Energy and Protein Nutrition for Transition Cows

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Energy and Protein Nutrition for Transition Cows

• Close-up transition cow
  – Energy
  – Protein

• Postfresh transition cow
  – Energy
  – Protein

• Conclusions
Close-up Energy

- Robert Boutflour at the World Dairy Congress (1928) first proposed the “steam up” ration as a way to circumvent “the neglect of the preparation of the cows for her lactation period”. The term was meant to be an analogy to the preparation of a steam thresher.
# Pre-fresh NFC??

<table>
<thead>
<tr>
<th>Trial</th>
<th>NFC, % DM</th>
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<tbody>
<tr>
<td>Minor et al., 1998</td>
<td>35</td>
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<td>Mashek and Beede, 2000</td>
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<td>Keady et al., 2001</td>
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<td>Holcomb et al., 2001</td>
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<td>30</td>
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<td>Doepel et al., 2001</td>
<td>24</td>
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<td></td>
<td>30</td>
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<td>Rabelo et al., 2003, 05</td>
<td>38</td>
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<td></td>
<td>45</td>
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<tr>
<td>Smith et al., 2005</td>
<td>34</td>
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<td>Kamiya et al., 2006</td>
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<td>Guo et al., 2007</td>
<td>26</td>
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<td></td>
<td>39</td>
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<td>Roche et al., 2010</td>
<td>13</td>
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<td></td>
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Adapt Microflora

Grow Papillae

More Energy

DMI

Energy Density

Decrease Fat

Mobilization
Summary of Results

- 6/8 Studies showed a significant increase in prepartum DMI.
- 0/7 Studies showed any significant effect on postpartum DMI.
- 0/9 Studies showed any significant effect on milk yield.
- 1/5 Studies showed a significant reduction in liver fat.
Transition Cow Index
(Nordlund and Co-workers)

• The Transition Cow Index uses fourteen factors from the historical DHIA record of each individual cow to project her milk yield

• Deviations from her expected milk yield are calculated and used at the herd level to evaluate the overall effectiveness of transition cow management programs
Close-up Ration NDF%

Herd Average TCI

NDF, % DM

y = -3.605x - 611.8

R² = 6E-05

Courtesy of Ken Nordlund
Why After 100 Years, We No longer Need to “Steam-up” Cows??

• TMR (elimination of slug feeding grain)
• Low feed intakes near the time of calving
• Gradual increases in concentrate consumption postpartum as DMI increases

• Exceptions??:
  – High straw diets, slug feeding grain
  – Situations in which energy requirements are not met (low feed intakes):
    • Poor facilities, heat stress, etc.
Close-up Protein

• Lots of different opinions
• Reasons:
  – Poor understanding of requirements, especially prepartum
  – Lack of high quality research, especially postpartum
  – $$$
Transition Cow: 2001 NRC

• Requirements accounted for
  – Maintenance, growth (heifer), Pregnancy

• Did not account for
  – Mammary growth
  – VandeHaar:
    • 130 g/d
    • 1-2 percentage units

• Calculated % CP needed in diets
  – \((\text{Metabolizable protein req}/0.7)/\text{Estimated DMI}\)
% CP Needed in Prefresh Diets

<table>
<thead>
<tr>
<th></th>
<th>%CP w/o Mammary</th>
<th>% CP w/ Mammary</th>
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</thead>
<tbody>
<tr>
<td>Heifer</td>
<td>13.2</td>
<td>14.6</td>
</tr>
<tr>
<td>Cow</td>
<td>8.9</td>
<td>9.9</td>
</tr>
<tr>
<td>Heifer</td>
<td>16.3</td>
<td>18.1</td>
</tr>
<tr>
<td>Cow</td>
<td>10.6</td>
<td>12</td>
</tr>
</tbody>
</table>

Day -21  | Day -7  | Day -1  |
N-Balance in Prepartum MP Cows Fed Diets with Different % CP

Putnam et al., 1998
Bell et al., 2000

• Response to increasing prepartum CP unremarkable, but most likely when:
  – Basal prepartum diet is below 12% CP
  – Postpartum diet is below 16% CP
Large Trial on CA Commercial Herd (Robinson et al., 2001; n=280)

• Treatments
  – 11.7 % CP vs 14.4 % CP
  – Extra protein from high RUP feeds

• Responses
  – Heifers
    • Increase milk yield, P < .01
    • Decrease in milk fat percentage, P = .06
  – Mature cows
    • No response
Diet Formulation Strategies
Prepartum??

