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Comparison of mating start date definitions for New Zealand dairy farms

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Abstract

If the mating start date (MSD) is incorrectly established through database monitoring, then several reproductive measures will also be incorrect in a seasonal calving dairy herd. The definition currently used by the InCalf Fertility Focus report is the first day with artificial breeding (AB) record(s) within a sequence of four of seven days with artificial breeding (AB) records (Method A). The objective was to compare this with alternative definitions to reduce the occasional incidence of incorrect MSD that have been encountered in these reports. The alternative definitions tested were two consecutive and four out of seven days (Method B), one percent (Method C) and three consecutive days (Method D). The National Dairy Database was used to test these alternate definitions. Among 963 herds with less than 150 cows, the current definition of MSD was the most appropriate. Among 7,004 herds with greater than or equal to 150 cows, visual assessment indicated that a new definition was more accurate. This was that MSD be set as the first of two consecutive days when followed with four of the next seven days having recorded AB matings.

Keywords: reproductive performance; mating start date**;** dairy cattle

Introduction

The New Zealand dairy system is essentially seasonal with more than 90% of dairy herds in New Zealand having a concentrated calving pattern in early spring (Macmillan et al. 1990). In order to achieve this calving pattern, there must be an intensive breeding programme beginning 283 days prior, during the previous season. Poor reproductive performance can lead to subsequent delays in mean calving date, increases in calving spread and reduced milk yield (Macmillan 1979). Hence, reproductive performance is one of the most important determinants of production efficiency, profitability and genetic gain (Xu & Burton 1996; Grosshans et al.1997). In order to achieve industry target levels of reproductive performance of 78% six-week in-calf rate, 90% or more cows need to be submitted for artificial breeding (AB) during the first three weeks of breeding (three-week submission rate) and the conception rate (CR) to these inseminations needs to be in the order of 60% (Macmillan & Watson 1973; Harris et al. 2005; Burke et al. 2007). A key aspect for farmers in improving reproductive performance is to achieve incremental gains in response to informed decision-making and being able to measure progress (Burke et al. 2007).

The mating start date (MSD) can be defined as the first day where any cow that is observed in oestrus will be inseminated. Most of the reproductive measures used are dependent on the interval from the MSD (Macmillan 2002). The InCalf Fertility Focus report, a standardised measure of reproductive performance in New Zealand dairy herds, defines MSD as the first day when four out of the next seven days have inseminations recorded (DairyNZ, 2008). The InCalf Fertility Focus report definition of MSD generally works well, but there are occasions where the mating of a single cow, or group of cows, just prior to the ‘true MSD’ at a time when all cows become eligible for breeding, triggers an earlier, false MSD. Most measures of reproductive performance such as the three-week submission and six-week in-calf rates, are underestimated when this occurs. Accordingly, the objective of this study was to assess alternative definitions for establishing the MSD from herd database records that would reduce, or eliminate, these occasional errors that have been reported.

