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Space allowance and barriers influence cow competition for mixed rations fed on a feed-pad between bouts of grazing

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ABSTRACT

The objective of this experiment was to evaluate how feeding space allowance and provision of feed barriers interact to affect feeding and social behavior of dairy cows fed a partial mixed ration on a feed-pad. The treatments were factorial with 3 feeding space allowances (0.6, 0.75, or 1.0 m of trough space per cow) and feed troughs that were either open or had head barriers that physically separated adjacent cows to reduce interactions during feeding. One hundred and forty-four Holstein-Friesian cows in mid lactation were allocated into 12 groups of 12 cows, with 1 of 6 treatments (3 × 2) randomly assigned to 2 groups out of 12. Treatments were changed weekly over 3 wk according to a row-column, crossover design, with week corresponding to rows and group corresponding to columns. Thus, the design included 2 replicated groups per treatment in each week. Grazed pasture intake was approximately 6.1 kg of dry matter (DM)/cow per day, supplemented with 3.5 kg of DM/cow per day of wheat (*Triticum aestivum*) grain fed during milking and 10.7 kg of DM/cow per day of a mixed ration offered on the feed-pad after each milking. The experiment comprised a 7-d pre-experimental period followed by a 21-d experimental period. The social hierarchy within each group was determined before the experiment commenced. Feeding and social behaviors of cows were analyzed using video recordings and the changes in heart rate and heart rate variability were determined using heart rate monitors. Data were analyzed using mixed effect models by REML. When feeding space allowance was increased, we observed an increase in the time a cow spent feeding and a decrease in the number of feeding bouts in relation to the total time feed was available, particularly in subordinate cows. The number of aggressive behaviors and displacements decreased when space allowance increased. In addition, HR was reduced and the reduction was more pronounced in subordinate cows compared with dominant cows. Use of feed barriers increased cow feeding time and decreased the number of feeding bouts in relation to the total time feed was available, particularly in subordinate cows, and reduced the number of cow displacements during feeding. We conclude that increasing the feeding space from 0.6 to 0.75 to 1.0 m reduces aggressive interactions and improves cow feeding behavior, with the effects being greatest for subordinate cows. The use of feed barriers further reduces competition at the feed trough in a partial mixed ration feeding system.

Key words: partial mixed ration, feeding space, feed barrier, competition

INTRODUCTION

Grazed pasture is a significant source of nutrients for dairy cattle in many parts of the world, including Australia, because of its inherent low cost (Doyle and Stockdale, 2011). However, the variable rainfall in pasture-based dairying regions can increase the variability in pasture supply and lead to increased reliance on purchased supplements to meet the nutritional requirements of the milking herd, especially in systems with a high stocking rate. Traditional systems for feeding supplements to grazing cows involve feeding cereal grain or pelleted concentrates in the milking parlor and conserved forages in the paddock. More recently, systems that offer cows high amounts of supplements as a mixed ration on a feed-pad between bouts of grazing have become increasingly common; such systems are defined as partial mixed ration (**PMR**) systems (Bargo et al., 2002a). These systems can offer milk production advantages over "slug" feeding of concentrates during milking (Bargo et al., 2002b; Auldist et al., 2013), with no indication of negative consequences for cow welfare (Hetti Arachchige et al., 2013).

One of the primary objectives of dairying is to profitably turn feed into milk. One way to contribute to improved profitability is to ensure that socially low-ranked cows are able to satisfy their DMI demands. However, feed intake can vary markedly between cows when they are fed as a group (Friend et al., 1977).

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One of the potential causes for this variation in DMI is competition between cows during feeding (Olofsson, 1999). In turn, the amount of available feeding space per cow is one of the major factors influencing the level of competition during feeding (DeVries et al., 2004), and inadequate feeding space can be a cause of stress associated with aggression in group-fed dairy cows (Morgan and Tromborg, 2007).

