Transition cow nutrition and management to optimize performance of dairy cattle

Thomas R. Overton, Ph.D.
Professor and Chair
Director, PRO-DAIRY
Department of Animal Science
Cornell University
Transition period goals

- High milk production
- Maintain/minimize loss of BCS
- Low incidence of metabolic disorders
- Minimize loss of immunocompetence
- Control/decrease days to first ovulation and maintain/enhance fertility
- Low stillborn rate and healthy calves

- Our high performing dairies achieve ALL of these by focusing on continuous improvement in all areas of transition cow management
Shift in mindset from the transition cow as a disease opportunity to the transition cow as a production and reproduction opportunity!!!
Incomplete list of current “hot topics” in transition cow nutrition/metabolism

- Hypocalcemia
  - biology, nutrition, management, assessment
- Fresh cow nutritional strategies
  - Starch levels, fiber levels?, MP and AA?
- Targeted supplies of nutrients
  - AA, choline, chromium, biotin?
- Protein metabolism
  - Regulation/nutritional influences
- Inflammation/immune/acute phase response/stress
  - Biology, nutrition, management, assessment
- Epigenetics of nutrition and management
- Cow and herd-level assessment strategies
  - Hyperketonemia, hypocalcemia, inflammation/immunity/stress
  - Technology implementation
Top ten things to do for healthy and productive transition cows!!
Top ten things to do for healthy and productive transition cows

• Manage macromineral nutrition/DCAD of dry cows, especially in the last 2 to 3 weeks before calving to prevent clinical and subclinical hypocalcemia
Subclinical hypocalcemia risks

• Impaired health
  – Metritis (Martinez et al., 2012)
  – DA (Chapinal et al., 2011)
  – Mastitis (Curtis et al., 1983)
  – Subclinical and clinical ketosis (Curtis et al., 1983; Ribeiro et al., 2011)
  – Immune function (Kimura et al., 2002; Martinez et al., 2012)

• Decreased milk production (Chapinal et al., 2012)

• Poorer reproductive performance
  – Reduced pregnancy rate (Martinez et al., 2012)
  – Reduced pregnancy to first service (Chapinal et al., 2012)
  – Longer interval to pregnancy (Martinez et al., 2012)

• Chronic subclinical hypocalcemia: increased disease frequency and increased time to pregnancy (Caixeta et al., 2017)
Prepartum dietary management is most effective way of preventing postpartum hypocalcemia

• Manipulate dietary cation anion difference (DCAD)
  – Minimize/avoid high potassium forages (legumes)
  – Supplement anions (chloride and/or sulfur containing supplements)

• Actualize a low calcium diet through use of a binder of calcium in the diet to decrease absorption
  – Synthetic Zeolite A
Major strategies for application of DCAD for close-up dry cows

• Focus on feeding low K (and Na) forages and feeds to close-up dry cows
  •  *Calculated DCAD ~ +10 mEq/100 g of DM*
  •  *Urine pH ~ 8.3 to 8.5*

• Feeding low K forages along with partial use of anionic supplement in close-up ration or one-group dry cow ration
  •  *Calculated DCAD ~ 0 mEq/100 g of DM*
  •  *Urine pH ~ 7.5*

• Feeding low K forages along with full use of anionic supplement in close-up ration or one-group dry cow ration
  •  *Calculated DCAD ~ -10 to -15 mEq/100 g of DM*
  •  *Urine pH ~ 5.5 to 6.0 – need to monitor weekly and adjust DCAD supplementation if out of range*

• Need to also supplement Mg (dietary target ~ 0.45%) during close-up
• Recommend supplementing Ca (0.9 to 1.0% if low K only; 1.4 to 1.5% if full anionic diet)
Summary considerations for effective DCAD diet implementation

• Account for macrominerals in forages (wet chemistry)
• CONSISTENCY in forages/feeds/mixing is key
• Prevent sorting of ration
  • Particle size of TMR and moisture
• Sources:
  • Commercial products best (palatability)
  • Some sources poor palatability (Ca chloride, ammonium chloride)
• Make sure you supplement Mg (Mg oxide, Mg sulfate, commercial Mg sources)
• Use urine pH monitoring to gauge implementation
  • Urine pH 6 to 7 has been general recommendation
  • With excellent management, can target urine pH 5.5 to 6
  • Target CV < 8% (12 to 15 cows; 4 to 6 h postfeeding if possible)
Feeding synthetic Zeolite A prepartum improves blood Ca status at calving

