Stocking Density and Cow Feeding Behaviour around Transition

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Take Home Messages

- The most consistently observed behavioural response to overstocking at the feed bunk is increased aggression. Heifers are less able to successfully compete for space; increased stocking density may decrease their ability to effectively transition into their lactation.
- Mature cows (going into 2nd lactation or greater) will increase their feeding rate to maintain dry matter intake when access to the feed bunk is reduced. Heifers are unable to alter this aspect of their feeding behaviour, instead, the available data suggest they alter the time of day that they are at the feed bunk. Heifers' apparent strategy for mitigating decreased feed access minimizes changes in their standing/lying behaviours.
- When stocking density is increased, there is a relationship among cows and heifers ability to compete for feeding space, their energy balance, and their stress physiology. A greater stress response and reduced energy balance will be evident in cows and heifers that are not able to successfully compete for feed access.
- When evaluating the impacts of stocking density on feeding behaviours, stocking density at the freestalls should also be considered. Cows place a greater priority on resting compared to feeding. Therefore, it is hypothesized that a relationship among freestall stocking density, feed bunk stocking density, and feeding behaviours exists.
- Presently, there is limited research on the impacts of stocking density on the feeding behaviour of dairy cows during the dry and transition periods. There is also a lack of information on the feed bunk and freestall management practices during the transition period in North America. Addressing the later can improve our ability to conduct applied research on the spatial needs of dairy cows and heifers.

▪ What is Stocking Density?

Simply put, stocking density is the number of dairy cows housed within a pen or pasture, divided by the fixed resources (feeding space, resting space, or a combination of both) provided by that pen. Stocking density presents a complex issue as it requires balancing the motivation for keeping housing costs low by maximizing the number of cows within a pen against the behavioural needs of those cows. Research has attempted to define this balance between these two interests since the 1970s (Friend et al., 1977). For lactating cows, there is a growing body of evidence suggesting overstocking reduces their overall productivity and health. This paper is a review of the current recommendations for stocking density for transition cows and the potential consequences of overstocking.

To What Extent Does Overstocking Occur?

At the present time, there is limited information available on Canadian dairy practices. There is an effort underway by the Dairy Farmers of Canada to complete a survey of practices across Canada in 2015 (http://www.dfns.ca/National%20Dairy%20Study.pdf). The most extensive data for North America come from the USDA-NAHMS 2007 survey (USDA, 2010). Across operations of all sizes, the housing for dry cows in the U.S. was quite diverse with stanchions/tie-stalls (23.3 ± 1.3%), freestalls (22.8 ± 1.1%), dry lot/outdoor group housing (18.7 ± 1.0%), indoor group housing (12.9 ± 0.9%), and pasture (20.5 ± 1.1%) commonly used. There was a strong regional bias to dry cow housing with tie-stall housing common (25.2 ± 1.4%) in the eastern part of the U.S. while being nearly non-existent in the west (0.5 ± 0.2%). On the other hand, dry lot housing was the predominant form of housing in the western region of the U.S. (48.1 ± 2.9%), but much less common in the east (16.3 ± 1.1%). Freestall housing (23 ± 1.9%) and pasture (20.3 ± 2.0%) were equally common across both regions of the U.S.

Unfortunately, the available data were not broken down by stage of lactation; however, overstocking of dairy housing facilities was a common practice. There is evidence of overcrowding regardless of the type of facility used for housing. However, there is variation depending on the type of feed barrier used (post-and-rail or headlocks) and the type of resting area (freestall or multiple animal area). At peak stocking density, over 48% of freestall operations provided less than 20” (51 cm) of feed bunk space and only 15% provided more than 28” (71 cm) of feed bunk space (USDA, 2010). Additionally, 36% of freestall farms provided less than 20” (51 cm) of feed bunk space on average (USDA, 2010). Farms using multiple animal housing areas were typically overstocked (53% providing less than 24” (61 cm)) and only 37% providing more than 28” (71 cm) of feed bunk space (USDA, 2010). For farms using a combination of freestall and multiple animal areas, over

