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Culling reasons in once-a-day milking cows and differences in production and type traits between retained and culled cows

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Abstract

The aim of this study was to investigate the culling reasons in cows milked once-a-day (OAD), evaluating the differences of production, fertility and traits other than production (TOP) between retained and culled cows. Cows in different lactations from Massey University Dairy 1 were scored for 18 TOP for three consecutive seasons from 2013 to 2015. Herd-test records were used to estimate milk yield (MY), fat yield (FY), protein yield (PY) and somatic cell score (SCS). Low fertility, poor udder conformation and low production were the main reasons for culling in all seasons. Overall, culled cows had a lower MY (3534±56 kg), FY (173.5±2.8 kg), PY (138.5±2.1 kg) and higher SCS (6.41±0.09) than retained cows (MY = 4006±41 kg; FY = 204.7±1.9 kg; PY = 160.6±1.5; SCS = 6.19±0.06). Culled cows had a poorer adaptability to milking (7.02 ± 0.04) and poorer farmer's overall opinion (7.62±0.06) than retained cows (7.23±0.03 and 7.89±0.04, respectively). Moreover, culled cows had a weaker udder support (5.56), weaker front udder (5.48) and lower rear udder (6.01) than retained cows (6.19, 5.85 and 6.25, respectively). These traits might have a higher influence on the culling decisions of OAD dairy farms than the age and production worth of cows.

Keywords: culling; milking frequency; traits other than production; conformation

Introduction

Full season once-a-day (OAD) milking has been adopted by approximately 5% of dairy farms in New Zealand (Stachowicz et al. 2014; Holmes 2016). The implementation of OAD milking has been associated with lifestyle and labour advantages for farmers (Stelwagen et al. 2013) and the improvement of some fertility and health parameters in the herd (e.g., higher submission rates, earlier conception rates, reduced incidence of sole lesions and white line disease in the hoof) (Clark et al. 2006; O'Driscoll et al. 2010). Conversely, a clear negative effect of a reduced milking frequency on production traits has been demonstrated in experimental trials in which cows milked twice-a-day (TAD) significantly outperformed those milked OAD (Tong et al. 2002; Clark et al. 2006). Nevertheless, this difference in production between OAD and TAD was smaller in studies in which production traits were analysed using a large number of commercial herds (Lembeye et al. 2016).

On the other hand, higher somatic cell counts (SCC) have been consistently found in OAD milking herds compared with TAD milking herds (Lacy-Hulbert et al. 2005; Clark et al. 2006), with the greatest difference observed in first-lactation cows (Lembeye et al. 2016). Furthermore, problems related with udder conformation and management during milking time have been reported in cows milked OAD, which could have important consequences on the culling decisions made in these herds (Holmes 2012; McCarthy 2012).

A particular tool that New Zealand dairy farmers use to determine the cows' performance and make culling decisions is the production worth (PW) index, which reflects the lifetime production ability of cows in dairy farms. Farmers could potentially take into account other factors like the health status or the suitability of cows for a particular milking system, the next expected calving date of the cow, and the expected future lifespan of the cow at the time of the culling decision (NZAEL 2009). It has been reported that New Zealand dairy cows are mainly culled because of poor reproductive performance and low milk production (Xu & Burton 2003). However, culling reasons in OAD milking herds have not been reported, and the production and type conformation of those cows that leave the farm have not been described.

The aim of this study was to investigate the culling reasons for OAD milking cows and the differences of production and type traits between retained and culled cows.

Materials and methods

Data

Data were obtained from the herd of Massey University Dairy 1, a pasture-based dairy farm located in Palmerston North, New Zealand. Individual milk samples were taken during several herd-tests to calculate the milk production of cows using the Livestock Improvement Corporation (LIC) herd-testing service. The first herd test for each season was carried out after all cows had calved, and subsequent herd-tests were performed approximately every 60 days. On average, each cow was tested eight times per season and the values for each lactation for milk yield (MY), fat yield (FY), protein yield (PY) and somatic cell count (SCC) were provided by LIC. The milk solids yield (MSY) was calculated from the sum of FY and PY. The somatic cell score (SCS) for each cow was estimated as $\log_2$ (SCC/1000) and then the average SCS was calculated as the mean for the multiple SCS obtained in the herd-tests. Live

weight (LWT) was recorded monthly using a walk-over weighing system; the values were then averaged. Indicators of the herd fertility were represented by submission rates of cows at 21 and 42 days after the start of each mating period (SR21 and SR42, respectively) and the interval, in days, from start of mating to first service (SMFS).

A total of 18 TOP were evaluated throughout October and November of each season. Four management traits: adaptability to milking, shed temperament, milking speed and overall opinion were scored by the herd manager, and 14 conformation traits: stature, weight, capacity, rump angle, rump width, legs, udder support, front udder, rear udder, front teat placement, rear teat placement, udder overall, dairy conformation and body condition score were scored by a TOP certified LIC inspector. The scores were given on a scale of 1 to 9. A description of each TOP was reported by DairyNZ (2014).

