J. Dairy Sci. 95:4298–4308
http://dx.doi.org/10.3168/jds.2011-4687

Short-term increases in stocking density affect the lying and social behavior, but not the productivity, of lactating Holstein dairy cows

P. D. Krawczel,*† L. B. Klaiber,* R. E. Butzler,* L. M. Klaiber,* H. M. Dann,* C. S. Mooney,* and R. J. Grant*[1]
*William H. Miner Agricultural Research Institute, Chazy, NY 12921
†Department of Animal Science, The University of Vermont, Burlington 05405

ABSTRACT

Reduced access to resources because of increased stocking density may have a detrimental effect on the behavior of the lactating dairy cow. The objective of this study was to determine the short-term responses in behavior, productivity, fecal cortisol metabolites, and udder and leg hygiene of lactating Holstein dairy cows housed at stocking densities of 100 (1 cow per freestall and headlock), 113, 131, and 142%. Multiparous cows (n = 92) and primiparous cows (n = 44) were assigned to 1 of 4 pens (34 cows per pen) in a 4-row freestall barn. Pens were balanced for parity, milk production, and days in milk. Stocking densities were imposed for 14 d using a 4 × 4 Latin square design. Time spent feeding and time spent ruminating were quantified by 24 h of direct observation of focal cows (n = 12 per pen) beginning at 0800 h on d 11 of each period. Data loggers recorded lying behavior (time and bouts) from the same focal cows per pen at 1-min intervals during the final 5 d of each period. Fecal cortisol metabolites were quantified from samples collected on d 13 and 14 of each period from the same focal cows. Displacements from the feed barrier were recorded on a pen basis after 9 milkings over the last 4 d of each period. Productivity was assessed on a pen basis from milk yield (recorded from d 10 to 14 of each period) and milk components (quantified from composite samples collected on d 12 of each period). Milk composition was further analyzed for milk fatty acid profiles, which were determined from a subset (n = 6 per pen) of the focal cows. Data were analyzed using the MIXED procedure of SAS, with the pen (n = 4 per treatment, except displacements where n = 3 per treatment) as the experimental unit. Feeding and ruminating (h/d) did not differ among treatments. Lying time was reduced at stocking densities of 131 and 142%, relative to 100 or 113%. Lying bouts were not affected by treatment. Stocking densities of 131 and 142% reduced the percentage of time cows spent ruminating within a freestall relative to 100%. Displacements from the feed bunk increased linearly across treatments. Fecal cortisol metabolites, udder hygiene score, milk yields, milk composition, and milk fatty acids did not differ among treatments. Decreased lying time and increased aggression at the feed bunk suggest that an alteration of the time budgets of lactating dairy cows may occur at higher stocking densities, but it is unclear at what point these changes might have further biological consequences.

Key words: dairy cow, stocking density, behavior, productivity

INTRODUCTION

Overstocking of freestall barns is defined as housing more cows within a pen than the available number of stalls or providing less than the recommended 0.6 m of linear feeding space per cow, or both (Grant and Albright, 2001). Overstocking, or increased stocking density, is a common practice among dairy producers. At their maximal herd size, approximately 48% of freestall-based producers stocked their freestall facilities at least 110%, and 28.8% of producers were above a stocking density of 110% on average (USDA, 2010). In terms of feed bunk space, 67.9% of freestall-based producers provided less than 0.6 m at their maximal stocking density, and 58.6% provided less than 0.6 m on average (USDA, 2010). Growing evidence of the priority given to resting when cows were forced to choose between behaviors (Metz, 1985; Munksgaard et al., 2005) suggests that increased stocking densities may impede the ability of a cow to meet her daily time budget needs, which Grant and Albright (2001) are defined as 3 to 5 h/d of feeding, 10 to 14 h/d of lying in a freestall, and 7 to 10 h/d of ruminating.