64% provided less than 20” (51 cm) of feed bunk space and only 14% provided more than 28” (71 cm) of feed bunk space (USDA, 2010). On farms using headlocks as their feed barrier, overcrowding was also prevalent. For any operation using headlocks, more than 56% housed more 1.1 cows or more per headlock at their peak stocking density and 39.1% averaged this stocking density. The stocking density of headlocks can also be broken down by the type of resting space used by the farm. For headlock-based farms using freestalls, more than 62% housed 1.1 cows per headlock or more at their peak stocking density and over 44% of farms averaged this stocking density (USDA, 2010). For headlock-based farms using multiple animal housing as the resting space, stocking density was typically lower with only 28% housing of these operations housing 1.1 or more cows per headlock at the maximum and 13.8% averaged this stocking density (USDA, 2010).

A more recent assessment of dairy cow comfort quantified stocking density on dairies from the northeast U.S., California, and B.C. (von Keyserlingk et al., 2012). The results of this assessment indicated that stocking density at the freestalls ranged from 71 to 197% with a majority (60%) of pens classified as “high-producing” managed with stocking densities exceeding 100%. Similarly, stocking density at the feed barrier ranged from 58 to 228%. However, this may have a greater regional variation with the highest average stocking density observed in the northeastern US (142%) and the lowest in California (94%). These data are consistent with the USDA survey and indicate that overstocking is a common practice.

Although it cannot be concluded from the available data that stocking density is problematic for cows during the transition period the commonality of overstocking housing facilities in general suggests that overstocking during the dry and transition periods are also likely. Overstocking during the transition period may be most problematic due to the inherent stresses that dairy cows undergo during this time.

What Are The Current Recommendations For Stocking Density?

Unfortunately, the Canadian Code of Practice for the Care and Handling of Dairy Cattle (2009) does not provide a clear requirement for space allocation during the transition period. Instead, general recommendations are provided. The primary requirements that are available do not address space, but provide guidance on basic housing needs as stated by the following:

- “Housing must allow cattle to easily stand up, lie down, adopt normal resting postures, and have visual contact with other cattle.”
- “Cattle must have a bed that provides comfort, insulation, warmth, dryness and traction.”
- “Bare concrete is not acceptable as a resting surface.”

Even the “best practices” section does not provide a recommendation for space per cow. The discussion of stocking density within the special needs section of the Code of Practice acknowledges that “appropriate stocking density should be used”, overstocking can be a source of stress, and facility design should try to minimize stress. The most specific best practice addressing post-fresh cows recommends providing at least 30” (76 cm) of feeding space and at least one freestall per cow (100% stocking density as the maximum). Within maternity pens, the Code of Practice recommends providing 160 ft^2 (15 m^2) of resting space. Finally, the main requirements in the Code of Practice (2009) for space allowances, across all stages of the lactation cycle, are:

- “Stocking density must not exceed 1.2 cows per stall in a free stall system.”
- “Resting areas must provide 120 ft^2 (11 m^2) per mature cow in bedded-pack pens.”
- “Provide adequate linear feed bunk space to meet the animals' nutritional needs.”

The lack of clear-cut requirements for stocking density to ensure the welfare of dairy cattle is also apparent in the main U.S.-based program. The FARM (Farmers Ensuring Responsible Management) program manual (www.nationaldairyfarm.com) provides the general recommendation to provide “adequate” space to avoid competition for feed and water resources and that a sanitary, comfortable resting space should be available.

The lack of clearly defined requirements for space allowance during the transition period may be driven by the limited information available on the extent and severity that overstocking occurs. It is promising the Canadian scientists will undertake a broad survey of management practices across the county in 2015. The recent inclusion of cow comfort measurements and facilities management within the USDA-NAMHS survey (USDA, 2010) is also a step in the right direction to address this issue.

