Impact of Feeding Management on Cow Behaviour, Health, and Productivity

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Take Home Messages

- Management of nutrition can be as important as nutritional composition in ensuring cow health, efficiency, and productivity.
- Good health and efficiency are maintained by utilizing feeding management strategies that promote dairy cows to consume frequent, small meals throughout the day, discourage extensive sorting of feed, and encourage cows to remain standing after milking.
- Cows need good access to the ration that is formulated for them throughout the day.
- Good feed access can be achieved through frequent delivery of feed close to the time of milking, frequent feed push-up, ensuring cows are provided sufficient feed amounts, and ensuring cows have sufficient space at the feed bunk.

Introduction

Past research in dairy cattle nutritional management has focused almost exclusively on the nutritive aspects of the diet, resulting in many discoveries and improvements in dairy cow health and production. Despite many advances in this field we are still faced with several challenges associated with feeding dairy cattle. Recent field observations suggest that housing and management can play as large of a role as nutrition in the performance of dairy cows. For example, Bach et al. (2008) found in a cross-sectional study of 47 herds, fed the exact same ration, that 56% of the variation in observed milk production between herds was explained by non-dietary factors (e.g., presence or absence of feed refusals, free stall stocking density, and whether feed was pushed up in the feed bunk). This paper will help shed light on such findings by describing the impact of feeding management on dairy cow behaviour, health, and productivity. To that end, the importance of dairy cow

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behaviour will be emphasized, including how dairy cows eat, when they eat, and what they actually consume. The paper will then describe how we can use that knowledge to evaluate feeding management strategies. In particular, empirical evidence will be presented on how dairy cattle need to be provided good access to, and enough, feed at the right times and frequency to ensure they can meet their requirements, satisfy their natural feeding behaviour patterns, and consume their feed in a healthy manner.

■ Importance of Feeding Behaviour

How Do Cows Eat?

Under natural grazing conditions dairy cattle will engage in foraging behaviour anywhere from 4 to 9 hours per day (Hafez and Bouissou, 1975). This feeding time would be split into a number of smaller meals occurring throughout the day, with the largest meals occurring in the early morning and late afternoon. Modern, intensively-housed dairy cattle fed a conserved ration typically consume their daily dry matter (DM) intake (DMI) in up to 6 hours per day, spread between 7 or more meals per day (DeVries et al., 2003). Management practices that cause adult dairy cattle to eat fewer and larger meals more quickly have been associated with an increased incidence of sub-acute ruminal acidosis (SARA; Krause and Oetzel, 2006). The reason for this risk is that ruminal pH declines following meals and the rate of pH decline increases as meal size increases and as dietary effective fiber concentration decreases (Allen, 1997). Further, as cows spend less overall time feeding and increase their rate of feed consumption, daily salivary secretion is reduced (Beauchemin et al., 2008), decreasing the buffering capacity of the rumen and reducing rumen pH. Alternatively, when cows slow down their rate of DM consumption, and have more frequent, smaller meals throughout the day, rumen buffering is maximized, large within-day depressions in pH are avoided, and the risk of SARA is decreased. Thus, to maximize rumen health, efficiency and productivity, it is important to utilize feeding management strategies that promote frequent consumption of feed in small meals throughout the day.

When Do Cows Eat?

It has typically been accepted that dairy cattle exhibit a diurnal feeding pattern where the majority of feeding activity occurs during the day, particularly around sunrise and sunset. However, this observation is almost exclusively based on the feeding patterns exhibited by grazing cattle. DeVries et al. (2003) demonstrated that the diurnal feeding patterns of free-stall housed dairy cows was mostly influenced by the time of feed delivery, feed push-up and milking. Further, these researchers noted that the most dramatic peaks in feeding activity occur around the time of feed delivery and the return from the

milking parlor. In a follow-up experiment, DeVries and von Keyserlingk (2005) separated feed delivery and milking times by 6 h. When animals were fed 6 h post milking, cow shifted their feeding pattern such that the greatest bunk activity was noted after the feed delivery and not after milking. These results indicate that for group-housed, TMR-fed dairy cattle, feed delivery acts as the primary influence on their daily feeding activity patterns; these patterns are not influenced to the same degree by feed push-up, milking activity or, as seen in grazing cattle, the time of day. As a result, even though dairy cattle may still spread their meals throughout the day, the largest ones will occur right after the delivery of fresh feed.

What Does The Cow Actually Consume?

