com/usa
Times are tough, but we’re in this together.

With the tightened dairy economy, producers and nutritionists are looking for ways to be financially efficient without sacrificing production or animal health.

The Natural Biologics products are cost-effective to implement into the dairy ration, while delivering functional results and measurable benefits.

To learn more, please contact Le Luchterhand at lluchterhand@naturalbiologics.com or 608-400-5657 or visit our website at naturalbiologics.com.
Lessons Learned from 2019 Growing Season

Dr. Mike Hutjens, University of Illinois
Dr. Steve Woodford, Nutrition Professionals, Inc.
Lessons Learned from 2019 Growing Season

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

A Look At The 2019 Growing Year

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

Monthly Departure Precipitation: May 1, 2019

Monthly Departure Precipitation: September 1, 2019

Prevented Plant—19 million acres

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

What Happened On Dairy Farms in NE Wisconsin?
What Happened On Dairy Farms In NE Wisconsin?

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

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

What Recommendations Were Made And Suggested?

- As we approached fall it was clear forage inventories would be down
- Suggested looking to contract best value forage-fiber replacements.
- Cottonseed, corn gluten feed, soy hulls, and beet pulp.
- Dry hay generally the higher priced option.
What Did Clients Do To Feed Herds In 2019/2020?

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

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

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

What Is The Situation Going Into 2020 Production Year?

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

What Long Term Lessons Were Learned?
What Long Term Lessons Were Learned?

• Many looking at alfalfa economics given the winter kill we are continually seeing.

• Producers are seeing cows perform fine with a high percentage of by-product fiber, even with shorter ration particle size.

• If current price trends continue, it is more profitable to grow your lower quality forage and buy higher energy fiber.

• Really important for good communications between nutritionist and agronomist.

• Cost to buy options versus cost to grow.

• The last 12 months demonstrated the need to source and contract supplies early.

• Covid-19 situation exposed weakness in supply chain.

Thanks For Attending!
GOT HERD HEALTH ON YOUR MIND?
THAT MAKES TWO OF US.

When I’m not exploring an exciting new recipe in the kitchen, I’m in the lab searching for new ingredients to help improve your herd’s resiliency. The Refined Functional Carbohydrates™ (RFCs™) in CELMANAX™ proactively prepare your cows’ immune systems so they can respond quickly when challenges occur. Now that’s a recipe for herd health.

I am #ScienceHearted.

Dr. Elliot Block

To learn more about CELMANAX contact your nutritionist, veterinarian or ARM & HAMMER™ representative or visit AHfoodchain.com.

© 2020 Church & Dwight Co., Inc. ARM & HAMMER, CELMANAX and their logos, RFC and Refined Functional Carbohydrates are trademarks of Church & Dwight Co., Inc.

CED05203631EB
Milk Fat Yield Declines with Increased Levels of Linoleic Fatty Acid

NovaMeal is Low in Linoleic Fatty Acid

Feed ingredients that are high in vegetable fat (like DDGS) are high in linoleic acid which based on a recent report shows for every 100 grams of linoleic acid fed per day reduces milk fat yield by .18%.

NovaMeal is high in digestible protein and fiber plus low in unsaturated fat.

For more information on the study, visit the Resources & Research page at www.NovaMeal.com

Natural algae based solutions

Since 1995, Olmix has developed solutions to improve animal performance and welfare while contributing to reduce antibiotic use thanks to algae.

1 range of natural algae based solutions

Thanks to algae!

www.olmix.com
Do Not Underestimate the Cost of Milk Quality

Dr. Derek T. Nolan
University of Illinois Dairy Extension
Do not underestimate the cost of milk quality

Dr. Derek T. Nolan
University of Illinois Dairy Extension

Presented during the 2020 Four State Dairy Nutrition & Management Virtual Conference. Do not reuse or reproduce without author permission.

The cost of mastitis

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

$2 Billion to US dairy industry

Underestimated

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

> $2 Billion to US dairy industry

Total mastitis cost

- Cost associated with disease can be explained with simple equation

\[ C = L + E \]

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

McInerney et al. (1993)

Total mastitis cost

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

- Expenses – Preventative Costs
  - Management practices
    - Proper milking procedures
  - Gloves
  - Milking equipment function
  - Cow environment management
  - Vaccination
  - Labor
Use of loss-expenditure frontier

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

Cost of SCC Management

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

McInerney et al. (1992)

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

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

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

### Stochastic Simulation

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

### Milk price

- Frequency of iterations

  - $14/cwt
  - $19/cwt
  - $23/cwt

  - $15/cwt
  - $20/cwt
  - $22/cwt
Cost of SCC

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

Milk Loss

<table>
<thead>
<tr>
<th>SCC Threshold (SCC*1,000 cells/mL)</th>
<th>Milk loss (lbs/yr) by lactation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower SCC</td>
<td>Upper SCC</td>
</tr>
<tr>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>300</td>
<td>400</td>
</tr>
</tbody>
</table>

Premiums

<table>
<thead>
<tr>
<th>Premium Level SCC (cells/mL)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 100,000</td>
<td></td>
</tr>
<tr>
<td>100,000 to 200,000</td>
<td>Farm A</td>
</tr>
<tr>
<td>200,000 to 300,000</td>
<td>Farm B</td>
</tr>
<tr>
<td>300,000 to 400,000</td>
<td>Farm C</td>
</tr>
</tbody>
</table>

All farms lost $0.25/cwt due to SCC

Cost of SCC

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

Stochastic Variables

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

Data Analyzed

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

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

$2 Billion to US dairy industry

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

Thank you

Derek Nolan
University of Illinois
Department of Animal Sciences
dtnolan@illinois.edu
217-244-7637
**All-Natural • High Bypass Soybean Meal**

Exceller Meal® is produced naturally from start to finish with locally grown soybeans & mechanical presses using no solvents.

The increased NEL value and high intestinal protein digestibility make Exceller Meal® a valued protein feed ingredient in any dairy diet.

Ask us about our new location in Reese, Michigan!

Contact our office or marketing team for more information.