▪ Behavioural Responses To Stocking Density

Much of the understanding of the behavioural response to stocking comes from research focused on mid-lactation cows. In the earliest research, feeding behaviour was not affected until less than 4” (10 cm) of feed bunk space per cow was provided (Friend et al., 1977). More recently, increasing from 20” (51 cm) of bunk space (the most common space allocation according to the USDA survey) to 40” (102 cm) reduced aggression at the feed bunk and increased the percentage of cows feeding during the 90 minutes following feed delivery (DeVries et al, 2004). Increasing feed bunk stocking density from 75 to 300% decreased feeding time and increased aggression (Huzzey et al., 2006). The effect became more pronounced with each increase in stocking density and when imposed in a post-and-rail barrier relative to headlocks. In a comparison of 24 versus 14 h/d of feed availability in conjunction with 100 or 200% stocking densities, dry matter intake (DMI) was reduced when the time that feed was available was reduced, but not when stocking density was increased (Collings et al., 2011).

The understanding of lying behaviour in response to overstocking has also shifted over time. Again, the earliest research suggested that there was no effect on total lying time until a stocking density greater than 150% was imposed. More recently, increasing stocking density from 100 to 150% (1.5 cows per stall) was sufficient to reduce lying time by approximately 2 h per day (Fregonesi et al., 2007). While it is clear that lying time is reduced at stocking densities lower than previously thought, the extent that lying time is reduced varies. Increasing free-stall and feed bunk stocking density simultaneously from 100 to 142% resulted in a decrease of lying time by 42 to 48 min per day for cows averaging 13 h/d of lying at a stocking density of 100% (Krawczel et al., 2012).

▪ Changes In Behaviour During The Transition Period

There are behavioural changes inherent with the transition period and calving. Understanding these changes is critical to understand the ramifications of stocking density during this stage of lactation. Feeding time may be reduced by approximately 30% in the days after calving relative to feeding time before calving (Huzzey et al., 2006); however, the number of meals per day is greater in the post-calving phase. There is also a general increase in feeding time per day over the days following calving. There are two potential effects of stocking density on these behaviours that characterize the transition period. The limited feeding time following calving may suggest a reduced motivation to feed. Competition at the feed bunk that reduces access may increase the risk of disease for this at-risk group of cows. Decreased access may also limit a cow's ability to increase her daily feeding time, which may also lead to increased risk of disease.

During the 12 hours leading up to calving, stocking density likely has little effect on feeding behaviour because of the very limited amount of feed time that occurs during this period (Jensen, 2012). When split into 2-hour blocks, dairy cows spent approximately 1 min out of each hour feeding. These data were generated via video, so it is impossible to determine how much feed was ingested during this time, but it is likely not biologically significant. Rather than access to feed, access to shelter, if calving alone, or segregation, if group housed, may be more important to dairy cows in the hours proceeding parturition (Proudfoot et al., 2014). Stocking density can affect either of these. Limited space within a pen may negatively impact a cow's ability to separate herself from the group for calving. Increased stocking density of a transition facility may lead to increased pressure on individual calving pens, which, in turn, can lead to the inability to clean calving pens between cows, reducing biosecurity.

▪ Effects Of Stocking Density On Feeding Behaviour During The Dry Period

The initial work on increasing stocking density during the transition period focused on the 1 week before calving and the 2 weeks following calving with cows housed in either a competitive (200%) or noncompetitive (100%) feeding arrangement with all cows having access to at least one freestall (Proudfoot et al., 2009). The effects of the competitive feeding arrangement on multi- and primiparous were limited. Feeding behaviours, including visits to the feed bin, DMI, duration of feeding time, and feed consumption per visit, did not differ between the 2 feedings arrangements. Instead, competition caused increased aggression at the feed bin with competitively housed primiparous cows involved in 3× as many displacements than their noncompetitively housed counterparts, and competitively housed multiparous cows involved in 2× as many displacements than their noncompetitively housed counterparts. Competitively housed multiparous cows also increased their feeding rate (g/min) relative to noncompetitively housed cows. Primiparous cows did not alter their feeding rate in response to competition. Standing times did not differ between the primiparous cows. However, the competitively feed multiparous cows spent more time standing during the week before calving and the week after calving. What is interesting about this response is that mature cows will expend more effort in an attempt to keep feeding behaviours consistent while primiparous cow may be more flexible and eat when the feed is available. Collectively, these data suggest that dairy cows in early lactation may be able to adjust to a competitive feeding situation.

