Applied Animal Behaviour Science 170 (2015) 14–19

Contents lists available at ScienceDirect

Applied Animal Behaviour Science

journal homepage: www.elsevier.com/locate/applanim

Effects of under- and overstocking freestalls on dairy cattle behaviour

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ARTICLE INFO

Article history:
Received 28 November 2014
Received in revised form 10 June 2015
Accepted 15 June 2015
Available online 29 June 2015

Keywords:
Cubicle
Animal welfare
Stocking density
Housing
Agonistic interactions

ABSTRACT

Freestall availability affects cattle behaviour and most studies in this area have focused on overstocking. We studied the effects of three levels of stall availability, including both over- and understocking on the time budgets and agonistic interactions in 36 dairy cattle in four stable groups. Using a switch-back design, with treatment order balanced, groups of nine cows were given access to 6, 9, and 12 stalls for 1 week each, allowing for a within-cow test of stocking density of 150, 100 and 75% (cows/stalls). After 5 days of acclimatization at each density, time budgets and displacements from stalls were measured during the last 48 h of each treatment period using continuous video recording and direct observation. When animals had access to fewer stalls, they spent less time lying down (11.6, 12.6, 12.8 h/24 h in 150, 100 and 75% treatments, respectively; SE: 0.31, 0.31, 0.28 h/24 h), particularly at night (6.6, 7.5, 7.6 h; SE: 0.20, 0.20, 0.17 h). Lying behaviour was also more synchronous when more freestalls were available (Kappa coefficient of agreement 0.00, 0.13, 0.17 for lying time in 150, 100 and 75% treatments, respectively). Cows spent more time standing in the alleyways when overstocked (between two rows of stalls: 1.8, 0.8, 0.6 h/24 h in 150, 100 and 75%, respectively; SE: 0.09, 0.09, 0.06 h/24 h; between feeder and stalls: 1.5, 1.3, 1.3 h/24 h in 150, 100 and 75%, respectively; SE: 0.13, 0.13, 0.11 h/24 h), but did not alter the time they spent feeding. Moreover, cows were more likely to displace one another from stalls at greater stocking densities (2.9, 1.1, 0.6 displacements per cow/24 h in 150, 100 and 75% treatments, respectively; SE: 0.16, 0.16, 0.11 displacements per cow/24 h). Cows that were less successful at displacing others spent a higher proportion of their time lying during the day when overstocked, indicating that lying during this time is less preferred. For all variables, the magnitude of response was most affected by overstocking; this practice reduced lying time, especially at night, synchrony of lying behaviour and increased competition for stalls. Understocking provided benefits, but the degree of behavioural change was smaller than when stalls were limited.

1. Introduction

Recent surveys suggest that in four out of every 10 USA freestall barns there are more cows than stalls available (USDA, 2010). Dairy producers overstock to save building costs, or because herd growth is not matched by expansion of barns. Epidemiological evidence indicates that this overstocking explains a significant portion of the non-dietary variation in milk production, with a lower milk yield per cow in overstocked farms (Bach et al., 2008). The mechanism associated with lower productivity is not understood, but could be related to increased lameness within the herd (e.g. Leonard et al., 1996), as lame cows or those with hoof injuries produce less milk (Amory et al., 2008; Archer et al., 2010; Green et al., 2002). Indeed, the cow:stall ratio was eligible for inclusion in the final model evaluating lameness prevalence in two recent epidemiological studies (Dippel et al., 2009; Espejo and Endres, 2007).

Increased lameness in overstocked barns is likely mediated by changes in behaviour. Cows spend less time lying down (Fregonesi et al., 2007; Hill et al., 2009; Krawczel et al., 2008, 2012) and less time standing partially in the stall (Hill et al., 2009; Lombard et al., 2010) when fewer freestalls are available. These changes in time budgets, particularly lying time, are robust; they are apparent regardless of the method used to experimentally overstocking freestalls, by either blocking stalls or adding new individuals to the group (Krawczel et al., 2012) or the method used to record stall usage, either through continuous monitoring over 24-h periods (Fregonesi et al., 2007; Hill et al., 2009; Krawczel et al., 2012) or less accurate single measures within a day

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http://dx.doi.org/10.1016/j.applanim.2015.06.003
0168-1591/

(Krawczel et al., 2008; Ito et al., 2009). However, lying time is not consistently affected by stocking density in on-farm research. Some studies have failed to find a relation between stocking density and lying behaviour (Charlton et al., 2014; Ito et al., 2014; Lombard et al., 2010). Understocking has been included in the epidemiological comparisons (e.g. median stocking density was 96% in Charlton et al., 2014; range was 71–197% in Ito et al., 2014), but has been rarely included in experimental studies.

Thirty-nine percent of US freestall farms understock (USDA, 2010) and recent research suggests that this practice could increase lying times beyond those seen when 1 stall is offered for every cow (Telezhenko et al., 2012). However, little is known about the other effects of this practice. For example, cows kept in overstocked conditions are more likely to both compete directly for freestalls and adopt non-competitive strategies, such as using the freestalls more at non-peak times, and thus reducing synchrony of lying behaviour (Fregonesi et al., 2007). It is unclear how understocking would affect competition and stall use. Our objective was to better understand how both under- and overstocking freestalls affects time budgets, social behaviour and synchrony of dairy cattle in stable groups.