Grabher et al., 2009, Thilsing-Hansen et al., 2001
Synthetic Zeolite A fed during the prepartum period

- **Objective:** To determine the effect of feeding sodium aluminum silicate to multiparous Holstein cows during the prepartum period on serum mineral status, dry matter intake, postpartum performance, and oxidative status

- **Enrolled 60 multiparous Holstein cows**
  - 5 cows removed; 3 calved with twins/calved early, 1 had a DA prepartum, 1 diagnosed with toxic mastitis
  - 2nd lactation: n=24, ≥3rd lactation: n=31

- **Cows enrolled 28 d prior to expected calving and randomly assigned to one of two dietary treatments starting 21 d prior to expected calving**
  - Control (CON; n=29) - Contains 40% CS, 33% wheat straw, and 27% concentrate
  - Experiment (EXP; n=26) - CON diet with the addition of sodium aluminum silicate (X-Zelit, Protekta Inc., Lucknow, Ontario, CA/Vitfoss, Graasten, DK) at 3.3% of DM, targeting 500 g/d as fed.

- **Cows fed same postpartum ration**

Kerwin et al., 2019. J. Dairy Sci. 102:5191–5207
Calcium

Kerwin et al., 2019. J. Dairy Sci. 102:5191–5207
Top ten things to do for healthy and productive transition cows

• Manage macromineral nutrition/DCAD of dry cows, especially in the last 2 to 3 weeks before calving to prevent clinical and subclinical hypocalcemia

• Control energy intake in both far-off and close-up cows – not too little, not too much

• Make sure supplying enough metabolizable protein before calving
  – Emphasis on “bypass” protein sources and balancing AA
Summary guidelines -- dry period nutritional strategies

• Far-off
  – Keep energy down (0.59 to 0.63 Mcal/lb; 1.30 to 1.39 Mcal/kg of NEL; 110 to 120% of energy requirements; < 13% starch
  – Macromineral balances not important (within reason)

• Close-up (if same ration fed to heifers and older cows)
  – Low to moderate energy (0.64 to 0.66 Mcal/lb; 1.40 to 1.45 Mcal/kg of NEL; 110 to 130% of energy requirements; 16 to 18% starch
  – Supplement with RUP (MP for Holsteins 1200 to 1400 g/d)
  – Macromineral relationships (K, Mg, Na, S, Cl; maybe Ca) critically important; Vitamins D and E; trace elements
General recommendations – one-group nutritional strategies

- Low to moderate energy (1.35 to 1.40 Mcal/kg -- ~ 0.63 Mcal/lb of NEL; 110 to 130% of energy requirements; 14 to 16% starch)

- Supplement with RUP (MP for Holsteins ~ 1200 g/d)

- Formulate minerals like close-up ration

- *Always a bit of a compromise (performance, health, cost) compared to two-group systems, but most practical option on some farms*
Top ten things to do for healthy and productive transition cows

• Manage macromineral nutrition/DCAD of dry cows, especially in the last 2 to 3 weeks before calving to prevent clinical and subclinical hypocalcemia
• Control energy intake in both far-off and close-up cows – not too little, not too much
• Make sure supplying enough metabolizable protein before calving
• Get the feeding management right, every day
Keys to feeding management of dry cow TMR

• Minimize sorting
  – Particle size of straw/hay
    • Longest particles < 1.5 in (4 cm)
  – Moisture content of TMR
    • Target 46 to 48 DM % -- add water if necessary
# Particle size recommendations using Penn State Particle Separator