There are several factors that may help explain this response. First, only healthy cows were included in the final dataset for analysis. A total of 39 cows (or 39% the total number of cows enrolled) were removed due to a wide range of transition cow health disorders (Proudfoot et al., 2009). From this data, it is not possible to evaluate the impact of the competitive housing situation on overall health. Sick animals will respond differently to overstocking, and commercial farms must be managed to minimize the impacts on these high-risk cows.

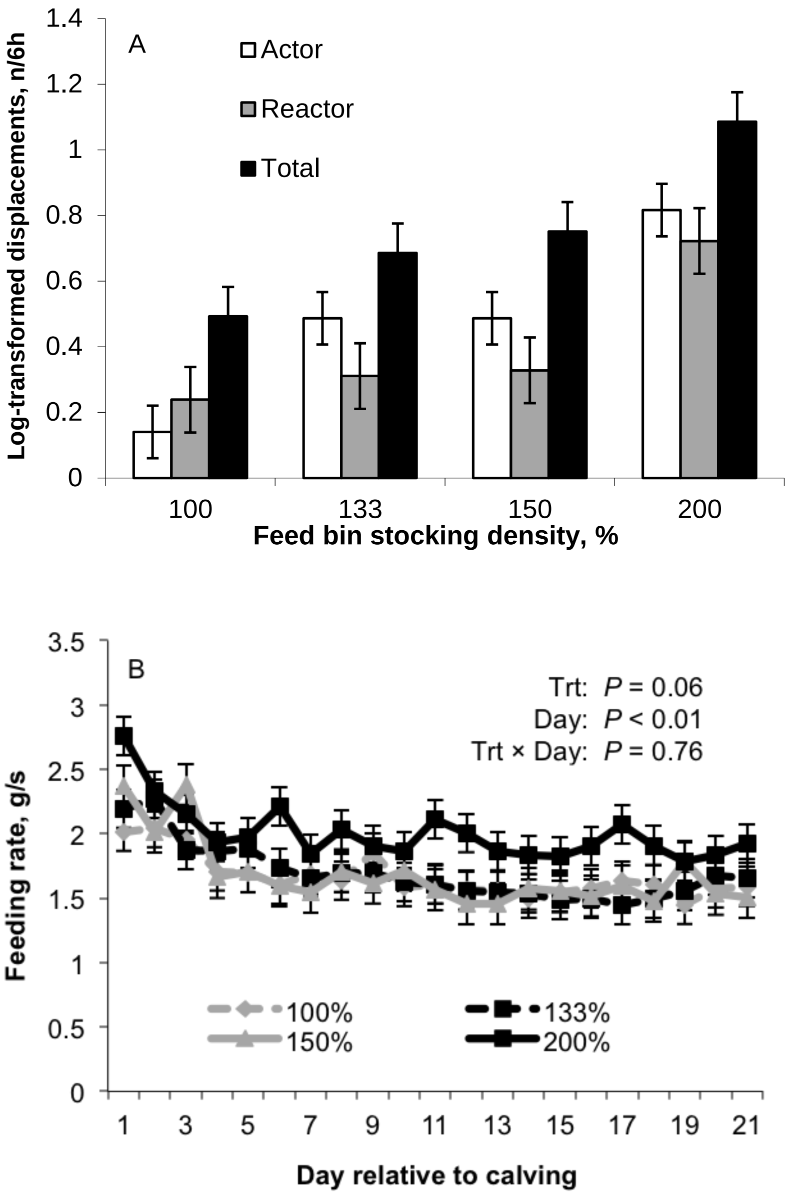

Figure 1. Number of times cows initiated an aggressive interaction at the feed barrier (actor), number of times cows were displaced from the feed barrier (reactor), and total number of aggressive interactions at the feed bunk (total; A) and daily mean feeding rate (B) for cows housed at feed bin stocking densities of 100, 133, 150, or 200%.

