Creating the Perfect Dining Experience:
Integrating Cow Behavior, Housing, and Feeding Management

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Chazy, NY
Miner Institute Dairy Herd
✓ 350 Holstein cows
✓ 3x, rbST
✓ 30,000 lb RHA, 4.2% fat, 3.2% protein
Creating the perfect dining experience ...

- Well-formulated, palatable ration
- Feed available when cow wants to eat
- Adequate bunk space
- Feed barrier design
- Competition doesn’t limit feed access
- Water availability
- No restrictions on resting activity
- Flooring
- Air quality . . .
Physical Environment

Social Environment

Feeding Environment

- Resting
- Ruminating
- Feeding
  - Meals
  - Meal length
  - Eating rate

Feed Intake, Productivity and Health
Management Environment: “The Big Picture”
Importance of management environment (Bach et al., 2008)

- 47 herds with similar genetics were fed the same TMR
- Mean milk yield = 65 lb/d
  - Range: 45 to 74 lb/d
- Non-dietary factors accounted for 56% of variation in milk yield
  - Feeding for refusals (64.1 vs 60.6 lb/d)
  - Feed push-ups (63.7 vs 55.0 lb/d)
  - Stalls per cow
Importance of management environment (Bach et al., 2008)

- 47 herds with similar genetics were fed the same TMR
- Mean milk yield = 65 lb/d
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**FEED AVAILABILITY**

- Stalls per cow
Will this “dining experience” affect diet accessibility?
Not even close to perfect: Non-uniformity of feed delivery

- Cows have preferred portions of the pen & bunk
- “Grazing” behavior increases competitive interactions
- 51% more switches in feeding location
- 3.5x more competitive interactions

(Huzzey et al., 2013)
Cows naturally have aggressive feeding drive ...

- Cows willingly exert >500-lb pressure against feed barrier while eating
  - 225 lb causes tissue damage

- Defines “aggressive feeding drive”
  (Hansen and Pallesen, 1999)
Natural head movement while eating (Reyes and Aguilar, 2012)

- Feed manger design and feed push-up should accommodate natural cow head movement while feeding.
Resting influences feeding behavior

- **Lying time has priority over eating**
- **Cows will sacrifice eating time to compensate for lost resting time**
- **With chronic rest deprivation**
  - For every 3.5 min of lost rest, cows sacrifice 1 min of eating

(Metz, 1985; Hopster et al., 2002; Munsgaard et al., 2005; Cooper et al., 2007)
What Naturally Stimulates Feeding Behavior?

- Delivery of fresh feed
- Feed push-up
  - More important during the day rather than at night (DeVries et al., 2005)
- Milking

Biggest driver of feeding is delivery of fresh feed
1x versus 2x TMR feeding
(Sova et al., 2013)

- Twice versus once daily feeding:
  - More feed availability throughout day
  - Less sorting against long particles
  - Increased DMI by 3.1 lb/d, milk by 4.4 lb/d

- **Overall improvement in efficiency**

- Greater feeding frequency:
  - Improved rumen fermentation
  - Greater rumination
  - Greater eating time
Feeding frequency greater than 2x/day?

<table>
<thead>
<tr>
<th>Reference</th>
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<th>Eating time %</th>
<th>DMI %</th>
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<td>NR</td>
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<td>-4.8</td>
<td>-1.0</td>
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<td>-6.3</td>
<td>-4.7</td>
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Increased TMR feeding frequency improves efficiency: Is it desirable long-term if it reduces resting time?
Feed push-up (Armstrong et al., 2008)

- 1 to 2 hours post-feeding is most competitive; most displacements
- Push-up each ½ hour for first 2 hours versus once per hour
  - Fed 3x/day

<table>
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<tr>
<th>Item</th>
<th>1x/h</th>
<th>2x/h</th>
</tr>
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<tr>
<td>DMI, lb/d</td>
<td>41.4</td>
<td>40.1</td>
</tr>
<tr>
<td>Milk, lb/d</td>
<td>61.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>65.3&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Milk/DMI, lb/lb</td>
<td>1.48&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.63&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Lying in stall, % of cows</td>
<td>45.3</td>
<td>43.8</td>
</tr>
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No fun being the cow in the middle ...

- As stocking density increases:
  - Greater aggression and displacements
  - Time of eating shifted
  - Fewer meals
  - Eating rate increased
  - Greater potential for sorting
  - Largest effect on subordinate cows

- Within limits, cows can adjust feeding behavior in response to variable SR
Stocking density and DMI by parity in mixed groups

Interaction between parity and stocking density

y = -64.2x^2 + 68.8x + 6.7  
R^2 = 0.82

y = -90.9x^2 + 109.0x - 8.6  
R^2 = 0.85

(Grant, 2010)
Primi- versus multiparous cows and stocking density (Hill et al., 2008)

<table>
<thead>
<tr>
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<th>113%</th>
<th>131%</th>
<th>142%</th>
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<tr>
<td>Multi - primi</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk, lb/d</td>
<td>+5.9</td>
<td>+13.8</td>
<td>+21.1</td>
<td>+14.9</td>
</tr>
</tbody>
</table>

- Milk losses reflect reductions in resting and rumination activity
Feeding environment and milk composition

- Higher *de novo* milk fatty acid synthesis
  - 17.5 vs 14.7 in/cow bunk space
  - 1.05 vs 1.20 stalls/cow
  - 65% of variation explained by bunk space
    (De novo, relative % = 20.12 + 0.09 x bunk space, cm; \( P < 0.002 \))

- Milk fat % reduced with overcrowding

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<tr>
<td>Milk fat %</td>
<td>3.84</td>
<td>3.77</td>
<td>3.77</td>
<td>3.67</td>
</tr>
</tbody>
</table>

Overstocked cows ate faster (+25%), ruminated less (1 h/d less)
Are 24 in/cow enough?

