J. Dairy Sci. 99:1–6
http://dx.doi.org/10.3168/jds.2015-9602

Short communication: Short-term changes in stocking density did not alter meal characteristics of lactating Holstein dairy cattle

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ABSTRACT

The study objectives were to determine the effect of short-term increases in stocking density and milking on meal duration, meal frequency, and time between meals and to determine the bioequivalence of different meal criterions in a competitive environment. Forty-eight Holstein dairy cows were allotted to 1 of 4 groups (n = 12 per group). Stocking density treatments of 100 (one cow per freestall and headlock), 113, 131, and 142% were assigned to groups using a 4 × 4 Latin square with treatments imposed for 14-d periods. On d 11 of each period, feeding time was recorded for 24 h using 10-min scan samples from direct observation. Meals were defined as repeated observations of eating with a maximum of 20, 30, or 40 min of not eating between observations constituting the same meal. A new meal was established when a cow was observed feeding and then not feeding for greater than 2 (20 min), 3 (30 min), or 4 (40 min) observations. To evaluate diurnal effects, the 24-h period of data was divided into 8-h intervals (based on milking time); morning (0400–1200 h), afternoon (1200–2000 h), and night (2000–0400 h). Feed delivery occurred daily at 0430 h, with feed pushed up throughout the day. A mixed linear model was used to determine the effect of stocking density and time of day on meals per day, meals per hour, meal duration, time between meals, and meal duration 2 h before and after milking. Regardless of stocking density, meal duration, meal frequency, meals per hour, and time between meals did not differ. Regardless of stocking density, mean meal duration was longer during the morning and afternoon compared with night. Meal duration was also greater after milking compared with before milking, regardless of stocking density. These results suggest meal length decreased throughout the day, relative to feed delivery, with periodic increases in length due to return from milking. Meals per hour, meal duration before and after milking, and meal frequency established bioequivalence for the 20-, 30-, and 40-min meal criteria. Bioequivalence was not met for meal duration when the meal criterion was increased from 20 to 40 min. Short-term increases in stocking density of 14-d duration did not affect the feeding pattern of lactating dairy cows, indicating that mid-lactation dairy cows can compensate for reduced feed bunk access during short-term overstocking. When calculating feeding behaviors, including meal frequency and time between meals, using a meal criterion of 20, 30, or 40 min resulted in similar outcomes when using 10-min scan samples. Future studies should investigate changes in other behaviors, such as resting, which may be altered to compensate for reduced access to the feed bunk.

Key words: dairy cattle, stocking density, feeding behavior, meal criterion

Short Communication

Cows typically eat approximately 5 to 8 meals throughout the day (Tolkamp et al., 2000; DeVries et al., 2003b), which consist of short intervals of feeding and nonfeeding activity within a meal and longer intervals between meals (Tolkamp et al., 1998). Feeder design, social hierarchy, and stocking density (**STDN**) may all affect the frequency and duration of visits to the feeder (Tolkamp et al., 2000). Use of meals to characterize feeding behavior reduces the variability associated with feeder visits (Tolkamp et al., 2000). Therefore, using a meal criterion, or a minimum time interval between visits constituting a new meal (Tolkamp et al., 1998), is necessary when assessing feeding behavior. Specifically, this technique can be used when assessing meal frequency and length instead of individual feed bunk visits.

Overstocking is a common practice in the United States (USDA, 2010). Current guidelines recommend providing lactating cows a minimum of 0.6 m of feed bunk space or one cow per headlock (USDA, 2010). However, based on the Dairy 2007 survey, 57.1% of

Received March 20, 2015.
Accepted January 29, 2016.
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producers provided less than 0.6 m of feed bunk space, whereas 45.9% of producers provided 1 headlock to 1.1 cows or more (USDA, 2010). Cows compensate for reduced time at the feeder by eating more frequent meals and increasing consumption rate (Olofsson, 1999) to maintain DMI (Krawczel et al., 2012b). Faster, less frequent meals, or "slug feeding," may reduce ruminal pH levels and cause cows to develop subacute ruminal acidosis, which is also associated with laminitis (Nocek, 1997), making feeding behavior and meal characteristics an important consideration when managing dairy cows.

