Improving Animal Well-Being Through Facilities Management

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Stocking density: Basic concepts

- Overstocking improves economic returns on facility investments (Bewley et al., 2001)
- Overstocking reduces cow’s ability to practice natural behaviors (Wechsler, 2007)
- Facilities and group dynamics influence response to stocking density

**Question:** “What is optimal stocking density to promote “natural” behaviors, health, and productivity?”
Typical time budget for lactating dairy cow

- Basic behavioral needs:
  - 3 to 5 h/d eating
  - 10 to 14 h/d lying (resting)
  - 2 to 3 h/d standing/walking in alley (grooming, agonistic, estrous activity)
  - ~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, 2008
Assessment of within and between herd variation in lying time

Ito et al., 2009
Importance of rest to dairy cows

• Deprivation of lying = \( \uparrow \) cortisol and \( \downarrow \) GH (Munksgaard and Simonsen, 1996)
• Priority over other resources (Munksgaard et al., 2005)
  • Rest \( \uparrow \)
  • Feeding \( \downarrow \)
  • DMI \( \leftrightarrow \)
  • Social behavior\( \downarrow \)
As stall width increases, lying time increases.

Neckrail alters stall use.

Brisket board can reduce lying time and increase lameness.

Tucker et al., 2006, 2009 and Bernardi et al., 2009
### Effect of bedding type on hock lesions

<table>
<thead>
<tr>
<th>Bedding</th>
<th>Cows with lesions, %</th>
<th>Mean hock score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mattress</td>
<td>91.7 (84.9 – 93.5)</td>
<td>1.9</td>
</tr>
<tr>
<td>Sand</td>
<td>23.8 (6.4 – 59.5)</td>
<td>1.3</td>
</tr>
<tr>
<td>Sawdust</td>
<td>69.7 (51.9 – 97.6)</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Greatest percentage of lesions found on the tarsal joint of cows on mattresses

(Weary and Taszkun, 2000)
What is the effect of overcrowding on the productivity of dairy cows?
Biological effects of stocking density

Milk yield = 20.4 + 7.5 x stall/cow

R²=0.32

Bach et al., 2008
Relationship between resting time and milk yield

Resting time (h) | Milk yield (lb/d)
---|---
60 | 7
70 | 10
80 | 13
90 | 17
100 | ~3.7 lb/d more milk for each extra hour
110 | ~3.7 lb/d more milk for each extra hour

y = 49.2 + 3.7x
R² = 0.30

(Grant, 2005)
Impact of stocking density on rumen function and udder health

<table>
<thead>
<tr>
<th></th>
<th>100%</th>
<th>113%</th>
<th>131%</th>
<th>142%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk fat, %</td>
<td>3.84</td>
<td>3.77</td>
<td>3.77</td>
<td>3.67</td>
</tr>
<tr>
<td>SCC, x 1000/ml</td>
<td>135</td>
<td>114</td>
<td>169</td>
<td>236</td>
</tr>
</tbody>
</table>

- Overstocked cows eat faster (25% increase), ruminate less (1 h/d less)

- Overstocked cows experience greater pathogen load in the environment; greater teat end exposure; experience immune suppression?

(Hill et al., 2006)
Clinical mastitis events per 305-day lactation: Preliminary Results

- Not statistically different!
- Similar hygiene score (<2)

(Krawczel et al., 2008)
What is the effect of overcrowding on the lying behavior of dairy cows?
Basic research design
### Overstocking and lying behavior

<table>
<thead>
<tr>
<th>Variable</th>
<th>100%</th>
<th>109%</th>
<th>120%</th>
<th>133%</th>
<th>150%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lying, h</td>
<td>12.9</td>
<td>12.1</td>
<td>12.0</td>
<td>11.5</td>
<td>11.2</td>
</tr>
<tr>
<td>Latency to lie, min</td>
<td>39</td>
<td>34</td>
<td>38</td>
<td>28</td>
<td>26</td>
</tr>
<tr>
<td>Displacements, n/5 h</td>
<td>0.7</td>
<td>0.9</td>
<td>1.6</td>
<td>2.1</td>
<td>1.9</td>
</tr>
</tbody>
</table>

