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# Genetic parameters of milking frequency and milk production traits in Canadian Holsteins milked by an automated milking system

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## ABSTRACT

Twice-a-day milking is currently the most frequently used milking schedule in Canadian dairy cattle. However, with an automated milking system (AMS), dairy cows can be milked more frequently. The objective of this study was to estimate genetic parameters for milking frequency and for production traits of cows milked within an AMS. Data were 141,927 daily records of 953 primiparous Holstein cows from 14 farms in Ontario and Quebec. Most cows visited the AMS 2 (46%) or 3 (37%) times a day. A 2-trait [daily (24-h) milking frequency and daily (24-h) milk yield] random regression daily animal model and a multiple-trait (milk, fat, protein yields, somatic cell score, and milking frequency) random regression test-day animal model were used for the estimation of (co)variance components. Both models included fixed effect of herd × test-date, fixed regressions on days in milk (DIM) nested within age at calving by season of calving, and random regressions for additive genetic and permanent environmental effects. Both fixed and random regressions were fitted with fourth-order Legendre polynomials on DIM. The number of cows in the multiple-trait test-day model was smaller compared with the daily animal model. Heritabilities from the daily model for daily (24-h) milking frequency and daily (24-h) milk yield ranged between 0.02 and 0.08 and 0.14 and 0.20, respectively. Genetic correlations between daily (24-h) milk yield and daily (24-h) milking frequency were largest at the end of lactation (0.80) and smallest in mid-lactation (0.27). Heritabilities from the test-day model for test-day milking frequency, milk, fat and protein yield, and somatic cell score were 0.14, 0.26, 0.20, 0.21, and 0.20, respectively. The genetic correlation was positive between test-day milking frequency and official test-day milk, fat, and protein yields, and negative between official test-day somatic cell score and test-day milking frequency.
**Key words:** automated milking system, milking frequency, variance component

## INTRODUCTION

In Europe, automated milking systems (**AMS**) have been commercially available since 1992. However, the first AMS in North America was installed in 1999. In Canada, AMS are gaining in popularity as hired labor is becoming increasingly unavailable and many producers want to expand their herd without hiring external labor. Furthermore, many producers listed a more flexible lifestyle and more frequent milking as some of the reasons for choosing an AMS (Rodenburg, 2002). With the use of an AMS, milking intervals can vary, and can sometimes be extremely short or extremely long. In a study by Hogeveen et al. (2001), the average milking interval was 9.2 h; that is, a milking frequency of 2.6 times per day. Mačuhová et al. (2003) found the average milking interval was 11.3 ± 0.5 h, with a milking frequency of 2.1 times per day. With an AMS, cows have a choice of when they want to be milked. Cows that visit the AMS less than twice a day have to be manually brought (or fetched) to be milked. Most producers set the AMS so that milking can be performed only after a minimum interval of 3 h (Bruckmaier et al., 2001) and set a secondary warning if the cow exceeds a maximum milking interval of (usually) more than 14 h. The secondary warning indicates that the cow needs to be brought to the AMS. Producers report that the effort required to fetch a cow involves identifying them in the milking interval data and then finding and bringing them to the holding area in front of the AMS (Rousing et al., 2005). Rodenburg (2008) reported that 15% of the cows included in their study needed to be fetched by the producers. Some of the reasons why cows needed to be fetched were lameness, mastitis, injured animal, injured udder or teat, poor teat placement, and cow inexperience. The majority of the producers, however, indicated that most of the cows

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they brought to the robot had no identifiable reason for being fetched (Rodenburg, 2008). Statistics show that the need to fetch cows has a greater incidence in Canada than in Europe, as the number of fetched cows can be as high as 19% according to data of an AMS herd in Ontario (Rodenburg and Wheeler, 2002). One possibility for this high fetching percentage may be associated with the use of a high-energy TMR feed that is used in North America. Rodenburg and Wheeler (2002) showed that by increasing the frequency of feeding the TMR, there was a slight increase in the cows visiting the AMS, especially in the long-interval cows. However, the high-energy diet fed in North American can also increase lameness in cows, because a relationship has been shown between high-grain diets and laminitis (Espejo and Endres, 2007). Feeding a high-energy TMR diet may thus indirectly cause high fetching rates in AMS herds because of increased lameness.