Dairy cows follow a diurnal feeding pattern with feed bunk attendance highest during the day and early evening and lowest late at night and during early morning hours (DeVries et al., 2003a). However, feeding motivation is typically highest after fresh feed delivery and the return from the milking parlor, with feed push up adding a little variation to the pattern (DeVries et al., 2003a). Considering that milking times can increase occupancy at the feed bunk and STDN can increase competition at the feed bunk, incremental increases in STDN may have negative effects on the feeding behavior of dairy cattle, especially around the time of milking.

The prevalence of overstocking the feed bunk creates a need to understand how it is affecting feeding behavior of dairy cows, particularly when cows are highly motivated to feed. Further, a competitive environment at feeding may affect meal length calculations. Therefore, the objectives of this study were to (1) determine the effect of short-term increases in STDN, and milking on meal duration and frequency of lactating Holstein dairy cattle, (2) determine the effect of time of day on feeding behavior, and (3) determine what meal criterion is most appropriate to use when cows are feeding in a competitive environment using bioequivalence.

This data set was part of a larger study (Krawczel et al., 2012a). Twelve focal cows from 4 pens (n = 48) were selected from a larger group of 44 primiparous and 92 multiparous lactating Holstein dairy cows. Cows were housed in a naturally ventilated, 4-row free stall barn at the William H. Miner Agricultural Research Institute (Chazy, NY), and feed delivery occurred once daily at 0430 h, with feed pushed up throughout the day. Full details of cow selection, housing, and management were described by Krawczel et al. (2012a).

Cows were assigned to 1 of 4 treatment groups (100, 113, 131, and 142% STDN; n = 34 cows per group) using a 4 × 4 Latin square design. Treatment periods lasted for 14 d (Krawczel et al., 2012a). Previous research has shown that 1 d is sufficient to generate treatment differences in feeding behavior of dairy cattle (Grant et al., 1990). Further, direct behavioral observations occurred on d 11 due to no conflicts with other sampling activities or herd health checks occurring to allow for 24 h of uninterrupted behavioral monitoring. Feeding behavior of focal cows (feeding, ruminating, drinking, or no activity) was recorded by 4 observers at 10-min intervals (Mitlöhner et al., 2001; Endres et al., 2005). Cows were considered feeding if their head was through the headlock at the time of observation.

The 10-min intervals used to monitor feeding behavior were used to develop meal criteria, or minimum time interval between visits constituting a new meal (Tolkamp et al., 1998). Many observational studies take advantage of a 10-min scan sampling technique, which was similar to continuous scan sampling for feeding behavior (Mitlöhner et al., 2001), making meal criteria of multiples of 10 necessary to use in the present study. Meal criteria of 20, 30, and 40 min were selected based on previous research by Tolkamp et al. (1998) who estimated a meal criterion of 44.7 min in a noncompetitive environment using preassigned automated feeders, and DeVries et al. (2003b) who estimated a pooled meal criterion of 27.7 min in a competitive environment using a post-and-rail feeding design. Using a range of 20- to 40-min meal criteria allows for comparison of feeding behaviors when cows are in a competitive environment but using a headlock design, which reduces the number of displacements and competition compared with the post-and-rail design (Endres et al., 2005).

Meal duration, meal frequency, and time between meals were calculated using the 3 meal criteria of 20, 30, and 40 min. Meal duration was defined as repeated observations of feeding with a maximum of 20, 30, or 40 min of not feeding between observations constituting the same meal. The total number of observations was multiplied by 10 min to determine meal feeding time. For example, when using a 20-min meal criterion, if a cow was feeding for one observation and then noted as not feeding for greater than 2 observations, the next feeding observation would establish a new meal. Time between meals was calculated by adding the total number of not-eating events after meals had been calculated using the relevant meal criterion, and then multiplying the total by 10 min. Meal frequency was the total number of meals calculated during the 24-h period. Meals per hour was calculated by totaling the number of meals within each hour block.

To evaluate diurnal effects, the 24 h of data were divided into 3 time blocks related to milking times: morning (0400 to 1150 h), afternoon (1200 to 1950 h), and night (2000 to 0350 h). To determine the effect of milking on meal duration, data were summarized into 2-h blocks before and after each milking. Milking times ranged from 0430 to 0640 h (**Milk1**), 1230 to 1430 h (**Milk2**), and 2030 to 2330 h (**Milk3**), with the first