---

**Marketing Team:**

**Tim Bailey**  
Director of Marketing  
Phone: 785-231-7189  
timexcel41@hotmail.com

**Justin Englebert**  
Marketing/Technical Support  
Phone: 920-791-1571  
justin.inglebert@gmail.com

**Main Office:**  
Phone: 920-775-9279  
Info@qualityroasting.com  
www.qualityroasting.com
Effect of Timing of Induction of Ovulation Relative to Timed AI Using Sexed Semen on Pregnancy Outcomes in Primiparous Holstein Cows

Megan R. Lauber and Paul M. Fricke
Department of Dairy Science
University of Wisconsin – Madison
Effect of timing of induction of ovulation relative to Timed AI using sexed semen on pregnancy outcomes in primiparous Holstein cows

Outline

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

Sperm Differences

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

Sexed Semen Processing

1. Ejaculates collected and examined
2. Quality Control
   1. Motility
   2. Concentration
   3. Morphology
3. Pool ejaculates and stain with fluorochrome Hoechst 33342 that binds to minor groove of DNA
4. Stained ejaculates aliquoted and begin sexing process

Sex Sorting

Selective Killing

- Sex Detection Laser
- Killing Laser
Inseminations in Holstein Females

Inseminations in Jersey Females

Commercial Application of Sexed Semen in Holstein Heifers

Assessment of an accelerometer system for detection of estrus and treatment with a gonadotropin-releasing hormone at the time of insemination in lactating dairy cows

Insminating later relative to the onset of activity yielded increased fertility with sexed semen
New Idea

Inseminating later relative to the onset of activity or estrus will lead to increased fertility with sexed semen
- May be the case when inseminating cows based on estrus or increased activity
- This idea has not been tested in a synchronized breeding protocol in which timing of ovulation is precisely controlled

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

Megan Lauber
Graduate Research Assistant
Fricke Lab

Hypothesis

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

Standard Double-Ovsynch Protocol
G2 to TAI = 16 h

<table>
<thead>
<tr>
<th>Sun</th>
<th>Mon</th>
<th>Tue</th>
<th>Wed</th>
<th>Thu</th>
<th>Fri</th>
<th>Sat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>GnRH a.m.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PGF&lt;sub&gt;2&lt;/sub&gt; a.m.</td>
<td></td>
</tr>
<tr>
<td>GnRH a.m.</td>
<td>GnRH a.m.</td>
<td>G2-16</td>
<td></td>
<td></td>
<td>G2</td>
<td>TAI a.m.</td>
</tr>
<tr>
<td>PGF&lt;sub&gt;2&lt;/sub&gt; a.m.</td>
<td>PGF&lt;sub&gt;2&lt;/sub&gt; a.m.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Modified Double-Ovsynch Protocol
G2 to TAI = 24 h

<table>
<thead>
<tr>
<th>Sun</th>
<th>Mon</th>
<th>Tue</th>
<th>Wed</th>
<th>Thu</th>
<th>Fri</th>
<th>Sat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>GnRH a.m.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PGF&lt;sub&gt;2&lt;/sub&gt; a.m.</td>
<td></td>
</tr>
<tr>
<td>G2-24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>G2</td>
<td>TAI a.m.</td>
</tr>
</tbody>
</table>
Collaborating Farms

- Three locations:
  - Nebraska, Ohio, Wisconsin

- Primiparous cows (n = 730)

- All farms submitted cows for first Timed AI using a Double-Ovsynch protocol
  - Farm A: 6,650 cows; ME305 = 24,900 lb.
  - Farm B: 1,800 cows; ME305 = 28,500 lb.
  - Farm C: 2,260 cows; ME305 = 31,000 lb.

Effect of Treatment on Pregnancy Outcomes

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

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

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.

Effect of Treatment on Pregnancy Loss
Hypothesis

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

Reject

6% and 7% decrease in P/Al 34 ± 3 d and 80 ± 17 d at 24 h interval
No difference in pregnancy loss at 24 h interval
No difference in fetal sex ratio

Thank you and Questions?
New AminoShure®-XM reliably delivers methionine at a substantial savings over other rumen-protected methionine sources. Research shows that savings could be as much as 5¢ per cow per day.*

Contact your local Balchem representative at ANH.Marketing@Balchem.com to access the X-Value Calculator, or visit BalchemANH.com/FindYourX for more details. We’ll show you how AminoShure-XM will fit your amino acid balancing program and deliver a significant savings to your bottom line.

*Based on a 16 g/cow/day feeding rate of a competitive product. © 2020 Balchem Corporation. All trademarks are property of Balchem Corporation. 2006-001
Small changes can redefine dairy productivity

The microbiome is a herd within your herd. In each cow are billions of microscopic organisms responsible for digesting feed. It only takes a fraction of the ration to power up the microbiome, but that fraction can expand your cows’ potential.

At PMI, we carefully research and select dairy feed ingredients that, when combined, deliver greater potential than each ingredient would on its own. These microscopic ingredients make a tremendous impact on feed digestibility, efficiency and performance. It’s called winning with a fraction.

Expand what’s possible in dairy performance at pmiadditives.com
Challenges of Barn Design and Performance in Automated Milking Systems

Nigel B. Cook MRCVS
University of Wisconsin-Madison
School of Veterinary Medicine
The US AMS Challenge:

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

UW Upper Midwest AMS Survey 2018

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

Milk per Cow (42 AMS herds)

Theoretical Robot Capacity

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

- BUT this forgets that cows are cows!
Daily Variation in Robot Visits

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

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

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

- Plan for 55 cows per robot!

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

Lameness Prevalence in AMS Herds

Easy access to a chute for individual cow attention is essential

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

- Produced 1.6 kg (3.5 lb) /d less milk
- Milked 0.3 fewer milkings per day
- 2.2 time more likely to be fetched
Impact of Stall Base on Lameness in AMS Units

Sand | Mat | Wet sand

% Lame

% Severe Lame

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

Deep loose bedding is best for cows!

Sand Challenges in Robots

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

• We believe most of these issues are manageable!

Bedding access and scrapers in AMS facilities

UW AMS Survey 2018 – Stall Base

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

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

Voluntary footbaths …. do not work!

The Ideal Footbath

- 10’ (3.3 m) long
- 24” (0.6 m) wide sloped to 3’ (1 m) at 3’ (1 m) high
- 10” (25 cm) high step

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

Having to put the footbath in a cross alley is a significant drawback to the L-shape, cross-way and side installation designs!
UW AMS Survey 2018 – Fresh Cows

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

24/7 fresh cow access to the robot

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

<table>
<thead>
<tr>
<th>Alley Type</th>
<th>Recommended Alley Width feet (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>AMS</td>
</tr>
<tr>
<td>Stall Alley</td>
<td>10 (3.0) 11 (3.4)</td>
</tr>
<tr>
<td>Feed Alley</td>
<td>12 (3.7) 14 (4.3)</td>
</tr>
<tr>
<td>Feed and Stall Alley</td>
<td>13 (4.0) 15 (4.6)</td>
</tr>
</tbody>
</table>

**Traffic Systems**

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

**Free- or Guided-Flow?**

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

**AMS Traffic Systems – Free-Flow**

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

**Cons**
- Often herds feed more pellet in the robot
- Operation requires more fetching of cows
- Makes footbath use and gating more complex
- May need more FTEs to operate
AMS Traffic Systems – Guided-Flow

