Cow Comfort Economics

- Focus on the *consistent economic benefits* of improved cow comfort.

- *Modest investments* in housing, or changes in cow management routines, can pay *large dividends* in greater cow health and performance.
How much does it cost …

- To keep “time outside pen” less than 3.5 h/d?
- To ensure feed availability 24/7?
- To lock cows in headlocks less than 1 h/d?
- To reduce overcrowding?
- Ensure access to comfortable resting area?
- To group first-calf heifers separately from older cows?

Factors Most Highly Associated with Welfare and Productivity (Popescu et al., 2013)

- Comfortable, clean stalls
- Adequate feed and water
- Access to exercise
- Relationship with stockperson
Cows need time to be cows: Practice natural behaviors

- Eating
- Resting
- Ruminating
- Drinking
- Socializing

A well rested cow eats and ruminates more...

- Lying time has priority over eating
- Cows sacrifice eating time to compensate for lost resting time (Metz, 1985; Hopster et al., 2002; Munsgaard et al., 2005; Cooper et al., 2007)

- Cows prefer to ruminate while lying down (Cooper et al., 2007).
  - 90+% of rumination should occur while lying down

Management that impairs lying time also reduces rumination and feeding!
Management Environment: “The Big Picture”

Importance of management environment (Bach et al., 2008)

- 47 herds with similar genetics were fed 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
Overcrowding

Relationship between stocking density and profit (De Vries et al., 2016)

Average optimal SD = 120% over all scenarios

Maximum profit/stall is ≥100% in 67% of scenarios.
Stocking density and lying time
(Miller, 2020)

9-study data set

Relationship between stocking density and performance

- **1-2 lb/d less milk** per 10% greater stocking density between 100-150% (Fregonesi et al., 2007; Grant, 2007; Bach et al., 2008)

- **0.1%-unit decrease in conception rate** per 1%-unit greater stocking density (Schefers et al., 2010)

- **% cows pregnant by 150 DIM decreased** from 70 to 35% as bunk space decreased from 24 to 12 in/cow (60 to 30 cm) (Caraviello et al., 2006)
Herds with highest F + P and rumen health have lower stocking density

(Odds Ratio: $P = 0.06$ for Bunkspace $\geq 18$ in/cow; $P = 0.08$ for Stall stocking density $\leq 110\%$)

<table>
<thead>
<tr>
<th>Bunkspace $\geq 18$ in/cow</th>
<th>Stall stocking density $\leq 110%$</th>
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</thead>
<tbody>
<tr>
<td><strong>Mean</strong> HDN LDN</td>
<td><strong>Mean</strong> HDN LDN</td>
</tr>
<tr>
<td>19.7 in 15.7 in</td>
<td>111% 116%</td>
</tr>
</tbody>
</table>

(Herds with highest F + P and rumen health have lower stocking density)

(Woolpert et al., 2016; 2017)

Overcrowding consequences

- Greater aggression
- Greater feeding rate
- Reduced resting time
- Increased idle standing
- Altered rumination

May result in these responses

- Low rumen pH
- Elevated cortisol
- Immune response
- Less milk
- Lower milk fat
- Greater SCC
- More health disorders
- Increased lameness
- Fewer cows pregnant

(Grant, 2017)
Sub-clinical stress of overstocking
(Moberg, 2000; slide courtesy of M. Campbell)

- Sub-clinical stress of overcrowding ...
- Secondary stressors abound on dairy farms
  - Poor feeding management
  - Disease
  - Heat stress
  - Inadequate ventilation
  - Mixed parity groups
  - Poor hygiene
  - The list goes on...
Effect of stocking density on lying time appears to be a key...

- If stocking density does not affect lying time, performance less likely to be affected (ex., Wang et al., 2016).

- Cows can adjust feeding behavior – up to a point...they cannot adjust lying behavior.
Ensuring rumen health (i.e., pH) boosts milk component synthesis from carbohydrate fermentation...

What are the rumen pH conditions for these cows?

(Campbell and Grant, 2017)
Perfect recipe for low rumen pH...