The breeding worth (BW) and production worth (PW) values for each cow were calculated by New Zealand Animal Evaluation Limited, a subsidiary of DairyNZ. The breed composition of all cows and their corresponding parents were recorded in 16ths. The status of purebred (F for Friesian or J for Jersey) was given to those cows with a breed composition ≥14th from either Friesian or Jersey breeds. Cows with a breed composition <14th from either Friesian or Jersey breeds were considered crossbred cows.

The specific cause of culling was determined for those cows removed from the herd during the study period of time from July 2013 to May 2016. The cause of culling was verified in the database of the farm and then confirmed with the manager of the herd.

Statistical analysis

All statistical analyses were performed using the statistical analysis system (SAS) version 9.3 (SAS Institute Inc., Cary, NC, USA, 2012).

Four different tests (Shapiro-Wilk, Kolmogorov-Smirnov, Anderson-Darling and Cramér-von Mises) showed that TOP variables were not normally distributed ($p<0.01$). A Snell transformation of TOP was implemented to reduce the departure from normality using the method described by Snell (1964). Average skewness and kurtosis of TOP using this approach were reduced by 50% and 32%, respectively.

Production traits, fertility traits and TOP were analysed using the MIXED procedure of SAS software with the following mixed linear model:

$$y_{ijklm} = \mu + S_i + B_j + L_k + C_l + SBC_{ijl} + b_l d + a_m + e_{ijkl};$$

where y_{ijkl} is the production, fertility or type trait; μ is the general mean; S_i is the fixed effect of the i^{th} season; B_j is the fixed effect of the j^{th} breed; L is the fixed effect of the k^{th} lactation number; C_l is the fixed effect of the l^{th} culling decision (culled or retained); SBC_{ijl} is the interaction between the fixed effects S_i, B_j and C_l; $b_l d$ is the regression coefficient for the covariation of days from median calving date of the herd in a given season; a_m is the animal random effect; e_{ijkl} is the random residual error.

The effects of season, breed, lactation number and culling on TOP were evaluated using the Snell scores previously obtained for all TOP. Therefore, P-values and significant differences between groups are based on analysis performed using Snell scores, while means and standard errors are based on actual (non-transformed) TOP scores to facilitate interpretation and discussion of results.

Results

The overall culling rates were between 21.0 and 24.7%. The main causes of culling for the entire three seasons in the herd of Massey University Dairy 1 were low fertility (37.2%), poor udder conformation (19.9%) and low production (12.8%). There were no particular trends over time for any culling reason, although it was observed that a higher percentage of cows was culled for low production and a lower percentage of cows was culled for udder conformation in 2013 compared with the other seasons (Table 1).

Cows removed from the herd had shorter lactations (226±2 days), lower MY (3534±56 kg/cow/year), FY (173.5±2.8 kg/cow/year), PY (138.5 kg/cow/year), and higher SCS (6.41±0.09) than cows retained in the herd (265±1 days in milk, MY = 4006±41 kg/cow/year, FY = 204.7±1.9 kg/cow/year, PY = 160.6±1.5 kg/cow/year, SCS = 6.19±0.06) (Table 2). Culled cows had a lower SR42 (97.7%) compared with retained cows (99.9%). Culled cows also had a lower BW (115±3 $/5tDM) compared to those that were retained in the herd (124±2 $/5tDM). No significant differences were found in the breed composition between retained and culled cows.

There were significant differences between culled and retained cows for both management and conformation TOP (Table 3). Cows that were retained in the herd had a better adaptability to milking and overall opinion (7.23±0.03 and 7.89±0.04, respectively) than culled cows (7.02±0.04 and 7.62±0.06, respectively). Likewise, legs of cows that were culled were more sickled/curved (6.23±0.06) than the legs from retained cows (6.11±0.03).

The most significant effects of culling were observed on udder-type traits. Culled cows had a poorer udder overall score (5.48±0.09) than retained cows (6.01±0.06). Cows that were retained in the herd had a stronger udder support (6.19±0.06) and front udder attachment (5.85±0.07) than those that were culled (5.56±0.09 and 5.48±0.10, respectively). Scores for rear udder were higher for retained cows (6.25±0.05) than culled cows (6.01±0.08). Moreover, culled cows showed lower scores (a wider separation) of their front teats (4.45±0.06) and also a lower score (wider separation) of their rear teats (5.87 ± 0.09) than cows that remained in the farm, which had their front and rear teats closer to the centre of the quarters (4.67±0.04 and 6.10±0.06, respectively).

Table 1 Frequency of different culling reasons for three seasons in the herd of Massey University Dairy 1.