<table>
<thead>
<tr>
<th>Screen</th>
<th>Lactating cow TMR</th>
<th>Dry cow TMR</th>
<th>Corn silage</th>
<th>Hay crop silage</th>
<th>Straw/dry hay for TMR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top (&gt; 0.75” sieve)</td>
<td>6 to 10%</td>
<td>10 to 20%</td>
<td>5 to 10%</td>
<td>10 to 20%</td>
<td>33%</td>
</tr>
<tr>
<td>Middle (0.31 to 0.75 in sieve)</td>
<td>45 to 55%</td>
<td>50 to 60%</td>
<td>45 to 65%</td>
<td>45 to 75%</td>
<td>33%</td>
</tr>
<tr>
<td>Bottom (&lt; 0.31 in sieve)</td>
<td>&lt; 50%</td>
<td>&lt; 40%</td>
<td>30 to 40%</td>
<td>20 to 30%</td>
<td>33%</td>
</tr>
</tbody>
</table>

Adapted from Penn State guidelines by T. Overton 9/2013
Recommendations and particle size distributions for 74 Prefresh TMR samples using the Penn State Particle Separator (n=72 farms; Lawton et al., 2015)
Deviations from total target weight and ingredient deviations for 25 CA dairies

Rodriguez et al (Silva-del-Rio), 2015 DCRC
Figure 4. Frequency of feedings delayed by 1h or more relative to the previous day feeding.

Rodriguez et al (Silva-del-Rio), 2015 DCRC
Top ten things to do for healthy and productive transition cows

• Manage macromineral nutrition/DCAD of dry cows, especially in the last 2 to 3 weeks before calving to prevent clinical and subclinical hypocalcemia
• Control energy intake in both far-off and close-up cows – not too little, not too much
• Make sure supplying enough metabolizable protein before calving
• Get the feeding management right, every day
• Clean and comfortable housing and fresh water
• Manage social interactions/hierarchy
  – Stocking density, commingling cows/heifers, group changes
Top ten things to do for healthy and productive transition cows

- Manage macromineral nutrition/DCAD of dry cows, especially in the last 2 to 3 weeks before calving to prevent clinical and subclinical hypocalcemia
- Control energy intake in both far-off and close-up cows – not too little, not too much
- Make sure supplying enough metabolizable protein before calving
- Get the feeding management right, every day
- Clean and comfortable housing and fresh water
- Manage social interactions/hierarchy
- Manage heat stress
Cooling during the entire dry period increases subsequent milk production (differences in lbs/d above bars)


Collier et al., 1982b
Wolfenson et al., 1988
Avendaño-Reyes et al., 2006
Adin et al., 2009
do Amaral et al., 2009
do Amaral et al., 2011
Tao et al., 2011
Thomson et al., 2012
Tao et al., 2012b
Heat stress in utero has the following effects on the calf (Dahl)

- Decreased birth weight
- Greater incidence of Failure of Passive Transfer
- Poorer immune function
- Poorer feed efficiency
- Decreased milk production (~ 11 lbs/d) during first lactation
Top ten things to do for healthy and productive transition cows

- Manage macromineral nutrition/DCAD of dry cows, especially in the last 2 to 3 weeks before calving to prevent clinical and subclinical hypocalcemia
- Control energy intake in both far-off and close-up cows – not too little, not too much
- Make sure supplying enough metabolizable protein before calving
- Get the feeding management right, every day
- Clean and comfortable housing and fresh water
- Manage social interactions/hierarchy
- Manage heat stress
- High quality forage and fermentable diets for fresh cows
# BMR corn silage during the transition period

<table>
<thead>
<tr>
<th>3 wk Prefresh</th>
<th>&gt; 3 wks post-fresh</th>
<th>Wks 3.5 – 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional corn silage hybrids</td>
<td>Conventional corn silage hybrids</td>
<td>Conv. CS</td>
</tr>
<tr>
<td>BMR corn silage</td>
<td>BMR corn silage</td>
<td></td>
</tr>
</tbody>
</table>

Diet formulation goal: Keep all parameters the same with the exception of NDF digestibility.

