Feeding Management Strategies for Cows in Automated Milking Systems

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There is considerable debate regarding optimal feeding strategies for dairy cows milked with automated milking systems (**AMS**). Generally, it is suggested that concentrate motivates cattle to enter the AMS. As such, it is often suggested that feeding more concentrate in the AMS not only stimulates voluntary attendance but also provides a mechanism to tailor the diet for each cow based on milk yield. While these beliefs are encouraging and exciting, they neglect to consider the largest portion of the diet (the partial mixed ration; **PMR**) and there has been very little research conducted in this area. While limited, the existing literature covering both free-flow and guided-flow barn designs indicates that providing a greater quantity of concentrate does not encourage voluntary attendance or stimulate milk yield (Halachmi et al., 2005; Bach et al., 2007; Tremblay et al., 2016; Hare et al., 2018). However, only 2 of those studies had measurements of both AMS concentrate intake and PMR intake (Bach et al., 2005; Hare et al., 2018). With support (alphabetical order) from the Alberta Livestock and Meat Agency, Alberta Milk, Dairy Farmers of Manitoba, the Saskatchewan Agriculture and Development Fund, and SaskMilk, we have initiated a series of studies to improve our knowledge on feeding management strategies for cows in AMS at the University of Saskatchewan Rayner Dairy Research and Teaching Facility.

An important question we sought to answer was 'how much concentrate should be provided in the AMS and consequently, in the PMR'? This question is relevant for producers adopting AMS and to refine dietary strategies for existing operations.

What we did. In this study, treatments consisted of 0.5, 2.0, 3.5, and 5.0 kg (DM basis) of concentrate per day in the AMS, while maintaining equal total dietary energy density and the forage to concentrate ratio across all treatments. This meant that for every unit increase in AMS concentrate, the same concentrate and quantity of concentrate was decreased in the PMR to ensure that the whole diet contained the same nutrient profile. Treatments were fed to 8 primiparous heifers in a replicated 4 × 4 Latin square design. More details regarding experimental design can be obtained upon request.

What we found. Our goal was to achieve 0.5, 2.0, 3.5, and 5.0 kg of concentrate in the AMS, and cows in our study consumed 0.50, 2.00, 3.49, and 4.93 kg/d. Thus, while we were close to achieving our target, this required us to program the AMS to provide slightly more than the target (0.51, 2.03, 3.52, and 5.03 kg on a DM basis). While most producers will focus on average consumption, variability in consumption for a cow across days is also meaningful as we want to provide a consistent diet every day. We found that as the quantity of concentrate offered in the AMS increased, the variability in AMS concentrate consumption across days also increased. In fact, we observed that the standard deviation (a measure of variation) for AMS concentrate intake was 0.8 kg/d for cows targeted at 5 kg. This means that the mean range in concentrate consumption would commonly be between 4.2 and 5.8 kg/d. The variation was only 0.06, 0.4, and 0.5 kg/d for cows fed 0.5, 2.0, and 3.5 kg of concentrate/d in the AMS. It is important to remember that consistency in dietary supply is an important management factor for highproducing dairy cattle. As expected, with increasing concentrate provided in the AMS, the intake of the PMR decreased linearly. The increased AMS intake and corresponding reduction for PMR intake resulted in a total intake that was not different among treatments (25.2 kg/d DM basis).

Perhaps most interesting, visits to the AMS (3.2 visits/d), milk yield (37.4 kg/d), milk fat yield (1.44 kg/d) and milk protein yield (1.23 kg/d) were not affected by dietary treatment. This data indicates that when holding dietary nutrient density constant, providing more concentrate in the AMS (and consequently less in the PMR) does not stimulate visits to the AMS or milk and milk component yield. That said, feeding greater quantities of concentrate does increase the daily variation in AMS concentrate intake.

The second question we addressed was 'would increasing the concentrate in the AMS vs. PMR be more effective to stimulate voluntary visits to the AMS and milk yield and milk component yield'? This study partially addressed the concept of whether providing more concentrate in the AMS would provide a benefit.

What we did. Eight second lactation cows were used in a replicated 4 × 4 Latin square design. The PMR treatments consisted of a low (54:46; **L-FOR**) and a high (64:36; **H-FOR**) forage-to-concentrate ratio PMR. Within each PMR, cows were also provided either a low (2.0 kg/d; **L-AMS**) or a high (6.0 kg/d; **H-AMS**) AMS concentrate allocation. This treatment structure allowed us to test whether increasing AMS concentrate would stimulate production responses and whether increasing the PMR concentrate would stimulate production responses.

What we found. Cows consumed 2.0 and 6.2 kg/d of AMS concentrate (DM basis) for the L-AMS and H-AMS respectively. However, to achieve this target intake, we programmed the AMS to allocate 2.07 and 6.55 kg (DM basis). We again found that the daily variation in concentrate intake for individual cows was greater (0.85 kg/d) when fed 6 kg of AMS concentrate than when fed 2 kg (0.25 kg/d). These findings raise two important points. Firstly, for producers wanting to feed large quantities of concentrate in the AMS, it is important to not only monitor the target concentrate desired but to also confirm that cows are eating the target quantity. Secondly, we confirmed that increasing the quantity of concentrate provided in the AMS increases day-to-day variability in the AMS concentrate intake. While PMR intake was not affected by the F:C ratio of the PMR, feeding a greater quantity of concentrate in the AMS reduced PMR intake by 3.5 kg per day (24.9 vs. 21.4 kg/d; $P < 0.01$). As a result, for every 1 kg increase in concentrate in the AMS, cows decreased PMR intake by 0.84 kg. Total DMI (PMR + AMS) was not affected by PMR or AMS treatments, averaging 27.3 kg DMI/d.

Milking frequency was not affected by the F:C ratio of the PMR or by the amount of concentrate provided in the AMS, averaging 3.6 visits/d. Nevertheless, daily milk yield tended to be greater for cows fed L-FOR than H-FOR (39.2 kg/d vs. 37.9 kg/d) and tended to be greater when fed H-AMS compared to L-AMS (39.2 kg/d vs. 38.0 kg/d). Milk protein yield followed the same pattern as daily milk yield while fat yield was not affected. These data are not surprising as increasing the AMS concentrate and decreasing the forage-to-concentrate ratio of the PMR increased the energy density of the diets. However, feeding the L-FOR PMR did increase time spent in the holding area before milking by 32 min/d suggesting some concern when feeding a high-energy PMR.

Take-home messages

- Increasing AMS concentrate allocation decreases PMR intake. Cows simply don't eat more. The challenge is predicting how much PMR intake will decrease with every unit increase in AMS concentrate.
- When feeding high quantities of concentrate in the AMS, the computer programmed amount must exceed the amount targeted.
- As the amount of concentrate offered in the AMS increases, variability in day-to-day AMS concentrate intake also increases.
- Increasing dietary energy density (by increasing the AMS concentrate or by increasing the energy density of the PMR) improves milk yield.

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