	2013		2014		2015		Total	
	N	%	N	%	N	%	N	%
Cows at the start of the season	172		247		262		681	
Culling reason								
Abortion	0	0.0	2	3.3	4	7.3	6	3.8
Died	1	2.5	8	13.1	1	1.8	10	6.4
Low production	8	20.0	4	6.6	8	14.6	20	12.8
Legs/foot related problems	1	2.5	1	1.6	2	3.6	4	2.6
Mastitis	2	5.0	2	3.3	3	5.5	7	4.5
Fertility[1]	14	35.0	19	31.2	25	45.5	58	37.2
Other causes	2	5.0	2	3.3	2	3.6	6	3.8
High somatic cell count	5	12.5	0	0.0	4	7.3	9	5.8
Management[2]	1	2.5	4	6.6	0	0.0	5	3.2
Udder conformation	6	15.0	19	31.2	6	10.9	31	19.9
Total	40	100	61	100	55	100	156	100.0
Culling rate		23.3		24.7		21.0		22.9

[1]Empty status.
[2]Poor shed temperament or slow milking speed.

Table 2 Production traits, fertility traits and herd characteristics of retained and culled cows from Massey University Dairy 1 over three seasons.

	Retained		Culled		P-value
	Mean	SE[9]	Mean	SE[9]	
Production					
Days in milk	265	1	226	2	<0.01
Milk yield, kg	4006	41	3534	56	<0.01
Fat yield, kg	204.7	1.9	173.5	2.8	<0.01
Protein yield, kg	160.6	1.5	138.5	2.1	<0.01
SCS[1]	6.19	0.06	6.41	0.09	0.03
Live weight, kg	478.7	2.13	479.0	2.76	0.93
Fertility					
SR21, %[2]	95.7	1.1	94.1	1.9	0.46
SR42, %[3]	99.9	0.5	97.7	0.8	0.02
SMFS, days[4]	10.74	0.38	10.73	0.66	0.99
Herd characteristics					
Age	5.06	0.01	5.07	0.02	0.83
BW, $/5tDM[5]	124	2	115	3	<0.01
PW, $/5tDM[6]	150	4	134	8	0.09
F[7]	0.51	0.01	0.50	0.01	0.52
J[8]	0.48	0.01	0.48	0.01	0.84

[1]SCS = somatic cell score calculated as $\log_2$ (somatic cell count).
[2]SR21 = submission rate at 21 days after the start of mating.
[3]SR42 = submission rate at 42 days after the start of mating.
[4]SMFS = interval from start of mating (SM) to first service.
[5]BW = Breeding worth.
[6]PW = Production worth.
[7]F = Proportion of Friesian.
[8]J = Proportion of Jersey.
[9]SE = standard error.

Discussion

The overall culling rate in cows milked OAD for the three seasons (23%) was higher than the overall culling rate reported by Xu and Burton (2003) in New Zealand dairy cows milked TAD (19.3%). The percentage of cows that were removed from the farm because they were empty was lower in cows milked OAD (37.2%) than that observed in TAD milking farms (44.8%) by Xu and Burton (2003), while the percentage culled due to low milk production was slightly lower in OAD milking cows (12.8%) than in TAD milking cows (15.9%). Although, poor productive and reproductive performance were also the main culling reasons found in the study of Xu and Burton (2003) where cows were milked TAD over three seasons, the percentage of cows culled for udder conformation-related reasons was much higher in the present study than that observed in TAD milking cows (19.9% vs 2.9%) (Xu & Burton 2003). Compton et al. (2016) found a higher incidence risk of culling in cows that had reproductive and udder-related problems in New Zealand TAD milking herds. However, these udder-related problems included mainly clinical or subclinical mastitis, with no specification of the percentage of cows culled for udder conformation reasons. Previous studies had shown that undesirable udder conformation accounted for only 0.7% of the culling reasons in New Zealand dairy cows (Xu & Burton 2000). The high culling rate for udder conformation observed in the present study might indicate the greater importance of udder traits when making culling decisions on OAD dairy farms.

It is important to note that the lower proportion of cows culled due to low fertility could be giving the OAD dairy farmers the chance to apply more selection pressure to other traits (e.g., TOP).

The percentage of cows culled for other udder-related reasons was lower than the percentage of cows culled for udder conformation in this study. Xu and Burton (2003) observed that in TAD dairy farms, 3.8% and 3.7% of cows were culled for mastitis and high somatic cell count, respectively, which are lower percentages than those observed in the present study (4.5% and 5.8%, respectively). This could be related to the higher somatic cell score observed in cows milked OAD when compared to those milked TAD (Lacy-Hulbert et al. 2005; Clark et al. 2006; Lembeye et al. 2016), and might have

Table 3 Scores for traits other than production of retained and culled cows from Massey University Dairy 1 over three seasons.

