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AGE AT FIRST CALVING AND ITS RELATIONSHIP WITH OTHER DAIRY TRAITS IN HOLSTEIN CATTLE IN AUSTRALIAN HERDS

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SUMMARY

Data on age at first calving (AFC) of Holstein cows were analysed to estimate genetic and environmental parameters and its association with other dairy traits. The analyses showed that the heritability of AFC is 0.02. Genetic correlations between AFC and other dairy traits were favourable and small in size (-0.15 to -0.19) showing that heifers that calve earlier produce more milk and also have a better chance of surviving to second lactation. Environmentally, however, the correlations between milk yield traits and AFC were positive. Both the genetic and environmental correlations of AFC with pregnancy were unfavourable. The estimated genetic trend showed that AFC is reducing by 0.2 days per year over 15 years possibly as a result of a correlated response to selection for milk yield traits.

INTRODUCTION

Age at first calving (**AFC**) is an important trait that affects profitability of dairy herds. A recent US study shows that rearing cost represents 15 to 20% of the total expense of milk production (Cole and Null 2010). By reducing AFC the net costs of rearing dairy replacements can be reduced significantly. For example, decreasing AFC from 25 to 21 months reduced rearing cost by 18% (Tozer and Heinrichs 2001) in US herds. However, changing AFC may affect functional and production traits. For example, a recent study based on Australia data (Haile-Mariam *et al.* 2010) showed that a cow's lifetime net income is associated with AFC because calving at an older age increased the chance of culling .The main factors that affect AFC are management factors such as heifer rearing practices which affect growth rate and age at puberty, and breeding practices which affect success of pregnancy after mating. However, intense genetic selection for milk production may affect liveweight and age at puberty (Macdonald *et al*. 2007) which in turn may affect AFC. In addition when heifers are managed and fed similarly to achieve a uniform growth rates and reproductive efficiency, variability in AFC is observed. In several developed dairy industries genetic evaluation for AFC is not part of the routine genetic evaluation system with the exception of Canada where age at first service is used (Jamrozik *et al.* 2005) and Ireland (Berry *et al.* 2010). According to Cole and Null (2010) routine genetic evaluation for AFC could be used as an additional tool for managing fertility. In Australia, information on the extent of variability in AFC and sources of the variability are lacking. Knowledge of genetic and environmental factors that affect AFC and its relationship with other traits can help to make better decisions. The objectives of this study were: 1) to document variation in AFC in Australia herds and, 2) to understand the genetic and environmental factors that affect AFC and to examine the relationship between AFC and other dairy traits.

MATERIALS AND METHODS

Milk yield, calving and survival data of Holstein cows that first calved between 1994 and 2009 was extracted from Australian Dairy Herds Improvement Scheme database. Cows with AFC between 18 and 36 months were selected. AFC data of cows born to progeny test bulls were excluded by selecting cows from bulls that were at least 5 years old when their daughter were born for this study. The bases for this decision were an earlier study by Visscher and Goddard (1995) and a preliminary analysis based on the current data which showed some confounding between the time of year young sires were used and the time of year that their progeny were born. The animals used for this study were from 345086 dams and 4759 sires and 3964 herds.

First, genetic parameters of AFC were estimated based on about 500 000 AFC fitting herd-year-season of birth, month of calving and month of birth and age at calving of their dam when the heifer with the data was born as fixed effect and animal as a random effect. There were about 1.6 million animals in the additive relationship matrix. Dam age varied between 20 and 165 months of age. The same data were used to estimate genetic and environmental correlations of AFC with 305-day milk yield traits, calving interval, pregnancy rate, calving to first service interval, survival and lactation length using sire model instead of animal model. The genetic and environmental correlations were estimated in bi-variate analyses fitting the same model as above for AFC and herd-year-season of calving and month of calving for the other traits. A larger dataset of about 1 million cows was used to calculate estimated breeding values (EBVs) for AFC and were used to estimate genetic trend. The genetic trend was calculated by regressing EBVs on the year of birth of bulls with 20 or more progeny.