2. Materials and methods

2.1. Animals and treatments

The experiment was conducted at the University of British Columbia Dairy Education and Research Centre in Agassiz, British Columbia. Thirty-six dairy cows were randomly assigned to four groups of nine animals averaging (mean ± SD) 40.2 ± 8.07 kg/day milk production, 146 ± 25.6 days in milk, 2.4 ± 1.19 parity, 679 ± 70.2 kg body weight and 47 ± 16.3 months in age.

Each experimental pen (width = 7.5 m, length = 13.5 m) contained 12 freestalls configured in three rows. In two rows, the stalls were open at the front ('head-to-head'; two cows facing one another) and had a bed length of 2.4 m. The third row of freestalls faced a cement wall, and these stalls were 0.3 m longer to allow more space for the cow to lunge forward when getting up and lying down. Freestalls were separated by Dutch comfort style partitions and measured 1.2 m wide centre to centre and the neck rail was 1.14 m from the stall surface. Stalls were deep-bedded with 0.4 m of sand. The flooring throughout the pens was grooved concrete. The alley closest to the feed bunk measured 3.5 m and the floor of half of this alley was inlaid with a 2.5 cm-thick durable rubber mat. The rubber surface was level with the concrete flooring and had grooving similar to the concrete flooring. Alleys were cleaned six times per day with automatic scrapers.

Each pen had 7.5 m of feed bunk space available through a post and rail barrier. Animals were fed for ad libitum consumption with a total mixed ration of corn silage, grass silage, barley, canola meal and soybean meal. Fresh feed was provided twice daily (at 06:00 h and 15:30 h) and feed was pushed up three times per day. Water was freely available from a self-filling trough. Cows were milked twice daily (approximately 06:00 h and 17:00 h) and spent 1.3 h/day (0.50 SD) away from the pen.

We manipulated stocking density by providing 6, 9, or 12 freestalls to groups of nine animals, thus creating stocking densities of 150, 100, and 75% (cows/stalls), respectively. Using a switch-back design with treatment order balanced, all groups were exposed to all treatments for 1 week each. Each group returned to the 75% stocking density treatment after exposure to either the 150% or the 100% treatment. Stalls along one side of the pen were blocked to create the 100% and 150% treatments. For the 100% treatment, the three stalls along a wall and closest to the crossover/water trough were blocked. To create the 150% treatment, cows were denied access to the three stalls adjacent to the stalls blocked for the 100% stocking density treatment.

2.2. Sampling and measurement

Behaviour was recorded using eight Panasonic WV 330 cameras, positioned approximately 10 m above the experimental pens for 48 h during each of the 5 weeks (i.e. days 6 and 7) at 3 frames/s. The cameras were attached to a Panasonic video multiplexer (WV-FS416) and time-lapse recorder (AG-6540p; Panasonic; Mississauga, Ontario, Canada). Red lights (100 W) were hung approximately 10 m above the pens to facilitate video recording at night.

Cows were marked with unique symbols using hair dye to identify individuals. Behaviour was recorded in two ways (Table 1). Time budgets were scored from video using instantaneous scan sampling once every 10 min. At each scan we scored if the cow was in the freestall (lying, standing with two or four legs in the stall), standing between the feeder and stalls, in the crossover, between the two rows of stalls, or at the feeder (Table 1). The number of displacements from the stalls was also recorded for each cow during 48 h of continuous observation from video, resulting in 240 h of observations per cow. Finally, we recorded social interactions at the feeder with continuous live observation in the 2 h after morning and afternoon milking. Each pen was observed for 30 min twice a day for 2 days during each week, for a total of 10 h observation/pen. The order of the 30-min observation period was balanced across pens and days. Both aggressive and positive interactions were recorded (Table 1). Displacements from the stalls were used

Table 1
Definitions of behaviours used to evaluate the effects of freestall availability on dairy cattle.

Behaviour	Definition
In the stall	
Lying[a]	Flank in contact with ground
Standing with front two legs[a]	Two front legs in contact with the stall surface, weight on legs
Standing with four legs[a]	Four legs in contact with the stall surface, weight on legs
Displacement[a]	Contact (butt or push) immediately followed by leaving the stall
In the alley	
Standing between feeder and stalls[a]	Four legs in contact with the alley surface between the feeder and the row of stalls closest to the feeder, weight on legs, head not above the feeder
Standing in crossover[a]	Four legs in contact with the alley surface on the crossover between the alleys, weight on legs
Standing between two rows of stalls[a]	Four legs in contact with the alley surface on the alley between the two rows of stalls, weight on legs
At the feeder	
Feeding[a]	Presence at the feeder with the head above the feed bunk
Displacements[b]	Contact (butt or push) immediately followed by leaving the feeding place by at least a cow width or half a cow length
Head butting[b]	Contact with the forehead or horn base using a forceful movement, receiving animal does not give up its present position
Pushing[b]	Applying steady force with any part of the head, receiving animal does not give up its present position
Total agonistic interactions[b]	Sum of displacements, head butting and pushing
Positive interactions[b]	Sum of social licking (tactile oral contact directed to the body except the anal region, udder or claws) and horning (rubbing of foreheads or horn bases against the head or neck of another animal)

[a] Scored from video recordings (48 h/week).
[b] Scored with live observation (2 h/week).