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

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

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

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

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

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

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

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

Conventional vs. AMS Units

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

AMS General Design Priorities

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

Thank you!
Road Map to Fatty Acid Balancing

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

- **Palmitic 16:0**
  - ↑ milk fat more than milk yield
- **Oleic 18:1**
  - ↑ digestibility of all fatty acids, milk production & body condition
  - 1% Palmitic and 1% Oleic for balanced energy partitioning (%DM)

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

- **Linoleic 18:2**
  - Found in corn, corn silage, distillers, cottonseed
  - Too much unprotected 18:2 = ↓ milk fat
  - 300+ grams is considered a milk fat risk factor

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

- **Omega-6 18:2**
  - Inflammatory = lost energy to immune
- **Omega-3 EPA/DHA**
  - Anti-inflammatory = ↑ milk & repro
  - 5:1 or ↓ ratio for optimal results in lactating cows

Free Download at VirtusNutrition.com/Roadmap
Maximizing Milk Fat Yield

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

Presenter’s Name: Kevin Harvatin, Ph.D.
Associate Professor of Nutritional Physiology
Penn State University
KMH587@psu.edu

Presented during the 2020 Four State Dairy Nutrition & Management Virtual Conference. Do not reuse or reproduce without author permission.

How to adapt to “Historic” times
- Production limits/reductions
  - Most are based on milk yield, not components

- Milk fat price bottomed out
  - Profitability depends on my cost to make it
  - Think about “marginal cost”

- Distiller’s grains price has increased and corn and soybean meal have decreased
  - Changes risk/value proposition
  - Is rumen available fat cheaper from soybeans or cottonseed?

- Price and some supply changes with some dry fat products

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

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

We can have both fat and protein yield!
Maximizing microbial protein yield gets you:
- Optimal amino acid supply
- Normal biohydrogenation
- Optimal acetate yield
- Optimal energy intake
  - Drives milk flow
  - Drives milk protein synthesis
  - (Don’t forget insulin-IGF-I story!)

What should you be thinking about to maximize milk fat yield
1. Set your goal
   • Seasonal pattern
   • Genetics

2. Balance the diet
   • Unsaturated fat
   • Fermentability
   • Fiber digestibility
   • Fat supply
   • Additives

3. Manage the feeding system
   • Feed mixing and delivery
   • Reduce slug feeding

4. Monitor and adjust
   • Milk fat concentration
   • De novo and trans-10 C18:1
   • Responses in 7 to 10 d

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

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

<table>
<thead>
<tr>
<th>Date</th>
<th>Milk Fat, %</th>
<th>Protein, %</th>
<th>Other solids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan-00</td>
<td>3.2</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-01</td>
<td>3.3</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-02</td>
<td>3.4</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-03</td>
<td>3.5</td>
<td>3.05</td>
<td>3.05</td>
</tr>
</tbody>
</table>

- 0.1 units of milk fat is $73/hd/yr at $2.51/lb

Harvatin unpublished based on USDA NASS milk price

<table>
<thead>
<tr>
<th>Date</th>
<th>Milk Fat, %</th>
<th>Protein, %</th>
<th>Other solids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan-04</td>
<td>3.6</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-05</td>
<td>3.7</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-06</td>
<td>3.8</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-07</td>
<td>3.9</td>
<td>3.05</td>
<td>3.05</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>Milk Fat, %</th>
<th>Protein, %</th>
<th>Other solids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan-08</td>
<td>4.0</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-09</td>
<td>4.1</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-10</td>
<td>4.2</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-11</td>
<td>4.3</td>
<td>3.05</td>
<td>3.05</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>Milk Fat, %</th>
<th>Protein, %</th>
<th>Other solids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan-12</td>
<td>4.4</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-13</td>
<td>4.5</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-14</td>
<td>4.6</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-15</td>
<td>4.7</td>
<td>3.05</td>
<td>3.05</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>Milk Fat, %</th>
<th>Protein, %</th>
<th>Other solids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan-16</td>
<td>4.8</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-17</td>
<td>4.9</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-18</td>
<td>5.0</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-19</td>
<td>5.1</td>
<td>3.05</td>
<td>3.05</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>Milk Fat, %</th>
<th>Protein, %</th>
<th>Other solids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan-20</td>
<td>5.2</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-21</td>
<td>5.3</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-22</td>
<td>5.4</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-23</td>
<td>5.5</td>
<td>3.05</td>
<td>3.05</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>Milk Fat, %</th>
<th>Protein, %</th>
<th>Other solids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan-24</td>
<td>5.6</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-25</td>
<td>5.7</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-26</td>
<td>5.8</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-27</td>
<td>5.9</td>
<td>3.05</td>
<td>3.05</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>Milk Fat, %</th>
<th>Protein, %</th>
<th>Other solids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan-28</td>
<td>6.0</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-29</td>
<td>6.1</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-30</td>
<td>6.2</td>
<td>3.05</td>
<td>3.05</td>
</tr>
<tr>
<td>Jan-31</td>
<td>6.3</td>
<td>3.05</td>
<td>3.05</td>
</tr>
</tbody>
</table>
Milk fat is affected by many factors

**Nutritional Factors**
- Inhibited by BH-induced milk fat depression
- Unsaturated fat
- Fermentability
- Acidity
- Feeding strategies
- Ionophores

**Non-nutritional Factors**
- These set our goals/expectations
- Genetics
- Season
- Stage of lactation
- Parity

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

Milk fat

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

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

Holstein genetic potential by birth year

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

This is a very common cause of reduced milk fat yield, but is not meant to explain every change in milk fat!!!
We must manage the risk factors that cause “Diet-Induced MFD”

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

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

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

Unsaturated fatty acids are a big risk factor

1. Amount of unsaturated fatty acids
   - Fatty acid concentration and profile
   - 18:2 more important than 18:1 and 18:3

2. Rate of availability of the fatty acids
   - Cottonseed vs DDGS

Can milk fatty acids be used to troubleshoot milk fat problems?

