Consistency is Key When it Comes to Feed Consumption in Dairy Cows!

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Take Home Messages

- Dairy cow health, production, and efficiency are optimized when cows consume consistent rations, both within the day and across days.
- Consistency is required in ration preparation; rations must be prepared accurately and precisely, by regularly monitoring feed components and ensuring mixing protocols are in place and followed.
- Rations need to be designed to minimize sorting and promote consistent, high intake.
- Feeding management should focus on ensuring cows have good access to their feed throughout the day.

Introduction

Dairy producers are continually challenged with ensuring adequate, consistent, and balanced nutrient intake in their cows to ensure good health and productivity of the cows and efficiency of production. Total mixed ration (TMR) feeding systems are widely recognized as the optimal way to maximize intake and provide the consistent balance of nutrients that dairy cattle need. In theory, TMR are formulated so that producers are confident they are providing their dairy cattle a well-balanced diet that is consumed to meet production requirements. Unfortunately, the full potential of the formulated TMR is not always reached on every farm. We need to consider if cows have access to the right TMR and if they consume that ration in a good manner. Only then can we design feeding systems to allow cows to optimize the use of those rations.

Access to the 'Right' Ration

Despite best efforts, the delivered ration on many dairy farms does not accurately match that which was formulated for the cows. In recent research

we observed that as the variability between the ration offered to the cows and the original formulated ration becomes greater, so does the chance that cows will not perform to expectation (Sova et al., 2014). While most of us have always suspected that cows do not always receive the ration exactly as it is formulated for them, this research is some of the first to support this idea and identify the potential consequences of such deviations. For our study we sampled the mixed and delivered TMR for 22 free-stall, parlor-milked herds for seven consecutive days in the winter and summer months. The nutrient analysis of these feed samples was then compared to that formulated on paper for those farms. Across farms, the average TMR fed did not accurately represent that formulated by the nutritionist. The average TMR delivered exceeded TMR formulation for net energy of lactation (NEL), non-fibre carbohydrate (NFC), acid detergent fibre (ADF), calcium, phosphorus, magnesium and potassium, and underfed crude protein (CP), neutral detergent fibre (NDF) and sodium. Theoretically, underfeeding might not be problematic because a safety margin is generally included in formulation to account for uncertainty in ingredient composition. Across farms, however, there was a huge range in this variation, with some farms consistently experiencing a 5–10% discrepancy (both positive and negative) between the fed and formulated ration for nearly all nutrients.

We also investigated the day-to-day consistency in physical and chemical composition of TMR and associations of this variability with measures of productivity. Greatest day-to-day variability was observed for refusal rate, particle size distribution, and trace mineral content. Delivery of a more consistent ration was associated with improved production. For example, greater dry matter intake (DMI; Figure 1), milk yield, and efficiency of milk production were all associated with less daily variability in energy content of the ration (Sova et al., 2014).

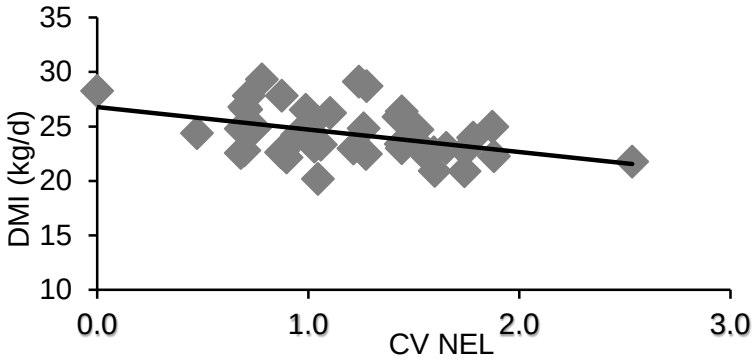

Figure 1. Association between fed ration coefficient of variation (CV) in NEL and average DMI. Coefficient of variation was calculated as the standard deviation of NEL over 7 d divided by the average NEL over 7 d. Figure adapted from Sova et al. (2014).

Lower daily variability in the percentage of long forage particles in the offered TMR was associated with greater milk yield (Figure 2; Sova et al, 2014) and efficiency of milk production. On average, day-to-day variability was greater for physical characteristics (i.e., particle size distribution) of the ration compared with the ration's nutritional composition. This suggests that this day-to-day variation may have been caused by variability in feed component nutrient and dry matter (DM) composition, but probably even more so by mixing errors associated with operators (timing, sequencing) or equipment. Regardless, these findings suggest that increased surveillance of the TMR composition, in addition to individual feed ingredients (e.g., regular, frequent forage DM determination, regular nutrient testing of feeds), may be helpful as a regular component of feeding management to ensure delivery of TMR with the intended nutrient composition to maintain production and feed intake. Further, this finding reinforces the need for standard feeding protocols and training to achieve those protocols, as well as provides support for the use of TMR management programs.