- Cows cannot access feed all together
- Distribution of DMI changed – pushed to later hours of day
  - 3- versus 2-row pens
  - Is TMR same quality?
- 24 vs 30 vs 36 in/cow
  - 10, 6, 3 displacements per cow/d
  - Greater feeding time
Feed bunk space affects where cows choose to eat (Rioja-Lang et al., 2012)

- Compared 30, 24, 18, and 12 in of bunk space and preference for:
  - low-palatability feed alone
  - high-palatability feed next to a dominant cow
  - Y-maze testing to offer choices

<table>
<thead>
<tr>
<th>Space (in)</th>
<th>HPF Dominant</th>
<th>Equal choice</th>
<th>LPF Alone</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>0</td>
<td>1</td>
<td>11</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>18</td>
<td>1</td>
<td>3</td>
<td>8</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>24</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>30</td>
<td>5</td>
<td>2</td>
<td>5</td>
<td>&gt;0.05</td>
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What is optimal stocking density?

Close-up and fresh cows:
- ≤80% of bunk space (30 in/cow)
- Also a function of stall availability

Lactating cows:
- 4-row barn: don’t exceed 115-120% of stalls
- mixed heifer & older cows: 100%
- 6-row barn: 100% of stalls?

Ensure access to feed, water, stalls
Two percent feed refusals: What it looks like...
Feed refusal amount: intake, milk, efficiency

<table>
<thead>
<tr>
<th>Study Details</th>
<th>DMI</th>
<th>MY</th>
<th>FCM</th>
<th>FE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5 vs 5.0</td>
<td>56.9 lb/d</td>
<td>92.6 lb/d</td>
<td>1.63</td>
<td></td>
</tr>
<tr>
<td>11.6 vs 16.1</td>
<td>47.5 lb/d</td>
<td>91.5 lb/d</td>
<td>1.93</td>
<td></td>
</tr>
<tr>
<td>11.5 vs 18.0</td>
<td>58.5 vs 65.3</td>
<td>87.6 lb/d</td>
<td>1.50 vs 1.34</td>
<td></td>
</tr>
<tr>
<td>2.9, 6.3, 9.4, 12.7</td>
<td>60.1 kg/d</td>
<td>96.6 lb/d</td>
<td>1.60</td>
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Refusal amount and sorting ...

**Individually fed cows:**
Sorting occurs over day, but by 24 h cows consume ration similar to that offered  (Maulfair and Heinrichs, 2013)

**Competitive feeding situation:**
- Each 2%-unit increase in refusals associated with 1.3% increase in sorting (Sova et al., 2013)
- Milk/DMI decreases 3% for each 1% increase in sorting
IOFC and refusals?
(T. Oelberg, person. comm., 2013)

- Ideal management
- Restricted intake due to poor feeding management

% Refusals
How long can the feed bunk be empty?

- Cow’s motivation to eat increases markedly after 3 hours (Schutz et al., 2006)
  - 0, 3, 6, 9 h/d feed restriction
  - Linear increase in motivation to eat

- Restricted feed access time by 10 h/d (8 pm to 6 am) reduced DMI by 3.5 lb/d (Collings et al., 2011)
  - 2x displacements at feeding
Effect of empty-bunk time
(Matzke and Grant, 2003)

Compared 0 vs 6 h/d functionally empty bunk (midnight to 6:00 am)

- +7.9 lb/d milk yield
- 1.8x greater lying in stalls
- 2x greater feeding at bunk
- Less restless
Restricted feed access and overcrowding (Collings et al., 2011)

- **Restricted Feed** (10 h/d) × **Overcrowding** (1:1 or 2:1 cows:bin)
  - ~3x displacements when restricted cows were overstocked
  - during 2 h after morning feeding and after afternoon milking
- 25% increase in feeding rate in first 2 h after feed delivery
Cows prefer the same entrée?

- Cows perform better when fed consistent ration in consistent environment – cows don’t particularly like change!
- Consistent feed, feeding environment, and feeding behavior ought to promote more efficient rumen fermentation throughout the day and more uniform delivery of nutrients to the cow.
- Dietary variability actually stimulates feed intake in sheep. Variability in ingredients with controlled TMR nutrient specs?

(ADSA Conference, 2014)
The Perfect Dining Experience?
Recommended Feeding Management

- Adequate access to stalls
- Feed available on demand
- Consistent feed quality/quantity along the bunk
- Bunk stocking density ≤100% (24 in/cow)
- TMR fed 2x/day
- ½-hr push-ups for 2 hours post-feeding?
- 3% refusal target
- Bunk empty <3 h/d
Thank you ...