Milk trans-10 18:1 & Milk Fat %

High producing cows normally most susceptible

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

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

<table>
<thead>
<tr>
<th>C18:2 (% DM)</th>
<th>Diet</th>
<th>90.0%</th>
<th>75.0%</th>
<th>50.0%</th>
<th>25.0%</th>
<th>10.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.62384</td>
<td>1.4094</td>
<td>1.2167</td>
<td>1.0954</td>
<td>0.93576</td>
</tr>
</tbody>
</table>

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

N = 497

Matamoros Unpublished
High oleic soybeans decrease risk of milk fat depression

<table>
<thead>
<tr>
<th>Feedstuff (% FA)</th>
<th>16:0</th>
<th>18:0</th>
<th>18:1</th>
<th>18:2</th>
<th>18:3</th>
<th>20:1</th>
<th>22:1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean</td>
<td>11</td>
<td>4</td>
<td>23</td>
<td>54</td>
<td>8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>High Oleic Soy</td>
<td>6.5</td>
<td>4</td>
<td>75</td>
<td>72</td>
<td>2.5</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

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

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

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

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

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

Other dietary effects with smaller impacts

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

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

<table>
<thead>
<tr>
<th>Milk, lb</th>
<th>Fat, lb</th>
<th>Preformed, lb</th>
<th>DMI, lb</th>
<th>Diet Fat % Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>2.4</td>
<td>1.3</td>
<td>45</td>
<td>5.3%</td>
</tr>
<tr>
<td>90</td>
<td>3.6</td>
<td>2.0</td>
<td>55</td>
<td>6.5%</td>
</tr>
<tr>
<td>120</td>
<td>4.8</td>
<td>2.6</td>
<td>65</td>
<td>7.4%</td>
</tr>
<tr>
<td>150</td>
<td>6</td>
<td>3.3</td>
<td>75</td>
<td>8.0%</td>
</tr>
</tbody>
</table>

Obviously, cows are making it work, but in some cases we might be limiting milk fat because of limited fat supply
Effect of high oleic soybeans on milk fat when increasing risk of MFD

<table>
<thead>
<tr>
<th>Treatment Means¹</th>
<th>Conv. Soybean</th>
<th>High 18:1 Soybean</th>
<th>P-Values²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
<td>5% 10%</td>
<td>5% 10%</td>
<td>SEM Type</td>
</tr>
<tr>
<td>Milk, lb/d</td>
<td>96.4</td>
<td>96.3</td>
<td>95.5</td>
</tr>
<tr>
<td>%</td>
<td>3.28</td>
<td>3.46</td>
<td>3.42</td>
</tr>
<tr>
<td>lb/d</td>
<td>3.06</td>
<td>3.22</td>
<td>3.22</td>
</tr>
<tr>
<td>Milk Fatty acids, % FA</td>
<td>&gt;16C³</td>
<td>37.4</td>
<td>41.5</td>
</tr>
<tr>
<td>C18:1</td>
<td>0.79</td>
<td>0.89</td>
<td>0.62</td>
</tr>
</tbody>
</table>

Palmitic acid is the most consistent to increase milk fat, but others can also increase in some cases
- May depend on concentration of FA in the basal diet, diet type, cow physiology, etc.

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

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

Increasing acetate increases milk fat under normal conditions

<table>
<thead>
<tr>
<th>Acetate (g/d)</th>
<th>0</th>
<th>300</th>
<th>600</th>
<th>900</th>
<th>SE</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMI, lb</td>
<td>59.9</td>
<td>62.2</td>
<td>60.0</td>
<td>59.5</td>
<td>2.2</td>
<td>-</td>
</tr>
<tr>
<td>Milk, lb</td>
<td>84.9</td>
<td>86.3</td>
<td>88.9</td>
<td>85.6</td>
<td>6.2</td>
<td>-</td>
</tr>
<tr>
<td>Milk Fat g</td>
<td>1382</td>
<td>1468</td>
<td>1582</td>
<td>1577</td>
<td>59</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>%</td>
<td>3.64</td>
<td>3.87</td>
<td>4.03</td>
<td>4.10</td>
<td>0.20</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

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

How do we get more acetate?
Forage quality and good rumen fermentation!

Nutrition is best practiced as an “Experiment in Progress”!!
- When milk fat is Acceptable
  - Inclusion of risk factors is advantageous to feed cost, production, and efficiency
- When milk fat is Low: Look For a Reason
  - When did it start and what happened ~7-10 d prior?
  - Is it a certain string or group of cows?
    - High producing cows are normally more susceptible
  - What season is it?
  - Is the sample a daily average?

The experiment in progress
1. Diet Polyunsaturated Fatty Acids
   - Concentration of C18:2
   - Source of C18:2
     - Very different rates of rumen release
     - Ca Salts are more slowly released, but are not inert
   - Fish oil is very potent (EPA and DHA)
   - Decreasing unsaturated fat has the lowest risk to losing milk yield!
2. Diet Fermentability
   - Analyze carbohydrate profiles and effective fiber
   - Experience with similar diets in the region is important
   - Sugars may be beneficial
   - Start to titrate down starch and increase fiber
   - Switch rapidly fermentable sources for less rapidly fermentable sources
   - Increase forage NDF and effective fiber

**Careful...... May Lose Milk!!

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

**Remember we are dealing with many interactions!

4. Feeding Strategies
   - Number of feeding times per day
   - Slick bunks before feeding?
   - Feeding times
     * You can slug feed TMR!

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

Monitor milk yield and milk fat over time!!!

**Set Expectations for the Time Required

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

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

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

Lab Members:

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

Disclosures
K.J. Harvatine’s research in the past 10 years were partially supported by the Agriculture and Food Research Initiative Competitive Grant No. 2010-65206-20723, 2015-67015-23358, 2016-68008-25025 from the USDA National Institute of Food and Agriculture [PI Harvatine], USDA Special Grant 2009-34281-20118 [PI Harvatine], Berg-Schmidt, Elanco Animal Health, BASF, Novus International, PA Soybean Board, Phode Laboratories, Kemien International, Milk Specialties Global, Adisseo, Micronutrients Inc., Organix Recycling, Insta-Pro Intl., and Penn State University. Harvatine has consulted for Milk Specialties Global, a manufacturer of prilled saturated fat supplements and Micronutrients Inc. as a member of their science advisory boards. Harvatine has also received speaking honorariums from Elanco Animal Health, Novus International, Cargill, Virtus Nutrition, Chr Hansen, NDS, Nutreco, Mycogen, and Milk Specialties Global in the past three years.

Thank You
WANT MORE MILK?

Consider increasing the percentage of canola meal in your dairy diet. Visit Canolamazing.com to download a free copy of the 2019 Canola Meal Dairy Feed Guide and learn why canola meal is the preferred protein source for dairy.

The guide provides up-to-date nutrient profiles, including optimized values for accuracy in the latest feed formulation platforms.
Premium Silage Inoculants for all Crop Types and Dry Matter Ranges.

www.provita-supplements.com | (888) 580-7797
Nutritional Regulation of Gut Health and Development: Weaning and Beyond

Dr. Michael Steele
University of Guelph
Weaning Challenges

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

More Milk = More Weaning Challenges

Pre and Post-Weaning

Pre and Post-Weaning Transition

1 wk 4 wk 8 wk 12 wk

Pre-ruminant Weaning Transition Ruminant

Milk Solid Feed

300 μm
Rumen Papillae - Transition

Abnormal Gut Development
- Ruminal parakeratosis is common during weaning (Bush, 1965)
- Ruminal acidosis has been documented however to date, no research has linked it to impairment of gut health (Laarman et al., 2012)
- Is ruminal acidosis good or bad for the calf?