- Overstocking creates illusion of good stall comfort
- May represent increased risk of environmental mastitis

(Fregonesi et al., 2007)
Relative response of stocking density on resting time: Suggests max of 120%

\[ y = -0.0038x + 1.36 \]

\[ R^2 = 0.51 \]

(Winkler et al., 2003; Fregonesi et al., 2007; Wierenga and Hopster, 1990; Matzke and Grant, 2002; Hill et al., 2009; Krawczel, 2008; 2009; 2010)
Resting posture and association with REM sleep (Girard et al., 1993)

- 1.8% of resting time
What is the effect of stall maintenance on the lying behavior of dairy cows?
Recently groomed sand-bedded stall and sawdust-bedded stall in need of cleaning
Effect of maintenance on sand bedding depth

Depth below curb; darker = less bedding
Lying time decreases as depth of sand decreases

Drissler et al., 2005
Amount of bedding affects lying and standing behavior

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Bedding Amount, lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Lying bouts, n/d*</td>
<td>8.5</td>
</tr>
<tr>
<td>Bout duration, h</td>
<td>1.5</td>
</tr>
<tr>
<td>Lying, h/d*</td>
<td>12.3</td>
</tr>
<tr>
<td>Standing, min/d*</td>
<td>106</td>
</tr>
</tbody>
</table>

* Significant linear contrast (Tucker and Weary, 2004)
Effect of bedding quality on lying time

A. Lying in stall

B. Perching in stall

A. Lying in stall

B. Perching in stall

C. Standing in stall

D. Standing in alley

C. Standing in stall

No Choice Phase

Choice Phase

Fregonesi et al., 2007
Effects of stocking density on feeding behavior
Cows have aggressive feeding drive …

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

- Defines “aggressive feeding drive”
Delivery of fresh TMR stimulates feeding behavior

DeVries and von Keyserlingk, 2005
Portion of cows feeding during 3 × milking, and 1 × feeding

Krawczel et al., 2012
Effect of increasing competition at the feed bunk

- Stocking densities of 75, 100, 150, 300%
  - Headlocks and post-and-rail
- As stocking density increased:
  - Feeding time decreased curvilinear
  - Aggression increased curvilinear
  - Inactive standing increased linearly
  - Shift in feeding times
- Greater effect for post-and-rail

(Huzzey et al., 2006)
Stocking density alters behavior but not DMI

Collings et al., 2011
Relationship between stocking density and DMI

Weak short-term relationship between stocking density or manger space and DMI

\[ y = 5.5x + 18.0 \]

\[ R^2 = 0.05 \]
Relationship between stocking density and eating rate

\[ y = -80.9x + 134.5 \]

\[ R^2 = 0.43 \]

- Eating rate increases with increased stocking density, reduced feeding space.
What are the effects parity and stocking density on behavior and productivity?
Territoriality: Stocking density from heifer’s perspective

- Cows displayed **territoriality** in use of free stalls
  - Social rank determines location
  - Stalls nearest the feed alley preferred (Gaworski et al., 2003)

- Subordinate cows avoided free stalls previously occupied by dominant cows

- **Overcrowded conditions** (from subordinate perspective) may exist even at lower stocking densities (Friend and Polan, 1974)
Changes in productivity for heifers vs cows and at increased stocking density

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<tbody>
<tr>
<td>Cows vs heifers</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>
<tr>
<td>Sound vs lame</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk, lb/d</td>
<td>-9.4</td>
<td>+1.9</td>
<td>+16.7</td>
<td>+13.9</td>
</tr>
</tbody>
</table>

- 8 pairs commingled in 4 pens
- Milk losses reflect reductions in resting and rumination activity.

(Hill et al., 2006)
Relationship of stocking density and DMI by parity in mixed groups

- Interaction between parity and stocking density
- Component of future models

\[ y = -90.9x^2 + 109.0x - 8.6 \quad R^2 = 0.85 \]

\[ y = -76.4x^2 + 79.2x + 4.5 \quad R^2 = 0.82 \]
Take-home messages

- Relationship between productivity and stall availability/resting time evident
- Facilities management and design have significant effects on the lying/feeding behaviors of lactating dairy cows
- Detrimental effects on behavior may explain impact of stocking density
Questions or comments?

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