Diets formulated with CPM Dairy

Stone et al., 2012. J. Dairy Sci. 95 :6665–6676
Days before or after calving
DMI of cows fed BMR or conventional corn silage during the transition period (Stone et al., 2012)

![Graph showing DMI over days before and after calving]

- **DMI d -14 to -1**: 14.3 vs. 13.2, \( P < 0.03 \)
- **DMI d 0 – 21**: 20.2 vs. 18.2, \( P < 0.001 \)

Stone et al., 2012. J. Dairy Sci. 95 :6665–6676
3.5% FCM of cows fed BMR or Control corn silage during the transition period

Stone et al., 2012. J. Dairy Sci. 95:6665–6676
• Holstein cows (n=85) entering second or greater lactation
• Four treatments (2 x 2 factorial arrangement)
  – Conventional vs. BMR corn silage-based diets beginning 21 d before expected calving through 42 d postpartum
  – 0 vs. monensin at 330 mg/d prepartum and 450 mg/d postpartum

Table 1. Main effect means for prepartum and postpartum intake and milk yield for cows fed conventional (CON) vs. brown midrib (BMR) during the transition period and 0 (NO) vs. 330 mg/d of monensin prepartum and 450 mg/d of monensin postpartum (MON). From LaCount et al., 2017.

<table>
<thead>
<tr>
<th>Item</th>
<th>Corn Silage</th>
<th>Monensin</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CON</td>
<td>BMR</td>
<td>SEM</td>
</tr>
<tr>
<td>Prepartum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intake, kg/d</td>
<td>14.0</td>
<td>14.7</td>
<td>0.21</td>
</tr>
<tr>
<td>Postpartum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intake, kg/d</td>
<td>23.0</td>
<td>23.3</td>
<td>0.39</td>
</tr>
<tr>
<td>Yield, kg/d</td>
<td>45.8</td>
<td>48.3</td>
<td>0.86</td>
</tr>
</tbody>
</table>

¹Interaction of Corn silage × Monensin × Time, no other interactions for these variables were significant.
Table 2. Prepartum and postpartum NEFA and BHBA presented as geometric means with back transformed 95% confidence limits for cows fed conventional (CON) vs. brown midrib (BMR) during the transition period and 0 (NO) vs. 330 mg/d of monensin prepartum and 450 mg/d of monensin postpartum (MON). From LaCount et al., 2017.

<table>
<thead>
<tr>
<th>Item</th>
<th>Corn</th>
<th>BMR</th>
<th>NO</th>
<th>MON</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CON</td>
<td>BMR</td>
<td>NO</td>
<td>MON</td>
<td></td>
</tr>
<tr>
<td>Prepartum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NEFA, μEq/L</td>
<td>110.6</td>
<td>94.8</td>
<td>99.3</td>
<td>105.6</td>
<td>0.02 0.35 0.05</td>
</tr>
<tr>
<td>BHBA, mmol/L</td>
<td>0.72</td>
<td>0.70</td>
<td>0.75</td>
<td>0.68</td>
<td>0.62 0.04 0.53</td>
</tr>
<tr>
<td>Postpartum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NEFA, μEq/L</td>
<td>458.9</td>
<td>369.1</td>
<td>440.0</td>
<td>385.0</td>
<td>&lt;0.01 0.06 0.48</td>
</tr>
<tr>
<td>BHBA, mmol/L</td>
<td>1.22</td>
<td>1.00</td>
<td>1.21</td>
<td>1.00</td>
<td>&lt;0.01 0.01 &lt;0.01</td>
</tr>
</tbody>
</table>

1Interaction of Corn x time, no other interactions for these variables were significant.

Top ten things to do for healthy and productive transition cows

• Manage macromineral nutrition/DCAD of dry cows, especially in the last 2 to 3 weeks before calving to prevent clinical and subclinical hypocalcemia
• Control energy intake in both far-off and close-up cows – not too little, not too much
• Make sure supplying enough metabolizable protein before calving
• Get the feeding management right, every day
• Clean and comfortable housing and fresh water
• Manage social interactions/hierarchy
• Manage heat stress
• High quality forage and fermentable diets for fresh cows
• Strategically use feed additives/specific nutrients
Strategically use feed additives/specific nutrients

• Research supports additional inclusion of certain nutrients and feed additives in rations for transition cows (close-up and fresh)

• Nutrients
  – Choline (rumen-protected) – helps the liver export fat and improves performance
  – Amino acids (protected and analog forms) – improved performance and immunity
  – Chromium-propionate – energy metabolism, immune function, cytological endometritis, DMI and performance
  – “Improved” trace mineral sources – hydroxy forms and organics
    • Decreased oxidative stress, improved milk yield, improved immune function