Total Metabolizable Energy

Ruminal pH During Weaning

[Graphs and images related to ruminal pH and energy content during weaning]

(Van Niekerk et al., in review)
Ruminal pH During Weaning

Van Niekerk et al., in review

Early and Abrupt Weaning

Van Niekerk et al., in review

Weaning Age

(Eckert et al., 2015)

Weaning Age - Bodyweight

(Eckert et al., 2015)
Weaning Strategy - Abrupt Weaning Impact on Ruminal Development

- Gradual vs. Abrupt Weaning
- Calf Age (d) vs. Starter Intake (grams)
- PC1 Percent variation explained 17.8%
- PC2 Percent variation explained 9.1%

Abrupt_post-weaning
Abrupt_pre-weaning
Step-down_post-weaning
Step-down_pre-weaning

(Meale et al., 2016)

Pre and Post-Weaning

- Pre-ruminant
- Weaning Transition
- Ruminant
- Solid Feed

1 wk 4 wk 8 wk 12 wk

Diversity in Fecal Scores

- Fecal microbiota displayed more diversity post-weaning
- Fecal Starch %
- Calf Age (d)

* P = 0.04

(Abrupt vs. Step-down)

(Meale et al., 2015)

Barrier Function at Weaning

- Starter feeding in calves decreased the expression of tight junctions
- Weaning related changes of the gut epithelium

(Rumen, Duodenum)

Not-Weaned, d 42
Weaned, d 42

(BARRIER FUNCTION AT WEANING)

(Wood et al., 2015)

(Pre- and Post-Weaning)

(Weaning Strategy - Abrupt Weaning Impact on Ruminal Development)

(Fecal microbiota displayed more diversity post-weaning)

(BARRIER FUNCTION AT WEANING)
Endoscopic Biopsy

Interaction Between Milk and Starter
Factor 1 - High and Low Milk
Factor 2 - Whole vs Flaked Corn

Interaction Between Milk and Starter
Factor 1 - High and Low Milk
Factor 2 - High vs Low Starch

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

The Investment of Raising Replacements

Are we assuming that calves are consuming more forage than what they are?
Post-Weaning Dry TMR Rations

70% Concentrate
30% Straw
Low Diet
2.31 Mcal/kg

85% Concentrate
15% Straw
High Diet
2.47 Mcal/kg

Dry TMR - Dry Matter Intake

70% Concentrate
85% Concentrate
All Silage

DMI (kg/d)

Week of Experiment

Dry TMR - Average Daily Gain

1.75 kg/day
70% = 1.28 kg/day
85% = 1.05 kg/day

Interaction Between Pre-Weaning and Post-Weaning

Pre-weaning milk intake
Pre-weaning starter intake

Post-Weaning Metabolizable Energy Intake

Energy intake (Mcal)

Week (P < 0.05)
Pre-Post (P = 0.66)

Growth Factors – IGF-1

Pre-weaning (P < 0.05)
Post-weaning (P < 0.05)
Pre-Post (P = 0.05)
Reproductive Development

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

(Bruinjé et al., 2019)

Take Home Messages

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

Industry Collaborators

Academic Collaborators

Thanks to my Team

Alberta, 2017  Guelph, 2019

Mike Steele
mastelee@uoguelph.ca
Stay The Course
Steer clear of changes during high risk periods.

Feeding Mepron® for health in pre-fresh, post-fresh, and early lactation diets will result in more Protein, more Fat, and more Flow.

A feeding program precisely designed for dairy beef.

- Whole shelled corn eliminates processing
- Less equipment and labor
- Simple feeding schedule
- Fast economic gains

Creating Generations of Healthy Cows
The High Fertility Cycle

Paul M. Fricke\textsuperscript{1}, Milo C. Wiltbank\textsuperscript{1}, and J. Richard Pursley\textsuperscript{2}

\textsuperscript{1}Department of Dairy Science, University of Wisconsin–Madison
\textsuperscript{2}Department of Animal Science, Michigan State University

Corresponding author: pmfricke@wisc.edu
The High Fertility Cycle
Paul M. Fricke¹, Milo C. Wiltbank¹, and J. Richard Pursley²
¹Department of Dairy Science, University of Wisconsin – Madison
²Department of Animal Science, Michigan State University
Corresponding author: pmfricke@wisc.edu

SUMMARY

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

INTRODUCTION

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

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

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

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

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

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

\(^a,b\)Items with different superscripts differ (P < 0.05)

\(^1\)Body condition scores based on a 1 (thin) to 5 (fat) scale.

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

To assess embryo quality, cows were superovulated using a modified Double-Ovsynch protocol. All cows were inseminated and flushed by two technicians, and cows were inseminated twice at 12 and 24 h after GnRH treatment. Seven days after GnRH treatment, ova/embryos were recovered using a nonsurgical shallow uterine horn flushing technique. Embryo characteristics were affected based on body weight quartile in which cows in the Fourth Quartile that dramatically lost weight during the first 3 weeks postpartum had overall poorer embryo characteristics than cows in the other three quartiles (Table 2).
Figure 2. Quartile analysis of percent body weight change from the first week postpartum in Holstein dairy cows. Adapted from Carvalho et al. (2014).

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

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

Note: a,b Items with different superscripts within the same row differ (P < 0.05).
A,B Items with different superscripts within the same row differ (P < 0.15).
1First quartile = gaining body weight; Fourth quartile = most body weight loss.
Effect of BCS change after calving on fertility
The second study from the first paper (Carvalho et al., 2014) included a retrospective analysis in which 1,887 Holstein cows from two commercial dairy farms in Wisconsin were submitted to a Double-Ovsynch protocol for first timed AI, and BCS was evaluated at calving and 21 days after calving. Overall, 42% of cows lost BCS, 36% of cows maintained BCS, and 22% of cows gained BCS during the first 3 weeks of lactation (Table 3).