Dairy cattle are commonly fed their feed components in the form of a total mixed ration (TMR). Total mixed rations are designed as a homogenous mixture with the goal to help minimize the selective consumption of individual feed components by dairy cattle, promote a steady-state condition conducive to continuous rumen function and ingesta flow, and ensure adequate intakes of fiber (Coppock et al., 1981). It is not surprising therefore, that providing feed as a TMR is standard on most commercial dairies, particularly for the lactating animals. Unfortunately, even when providing feed as a TMR, dairy cattle have been shown to preferentially select (sort) for the grain component of a TMR and discriminate against the longer forage components (Leonardi and Armentano, 2003; DeVries et al., 2007). The sorting of TMR by dairy cows can result in the ration actually consumed by cows being greater in fermentable carbohydrates than intended and lower in effective fiber, thereby increasing the risk of depressed rumen pH (Figure 1; DeVries et al., 2008).

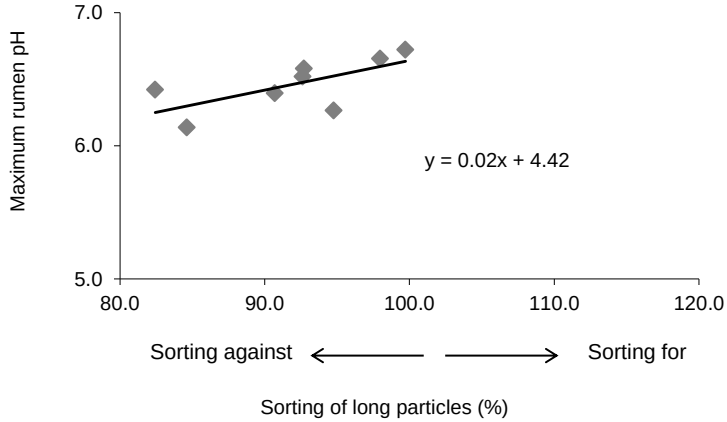

Figure 1. Association of sorting of long particles and maximum rumen pH (adapted from DeVries et al., 2008).

Likely related to this, in two recent studies it has been observed that such sorting of a TMR is associated with producing milk with lower fat percentage (milk fat decreases by 0.15% for every 10% refusal of long forage particles in the ration; DeVries et al., 2011a; Fish et al., 2012: Figure 2). Sorting of a TMR can also reduce the nutritive value of the TMR remaining in the feed bunk, particularly in the later hours past the time of feed delivery (DeVries et al., 2005; Hosseinkhani et al., 2008). For group-fed cattle, this may be detrimental for those animals that do not have access to feed at the time when it is delivered, for example, when there is high competition at the feed bunk. In such cases, these cattle may not be able to maintain adequate nutrient intake to maintain high levels of production and growth (Krause and Oetzel, 2006).

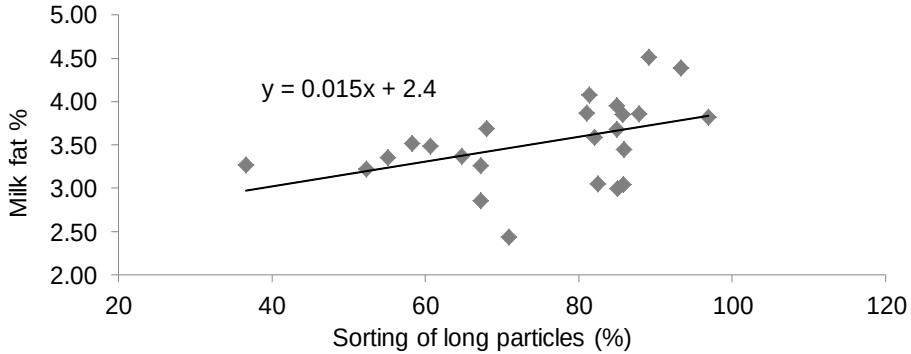

Figure 2. Association of sorting of long particles and milk fat percentage (adapted from Fish and DeVries, 2012).

Thus, overall, there is a large body of evidence to suggest that the way cows eat, when they eat, and what they eat, has a significant impact on rumen digestion, health, and efficiency. We can use that knowledge, therefore, to improve our feeding management strategies.