Materials and methods

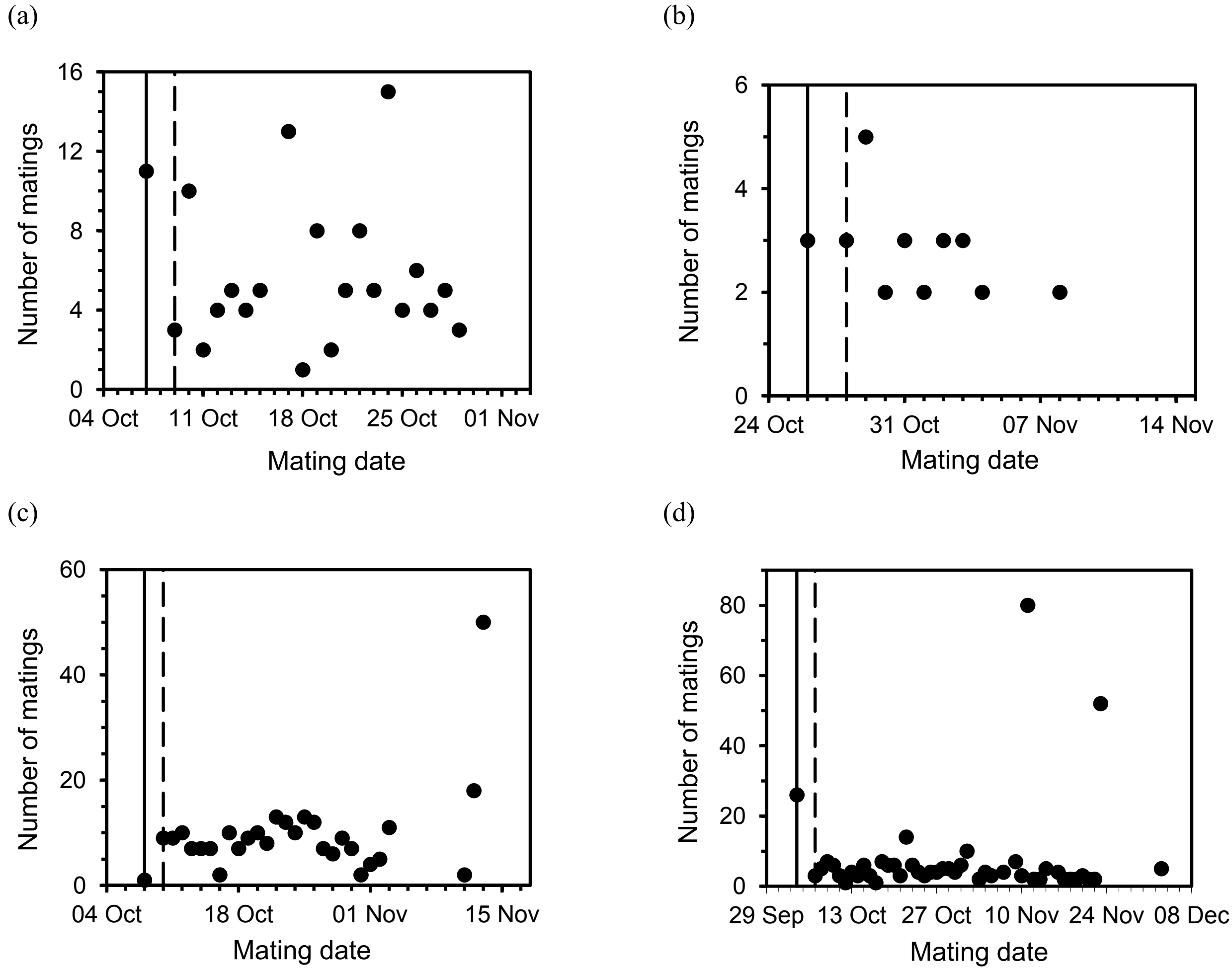
Data set

Data for all New Zealand dairy herds with records on the National Dairy Database during the 2010 season were analysed to compare methods of calculating the MSD date. International records, non-dairy herds, yearling heifers, natural matings and records with no herd number and/or map reference were removed prior to analysis. A unique herd indicator was established by merging map reference and herd number. Herd size data were also retrieved from the National Dairy Database. Herd size was determined according to the Fertility Focus Report inclusion and exclusion criteria, that is, that cows needed to have calved from 130 days prior to, to 59-days post the MSD (DairyNZ, 2008). Herd size was merged with the reproduction data by map reference and herd number. The most recently recorded herd size for each herd was used. The R statistical package was used for all analyses. Methods used to calculate the MSD are described below.

Calculating the mating start date

The numbers of AB matings per day were compiled for each herd. The herds were defined as having either a seasonal or a non-seasonal pattern. A seasonal pattern was when a 40 day interval was observed between mating periods for each herd. A non-seasonal pattern was when no 40 day interval was

Figure 1 Examples of the plots used to compare methods of calculating the MSD for each herd, showing the number of matings on each date for a single herd. The solid black line shows the MSD calculated by the current method (Method A). The dashed black line shows the MSD calculated by Method B. (a) and (b) are two examples of the standard result observed for herds with less than 150 cows, (c) and (d) are two examples of the standard result observed for herds with greater than or equal to 150 cows.



observed between mating periods for each herd. Herds with less than 150 cows were analysed as a separate data set from herds with greater than or equal to 150 cows.