All cows on the study were provided the same access to resting space. A dynamic interaction is expected between feed bunk and freestall stocking density (more on this in later section). The lack of pressure on freestall space may have provided these cows with greater flexibility to modify feeding behaviours, such as the time of day that they engaged in feeding to maintain DMI, meals, and feeding time. Finally, these cows were only spending 2 to 3 hours per day feeding, which was relatively low compared to the 3 to 5 hours per day that mid-lactation cows would be expected to spend feeding. This reduced feeding time may give cows in the first few weeks of lactation a greater ability to modify feeding behaviours to accommodate reduced access than they would have further into the lactation when more of the day will be spent feeding.

An incremental increase in stocking density at the feed bin resulted in a similar limited response (Krawczel et al., 2010) as the competitive vs. noncompetitive comparison (Proudfoot et al., 2009). This study collected feeding behaviour data from cows housed at feed bin stocking densities of 100, 133, 150, and 200% during the 21 days following calving with freestall stocking density maintained at 67% for all cows. Again, there were no differences across stocking densities for meals, meal-time, or feed bin visits, but there was a tendency for a feeding rate increase for the cows housed at 200% compared to the other treatments (Krawczel et al., 2009; Figure 1B). Social aggression, in the form of displacements from the feed bunk, increased as stocking density increased above 100% (Figure 1A). These data indicated that cows with access to at least 1 feed bin were less likely than cows in any of the overstocked treatments (133, 150, or 200%) to initiate an aggressive encounter at the feed bin. This suggests that providing sufficient space can reduce either the opportunity or motivation for a cow to displace her pen mate. On the other hand, the number of times a cow was displaced from the feed barrier did not differ among those housed from 100 to 150%. This may mean that the stocking density at the feed barrier altered the motivation of dairy cows to aggressively seek access to feed. Collectively, reducing stocking density to provide sufficient feed bin space can reduce one source of social stress for transition cows. Again, the lack of differences in feeding behaviour can be attributed to the use of only healthy cows (5 cows were removed from the study due to health reasons) and removal of overstocking pressure at the feed bin. The present study also used only multiparous cows, which may have helped reduce some of the variability in feeding response.

One of the challenges in interpreting this type of data (Proudfoot et al., 2009; Krawczel et al., 2010) is converting the artificial stocking density created by manipulating access to feed bins to a stocking density for a headlock or post-and-rail type barrier. While these studies suggest that 100% is sufficient for reducing aggression, this may not the case for traditional feed bunks. At 100% stocking density in the feed bins, all cows can comfortably feed, which cannot be said for cows at a stocking density of 100% with 24” (61 cm) headlocks or similar feeding space. Even with the larger 30” (76 cm) headlocks (currently recommended), the total feeding space provided at 100% in these feed bins is much greater.