RESULTS AND DISCUSSION

The average AFC in all herds was 26 months and varied from 25 months in seasonal calving herds to 29 months in year-round calving herds. As expected in seasonal calving herds most (i.e. 66%) cows calved at the age of 24 or 25 months. These estimates are close to the average AFC in US Holsteins (~ 25.9 to 26.9 months) reported by Hare *et al.* (2006) and Cole and Null (2010). All the fixed effects fitted in the model affected AFC in the current study. The age of the dam when her daughter was born affected the AFC of the daughter. However, the magnitude of this effect was small. AFC of cows from dams that calved at 20-months of age was about 8 days longer than those that were from dams that were 165 months old.

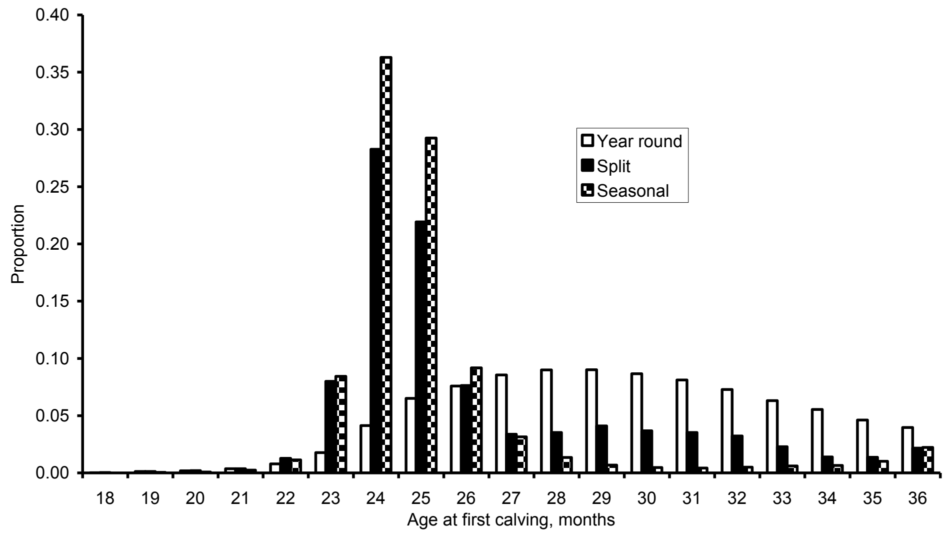

Figure 1. Proportion of heifers that calved at different ages for the first time in seasonal, split and year-round calving herds.

Months of first calving and month of birth had a substantial effect on AFC. Heifers that calved in the main calving season in South Eastern Australian (mainly July and August) calved about a month earlier compared to heifers that calved between October and December. The AFC of heifers that calved for the first time at the end of the year (i.e. November and December) was about 10 days later than an average heifer. The effect of month of birth was smaller compared to the effect of month of calving with heifers born in the second half of the year (August to January) calving earlier than heifers born between February and April.

The heritability (h^2) of AFC was low at 0.023±0.002 and is similar to a recent US estimate for Holstein cattle (Cole and Null 2010). Literature estimates of h^2 for Holstein cattle vary from 0.02 (VanRaden and Klaaskate 1993) to 0.47 (Ruiz-Sánchez *et al.* 2007). Genetic and environmental correlations between AFC and other dairy traits (Table 1) were low. Literature estimates of phenotypic correlations between AFC and milk yield traits vary from small negative (e.g. Ojango and Pollott 2001) to small positive (e.g. Moore *et al.* 1991). As in the present study most genetic correlation estimates between AFC and milk yield traits were negative. However, Grosshans *et al.* (1997) also reported positive genetic and phenotypic correlation between AFC and milk yield in pasture based production system in New Zealand.