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

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

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

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

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Change in BCS[^1]</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gained</td>
<td>Maintained</td>
</tr>
<tr>
<td>Cows, % (no./no.)</td>
<td>28 (69/245)</td>
<td>22 (54/245)</td>
</tr>
<tr>
<td>P/Al 30 d, % (no./no.)</td>
<td>53.0 (35/66)^a</td>
<td>26.9 (14/52)^b</td>
</tr>
<tr>
<td>P/Al 60 d, % (no./no.)</td>
<td>45.5 (30/66)^a</td>
<td>25.0 (13/52)^b</td>
</tr>
<tr>
<td>Pregnancy loss, % (no./no.)</td>
<td>14.3 (5/35)</td>
<td>7.1 (1/14)</td>
</tr>
</tbody>
</table>

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

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

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Change in BCS[^1]</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gained</td>
<td>Maintained</td>
</tr>
<tr>
<td>n</td>
<td>66</td>
<td>52</td>
</tr>
<tr>
<td>Metritis</td>
<td>19.70 (13/66)</td>
<td>21.20 (11/52)</td>
</tr>
<tr>
<td>Mastitis</td>
<td>16.70 (11/66)^b</td>
<td>17.30 (9/52)^a,b</td>
</tr>
<tr>
<td>Ketosis</td>
<td>15.20 (10/66)</td>
<td>19.20 (10/52)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>9.10 (6/66)</td>
<td>11.50 (6/52)</td>
</tr>
<tr>
<td>&gt; 1 Health problem</td>
<td>39.4 (26/66)^b</td>
<td>46.2 (24/52)^b</td>
</tr>
</tbody>
</table>

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

*The High Fertility Cycle*

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

![High-Fertility Cycle Diagram](image)

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

**CONCLUSION**

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

REFERENCES


Papillon is proud to work side by side with feed mills and nutritionists striving to help dairies maximize feed efficiency.

For more information on our cutting-edge nutritional products, call our Regional Sales Managers:

- **Stu Herbst**, Midwest, 920-851-5133, (WI, IL)
- **Noelle Harding**, North Central, 605-310-1436, (MN, IA)

**Phileo by Lesaffre**

Phileo by Lesaffre
7475 West Main Street
Milwaukee, WI 53214, USA
Ph: 1-877-677-7000
info@phileo.lesaffre.com

**DON’T LET HEAT STRESS STEAL YOUR PROFIT**

**Incorporating yeast probiotics during heat stress:**

- Decreases ruminal ammonia concentrations by 20% ¹
- Increases dry matter intake by 1.3 lbs. ¹
- Improves fat corrected milk by 4.4 lbs. ¹
- Raises dry matter efficiency by 3.7% ¹
- Reduces rectal temperatures ²
- Reduces respiration rates by 16% ²
- Improves plasma niacin levels by 7% ²

**Using SafMannan during heat stress:** ³, ⁴

- Reduces corticosterone concentrations
- Binds pathogens in the gut


Phileo by Lesaffre provides evidence based solutions to optimize your profitability.
Using MUN to Manage Protein Feeding

Mark D. Hanigan
Dept. of Dairy Science
Virginia Tech
mhanigan@vt.edu
Using MUN to Manage Protein Feeding
Mark D. Hanigan; mhanigan@vt.edu
Dept. of Dairy Science, Virginia Tech

Dairy Nutrient Values – 5-year Average

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

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

Environmental Impact of Waste N

Eutrophication
Air Quality and High N Rain

RDP/RUP and MUN

What Goes In MUST Come Out!

RDP = Ruminally Degraded Protein
RUP = Ruminally Undegraded Protein
CP = RDP + RUP
MP = Digestible (Microbial Protein + RUP)

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

- MUN mg/dl
- N Efficiency, %

Bequette et al., 2003

Relationship of MUN and Urinary N Output

\[ \text{Milk Urea (mg/dl)} = \text{MUN (mg/dl)} / 0.467 \]

Burgos et al., 2007

MUN Responses to RDP/RUP

Does it Matter where the Water Enters the Pool?

Spek et al., 2013

Effects of Protein and CHO on MUN

Kaufman and St-Pierre., 2001

High Salt Reduces MUN

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

Aguilar et al., 2012

Genetics and MUN

<table>
<thead>
<tr>
<th>Effect</th>
<th>Estimate</th>
<th>SE</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-1.06</td>
<td>26</td>
<td>0.002</td>
</tr>
<tr>
<td>Dietary CP, % of DM</td>
<td>5.4</td>
<td>1.1</td>
<td>0.0001</td>
</tr>
<tr>
<td>Dietary NDF, % of DM</td>
<td>2.84</td>
<td>0.45</td>
<td>0.0001</td>
</tr>
<tr>
<td>Milk Yld, kg/d</td>
<td>0.66</td>
<td>0.12</td>
<td>0.0001</td>
</tr>
<tr>
<td>Milk Protein, %</td>
<td>7.7</td>
<td>3.5</td>
<td>0.0001</td>
</tr>
<tr>
<td>CP x NDF</td>
<td>-0.038</td>
<td>0.018</td>
<td>0.03</td>
</tr>
<tr>
<td>CP x Milk Yld</td>
<td>-0.0194</td>
<td>0.0057</td>
<td>0.001</td>
</tr>
<tr>
<td>CP x Milk Protein</td>
<td>-0.73</td>
<td>0.24</td>
<td>0.003</td>
</tr>
<tr>
<td>NDF x Days in Milk</td>
<td>-0.00005</td>
<td>0.00002</td>
<td>0.009</td>
</tr>
<tr>
<td>NDF x Milk Protein</td>
<td>-0.65</td>
<td>0.11</td>
<td>0.0001</td>
</tr>
<tr>
<td>Milk x Milk Protein</td>
<td>-0.073</td>
<td>0.023</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Random Effects

<table>
<thead>
<tr>
<th>Term</th>
<th>Estimate</th>
<th>SE</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herd</td>
<td>1.6</td>
<td>0.88</td>
<td>0.08</td>
</tr>
<tr>
<td>Cow(herd)</td>
<td></td>
<td>0.0001</td>
<td></td>
</tr>
</tbody>
</table>

Aguilar et al., 2012

Are MUN Data Reliable?