Increased aggression and displacements at the feed trough when cows are overcrowded have been noted by several researchers (DeVries and von Keyserlingk, 2006; Huzzey et al., 2006; Proudfoot et al., 2009). von Keyserlingk and Weary (2010) reviewed recent empirical work addressing how changes in management affect feeding behavior of group-fed dairy cows and reported that when a competitive situation exists at the feed bunk, dominant cows spend more time eating than socially low-ranked cows, which may consequently have lower DMI and produce less milk, affecting overall herd production. Olofsson (1999) further reported that dominant cows were recorded as being those cows that gained eating time at the higher competition level while subordinate cows were forced to alter the allocation of their feed consumption to less preferred hours of the day. This is of concern in dairy operations when access to feed is limited (Dickson et al., 1967; Greter et al., 2013), as is the case with cows consuming nutrient-dense mixed rations on a feed-pad for only part of the day, without the opportunity to shift their feeding times. Furthermore, at reduced pasture allowances, subordinate cows are less able to compensate for the reduced supplement intake by consuming more pasture.

One strategy for reducing competition between cows on a feed-pad is to provide adequate feeding space per cow. Although current industry recommendations for feed-pads in Australia advise a feeding space of 0.60 to 0.76 m per cow (O'Keefe et al., 2010), there is no evidence to substantiate the relationship between feeding space and competition on the feed-pad in a PMR feeding system. In reality, feeding space allowances vary considerably from farm to farm due to changes in herd size, farm facilities, and different management decisions (Davison and Andrews, 1997). In this experiment, we evaluated the effects of different feeding space allowances on a feed-pad on feeding and social behaviors in lactating dairy cows in a PMR feeding system.

Another way of reducing competition during feeding is to provide a physical barrier that provides a separation between adjacent cows (Endres et al., 2005; Huzzey et al., 2006). Such barriers may reduce the negative effects of crowding at a given feeding space, providing cows more equal access to feed on the feed-pad. Because inadequate feeding space is a potential stressor during group-feeding of dairy cows, heart rate (**HR**) and heart rate variability (**HRV**) may be suitable and noninvasive biological responses to measure the functional regulatory characteristics of autonomic nervous system in response to a stressor (Moberg and Mench, 2000; von Borell et al., 2007). Heart rate and HRV have been used as indicators of acute and chronic stress in dairy cows to assess their welfare under different housing and management conditions (Hagen et al., 2005; Arnold et al., 2007; Gygax et al., 2008).

The current experiment was conducted to test the following hypotheses: (1) that increasing the feeding space allowance from 0.6 to 0.75 to 1.0 m per cow on a feed-pad would increase cow feeding time and decrease feed bout frequency as a result of decreased agonistic social interactions in group-fed dairy cows; (2) that at a given feeding space allowance, feed barriers that provide physical separation between adjacent cows would increase cow feeding time and decrease feeding bout frequency as a result of fewer agonistic interactions; and (3) that increasing the feeding space allowance from 0.6 to 0.75 to 1.0 m along with provision of feed barriers on a feed-pad would decrease the level of competition among cows, resulting in lower physiological stress responses as measured by HR and HRV.

MATERIALS AND METHODS

This experiment was conducted at the Department of Environment and Primary Industries (DEPI), Ellinbank Centre, Victoria, Australia (38°24′S, 145°94′E) during April and May (autumn) 2012, with approval from the DEPI Agricultural Research and Extension Animal Ethics Committee and in accordance with the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes (National Health and Medical Research Council, 2004).

Cows and Design

One hundred and forty-four multiparous Holstein-Friesian dairy cows in mid lactation were used. Cows grazed pasture for approximately 19 h/d. This was supplemented with wheat (*Triticum aestivum*) grain fed individually to cows during milking and a mixed ration offered on a feed-pad after each milking. All cows were milked twice daily between 0700 and 0830 h and 1500 and 1630 h. Immediately before the experiment, cows were allotted into 12 groups of 12 cows, with groups balanced for (mean ± SD) age (5.8 ± 1.87 yr), BCS on an 8-point scale (4.4 ± 0.22; Earle, 1976), body width at the widest point (75 ± 3.3 cm), BW (586 ± 46.5 kg), DIM (180 ± 19), and milk yield in the previous lactation (7,518 ± 1,363 kg/cow), using a method by Harville (1974) implemented in GenStat software (15th