• How do you deal with the differing needs of heifers vs. cows, particularly if they are intermingled
• Do you formulate for the average need for the three week period?
• Do you formulate to make sure there is sufficient protein for the period of greatest demand (last few days before calving)??
Prepartum Protein Feeding

• Diets should never go below 12% CP!
  – Needed to maximize fiber digestion
  – Needed to maximize microbial protein synthesis

• Requirements (including mammary growth)
  – Heifers: 1000 g metabolizable protein (1400 g CP)
  – Cows: 860 g metabolizable protein (1230 g CP)
  – Heifers: 14% CP, include some protein source with high RUP
  – Cow: 12% crude protein

• Some recommend higher levels (g/d) of MP/CP
  – Safety net, not data to support
  – High straw diets may mandate higher % CP/RUP
  – Negative effects on postpartum DMI??
Postfresh Energy

• The most important period that nobody wants to study??
  – Cow variation is high!
    • Increases number of cows needed for sufficient statistical power
    • University herds not large enough
  – Likelihood of loosing cows from experiment is greater immediately postfresh.
Energy Balance for Transition Cows

The graph shows the energy intake (E intake), energy requirements (E req), and energy balance (E bal) over days relative to calving. The graph indicates the net energy of lactation (Mcal/d) and highlights the transition phases before and after calving.
When Do Lactating Dairy Cows Reach Positive Energy Balance?

Grummer and Rastani, 2003: Literature Survey - 20 studies, 52 treatments

Mean = 45 d
Range = 7 to 105 d
SD = 21 d

When Do Lactating Dairy Cows Reach Energy Balance Nadir?

Beam and Butler, 1998: 10 d
Canfield and Butler, 1990: 12 d
Senatore et al., 1996: 18 d
Lots of Questions!!

• Do you put cows right onto high group diet?
• Should you feed straw/low quality forage right after calving?
• Hepatic oxidation theory (HOT)?
  – The bad guys:
    • NEFA oxidation generates satiety signals
    • Propionate enhances oxidation and generation of satiety signals
  – The solution according to Allen:
    • Block fatty acid mobilization
    • Decrease rate of propionate production in rumen
University of Wisconsin Study
Rabelo et al., 2003 & 2005

- Objective: To examine the influence of pre- and postfresh dietary energy density on health and production of periparturient dairy cows
**L**: “low” energy diet

**H**: “high” energy diet

<table>
<thead>
<tr>
<th>Diet</th>
<th>Energy (Mcal NE/lb)</th>
<th>NDF (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DH</td>
<td>1.65</td>
<td>32</td>
</tr>
<tr>
<td>L</td>
<td>1.67</td>
<td>30</td>
</tr>
<tr>
<td>DL</td>
<td>1.55</td>
<td>40</td>
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</tbody>
</table>

-28 d

0 d

+21 d

+70 d
## Postpartum Diets Ingredients (% of DM)

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Low Energy</th>
<th>High Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa Silage</td>
<td>29.7</td>
<td>19.9</td>
</tr>
<tr>
<td>Corn Silage</td>
<td>29.7</td>
<td>19.9</td>
</tr>
<tr>
<td>Ground Corn</td>
<td>19.6</td>
<td>36.0</td>
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<tr>
<td>Soybean Meal</td>
<td>7.9</td>
<td>13.0</td>
</tr>
<tr>
<td>Blood Meal</td>
<td>.6</td>
<td>.6</td>
</tr>
<tr>
<td>Brewer’s Grain, dehy</td>
<td>7.8</td>
<td>7.8</td>
</tr>
<tr>
<td>Corn Gluten Meal</td>
<td>2.1</td>
<td>---</td>
</tr>
<tr>
<td>V&amp;M</td>
<td>1.9</td>
<td>2.2</td>
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</table>
Treatment x Time, $P < 0.001$
# Postpartum Plasma, 1-35 DIM

<table>
<thead>
<tr>
<th>Postpartum Diet</th>
<th>Low Energy</th>
<th>High Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Glucose, mg/dL</strong></td>
<td>45.9</td>
<td>49.2*</td>
</tr>
<tr>
<td><strong>BHBA, mg/dL</strong></td>
<td>6.3</td>
<td>4.1*</td>
</tr>
<tr>
<td><strong>NEFA uEq/L</strong></td>
<td>310</td>
<td>296</td>
</tr>
</tbody>
</table>