The initial investigations of the effect of space allocation on the behavioral response of lactating dairy cows manipulated the stocking density at each resource independently (Friend et al., 1977). Resting time was unaffected until freestalls were stocked at 200%, and feeding was unaffected if more than 0.2 m of linear bunk space per cow was provided. More recently, in-

Received July 5, 2011.
Accepted April 6, 2012.
[1]Corresponding author: pkrawcze@utk.edu

creasing the stocking density at one resource in absence of competition for the other has yielded similar results at lower stocking densities. Fregonesi et al. (2007) demonstrated a linear reduction in lying time as freestall stocking density increased from 100 to 150%. Huzzey et al. (2006) observed a linear reduction in feeding time as stocking density at the feed barrier (independent of feed barrier type) was increased from 75 to 300%. Linear increases in the number of displacements from the overstocked resource also were reported (Huzzey et al., 2006; Fregonesi et al., 2007). Increasing the stocking density of the freestalls and feed barrier concurrently has resulted in mixed responses. Lying, feeding, and ruminating behaviors were unaffected during a comparison of high (67% stocking density, relative to freestalls) and low (113% stocking density) space allocations (Fregonesi and Leaver, 2002). On the other hand, Hill et al. (2009) observed decreased resting time as stocking density increased from 100 to 142%, but found no effect on feeding time.

Little research has been done on the effect of stocking density on rumination. Batchelder (2000) reported a 10% reduction in the maximum percentage of cows within a pen ruminating at any given time as stocking density increased from 100 to 130% in a 4-row barn. Conversely, Fregonesi and Leaver (2002) observed no differences in total rumination time (approximately 8.6 h/d) or time spent lying and ruminating (approximately 7.5 h/d) as stocking density increased from 67 to 114% of freestalls. Both resident cows and newly introduced cows decreased rumination times after regrouping (by a maximum of 6% over 1 or 2 d, respectively) without a change in diet (Schirmann et al., 2011). This suggests the potential for a social stress to alter a behavior typically related to diet composition. The potential consequence of altered rumination behavior was the shift in biohydrogenation of linoleic acid toward the production of *trans*-10, *cis*-12 CLA, which causes milk fat depression (Bauman et al., 2006). Furthermore, adequate buffering of the rumen for the maintenance of physiological pH was dependent on salivary buffer flow, which was estimated using the daily eating, ruminating, and resting times and the flow rate of saliva during those behaviors (Allen, 1997).

These behavioral changes may be related to growing evidence that increasing the stocking density alters the productivity and physiology of lactating dairy cows. Survey data suggested a positive relationship between stall availability and milk yield (Bach et al., 2008), which was similar to a previously reported relationship between lying time and milk yield (Grant, 2007). It is possible that increasing the stocking density may influence milk production as well as milk composition.

The blood corticoid response of cows to an ACTH challenge was associated with their access to feed (González et al., 2003), which indicates that the reduced or altered feed activity resulting from overcrowding may be stressful for cows. Additionally, cows had a greater corticoid response to an ACTH challenge when freestall availability was reduced to less than 0.5 freestalls per cow (Friend et al., 1979). Assessment of the stress response to increased stocking density using the concentration of fecal cortisol metabolites, which reflects the concentration of circulating cortisol 10 to 12 h earlier, eliminates the potentially confounding effect of blood sampling on cortisol concentrations (Möstl et al., 2002). To date, however, no evaluation of the effect of variable stocking density on the excretion of fecal cortisol metabolites has been reported.

Despite the potential for substantial effects of stocking density on the behavior, physiological responses, and productivity of lactating dairy cows, data on this subject are scarce within the range of stocking densities commonly observed on commercial dairy farms. Therefore, the objective of this study was to determine the short-term responses in behavior, productivity, fecal cortisol metabolites, and udder and leg hygiene of lactating Holstein dairy cows housed at stocking densities of 100 (1 cow per freestall and headlock), 113, 131, and 142%. Our hypothesis was that increased stocking density of freestalls and headlocks would alter the resting and feeding behavior, milk composition, stress response, and cleanliness of lactating dairy cows within a 4-row barn system during the 14-d treatment period.

MATERIALS AND METHODS

Animals, Management, and Housing

Ninety-two multiparous and 44 primiparous Holstein cows were assigned to 1 of 4 pens (n = 34 cows per pen) in a naturally ventilated, 4-row free-stall barn at the William H. Miner Agricultural Research Institute (Chazy, NY). The 4 groups were balanced for parity (2.4 ± 0.2; mean ± SE), DIM (176.9 ± 15.7), and milk production (51.3 ± 1.6 kg/d) at the beginning of the study. Cows were milked 3 times daily in a double-12 parallel parlor (Xpressway Parallel Stall System; BouMatic, Madison, WI). A TMR formulated for 40 kg of milk/d was delivered once daily when cows were removed for the 0430 h milking and was pushed up approximately 6 times daily (Table 1). Water troughs were located at both ends of each pen as well as in the return alley between the experimental pens and parlor in the same overall barn arrangement diagramed by Hill et al. (2009).