The methods that were compared for calculating MSD were defined as:

Method A: ***Four out of seven days*** - The first date where four days out of any of the next seven days had AB mating records for a given herd. This is the definition currently used by the InCalf Fertility Focus report.

Method B: ***Two consecutive and four out of seven days*** - The first date where, given that there were matings on two consecutive days, there were also two more matings within the next five days. Another way to explain this is that within seven days, there were four matings and the first two of these matings were on consecutive days.

Method C: ***One percent*** - The first date where greater than or equal to 1% of the herd had been mated.

Method D: ***Three consecutive days*** - The first date where there were matings on each day for three consecutive days.

The percentage of herds where MSD was found to be the same when determined by different methods was calculated. The herds where application of these methods resulted in different mating start dates were then compared graphically to determine the accuracy of each method. Figure 1 shows examples of these graphical comparisons. The correlations (r^2) between the MSDs calculated by each method were determined using the linear modelling function in R. Standard errors were reported for the average number of days with matings, herd size, number of matings per herd, number of matings per day and the mean number of days difference between Methods A, B and C.

Results

In the 2010 season, there were 7,967 dairy herds, excluding natural mated herds, in New Zealand that were registered with the National Dairy Database. The

Table 1 The mean ± standard error of the mean of days with recorded AB matings, herd size, number of matings per herd and number of matings per day for all herds with less than 150 cows and all herds with greater than or equal to 150 cows within the analysed data set.

Herd size	Number of days with matings	Number of cows	Number of matings per herd	Number of matings per day
Less than 150 cows	31.14 ± 0.02	106.1 ± 1.1	163.4 ± 1.5	7.80 ± 0.10
Greater than or equal to 150 cows	37.09 ± 0.01	410.2 ± 0.3	486.4 ± 0.3	17.55 ± 0.02

Table 2 Comparison between estimates calculated by Methods A, B and C of the percentage of herds where the derived mating start dates did not match (No match), the range of days difference (Range) and the mean ± standard error of the mean of days difference (Mean) for herds with less than 150 cows and herds with greater than or equal to 150 cows.

Herd size	Estimate	Comparison of methods of calculation		
		A versus B	A versus C	B versus C
Less than 150 cows	No match (%)	12.7	3.0	8.5
	Range (days)	2–117	5–61	2–61
	Mean (days)	6.3 ± 0.1	14.1 ± 2.0	6.8 ± 0.1
Greater than or equal to 150 cows	No match (%)	3.9	8.2	8.9
	Range (days)	2–13	1–32	1–32
	Mean (days)	2.8 ± 0.1	3.6 ± 0.2	3.8 ± 0.1

size of these herds ranged from 1 to 5,355 cows. The average herd size across all herds was 368 cows with a median herd size of 292 cows.

Data for herds with less than 150 cows

During the 2010 season, there were 963 herds with less than 150 cows. For these herds there was an average of 106 cows per herd (Table 1). The MSD differed in 12.7% of these herds when comparing Method B with the current method, Method A. These methods differed by an average of 6.3 days. The correlation (r^2) between the dates calculated as the MSD was 0.998. The MSD differed in 3.0% of these herds when comparing Method C with the current method, Method A. These methods differed by an average of 14.1 days ($P < 0.05$) and the correlation (r^2) between the dates calculated as the MSD was 0.998. The MSD differed in 8.5% of herds when comparing Method C with Method B. These methods differed by an average of 6.8 days and the correlation (r^2) between the dates calculated as the MSD was 0.998 (Table 2). It was found that for herds with less than 150 cows, Method D was unreliable due to the high degree of variation seen in the data. Hence, this definition was excluded from further analysis. Although there were no significant differences between any of these comparisons, the current method (Method A) was found to be the most accurate when methods were compared visually (Figure 1).

Data for herds with greater than or equal to 150 cows

During the 2010 season, there were 7,004 herds with greater than or equal to 150 cows. For these herds there was an average of 410 cows per herd (Table 1). The MSD differed in 3.9% of these herds when comparing Method B with Method A. These methods differed by an average of 2.8 days and the correlation (r^2) between the dates calculated as the MSD was 0.998. The MSD differed in 8.2% of these herds when comparing Method C with Method A. These methods differed by an average of 3.6 days and the correlation (r^2) between the dates calculated as the MSD was 0.994. The MSD differed in 8.9% of these herds when comparing Method C with Method B. These methods differed by an average of 3.8 days and the correlation (r^2) between the dates calculated as the MSD was 0.998 (Table 2). Although there were no significant differences ($P > 0.05$) between these comparisons, Method B was found to be the most accurate by visual assessment (Figure 1).