■ Impact of Nutritional Management

The delivery of fresh feed is clearly an important factor in stimulating cows to eat. Thus, increased frequency of feed delivery can greatly influence feeding behaviour patterns and also affect cow health and productivity. When cows are offered feed only once daily, there are significant peaks in feeding activity in the immediate time period following feed delivery compared to 2x feeding (DeVries et al., 2005). This behavioural response elicited by the delivery of fresh feed provided 1x daily could result in slug feeding and predispose cows to SARA (DeVries et al., 2005) due to large diurnal fluctuations in ruminal pH (Shabi et al., 1999). Inversely, cows fed more frequently (4x and 5x daily)

tend to consume feed more evenly after each feed delivery, increasing their feeding time throughout the day (DeVries et al., 2005; Mantysaari et al., 2006). Added to that, DeVries et al. (2005) found that subordinate cows were not displaced as frequently when fed more often, indicating that these cows would have greater access to feed, particularly fresh feed, when the frequency of feed delivery is high. Further, providing feed 2x/d or more often has also been demonstrated to reduce the amount of feed sorting as compared to feeding 1x/d (DeVries et al., 2005; Endres and Espejo, 2010), which would further contribute to more consistent nutrient intakes over the course of the day. Thus, such desirable feeding patterns are conducive to more consistent rumen pH , which likely contributes to improved milk fat (Rottman et al., 2011); fiber digestibility (Dhiman et al., 2002), and possibly production efficiency (Mantysaari et al., 2006) observed when cows are fed more frequently than 1x/d. Interestingly, in a recent field study of free-stall herds in Eastern Ontario, feed delivery of 2x/d compared to 1x/d has been demonstrated to be associated with less feed sorting, greater milk fat %, and greater milk yield (Sova et al., unpublished results). On a final note regarding frequency of feed delivery, increased sorting of a TMR when fed 1x per day may be particularly troublesome under some management situations; when feeding higher moisture TMR during periods of high ambient temperatures, delivering feed 1x per day may increase the risk of greater amounts of sorting and may also limit DMI (Miller-Cushon and DeVries, 2009).

When fed a TMR, dairy cows have a natural tendency to continually sort through the feed and toss it forward where it is no longer within reach. This is particularly problematic when feed is delivered via a feed alley and, thus, producers commonly push the feed closer to the cows in between feedings to ensure that cows have continuous feed access. Research suggests that feed push-up does not have the same stimulatory impact on feeding activity as does fresh feed delivery (DeVries et al., 2003); nonetheless, push up does play a vital role in ensuring that feed is accessible when cows want to eat.

There is evidence to suggest that the timing of feed delivery is also important for lactating dairy cows. Availability of fresh feed following the return from milking has typically been used to encourage cows to remain standing (while feeding) rather than to lie down. Researchers have shown that the presence of fresh feed in the bunk encourages longer post-milking standing times (DeVries and von Keyserlingk, 2005). DeVries et al. (2010) recently found that the provision of feed around milking time resulted in the longest post-milking standing times. Further, this was the first study to document how post-milking standing time relates to the risk of intramammary infection; cows that lay down, on average, for the first time 40 to 60 min after milking tended to have lower odds of a new intramammary infection caused by environmental bacteria compared to cows that lay down within 40 min after milking. These results suggest that management practices that discourage cows from lying down immediately after milking, such as providing fresh feed frequently

through the day (near the time of milking) may help decrease the risk of intramammary infection. For robotic milked cows that milk frequently throughout the day, ensuring continual access to feed in the bunk via frequent fresh feed delivery as well as feed push up is important to promote standing time after milking and reduce the risk of intramammary infection (Figure 3; DeVries et al., 2011b)

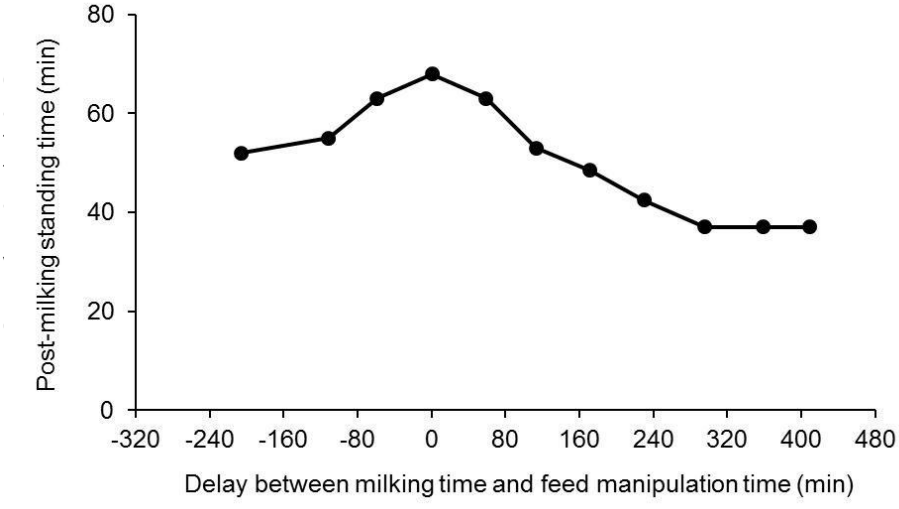

Figure 3. Impact of delay between milking and feed manipulation (feed delivery and feed push up) on post milking standing time (adapted from DeVries et al., 2011b).

