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Short communication: Milking order consistency of dairy cows in large Australian herds

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ABSTRACT

We used on-farm records from dairy infrastructure to examine the consistency of the milking order over 150 d in 5 Australian dairy herds that were milking more than 500 cows as a single group. Within a single day the difference in milking order rank position was less than 20 percentage points for 72% of cows. The correlation coefficient comparing milking rank position in the morning and afternoon was 0.72, with the position of cows at the beginning and end of the milking order being more consistent than cows toward the middle of the milking order. Over a period of 150 d, cows with a mean position in the first and last 20% of the milking order maintained their position more consistently than cows in the middle of the milking order. Milking position of cows between one month and the next was highly correlated (r = 0.88). In large herds, subpopulations of cows are regularly milked toward the beginning and the end of the milking order. It is common for cows to be collected from the paddock as a group, to wait as a group in the dairy yard to be milked, and to return individually to the paddock or feed pad immediately after they have been milked. Thus, cows milked later in the milking order are likely to be away from the paddock for several hours longer than cows milked earlier in the milking order. This may affect their welfare though differences in time available for lying down, equality of pasture eaten, and time spent standing in the dairy yard.
Key words: milking order, dairy cow behavior

Short Communication

Large pasture-based dairy herds, where more than 500 cows are milked at a time, are a significant part of the Australian dairy industry, accounting for more than 35% of the approximately 1.65 million cows milked in 2014 (Dairy Australia, 2013; Beggs et al., 2015). On most large Australian dairy farms, cows graze pasture during the day, with supplementary feed provided in the form of concentrates fed in the dairy parlor during milking, and forages fed either in the paddock following milking or on a feed pad (an intermediate area between the exit of the dairy and the paddock). It is common for cows to be collected from the paddock as a group, to wait as a group in the dairy yard to be milked, and then individually return to the paddock or feed pad immediately following milking (Scott et al., 2014). Thus, cows milked later in the milking order are likely to be away from the paddock for longer than cows milked earlier in the milking order. This has a potential effect on cow health and welfare, particularly if the same cows are consistently milked toward the end of the milking order, as the mean duration of milking in large Australian dairy herds has been reported as exceeding 2.5 h (Beggs et al., 2015).

Consistency in entrance order of dairy cows to the milking parlor in groups of less than 300 cows has been demonstrated by several authors (Soffié et al., 1976; Rathore, 1982; Sauter-Louis et al., 2004; Botheras, 2006; Grasso et al., 2007; Berry and McCarthy, 2012; Polikarpus et al., 2015). Many factors have been shown to affect the milking position of individual dairy cows, including position in the social hierarchy (Rathore, 1982; Sauter-Louis et al., 2004); introduction of new animals to the herd (Soffié et al., 1976); stage of lactation (Rathore, 1982; Sauter-Louis et al., 2004); estrus (Scott Mitchell et al., 1996); lameness (Botheras, 2006); milk yield (Rathore, 1982; Berry and McCarthy, 2012); cell count or mastitis (Rathore, 1982; Berry and McCarthy, 2012; Polikarpus et al., 2015); genetics (Berry and McCarthy, 2012); and the presence of disease such as metritis and pneumonia (Polikarpus et al., 2015). The milking order (order in which cows are milked) is also related to the walking order (the order in which they leave the paddock; Sauter-Louis et al., 2004).

As herd size increases above 500 cows, it seems likely that sheer crowd size combined with the myriad of factors at play that affect milking order could make a stable milking order less likely. To our knowledge, the

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consistency of the milking order in larger herds has not been examined closely.

We examined the consistency of the milking order in 5 large Australian dairy herds. We assessed the relationship between milking position in the morning versus milking position in the afternoon; the relationship between mean milking position in one month versus milking position in the next month; and assessed whether variation in milking position was related to mean milking position itself.

To achieve this, 5 southwest Victorian seasonally calving dairy farms were identified that milked more than 500 cows twice a day as a single group in a rotary dairy and had specific infrastructure that recorded the time and milking position of each cow as they entered the milking platform (Identity, Jantec Systems, Geelong East, Victoria, Australia). The mean number of cows in the 5 milking herds during the study period were 525, 595, 654, 657, and 793.

We chose a study period with the aim of minimizing the number of cows entering the herd to maximize the potential stability of the milking order. Two herds did not have any cows calve during the study period, 2 herds had less than 20 cows calve, and 1 herd had approximately 200 cows calve during the first 2 mo of the 5-mo study period.

In these herds, as cows walked on to the dairy platform, the dairy infrastructure reads a microchip embedded in the ear tag of each cow and records the time and bail position of the cow within the rotary dairy. The process is not failsafe, and occasionally (generally less than 2% of cows at an individual milking) a tag is not read. Ranking methodology should be fairly robust against this, as occasional missing cows reduce the sample size a little but will not change the order or alter the rank position of the other cows in a meaningful way.

Daily milking records were extracted from each farm for approximately the same period of 150 d between August 2014 and January 2015. The individual periods varied by up to 14 d and were chosen to minimize cows entering or leaving the herd during the period and, thus, maximize the potential stability of the milking order. Records consisted of a separate file for each milking that contained individual cow records with the cow identification, calving date, age, time the cow entered the milking platform, and the platform bail position. The number of cows milked at each morning and evening was calculated, and the rank order (rank position) of each cow within each milking was calculated after accounting for empty bails where a cow did not enter the milking platform. A percentile rank position calculated for each cow milking using the formula rank percentile = (rank position/cows milked + 1) × 100.

The potential to deviate from a rank percentile position decreases toward the beginning and the end of the milking order because the rank percentile positions are bounded by 0 and 100. For example, the cow that enters the milking platform first can only change position in one direction. To examine the relationship between rank position and variation in rank position accounting for the effects of bounding by 0 and 100, a normal score (Dickinson Gibbons, 2006) was calculated for the rank percentile of each cow milked using the formula normal score = Φ^{-1}(rank percentile), where Φ^{-1} is the inverse cumulative normal distribution function. The difference in normal score places more emphasis on changes early (or late) in the milking order. For example, a cow that changes from rank percentile 1 to 6 is a change in rank percentile of 5 and a change in normal score of 0.67, whereas changing positions from 47 to 52 is still a rank percentile change of 5 but a normal score change of 0.1 (Botheras, 2006).

To investigate the correlation between morning and afternoon rank percentile and normal score, a database was constructed that included all cow days where a cow was milked at both morning and afternoon milkings. Pearson Correlations were calculated using SPSS (IBM SPSS Statistics for Windows, Version 24.0. IBM Corp., Armonk, NY) to assess the correlation between position in the afternoon milking and position in the morning milking, age, and day of lactation.

Data were available for 483,887 cow-days where individual cows were recorded at both the morning and evening milking. Correlation between rank position at the morning and evening milkings is shown in Table 1. Overall, rank position in the morning and afternoon milking was strongly correlated ($R^2 = 0.52$), suggesting that 52% of the variation in position at the evening milking could be explained by position at the morning milking. We found no linear relationship between rank position and either DIM (r <0.1, $P < 0.001$) or age (r <0.1, $P < 0.001$). Using the normal score instead of the raw rank percentile did not change the interpretation (r

Table 1. The correlation between rank position at morning and afternoon milkings over a period of 150 d

Farm	Pearson correlation coefficient (r)	Coefficient of determination (R^2)	Significance (*P*-value)
A	0.72	0.52	<0.001
B	0.57	0.31	<0.001
C	0.78	0.61	<0.001
D	0.72	0.52	<0.001
E	0.77	0.59	<0.001
Overall	0.72	0.52	<0.001