P < 0.001
Liver Triglyceride

Postpartum treatment x time $P = 0.08$ *

Day relative to calving

Rabelo et al., 2005
Fermentability of Corn?
Rockwell and Allen, 2011

- **Design:**
  - Dry Corn vs HMC
  - 0 to 28 DIM
  - Common diet from d28 to 84
  - n= 24 per treatment

- **Results**
  - No differences in DMI for first 28 days postpartum

![Milk Yield, kg/d chart]

- **Milk Yield, kg/d**
  - Day 42: DC 48.0, HMC 57.0
  - Day 84: DC 48.3, HMC 49.3
  - Trt x day interaction \( P < 0.001 \)
Postfresh Energy Summary

- High NDF/
  Low Energy
- Low NDF/
  High Energy

- Fatty Liver/Ketosis
- Acidosis
- Fewer DA
- More milk
2010 High Group TMR Survey of WI Top Herds, Shaver et al.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
</tr>
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<tbody>
<tr>
<td>TDN1x, % DM</td>
<td>75-77</td>
</tr>
<tr>
<td>NDF, %</td>
<td>25-31</td>
</tr>
<tr>
<td>Forage NDF, % DM</td>
<td>20-24</td>
</tr>
<tr>
<td>Fat, % DM</td>
<td>4-6</td>
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</tbody>
</table>
Postfresh Transition Cow Protein

• VERY LITTLE RESEARCH
• Similar to energy
  – Need for AA/MP/CP is high due to lactation
  – DMI intake is low
• Different than energy
  – Limits to amount of corn and fat that can be fed
  – No real limits to “protein or AA density” of diets
Potential Deficiency in MP? (NRC 2001)

Predicted Deficiency in Metabolizable Protein, g/day

- 60 lb cow
- 100 lb cow

3.2% True Protein

Day 7
- 17% Crude Protein Diet
- Predicted Deficiency: 400 g/day

Day 21
- 17% Crude Protein Diet
- Predicted Deficiency: 200 g/day

Day 7
- 15.7% Crude Protein Diet
- Predicted Deficiency: 800 g/day

Day 21
- 15.7% Crude Protein Diet
- Predicted Deficiency: 400 g/day
So What Gives: The Cow with a 300 to 800 g MP/d deficit??

• Mobilize protein reserves??
  – NRC gives a MP reserve number based on body weight loss to support energy needs
  – NRC: Potentially ~ 180 g MP
    • Assuming it is not used for energy!!??

• Cow eats more dry matter??

• Cow makes less milk??
The Cow with a 300 to 800 g MP/d deficit?? Diet Strategies?

• Assume the cow eats at “predicted” DMI:
  — Rebalance the diet for higher CP using sources high in RUP? (~21% CP)
  — Rebalance the diet for less CP and supplement with limiting ruminally protected AA?

• Assume the cow eats more than predicted DMI
  — After all there are cows that produce 100 lb/d of milk at 10 d postpartum fed “conventional” diets
Diet Scenario Examples

– Ration parameters used:
  • Cows: 3rd lactation, 1550 lb mean BW with 1,600 mature BW, 10 DIM, producing 100 lb milk with 3.8% fat, 3.1% true protein, 3.5 BCS.
  • Used AMTS model to create 4 scenarios (2x2)
    – Protein
      » “High” (18.3% CP)
      » “Low” (17.7% CP) with AA
    – Dry matter intake
      » Model prediction plus 10%: 45 lb DMI
      » Sufficient DMI to meet MP requirement
        56 lb (18.3% CP)
        58.5 lb (17.7% CP)
Postpartum Transition Cow Protein Feeding

• Due to cost of protein supplements and environmental concerns, pressure to scale back % CP in diet.
• Postfresh: Need to be careful when considering a reduction of CP/MP.
• 21 day postfresh pen allows brief period of high CP.
• Incorporate supplements with high RUP.
• Consider feeding rumen protected AA to reduce CP/RUP/MP and create space for energy.
Transition Cows - Where Should We Focus??

Prefresh

Postfresh

‡

Prefresh

Postfresh
Questions???
HOT

Adipose

TAG

FA + glycerol

Liver

NEFA

Acetyl-CoA

CO₂

ATP

Ketones

TAG

VLDL

Propionate from rumen

Brain

Depressed Feed Intake

“HOT”