Potential undesirable impacts of nutritional management on the behaviour of dairy cows can be intensified under situations where cows do not have good access to their feed (i.e., as a result of higher stocking densities at the feed bunk). When feed bunk competition is high (for example when feed bunk space is limited), increases in aggressive behaviour limit the ability of some cows to access feed at times when feeding motivation is high, particularly after the delivery of fresh feed (DeVries et al., 2004; Huzzey et al., 2006). As a result, increased feed bunk competition will increase the rate at which cows feed throughout the day, resulting in cows having fewer meals per day that tend to be larger and longer (Hosseinkhani et al., 2008). Feed bunk competition may also force some cows to shift their intake patterns, such that they will consume more feed later in the day during the later hours after feed delivery after much of the feed sorting had already occurred. These effects of feed bunk competition on feeding behavior patterns, and the potential to reduce DMI, may be greatest for transition dairy cows (Proudfoot et al., 2009). Reducing feed bunk competition by providing adequate feed bunk space (to

allow animals to eat simultaneously), particularly when combined with a physical partition (e.g., headlocks or feed stalls), will improve access to feed, particularly for subordinate dairy cattle (Endres et al., 2005; DeVries and von Keyserlingk, 2006; Huzzey et al., 2006). This, in turn, will contribute to more consistent DMI patterns, both within and between animals, as well as promote healthy feeding behaviour patterns.

Conclusions

This proceedings chapter summarizes a number of studies that have been undertaken that collectively provide us with a basic understanding of how feeding management influences dairy cattle behaviour, health, and productivity. In particular, using knowledge of feeding behaviour, particularly how, when, and what cows eat of the feed provided to them, we can evaluate feeding management strategies. Strategies may then be implemented that allow cattle to have good access to the feed provided to them, and consume it in manner that is conducive to good health, productivity, and welfare. Examples of this include frequent delivery of feed close to the time of milking, frequent feed push-up, ensuring cows are provided sufficient feed amounts, and ensuring cows have sufficient space at the feed bunk.

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References

Allen, M. S., 1997. Relationship between fermentation acid production in the rumen and the requirement for physically effective fiber. J. Dairy Sci. 80:1447-1462.

Bach, A., N. Valls, A. Solans, and T. Torrent. 2008. Associations between nondietary factors and dairy herd performance. J. Dairy Sci. 91:3259-3267.

Beauchemin, K. A., L. Eriksen, P. Nørgaard, and L. M. Rode. 2008. Salivary secretion during meals in lactating dairy cattle. J. Dairy Sci. 91:2077-2081.

Collings, L.K.M., D.M. Weary, N. Chapinal and M.A.G. von Keyserlingk. 2011. Temporal feed restriction and overstocking increase competition for feed by dairy cattle. J. Dairy Sci. 94:5480-5486.

Coppock, C. E., D. L. Bath, and B. Harris, Jr. 1981. From feeding to feeding systems. J. Dairy Sci. 64:1230-1249.

DeVries, T. J., F. Dohme, and K. A. Beauchemin. 2008. Repeated ruminal acidosis challenges in lactating dairy cows at high and low risk for developing acidosis: Feed sorting. J. Dairy Sci. 91:3958-3967.

DeVries, T. J., M. A. G. von Keyserlingk, and K. A. Beauchemin. 2003. Diurnal feeding pattern of lactating dairy cows. J. Dairy Sci. 86:4079-4082.

DeVries, T. J., M. A. G. von Keyserlingk, and D. M. Weary. 2004. Effect of feeding space on the inter-cow distance, aggression, and feeding behavior of free-stall housed lactating dairy cows. J. Dairy Sci. 87:1432-1438.

DeVries, T. J. and M. A. G. von Keyserlingk. 2005. Time of fresh feed delivery affects the feeding and lying patterns of dairy cows. J. Dairy Sci.88:625-631.

DeVries, T. J., M. A. G. von Keyserlingk, and K. A. Beauchemin. 2005. Frequency of feed delivery affects the behavior of lactating dairy cows. J. Dairy Sci. 88:3553-3562.

DeVries, T. J. and M. A. G. von Keyserlingk. 2006. Feed stalls affect the social and feeding behavior of lactating dairy cows. J. Dairy Sci. 89:3522-3531.

