AN EXPLORATION OF RELATIONSHIPS BETWEEN DAIRY COW BUNCHING BEHAVIOR AND ENVIRONMENTAL FACTORS

Jenifer Cruickshank & Molly T. Stern*, Oregon State University Extension Service

* recently graduated BS student in Animal Science

INTRODUCTION

Dairy cattle bunching is a perennial problem in some barns. We conducted a detailed examination of a free-stall barn known to have a seasonal bunching problem. We collected data on environmental measures along with photographs used to score the distribution of cows in the pens to try to determine what was driving the bunching behavior.

STUDY SITE

- Free-stall barn with two cow alleys, feed alley between
- Barn oriented longways north to south, open sided, equipped with fans that turn on at 65°F
- Each pen typically housed ~110 lactating cows
- milking at ~13:00-16:00 and early morning

DATA COLLECTION

- Stationary cameras positioned to capture the north and south ends of the east pen and similarly for the west pen (NE, SE, NW, and SW quadrants of the barn); still photos taken every 10 minutes, June 2017–November 2018
- 4 Kestrel D2 devices evenly positioned the length of each pen recorded temperature and humidity, June 2017–November 2018
- 1 Kestrel 5500AG recorded temperature, humidity, and wind data north of the barn, August–November 2018
- CO_2 measured in two 24-hour periods in north and south halves of the pens, August and October 2017
- Ammonia measured in one 24-hour period in north and south halves of the west pen, August 2017

DATA ANALYSIS

- Photos from timepoints 6:30, 9:00, 11:00, 12:00, 17:00, 18:00, and 19:00 were scored in random order by one person on a +5 to -5 scale, where a score of 0 indicates that about half the cows appeared to be in that half of the pen (uniform distribution); a score of +3 indicates an estimated 66 extra cows appeared to be present; a score of -2 indicates an estimated 44 cows appeared to be "missing" from that end of the barn (n = 12,975 photos; see Figure 1 for examples)
- North – South difference for each pen calculated for each photo-scored timepoint ("score difference")
- Mean temperature humidity index (THI) calculated from all 8 Kestrel D2s
- Difference between mean north end THI and mean south end THI calculated
- Three analyses performed in R
  1. score difference = month + time of day + pen + month*time
  2. sum of score difference = month + meanTHI + meanTHI^2 + mean THI^3 + North-South THI difference
  3. score difference = month + time of day + pen + THI + THI^2 + THI^3 + wind direction + wind speed

Figure 1. Examples of scored photo pairs on two different day-time points. Scored "0" where cows are uniformly distributed in the pen, and "+4" and "-4" where there are many "extra" cows and where there are many "missing" cows.

RESULTS

- Ammonia levels did not differ significantly between the north and south ends of the barn. Also, they never exceeded 7 ppm, well below the threshold of concern (30 ppm).
- CO_2 levels did not differ significantly between the north and south ends on either day of measurement.
- Wind direction did not appear to be influential in cow bunching behavior, although wind speed approached a suggestive level of significance (Table 1). Regrettably, there were only 3.5 months of wind data. More comprehensive wind data might clarify the relationship.
- Month and time of day were significantly associated with bunching behavior (Figures 2 & 3).
- In the regression analysis, the relationship between cow bunching and THI was cubic rather than linear (or even quadratic), with increasing THI associated with increased bunching at the north end for all but the extreme ends of the THI range in these data (Table 1, Figure 4).

Table 1. Results of ANOVA procedure of three models (see Data Analysis) comprising different components of environmental effects on cow bunching (quantified by difference in scores, north-south). Also, adjusted R^2 values from the regression analyses.

	Model 1 (18 months photo data)	Model 2 (18 months photo data + THI daily means)	Model 3 (4 months photo data + THI, wind by time of day)
month	p < 0.001	p < 0.001	p < 0.001
time of day	p < 0.001	---	p < 0.001
month:time	p < 0.001	---	---
pen	p < 0.001	---	p < 0.001
(mean)THI	---	p < 0.001	p < 0.001
(mean)THI^2	---	p < 0.001	p = 0.005
(mean)THI^3	---	p = 0.005	p = 0.076
N-S THI difference	---	p = 0.091	---
time* pen	---	---	p = 0.127
wind speed	---	---	p = 0.149
wind direction	---	---	p = 0.642
adjusted R^2	0.316	0.731	0.226

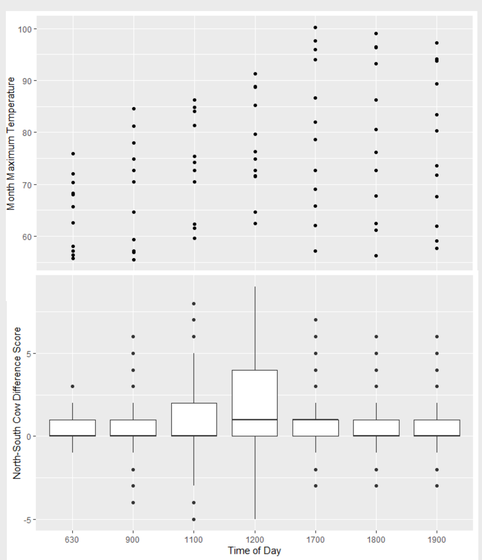

Figure 2. Box plot of difference in score between north and south ends of pens by time of day. Upper panel shows mean monthly maximum temperatures at same times (°F).

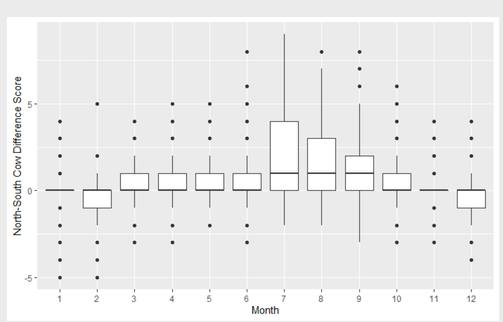

Figure 3. Box plot of difference in score between north and south ends of pens by month.

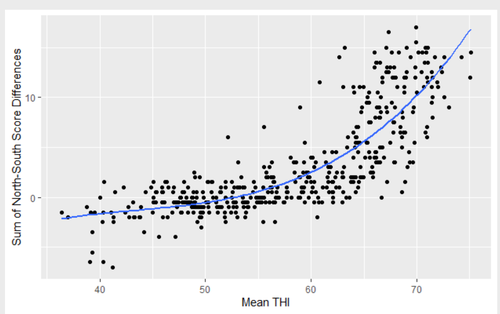

Figure 4. Scatter plot of mean THI and the difference in score between north and south ends of pens, with fitted cubic regression line (blue).

CONCLUSIONS

- THI appears to strongly influence cow bunching behavior.
- Month and time of day also affect bunching, likely due to seasonal/hourly changes in how sunlight enters the barn.

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