Economic evaluation of dairy cow stocking density

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Stocking density

- Cows / stall
- Feed bunk space / cow
- Total area / cow
- Shade / cow

Transition cows
Lactating cows

USDA-NAHMS Dairy Survey 2007

<table>
<thead>
<tr>
<th>Cows per Stall</th>
<th>Current Percent</th>
<th>Std. Error</th>
<th>Maximum Percent</th>
<th>Std. Error</th>
<th>Average Percent</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 0.95</td>
<td>38.9 (4.2)</td>
<td></td>
<td>13.4 (3.6)</td>
<td></td>
<td>34.9 (4.1)</td>
<td></td>
</tr>
<tr>
<td>0.95 to 0.99</td>
<td>7.4 (1.9)</td>
<td></td>
<td>3.1 (1.1)</td>
<td></td>
<td>8.1 (2.0)</td>
<td></td>
</tr>
<tr>
<td>1.00 to 1.04</td>
<td>12.6 (2.7)</td>
<td></td>
<td>28.7 (3.7)</td>
<td></td>
<td>16.2 (3.1)</td>
<td></td>
</tr>
<tr>
<td>1.05 to 1.09</td>
<td>10.7 (2.3)</td>
<td></td>
<td>9.3 (2.2)</td>
<td></td>
<td>12.0 (2.6)</td>
<td></td>
</tr>
<tr>
<td>1.10 or more</td>
<td>30.4 (3.7)</td>
<td></td>
<td>48.5 (4.2)</td>
<td></td>
<td>26.8 (3.7)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td></td>
<td>100.0</td>
<td></td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

N = 2500 dairy farms

USDA-NAHMS (2010)
Wisconsin survey 1999

- 4-row barns: 111% stocking density
- 6-row barns: 104% stocking density

Bewley et al., 2001

Basic concepts

- Overstocking reduces cow’s ability to practice natural behaviors (Wechsler, 2007)
- Response to overstocking depends on facilities and grouping (P. Krawczel)
- Overstocking improves economic returns on investments in facilities (Bewley et al., 2001)
- How much overstocking is most profitable?

Stall stocking density

British Columbia (BC; n = 42), California (CA; n = 39), northeastern United States (NE-US; n = 40).

- Overstocked
- Understocked

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 hours / day

Slide Peter Krawczel, U of Tennessee
Overstocking and resting time: max = 120%?

(Winkler et al., 2003; Fregonesi et al., 2007; Wierenga and Hopster, 1990; Matzke and Grant, 2002; Hill et al., 2009; Krawczel, 2008; 2009; 2010)

Grants et al., 2004

Resting time and milk yield

~3.7 lb/d more milk for each extra hour

\[ y = 49.2 + 3.7x \]

R² = 0.30

Bach + Fregonsi + Grant studies:
1.2 lbs less milk/day per 10% greater stocking density in range 100% to 150%

Conception rate decreases

Per 1%-unit greater stocking density, a loss of 0.1%-unit conception rate

\[ y = -0.01x + 0.46 \]
Economics

Marginal economics

- Marginal profit = profit from the additional cow – decrease in profit from all other cows already in the pen
- Add cows to pen until marginal profit/stall = $0

Approach

- Stall stocking density = cows / stall
- Includes effects of stocking density on:
  - Milk production
  - Fertility
- Calculate changes in herd measures
  - Herd budget model
  - Vary stocking density 100% → 150%
  - Measure profit/stall/year

Effect of milk loss

\[ \Delta \text{ Profit} \, (\$/\text{stall/year}) \]

- Milk loss per 10% more cows/stall (lbs/day)
  - Stocking density 100% → 150%

- Measure profit/stall/year
Effect of milk price

Δ Profit ($/stall/year)

Milk price ($/cwt)

23
20
18

Reproduction has smaller effect

Δ Profit ($/stall/year)

Estrus Detection rate

61%
48%
34%

How much ↓ milk yield for =profit?

Milk price/cwt

$ 18
$ 20
$ 23

Email exchange with dairy consultant
April 2015

... In this case, the farmer’s decision to overstock by over 30% resulted in very large milk checks due to milk prices even though his milk per cow remained level. I’ve learned that overstocking is not necessarily a bad thing when it comes to profitability.
Welfare Assessment

- **Lying time (Hill et al., 2009)**
  Hours / day

- **Stall use index (Overton et al., 2003)**
  # cows lying / # cows not eating

- **Feeding activity (Huzzey et al., 2006)**
  % Cows eating simultaneously

Overstocking reduces welfare of cows

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**Take home messages**

- Quantitative measures of overstocking on factors that directly affect cow cash flow (milk yield, fertility, culling) are **scarce**

- Some overstocking is **profitable** under plausible economic conditions (say 120% stocking density)

- To maximize profitability per stall, stocking density should be **reduced** when milk sales - feed cost per cow decreases (low milk price, high feed price)

- Tradeoff between profitability and welfare in some situations


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Thank you
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