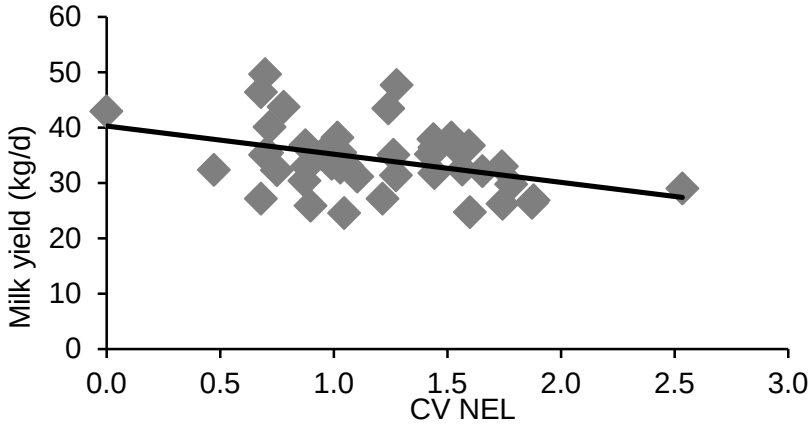

Figure 2. Association between fed ration coefficient of variation (CV) in NEL and test-day milk. Coefficient of variation was calculated as the standard deviation of NEL over 7 d divided by the average NEL over 7 d. Figure adapted from Sova et al. (2014).

■ Consuming the Right Ration in a 'Good' Manner

Even if we get the TMR right and deliver it as formulated on a consistent basis, it does not mean cows will eat that ration as distributed to them or in a manner that is good for them. Since changes in DMI must ultimately be mediated by changes in feeding behavior, it is important to understand the factors that influence cow feeding behavior patterns. Further, we know that patterns of feed consumption may affect rumen digestion and efficiency.

Total mixed rations are designed as homogenous mixtures with the goal to minimize the selective consumption of individual feed components by dairy cattle and promote consistent intake of a complete diet. 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 lesser in effective fiber, thereby increasing the risk of depressed rumen pH (DeVries et al., 2008). Likely related to this, we have observed that such sorting of a TMR is associated with cows producing milk with lower fat percentage (milk fat decreased by 0.15% for every 10% refusal of long forage particles in the ration; DeVries et al., 2011a; Fish and DeVries, 2012). In Miller-Cushon and DeVries (2017) we also demonstrated that same association, finding that milk fat decreased by 0.10 percentage points for every 10% refusal of long particles.

We also found that milk protein content decreased by 0.04 percentage points for every 10% refusal of long particles (Miller-Cushon and DeVries, 2017). This finding suggests that sorting also disrupts the balance of nutrients required to optimize microbial protein growth. Imbalanced nutrient intake as a result of sorting also has the potential to impact the efficiency of digestion and production. In support of this, Sova et al. (2013) demonstrated that efficiency of milk production decreased by 3% for every 1% of group-level selective over-consumption (sorting) of fine ration particles. 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, particularly when there is high competition at the feed bunk. As a result, sorting may impact production at a herd-level. Sova et al. (2013) showed that every two-percentage point increase in selective refusal (i.e., sorting against) of long ration particles on a group level was associated with a per cow reduction of 0.9 kg/d of 4% fat-corrected milk.

It is important to not only consider what dairy cows actually consume from their provided ration, but also the manner in which the ration is consumed. Intensively-housed dairy cattle fed a TMR typically consume their daily DMI in up to 6 h/d, spread between seven or more meals per day (DeVries et al., 2003). Management practices that cause dairy cows to eat fewer and larger meals more quickly have been associated with an increased incidence of sub-acute ruminal acidosis (Krause and Oetzel, 2006). 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 sub-acute ruminal acidosis is decreased. These improvements in the rumen environment may also

translate into improved DMI. In recent research we demonstrated, using data from multiple studies of high production cows, that both meal frequency and total feeding time were stronger predictors of daily DMI, and subsequently milk yield, than the size of meals consumed or the speed at which they were consumed (Johnston and DeVries, 2018). Thus, to promote consistency in consumption and digestion, it is important to use rations, management, and housing that promote the frequent consumption of feed in small meals, spread over a longer period of time at the feed bunk.

■ Rations that Encourage Consistent Feed Consumption

From a feed perspective, providing TMR that are high in physically-effective forage will promote slower consumption of feed, in smaller, more frequent meals per day (DeVries et al., 2007). Such diets are also sorted to a lesser degree (DeVries et al., 2007, 2008). Despite this, the tendency in the dairy industry is to not provide higher forage diets to lactating cows, but rather diets that contain more moderate levels of forage, which in itself tends to be chopped quite moderately in length. This is done in effort to maximize intake and digestibility, which in turn helps meet the nutrient requirements to optimize cow health and productivity.