As transition cows appear to compensate for the reduced access to feed caused by overstocking, one concern is that feed sorting may have negative consequences on cow health. If the diet is sorted, the cows with initial access may be at risk for ruminal acidosis. On the other hand, cows with later access may be consuming a diet that is less energy dense, or poorer quality in general, compared to the formulated diet. The hypothesis that competition for feeding space would alter the sorting behaviour of pre-fresh dairy cows was tested using the competitive (200%) vs. noncompetitive (100%) approach discussed earlier (Hosseinkhani et al., 2008). In this scenario, cows that feed in the competitive environment will consume their feed at a greater rate and spend less time selectively feeding, resulting in a reduction of overall sorting. Similar to previous studies, the cows from this study, in the competitive situation, consumed their feed at a greater rate than those in the noncompetitive situation. Additionally, in this study, the cows in the competitive housing also consumed fewer meals with the duration of each meal increasing. Despite these differences in behaviour, the general conclusion from their data was that competitive feeding did not influence sorting behaviour. In both groups, cows consumed the fine and short particles at a rate greater than the predicted values, and the long particles at a rate lower than the predicted values. There was a tendency evident for noncompetitively housed cows to select against medium length particles as well, but this was only for the first 4 hours following feeding. After 12 hours, neither group was selecting against the medium particle lengths. Collectively, these data do suggest that there may be some preferences for feed selection that are negatively impacted by competition. Again, there is some difficulty in translating this directly into recommendations for space allocations on commercial farms with traditional feed barriers.

▪ Factors That May Influence The Effect Of Stocking Density On Feeding Behaviour

Social aggression is the most commonly observed response to increased stocking density at the feed bunk. Recent research began to investigate potential underlying reasons for the variation in a cow’s ability to successfully displace a pen mate from a feeding space. Dairy cows in the late stages of gestation (approximately 80 to 60 days before projected calving date) were housed with feed bunk stocking densities of 200% of industry recommendations (2 cows per feeding and resting space) for 14 days and then divided into high, medium, and low success index groups. This index was calculated for each cow by dividing the number of displacements she initiated by the total number of aggressive interactions she was involved in

(Huzzey et al., 2012). Two important trends emerged from this data. First, cows and heifers in the low success group had greater concentrations of nonesterified fatty acids and 11,17-dioxoandrostane, a metabolite of the stress hormone cortisol, indicating a likely a relationship between low success in a competitive environment and decreased energy balance. What is not clear from the data is what is the cause and what is the effect, i.e. does decreased energy balance lower success in competition or does poor performance decrease energy balance? Furthermore, these data indicate that poor success is sufficient to cause a stress response in the cow. Combined, these may lead to difficulties during the transition phase. The low success group was predominantly heifers (79% of the group) while the high success group contained very few heifers (7%); this indicates that in mixed parity pens, heifers might be set-up for a difficult transition period.

Recent work with lactating cows gives some insight into the benefit of understocking transition pens to minimize social aggression (related to co-mingling and regrouping). In particular, the work of Talebi et al. (2014) altered stocking density at the freestalls going from a maximum of 400% to a minimum of 25%. Displacements at the feed bunk occurred more frequently when cows were overstocked at the freestalls and less frequently when understocked on the day after regrouping relative to 1 day before regrouping. This suggests that decreasing stocking density can ease the relocation into a new social group that may occur 4 or more times in the span of a few months. While not specifically evaluated, heifers may directly benefit from the reduced stocking density because of the limited ability to successfully compete for resource access.

Finally, freestalls may have a direct impact on the feeding behaviour of transition cows. When cows were forced to choose between resting, feeding, and socializing due to restricted access to all 3, the portion of time spent lying increased in an effort to maintain a consistent number of hours of rest (Munksgaard et al., 2005). This suggests that transition cows, whose motivation to feed is being affected by multiple metabolic stressors, will likely forgo feeding to maintain resting time if forced to choice. When evaluating or troubleshooting the impacts of feed bunk stocking density, the freestalls should not be overlooked. Within the context of low overall feeding times, overstocking transition cows likely results in an increasing percentage of cows standing idly rather than engaging in productive behaviours (Hill et al., 2007). Finally, while headlocks are a great tool for managing cows at transition, the potential for negatively affecting cow behaviour exists. Depriving cows of lying for a relatively limited period (2 to 4 hours of a 24-h period by restraining them in a headlock) resulted in cows attempting to recoup the lost resting time for the next 40 hours (Cooper et al., 2007). Routine management practices of these cows could be sufficient to deprive cows of lying for this duration.

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