• Additives
  – Monensin – improves propionate production, energy metabolism/hyperketonemia, production, postpartum DMI (400 mg/d prepartment; 450 mg/d postpartum in our research)
  – Yeast culture/yeast products – improves rumen function/transition/DMI/performance
Top ten things to do for healthy and productive transition cows

- Manage macromineral nutrition/DCAD of dry cows, especially in the last 2 to 3 weeks before calving to prevent clinical and subclinical hypocalcemia
- Control energy intake in both far-off and close-up cows – not too little, not too much
- Make sure supplying enough metabolizable protein before calving
- Get the feeding management right, every day
- Clean and comfortable housing and fresh water
- Manage social interactions/hierarchy
- Manage heat stress
- High quality forage and fermentable diets for fresh cows
- Strategically use feed additives/specific nutrients
- Implement cow- and herd-level monitoring programs
Types of monitoring

• Cow-level
  – Seeking to make a diagnosis/treatment decision on an individual animal

• Herd-level
  – Periodic (e.g., weekly) evaluation of a representative sample of cows in a sampling window of interest
  – Using as a barometer of the herd
Potential herd level monitors for transition cow performance and health opportunities

- Most of dairy industry works on averages
- Challenges related to nutrition/non-nutritional factors cause increases in *variation* in DMI/performance/metabolism
  - Almost impossible to detect some of these on farms
- Potential tools for use in monitoring variation in transition cow management and subclinical opportunities
  - BHBA (“gold standard” blood ketone)
  - NEFA (best marker for negative energy balance)
  - Calcium (moving closer to cowside testing)
  - Haptoglobin (acute-phase response/systemic inflammation)
  - Rumination monitors? – other electronic monitoring?
  - Variation in early lactation milk yield / Transition Cow Index (TCI)
  - Urine pH – only if feeding anionic supplements, but can be great monitor of feeding management
Histogram of prevalence of subclinical ketosis (SCK) in 1,717 Holstein dairy cows undergoing repeated testing for ketosis from 3 to 16 DIM. A positive test was defined as a blood BHBA concentration of 1.2 to 2.9 mmol/L

McArt et al., 2012. J. Dairy Sci. 95:5056–5066
Prevalence of hyperketonemia between 3 and 14 DIM on 71 commercial dairy farms

Lawton et al., 2015 JAM
Approach for monitoring energy-related blood analytes in transition cows

• Sample size
  – ~ 15 to 20 cows

• Cows to sample
  – Pre-partum: 14 to 2 days before calving (NEFA)
  – Post-partum: 3 to 14 DIM (BHBA and/or NEFA)

• Sample to take
  – Serum (red top) or plasma (green top)
  – Don’t shake, keep cool

• What to do with sample?
  – BHB: Precision Extra Meter or other cowside meter for blood
  – NEFA: Lab

• What to do with results
  – Interpret % above cut-point
  – More than 15% above cut-point indicates herd-level problem
**Herd-level impacts of elevated NEFA/BHB**

<table>
<thead>
<tr>
<th>Metabolite level</th>
<th>Herd Alarm</th>
<th>Associated with:</th>
</tr>
</thead>
</table>
| **PRE-Partum**   | 15%        | +3.6% Disease incidence  
| NEFA $\geq 0.3$ mEq/L |            | -1.2% Pregnancy rate  
|                  |            | - 240 kg ME305 milk (both heifers and cows) |
| **POST-Partum**  | 15%        | +1.7% Disease incidenceb  
| NEFA $\geq 0.6^a - 0.7^b$ mEq/L |            | - 0.9% Pregnancy ratea  
|                  |            | Heifers: -291 kg, Cows: - 577 kg |
| **POST-Partum**  | 15%        | +1.8% Disease incidenceb  
| BHB $\geq 1.0^a - 1.2^b^*$ mmol/L | *20%       | -0.8% Pregnancy rateb  
|                  |            | Heifers: -535 kg*, Cows: - 332 kga |

*15% of 15 = 2-3 animals

Ospina et al., 2010
Thanks!!

tro2@cornell.edu