Food is used as a motivator for cows to visit the AMS. As a result, most producers place high-concentrate pellets within the AMS to entice cows to attend the AMS. A study by Klaas et al. (2003) concluded that high-yielding cows receive a large proportion of concentrates during milking in the AMS, which causes them to go to the milking machine more frequently. Consequently, Prescott et al. (1998) found that low-yielding cows did not significantly increase their level of attendance when fed, suggesting that the feed was insufficient to increase the motivation of low-yielding cows to visit the AMS.

Subsequently, if the intervals between cow milkings are too long, it can have a negative effect on milk production (Hogeveen et al., 2001; Ayadi et al., 2003), as well as milk flow rate (Hogeveen et al., 2001). Prolonged milk intervals could be an indication of an underlying health problem with the cow such as lameness, foot problems, udder problems, or overall health. Short milking intervals, on the other hand, were associated with greater milk production per cow per hour (Hogeveen et al., 2001) and increased fat and protein yields (DePeters et al., 1985; Erdman and Varner, 1995). When milking frequencies increased from 2 to 3 times per day an increase in milk yield from 6 to 25% per lactation was observed (Amos et al., 1985; DePeters et al., 1985; Allen et al., 1986; Klei et al., 1997). The difference in milking intervals may best be explained by cow-related factors, such as their motivation to be milked, their social dominance in the group, their udder pressure, udder depth, milk yield, parity, and health status.

A study by König et al. (2006) found that the heritability of milking frequency was 0.18, which is enough for direct selection of cows against long milking intervals. That same study revealed a positive genetic correlation between test-day milk yield and test-day milking frequency in the range from 0.46 to 0.57. This may indicate that higher producing cows visit the AMS more often. In addition, genetic correlations between milking frequency and SCC ranged from 0.01 to 0.06, which indicates that there was no genetic relationship between these 2 traits.

The objective of this study was to estimate genetic parameters for milking frequency and for production traits of cows milked within an AMS in Canadian Holstein herds.

## MATERIALS AND METHODS

### *Data*

Fourteen farms using a free-flow traffic (Lely, Maassluis, the Netherlands) robotic milking system in Ontario and Quebec were included in the study. Six farms had 1 AMS per farm, 6 farms had 2 AMS per farm, 1 farm had 3 AMS per farm, and 1 farm had 6 AMS per farm. However, each farm only permitted a cow's access to 1 AMS each. In total, the data were from 953 primiparous Holstein cows with 141,927 daily records (Table 1). Only primiparous cows were included to avoid bias associated with culling. Farms had to have had their AMS for at least 1 yr. Most of the data collected were over 13 mo, with a maximum of 22 mo and a minimum of 12 mo. Cows were fed a TMR diet that was pushed up 4 to 6 times per day. All farms had similar robotic training protocols for cows that were inexperienced with the AMS. Only DIM from 5 to 305 were included. Milk yields per milking that were $<1$ kg and $>50$ kg were excluded. Only milk intervals between 3 and 24 h were used in the study.

Two types of data were used for this study, daily (24-h) records and official test-day records. The daily (24-h) records used were from the AMS herd management program and were recorded for every DIM. These data consisted of daily (24-h) milking frequency and daily (24-h) milk yield only, and did not include fat and protein yields or SCS. Daily (24-h) milk yield was calculated as the sum of cow's milk yields produced within each day in milking as recorded by the herd management program. For example, if a cow produced 13.7 kg for milking 1 and 13.4 kg for milking 2, then the daily milk yield would equate to 27.1 kg. Daily (24-h) milking frequency was calculated as the number of milkings on that particular day.

Considerable day-to-day variability was observed for both daily (24-h) milk yield and daily (24-h) milking frequency, which was caused by not averaging the data. Therefore, a smoothing procedure was used to account for the calculated daily milk yield and daily milking frequency, which is recommended by the International Committee of Animal Recording (Miglior et al., 2000).