Diets that are adequate in physically-effective fiber do not necessarily need to contain forages that are excessively long in particle size. Researchers have shown that particles over 4 mm in length may be considered physically effective. Long forage particles, particularly those sitting on the top screen of a particle separator (i.e., >19 mm), are easily sorted and may cause nutrient imbalances. We recently demonstrated this in a study where we provided cows with either one of two diets for the first 28 days of lactation; the only difference in these diets was the length of the wheat straw (chopped with either a 2.54 cm [1 inch] or 5.08 cm [2 inch] screen) that was included in those diets (Coon et al., 2018). Across the study, cows sorted their TMR to a greater degree when fed the diet with the longer chopped straw, sorting particularly against the longest particles within their TMR. The decreased sorting by the cows fed the diet with the shorter chopped straw contributed to more stability over the first 28 days of lactation in time spent ruminating per day and ruminal pH (Figure 3). Consequently, cows fed the diet with the shorter straw particle size exhibited more stability in their milk production and tended to produce 75 kg more milk cumulatively over that 28-day time period than cows fed the diet with straw chopped to a longer particle size.

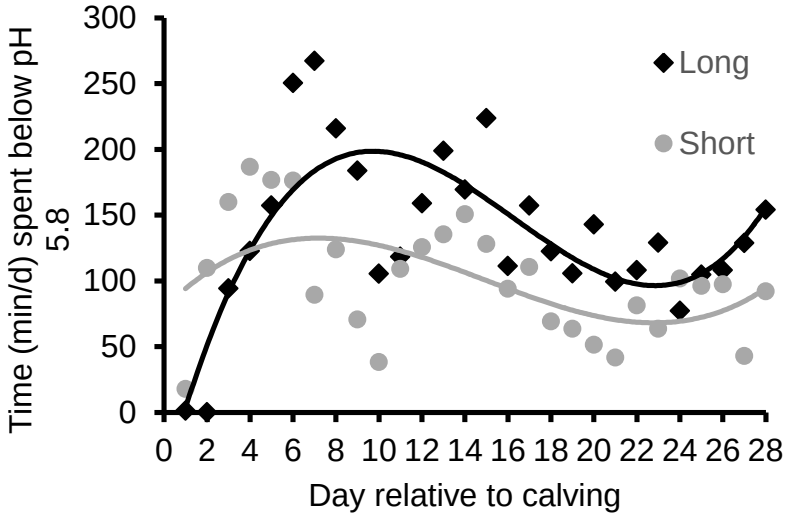

Figure 3. Mean time (min/d) spent below a reticulorumen pH of 5.8 for cows fed 1 of 2 dietary treatments differing in the length of the wheat straw component: 1) straw chopped using a 2.54 cm screen (Short,) or 2) straw chopped using a 5.08 cm screen (Long). Figure adapted from Coon et al. (2018).

▪ Feeding Management that Encourages Consistent Feed Consumption

The diurnal feeding patterns of dairy cows fed a TMR are primarily influenced by the time of feed delivery, feed push-up, and milking (DeVries et al., 2003). Of these, the delivery of fresh TMR has the single largest impact on stimulating feeding activity at the bunk (DeVries and von Keyserlingk, 2005; King et al., 2016a). As a result, greater frequency of feed delivery can greatly influence feeding behavior patterns, promoting more consistency in feed activity across the day (DeVries et al., 2005). In some studies, greater frequency of TMR delivery has also been associated with greater DMI (Sova et al., 2013; Hart et al., 2014) Further, delivering a TMR 2x/d or more often has also been demonstrated to reduce the amount of feed sorting compared with feeding 1x/d (DeVries et al., 2005; Endres and Espejo, 2010; Sova et al., 2013), which would further contribute to more consistent nutrient intakes over the course of the day.

Such desirable feeding patterns are conducive to more consistent rumen pH, which likely contributes to improved milk fat (Rottman et al., 2014). In support of that, Woolpert et al. (2017) reported that dairy herds with high de novo fatty acid concentration in bulk tank milk, compared with those with low de novo

fatty acid concentration, tended to be 5x more likely to be fed 2x versus 1x per day, confirming the positive impacts of feeding >1x/d on maintaining a consistent rumen environment. De novo fatty acids are those that are synthesized in the cow's mammary gland using acetate and butyrate; their level in milk reflects the amount of fermentation of fibrous feeds in the rumen as well as the stability of rumen pH (i.e., low rumen pH may lead to reduced formation of de novo fatty acids in the mammary gland).