- Highly fermentable diet
- Overcrowding feed bunk and stalls
  - Slug feeding
  - Impairs rumination in stalls
    - Recumbent rumination related to less SARA
- Empty bunk

Low rumen pH: Management versus diet

Bottom line: Feeding environment affects rumen pH as much as (more than) diet itself.
For cows, time is money ...

Typical time budget of dairy cow (free-stall environment)

- 5.0 h/d eating
- 12-14 h/d lying (resting)
- 2.0-3.0 h/d standing, walking, grooming, agonistic, idling
- 0.5 h/d drinking
- 20.5 to 21.5 h/d total needed
- 2.5 to 3.5 h “milking” = 24 h/d

(Grant, 2004)
Do time budgets really matter?

- **3 vs 6 h/d outside pen**
  - Adjusted pen size versus parlor capacity
  - Mixed primi- and multiparous cows
  - 100% stocking density
  - 14-d periods

➤ Economics of 5 to 8 lb/d more milk?

(Matzke, 2003)

What causes lameness in high producing cows? (Espejo and Endres, 2007)

- 53 high-production pens on 50 dairy farms
- Higher lameness prevalence most highly associated with:
  - Greater time outside the pen
  - **Time budgeting!**
Importance of lying time

- Dairy cows are highly motivated to lie down for up to 12+ h/d
  - Inelastic requirement
- Lower blood cortisol
- More recumbent rumination
- Less lameness
- Greater longevity
- Potential milk increase

Relationship between resting and milk yield
(9-study dataset; Miller, 2020)

\[ y = 0.04056x + 11.2444 \]
\[ R^2 = 0.56 \]

2.4 lb milk per hour of resting time
Optimizing resting area comfort...

- Modify stall structure to allow more freedom of use
- Improve resting surface comfort – deep beds
- Increase bedding volume and frequency
- More frequent stall bed grooming
- Don’t overcrowd!

Heifers Need Their Space...
Time Budget Behaviors: Primi- versus Multiparous Cows

- Numerous natural behavioral differences.
- Heifers take smaller bites, eat more slowly, spend more time feeding.
- Heifers typically less dominant, more easily displaced from manger, stalls, and water.
- Heifers avoid stalls previously occupied by dominant cows and ruminate less.

Economic cost of competition with older cows . . . no overcrowding

- DMI reduced by 10%
- Resting reduced by 20%
- Milk reduced by 9% (Kongaard and Krohn, 1980)
- Greater loss of BW by 30 DIM
- Reduced FCM/DMI by 30 DIM (Bach et al., 2006)
- Less drinking, rumination, and milk fat % (Bach et al., 2007)
- For primiparous cows, separate pens for 1 month after calving increased milk yield by 506 lb per 305-d lactation and reduced ketosis (Ostergaard et al., 2010)
Primi- versus multiparous cows and stocking density (Hill et al., 2008)

<table>
<thead>
<tr>
<th></th>
<th>100%</th>
<th>113%</th>
<th>131%</th>
<th>142%</th>
</tr>
</thead>
<tbody>
<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
- Economics of 8 to 15 lb/d less milk?

Creating the perfect dining experience...

- Well-formulated, palatable ration
- Feed available 24/7
- Competition doesn’t limit feed access
- Water availability
- No restrictions on resting or ruminating
Food for thought …

- Feed push-up
- Feeding frequency
- Feed refusals
- Bunk space
- Do we need to re-assess industry norms?

No fun being the cow in the middle … Necessary bunk space?

- 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 stocking density.
Table for one? (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>
</tr>
</tbody>
</table>

Are 24 in/cow enough?

- Cows cannot access feed all together
- Distribution of DMI changed – pushed to later hours of day
- 24 vs 30 vs 36 in/cow
  - 10, 6, 3 displacements per cow/d
  - Greater feeding time

- If you ask the cow, the answer is no.
Take home points…

- Don’t EVER forget the basics of cow comfort: feeding, resting, and rumination.
- Don’t underestimate the magnitude of cow response to enhanced comfort and management.
- Overstocked pens – subclinical stressor.
- Management more important than diet in keeping rumen pH healthy.
- Remember the power of recumbent rumination.

Carrying on William Miner’s vision: “Science in the Service of Agriculture.”