<table>
<thead>
<tr>
<th>Method</th>
<th>Recovery(%)</th>
<th>SE(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bentley</td>
<td>92.1*</td>
<td>2.74</td>
</tr>
<tr>
<td>CL-10</td>
<td>85.0*</td>
<td>2.74</td>
</tr>
<tr>
<td>FOSS4000</td>
<td>95.4a</td>
<td>10.1</td>
</tr>
<tr>
<td>Skalar</td>
<td>95.1a</td>
<td>7.61</td>
</tr>
</tbody>
</table>


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

Peterson et al., 2004 JDS
Monitor MUN to Achieve Optimum Return

1. Establish a baseline for your herd
   - Balance ration to NRC 2001 or equivalent
   - Feed ration for 2 weeks and Measure MUN (~11 mg/dl)

2. Systematically reduce RUP (0.25% units at a time)
   - For example, CP from 16.5% to 16.25% via RUP (0.06/c/d)
   - Keep RDP and energy constant
   - Feed for 1 week; Monitor MUN and milk yield
   - MUN should drop by ~0.5 mg/dl
   - Any milk loss will be half of NRC predicted loss
   - Calculate Income/Feed Cost (IOFC)
   - If greater, retain reduction and lower another 0.25%

3. Reduce RDP by 0.5% of Diet DM while holding RUP constant
   - Same approach as for RUP, e.g. 16% to 15.5% (~0.02/c/d)
   - RDP < 9% of DM is safe
   - Decrease DMI is first sign of deficiency

4. MUN at maximal IOFC is target for the herd
   - Can operate at 8 or below
   - May require RPAA → IOFC
   - High MUN = overfeeding protein
   - Low MUN = lost milk

Summary

1. Excess N harms the environment and cost $
   - Environmental regulations are not going away!!!

2. Feed to requirements
   - 2001 RDP requirements are too high
   - MP Requirements → AA in 2021

3. Feeding Management is Critical
   - Monitor feeds for nutrient content
   - Balance to requirements
   - Monitor programs for feeding accuracy
   - Verify milk processor MUN accuracy
   - Monitor MUN as a process indicator
The Fly Stops Here.

FLY CONTROL FOR DAIRY

Over 96% Effective at Ending the Fly Life Cycle at the Larval Stage
House Flies | Stable Flies | Face Flies | Horn Flies

Kick flies to the curb today by contacting your nutrition provider. Visit us at CentralFlyControl.com or give us a call at 1-800-347-8272.

* Data on File.

ClariFly Larvicide with design is a registered trademark of Wellmark International.
Central Life Sciences with design is a registered trademark of Central Garden & Pet Company. ©2020 Wellmark International.

WHEN TIMES ARE TOUGH,
IT’S MORE IMPORTANT THAN EVER
THAT ESSENTIAL INGREDIENTS
DELIVER QUALITY AND CONSISTENCY,
ALL THE TIME.

ASK ABOUT OUR FREE SOYCHLOR
FEEDING TRIAL FOR NEW
CUSTOMERS, AND SEE WHAT
SOYCHLOR CONSISTENCY WILL
ADD TO YOUR BOTTOM LINE.

Call BRANDI GEDNALSKE
Regional Sales Manager
(715)-220-9238
Brandi@dairynutritionplus.com
High Energy Forages

We are focused on the highest digestible fiber and energy in forage production per acre.

We feature alternative forages and custom mixes.

Contact us to learn more about the custom opportunities for each farm.

www.peakforage.com
Tim Huffman  608-574-7918
Nick Huffman 608-574-0827
Rumen-Protected Amino Acids Fed to Dairy Cows During Stressful Periods: *Does it work?*

Dr. Phil Cardoso
University of Illinois
Rumen-protected amino acids fed to dairy cows during stressful periods: Does it work?

Dr. Phil Cardoso
University of Illinois

Stress is an external event or condition that places a strain on a biological system.

So, What do we want from this cow?

We should feed and manage dry and transition cows to:
1. Minimize health disorders
2. Maximize production
3. Maximize reproduction
Dietary Recommendations for Dry Cows

- **NEL:** Control energy intake at 14 to 16 Mcal daily [diet ~ 1.32 Mcal/kg (0.60 Mcal/lb) DM] for mature cows

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

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

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

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

Treatments were given as top-dress

- Methionine
- Lysine

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

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

Treatments were given as top-dress
Effects of Rumen-Protected Methionine or Choline Supplementation on the First Dominant Follicle

1. Rumen-protected methionine (MET; n = 20, received 0.08% of the DM of the diet as methionine, Smartamine M®, Adisseo, Alpharetta, GA, USA, to a Lys:Met = 2.9:1)

2. Rumen-protected choline (CHO; n = 17, received 60 g/d choline, Reassure, Balchem Corporation, New Hampton, NY)

3. Both rumen protected methionine and choline (MIX; n = 19, received 0.08% of the DM of the diet as methionine to a Lys:Met = 2.9:1 and 60 g/d choline)

4. No supplementation to serve as control (CON; n = 16, fed TMR with a Lys:Met = 3.5:1)

Ingredients

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>% DM Pre-Fresh</th>
<th>% DM Fresh</th>
<th>% DM High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa silage</td>
<td>8.35</td>
<td>5.07</td>
<td>6.12</td>
</tr>
<tr>
<td>Alfalfa hay</td>
<td>4.29</td>
<td>2.98</td>
<td>6.94</td>
</tr>
<tr>
<td>Corn silage</td>
<td>36.40</td>
<td>33.41</td>
<td>35.09</td>
</tr>
<tr>
<td>Wheat straw</td>
<td>15.63</td>
<td>2.98</td>
<td>---</td>
</tr>
<tr>
<td>Cottonseed</td>
<td>---</td>
<td>3.58</td>
<td>3.26</td>
</tr>
<tr>
<td>Wet brewers grain</td>
<td>4.29</td>
<td>9.09</td>
<td>8.16</td>
</tr>
<tr>
<td>Soy hulls</td>
<td>4.29</td>
<td>4.18</td>
<td>4.74</td>
</tr>
<tr>
<td>Concentrate mix</td>
<td>26.75</td>
<td>38.71</td>
<td>35.69</td>
</tr>
</tbody>
</table>

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

Uterine Cytology – Polymorphonuclear (PMN)
PMN in Uterus of Cows Fed rumen-protected methionine (MET) or not (CON)

<table>
<thead>
<tr>
<th>Effect</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRT</td>
<td>0.93</td>
</tr>
<tr>
<td>DIM</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>TRT*DIM</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Schematic Representation of Concepts of the Patterns of Immune and Inflammatory Response in Dairy Cows in the Postpartum Period

Gene expression in uterine samples of cows fed rumen-protected methionine (MET - †) or not (CON - ○)

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

Day relative to calving
Liver Functionality Index: LFI

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

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

- High LFI (HLFI) is suggestive of a smooth transition.

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

A tendency for a greater number of Met-supplemented cows in the HLFI was observed.

Liver Functionality Index: LFI

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

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

- High LFI (HLFI) is suggestive of a smooth transition.

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

A tendency for a greater number of Met-supplemented cows in the HLFI was observed.

Liver Functionality Index: LFI

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

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

- High LFI (HLFI) is suggestive of a smooth transition.

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

A tendency for a greater number of Met-supplemented cows in the HLFI was observed.

Liver Functionality Index: LFI

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

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

- High LFI (HLFI) is suggestive of a smooth transition.

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

A tendency for a greater number of Met-supplemented cows in the HLFI was observed.