Comparison of the large and small herd data sets

When herds with less than 150 cows were compared with herds with greater than or equal to 150 cows, the average number of days with matings for the smaller herds of 31.1 days was not significantly different ($P > 0.05$) to that of the larger herds at 37.2 days (Table 1).

Discussion

The term 'mating start date' was used in preference to 'planned start of mating' throughout this paper as it was more correct considering this study was based on retrospective data. This decision also allowed the terminology to remain consistent with that used in the Fertility Focus Report.

True MSD

One weakness of this study is that the "true" values for the MSD were derived from insemination data. As such the derived variable may not in fact be the true MSD. One definition for the true MSD could be the first date where any cow that is observed in oestrus is inseminated. This means that on and after this date all cows in the herd are "at risk" of being inseminated. This date can be estimated from the insemination data available, but it can be argued that the "true MSD" cannot be known with certainty from the information available. Additional information, such as talking to farmers would be required. The insemination data can tell you which cows were mated each day, but it cannot tell you why a particular cow was mated. For example, a top cow may be contracted by a breeding company to be inseminated when she is observed in oestrus. This may occur prior to the MSD. Another example is a cow that calves, but for some reason is dried off and retained. It is then deemed to have been inseminated prior to the MSD. Depending on where these inseminations occur, relative to the "true" MSD, either situation could potentially trigger the MSD definition. If the insemination data for a herd are displayed graphically and then examined, potential outlier matings can be detected. An example would be the herd shown in Figure 1(c). The first day of mating in this case seems unlikely to be the true MSD as there is only a single mating event, which is less than the daily number of matings subsequently recorded and there are no inseminations on the subsequent day. A day without matings is unlikely to occur in the first three-weeks of the breeding season in a herd of more than 150 cows. Similarly, the example in Figure 1(d) appears to be a synchrony event, occurring two days prior to the "true" MSD event. If the MSD is defined as the date on which any cow that is observed in oestrus is inseminated then the MSD is correctly defined by excluding this date.

Small versus large herds

Small herds tend to have less structured breeding periods than larger herds. Hence, for herds with fewer than 150 cows, the methods for calculating MSD, that are effective for larger herds, are not always useful estimators. For example, the average number of days with matings for herds with less than 150 cows of 31 days was not significantly different to that of larger herds at 37 days. This was true in spite of the average herd size being significantly smaller at 106 cows compared with 410 cows, indicating that matings in smaller herds are more spread out (Table 1). This means there is a large degree of variation in the dates on which small herds could be mated (Bliss & Fisher 1953). The result of this is that many small herds have days within their mating period where there are no matings. This can affect the predicted MSD under many of the MSD definitions. Also, one mating is often 1% of the total herd matings for a small herd. Hence, using Method C for herds with less than 150 cows tended to select just the very first mating for a given herd. The range of the number of days difference between methods of calculating MSD were also much smaller for the larger herds then the small herds. For example, for herds with less than 150 cows, the range of days difference between estimates across all methods was 2 to 117 days. However, for herds with greater than or equal to 150 cows, the range of days difference between estimates was 1 to 32 days (Table 2). This shows that the methods of estimating MSD are more effective for larger herds. Hence, herds with fewer than 150 cows were analysed separately in this analysis.

The percentage of herds for which methods of calculating the MSD differed were between 3.0% and 12.7% for smaller herds and 3.9% to 8.9% for larger herds indicating a high level of agreement among all the definitions tested (Tables 2). This indicates that the true MSD has been found in most instances. From visual assessments of the AB mating data, the currently used four out of seven day definition for Method A was the most appropriate for calculating MSD in smaller herds. For larger herds of greater than or equal to 150 cows, the two consecutive and four out of seven days definition used in Method B was assessed as being a more accurate alternative for establishing the MSD from herd database records.

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