DeVries, T. J., K. A. Beauchemin, and M. A. G. von Keyserlingk. 2007. Dietary forage concentration affects the feed sorting behavior of lactating dairy cows. J. Dairy Sci. 90:5572-5579.

DeVries, T. J., S. Dufour, and D. T. Scholl. 2010. Relationship between feeding strategy, lying behavior patterns, and incidence of intramammary infection in dairy cows. J. Dairy Sci. 93:1987-1997.

DeVries, T. J., L. Holsthausen, M. Oba, and K. A. Beauchemin. 2011a. Effect of parity and stage of lactation on feed sorting behavior of lactating dairy cows. J. Dairy Sci. 94:4039-4045.

DeVries, T. J., J. A. Deming, J. Rodenburg, G. Seguin, K. E. Leslie, H. W. Barkema. 2011b. Association of standing and lying behavior patterns and incidence of intramammary infection in dairy cows milked with an automated system. J. Dairy Sci. 94:3845-3855.

Dhiman, T. R., M. S. Zaman, I. S. MacQueen, and R. L. Boman. 2002. Influence of corn processing and frequency of feeding on cow performance. J. Dairy Sci. 85:217-226.

Endres, M. I., T. J. DeVries, M. A. G. von Keyserlingk, and D. M. Weary. 2005. Effect of feed barrier design on the behavior of loose-housed lactating dairy cows. J. Dairy Sci. 88:2377-2380.

Endres, M. I., and L. A. Espejo. 2010. Feeding management and characteristics of rations for high-producing dairy cows in freestall herds. J. Dairy Sci. 93:822-829.

Fish, J. A., and T. J. DeVries. 2012. Varying dietary dry matter concentration through water addition: Effect on nutrient intake and sorting of dairy cows in late lactation. J. Dairy Sci. 95:850-855.

French. P., J. Chamberlain, and J. Warntjes. 2005. Effect of feed refusal amount on feeding behavior and production in Holstein cows. J. Dairy Sci. 88(E. Suppl. 1):175.

Hafez, E. S. E., and M. F. Bouissou. 1975. The behavior of cattle. Pages 203-245 in The behavior of domestic animals. 3rd ed. E. S. E. Hafez, ed. Bailliere Tindall, London, UK.

Hosseinkhani, A., T. J. DeVries, K. L. Proudfoot, R. Valizadeh, D. M. Veira, and M. A. G. von Keyserlingk. 2008. The effects of feed bunk competition on the feed sorting behavior of close-up dry cows. J. Dairy Sci. 91:1115-1121.

Huzzey, J. M., T. J. DeVries, P. Valois, and M. A. G. von Keyserlingk. 2006. Stocking density and feed barrier design affect the feeding and social behavior of dairy cattle. J. Dairy Sci. 89:126-133.

Krause, K. M. and G. Oetzel. 2006. Understanding and preventing subacute ruminal acidosis in dairy herds: a review. Anim. Feed Sci. Tech. 126: 215-236.

Leonardi, C., and L. E. Armentano. 2003. Effect of quantity, quality, and length of alfalfa hay on selective consumption by dairy cows. J. Dairy Sci. 86:557-564.

Mantysaari, P., H. Khalili, and J. Sariola. 2006. Effect of feeding frequency of a total mixed ration on the performance of high-yielding dairy cows. J. Dairy Sci. 89:4312-4320.

Martinsson, K. and Burstedt, E. 1990. Effect of length of access time to feed and allotment of hay on grass silage intake and production in lactating dairy cows. Swed. J. Agric. Res. 20:169-176.

Miller-Cushon, E. K., and T. J. DeVries. 2009. Effect of dietary dry matter concentration on the sorting behavior of lactating dairy cows fed a total mixed ration. J. Dairy Sci. 92:3292-3298.

Miller-Cushon, E. K., and T. J. DeVries. 2010. Feeding amount affects the sorting behaviour of lactating dairy cows. Can J. Anim. Sci. 90:1-7.

Proudfoot, K. L., D. M. Veira, D. M. Weary, and M. A. G. von Keyserlingk. 2009. Competition at the feed bunk changes the feeding, standing, and social behavior of transition dairy cows. J. Dairy Sci. 92:3116-3123.

Rottman, L. W., Y. Ying, and K. J. Harvatine. 2011. Effect of timing of feed intake on circadian pattern of milk synthesis. J. Dairy Sci. E-Suppl. 1 94:750.

Shabi, Z., I. Bruckental, S. Zamwell, H.Tagari, and A. Arieli. 1999. Effects of extrusion of grain and feeding frequency on rumen fermentation, nutrient digestibility, and milk yield and composition in dairy cows. J. Dairy Sci. 82: 1252-1260.