The timing of TMR delivery may also play a large role in ensuring good, consistent eating patterns. A goal of TMR management should be to stimulate feeding activity at as many time points across the day as possible to try to increase the distribution of feed intake. In addition to using the delivery of fresh TMR to stimulate feeding activity in cows, we also know that cows will be more likely to eat following milking, as well as near the time of other management events during the day. Knowing that, it is possible to stimulate greater meal frequency across the day by staggering these management events. For example, more feeding activity throughout the day may be achieved by moving the time of feed delivery away from the time of milking. In King et al. (2016a), we shifted feed delivery (2x/d) ahead of milking (3x/d) by 3.5 h and demonstrated that cows consumed their feed more slowly in smaller, more frequent meals (Figure 4).

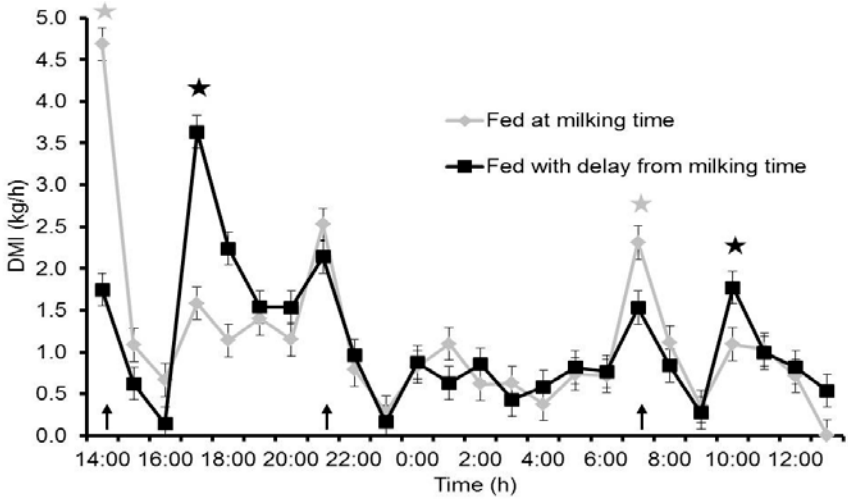

Figure 4. Hourly average DMI (kg) of lactating dairy cows fed 2x/d: 1) at milking time (at 1400 and 0700 h, denoted with ★) or 2) fed with delay from milking time (at 1730 and 1030 h, denoted with ★). Cows were milked 3×/d at 1400, 2100, and 0700 h (denoted with ↑) (adapted from King et al., 2016a).

That change in feeding pattern likely contributed to the improvement in efficiency of milk production that we observed in that study. Therefore,

producers are encouraged to find ways of staggering times of milking and feed delivery to encourage a wide distribution of feeding activity throughout the day.

TMR push-up is also critical to ensure that feed is accessible when cows want to eat. Feed push up needs to occur frequently enough such that any time a cow decides to go to the feed bunk, there is feed available to her.

Feed push-up also helps minimize variation in feed consumed because it mixes up the feed that is no longer in reach with that which is currently available in the bunk. Thus, frequent pushing up of TMR in the bunk is necessary, particularly in the first few hours after feed delivery, when the bulk of the feeding activity has occurred. We have demonstrated that greater lying duration is associated with greater frequency of feed push-ups (Deming et al., 2013; King et al., 2016b), suggesting that frequent push-up minimizes the time cows need to spend waiting for feed access and cows can devote more time to lying down. Feed push-up will also ensure that DMI is not limited and thus production is optimized. Evidence for this was shown in a cross-sectional study of 47 herds, all with similar genetics and feeding the exact same TMR (Bach et al., 2008). In that study it was reported that those herds where feed was not pushed up (5 out of 47 herds) produced 3.9 kg/d/cow less milk (-13% difference) than herds where feed was pushed up. Interestingly, in a more recent observational study of robot herds, Siewert et al. (2018) reported that farms with automatic feed push-up produced 352 kg more milk/robotic unit and 4.9 kg more milk/cow per day than farms that manually pushed up feed. This effect may not be directly attributable to the use of an automated feed pusher, but rather that those farms using such automated equipment had more consistent feed push-up, and thus continuous feed access, than those pushing up feed manually. In situations where manual feed push-up is done consistently and frequently, the same results should be achievable. More frequent feed push-up may be particularly beneficial for robotic milking systems, where cows are milking throughout the day and could potentially be distributing their feeding activity throughout the day (DeVries et al., 2011b).

■ Conclusions

It is important for us to consider innovative ways to encourage consistent feed consumption in dairy cows, not only to optimize DMI, but also ensure that feed is consumed as delivered and in a manner that is conducive to good rumen health and efficiency. This firstly involves ensuring rations are delivered accurately and precisely through regular monitoring of feed components and mixing protocols. Rations need to be designed to minimize sorting and promote consistent, high intake, and to be consumed in small, frequent meals. Finally, feeding management should focus on ensuring cows have good access to that feed and consume it in a manner that is conducive to good health, productivity, and efficiency.

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