Trait	Retained		Culled		P-value
	Mean	SE[1]	Mean	SE[1]	
Adaptability to milking	7.23	0.03	7.02	0.04	0.01
Shed temperament	8.01	0.02	7.96	0.02	0.16
Milking speed	6.59	0.03	6.43	0.05	0.39
Overall opinion	7.89	0.04	7.62	0.06	<0.01
Stature	6.31	0.05	6.27	0.07	0.62
Weight	5.33	0.05	5.36	0.07	0.68
Capacity	7.02	0.04	7.08	0.07	0.33
Rump angle	4.11	0.04	4.05	0.06	0.38
Rump width	6.37	0.05	6.45	0.08	0.42
Legs	6.11	0.03	6.23	0.06	<0.05
Udder support	6.19	0.06	5.56	0.09	<0.01
Front udder	5.85	0.07	5.48	0.10	<0.01
Rear udder	6.25	0.05	6.01	0.08	0.02
Front teat placement	4.67	0.04	4.45	0.06	<0.01
Rear teat placement	6.10	0.06	5.87	0.09	0.02
Udder overall	6.01	0.06	5.48	0.09	<0.01
Dairy conformation	7.06	0.04	6.95	0.06	0.21
Body condition score	4.48	0.02	4.50	0.03	0.83

[1]SE = standard error.

had an influence on the culling decisions of OAD herds as shown by the significant difference in the SCS between retained (6.19±0.06) and culled cows (6.41±0.09) in the present study.

Leg-related problems and management traits (e.g., shed temperament, milking speed) were the least common culling reasons (2.6% and 3.2%, respectively). Similarly, Xu and Burton (2000) showed that feet and leg problems accounted for 3.1%, while slow milking and poor temperament accounted for 1.5% and 1.2% of the culling reasons in TAD dairy farms. An extension of this study using a larger dataset found that 3.0% of cows milked TAD in New Zealand were culled due to slow milking and poor temperament (Xu & Burton 2003). This, in part, agrees with the results of the present study, since there were no differences in the shed temperament and milking speed between retained and culled cows, however, a lower score for leg conformation was observed in retained cows.

The differences observed between retained and culled cows corroborate the main culling reasons found in Massey University Dairy 1. Overall, culled cows had poorer fertility, lower milk production and less desirable scores for udder traits. Nevertheless, detailed differences between retained and culled cows are more informative than the main farmer-attributed causes of culling. For instance, retained cows had a better adaptability to milking and overall opinion, which is expected as these traits relate to the management of the cows and describe how well they fit into the milking routine (DairyNZ 2014). The higher SR42 in retained cows is, in part, expected as cows that are submitted earlier for artificial insemination have more chance of achieving a 365-day calving interval, a constraint inherent to the New Zealand seasonal milking system (Blackwell et al. 2010). Cows with no submission by this time will be more likely to be culled and this explains the significantly lower SR42 of culled cows in the present study.

The significant differences for udder traits found between retained and culled cows indicate that those cows with weaker udder support, weaker front udder and lower rear udder are less desirable for OAD milking. Additionally, cows with front and rear teats closer to the centre of the quarters (as viewed from the rear) would be preferred for OAD. The importance of udder conformation to the survival of dairy cows has been shown in New Zealand (Winkelman et al. 2000; Berry et al. 2005) and overseas dairy cattle (Larroque & Ducrocq 2001; Caraviello et al. 2004; Zavadilová et al. 2011; Sasaki 2013). The particular importance of udder traits in the culling decisions of herds milked OAD might be due to the effect of the reduced milking frequency on the suspensory system in the mammary gland. There is greater udder distension in OAD cows due to the larger volume of milk accumulated since the previous milking. This has been evidenced by milk leaking prior to the morning milking and higher udder firmness scores observed in cows milked OAD during the first third of lactation and close to peak production (Gleeson et al. 2007).

There were no significant differences for age, breed proportion and PW between retained and culled cows. As the results of other studies suggest, cows with lower PW or with an old age in New Zealand dairy farms would be expected to leave the herd sooner than younger cows with a higher PW (Xu & Burton 2003; Clark et al. 2013). However, low fertility and poor udder conformation might have a larger influence than the age and PW of cows on the culling decisions of OAD milking herds.

Conclusion

Low fertility and poor udder conformation were the most important culling reasons in cows milked OAD. Adaptability to milking, overall opinion and leg conformation have an influence on the survival of cows milked OAD, even when these traits are not listed as the main culling reasons. Management traits (e.g., adaptability to milking, overall opinion) and udder conformation might have a higher influence than the age, breed and production worth of cows on the culling decisions of OAD dairy farms.

Acknowledgements

The principal author acknowledges the support from the MFAT through its New Zealand Aid Programme and

the data provided by Massey University (Palmerston North, New Zealand).

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