Liver Functionality Index: LFI

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

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

- High LFI (HLFI) is suggestive of a smooth transition.

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

A tendency for a greater number of Met-supplemented cows in the HLFI was observed.

Liver Functionality Index: LFI

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

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

- High LFI (HLFI) is suggestive of a smooth transition.

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

A tendency for a greater number of Met-supplemented cows in the HLFI was observed.

Liver Functionality Index: LFI

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

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

- High LFI (HLFI) is suggestive of a smooth transition.
Heat Stress

Approximately $900 million lost annually
Physiological and production responses
† Respiration rate
† Dry matter intake
† Milk yield
Altered milk content and composition
† Milk fat %
† Milk protein %
Altered protein metabolism
† Total plasma AA concentration
† Sulfur-AA (i.e. Methionine)

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

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
* Mixed with 300 g molasses

Environmental Treatment: Electric Heat Blankets

Environmental Treatment: Pair-Fed Thermoneutral

Split-Plot Crossover Design
### Performance Measurements

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

### Period Timeline

<table>
<thead>
<tr>
<th>Phase 1 – Baseline Phase (No HS or PFTN)</th>
<th>Phase 2 – Trial Phase (HS or PFTN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

### Physiological Measurements

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

### Paired Difference Values:

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

<table>
<thead>
<tr>
<th>Item</th>
<th>RPM</th>
<th>CON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk yield:</td>
<td>30 kg/d</td>
<td>30 kg/d</td>
</tr>
<tr>
<td>Paired Difference Values:</td>
<td>0 kg/d</td>
<td>-5 kg/d</td>
</tr>
</tbody>
</table>

### Diet Formulation

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>% of DM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn silage</td>
<td>40.3</td>
</tr>
<tr>
<td>Dry ground corn grain</td>
<td>17.7</td>
</tr>
<tr>
<td>Alfalfa silage</td>
<td>12.3</td>
</tr>
<tr>
<td>Corn gluten feed pellets</td>
<td>8.4</td>
</tr>
<tr>
<td>Alfalfa hay</td>
<td>6.3</td>
</tr>
<tr>
<td>Grain and mineral mix</td>
<td>6.7</td>
</tr>
<tr>
<td>Soybean meal RUP source</td>
<td>3.4</td>
</tr>
<tr>
<td>Molasses</td>
<td>3.3</td>
</tr>
<tr>
<td>Canola meal</td>
<td>1.7</td>
</tr>
<tr>
<td>Rumen protected lysine</td>
<td>0.4</td>
</tr>
</tbody>
</table>

### Chemical Analysis*

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM, %</td>
<td>47.0</td>
<td>1.0</td>
</tr>
<tr>
<td>CP, % of DM</td>
<td>15.6</td>
<td>0.2</td>
</tr>
<tr>
<td>ADF, % of DM</td>
<td>18.5</td>
<td>0.7</td>
</tr>
<tr>
<td>NDF, % of DM</td>
<td>29.0</td>
<td>0.6</td>
</tr>
<tr>
<td>Starch, % of DM</td>
<td>31.8</td>
<td>2.2</td>
</tr>
<tr>
<td>Crude fat, % of DM</td>
<td>5.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Ash, % of DM</td>
<td>7.5</td>
<td>0.9</td>
</tr>
</tbody>
</table>

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

### TMR Analysis

- **CP**: 16.08 vs. 16.02
- **Met as % of MP**: 2.57 vs. 2.03
- **Lys as % of MP**: 7.01 vs. 7.05
- **Lys to Met Ratio**: 2.73 vs. 3.47

### Paired Difference Analysis

- **Respiration Rate**: RPM vs. CON
- **Heart Rate**: RPM vs. CON

### Physiological Parameters

- **Rectal Temperature**
- **Vaginal Temperature**

Pate et al., 2020

- HS had greater increase in vaginal and rectal temperature than PFTN

### HS had greater increase in respiration rate and heart rate

- Respiration Rate
- Heart Rate

Pate et al., 2020
**PFTN had greater decrease in DMI and milk yield compared to HS**

**Lactation Performance**

**CON had greater decrease in milk protein % and milk casein % than RPM**

**Lactation Performance**

**RPM increased and CON decreased milk fat % during HS; HS had greater decrease in de novo FA than PFTN**

**Lactation Performance**

**Cows in PFTN had greater decrease in insulin and greater increase in insulin sensitivity (RQUICKI) than HSC**

**Blood Metabolites**

**Cows in PFTN had greater increase in non-esterified fatty acids (NEFA) and greater decrease in plasma urea N (PUN)**

**Blood Metabolites**
From this study:

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

- Impacted (+)
- Uterine environment
- Pregnancy recognition
- Dry matter intake
- Pregnancy loss
- Milk Yield
- Oxidative burst
- Milk components
- Phagocytosis
- Liver Functionality Index

Manage dietary ingredients for
- Manage for adequate CP (~13% Dry & 16% Lactation)
- Metabolizable methionine in TMR (30 g/d Dry & 46 g/d Lactation)
  - 15 g/d Dry & 20 g/d Lactation of rumen-protected methionine
- Metabolizable lysine in TMR (84 g/d Dry & 129 g/d Lactation)
  - 26 g/d Dry & 38 g/d Lactation rumen-protected lysine
  ▪ Balanced for the ratios: Met 2.6% MP; Lys, 7.0% MP (9% PRE) (LYS:MET 2.7:1)
  ▪ Methionine supply relative to energy is ~ 1.15 g/Mcal ME
  ▪ Lysine supply relative to energy is ~ 2.9 – 3.16 g/Mcal ME
- Pregnancy rate > 20% (go for > 25%; conception rate at first AI > 40%)
- Embryonic death < 15% (go for < 10%)

THANK YOU!
cardoso2@Illinois.edu
www.dairyfocus.Illinois.edu

Dairy Extension
ILLINOIS ACES
Her Biology. Our Technology.

Smart science brings us more than data and devices. It delivers the industry’s most effective immune support product — NutriTek®.

Working naturally* with the cow’s biology, NutriTek helps maintain immune strength for optimal health and more quality milk.

Healthy herd. Total dairy performance.

Life Stage Solutions®. Only from Diamond V.

*natural as defined by AAFCO

For more information, visit www.diamondv.com/nutritek
From calf to cow, dairy cattle thrive when they receive optimal trace mineral nutrition throughout their life. It’s what we call “Lifetime Performance®.” In fact, research shows that when dry and lactating cows were fed the complexed minerals in Availa®Dairy they experienced a 7% increase in pregnancy and 13 fewer days open.

Contact your Zinpro representative or visit Zinpro.com/lifetime-performance to learn more.