Table 1. Genetic and environmental correlation between age at first calving and other traits

Traits	Correlation	
	Genetic	Residual
Milk yield	-0.15±0.06	0.15±0.0
Fat yield	-0.19±0.06	0.19±0.0
Protein yield	-0.16±0.06	0.19±0.0
Fat percent	-0.07±0.06	0.04±0.0
Lactation length	0.09±0.09	-0.02±0.0
Survival	-0.16±0.08	-0.04±0.0
Calving interval	0.20±0.08	-0.03±0.0
Calving to first service	-0.01±0.17	-0.01±0.0
Pregnancy rate	-0.38±0.17	-0.03±0.01

Cows that are older at first calving produced more protein yield (Figure 2) than cows with AFC of 18 to 20 months. In general milk yield traits increased with AFC. Survival of cows that calved before 21 and after 25 months was lower than cows with AFC of 23 to 25 months (Figure 2). Cows that calved at 24 to 27 months of age had shorter calving interval than cows that calved before 24 months of age. In general the relationship of AFC with survival and calving interval may be linked with the desired of farmers to achieve a strict seasonal calving system. The genetic correlation between AFC and pregnancy rate is unfavourable, though it was estimated with a relatively large standard error. Small but unfavourable correlation was also estimated with conception rate based on US data (Cole and Null 2010). The genetic and environmental trend in AFC is favourable so that in both cases AFC is declining over the years. The environmental trend was quite variable with wide variation over the years (1992-2006) considered in this study. The range in EBVs of 1464 bulls born between 1971 and 2001 with at least 20 or more daughters varied from +23 to -14 days with an average of 7. The wide variation in EBV of bulls suggests that there is a scope for selection if desired. Currently AFC is reducing by about 0.2 days per year. This decline which is higher than a 0.1 day per year reported by Cole and Null (2010) for US Holstein may be due to a correlated response to selection for milk yield. Assuming that AFC is a proxy for age at puberty these results and the genetic correlation estimates do not support that results of Macdonald *et al*. (2007) who found that age at puberty were delayed in highly selected North American Holstein compared to less selected New Zealand Friesian of the 1970s.

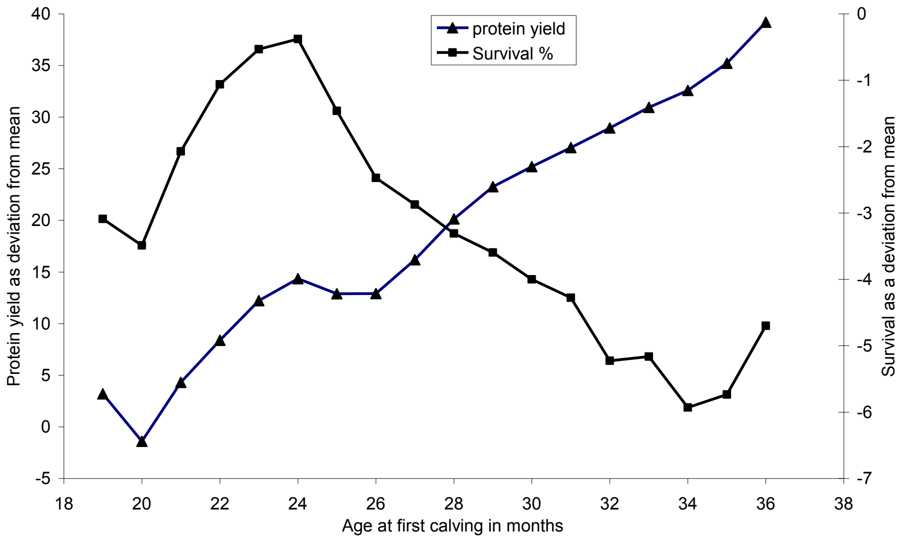

Figure 2. Effect of age at first calving on 305-day protein yield (kg) and survival to second lactation (%).

CONCLUSIONS

In Australia, the ability of dairy farmers to manage AFC seems to be reasonably good but relationships with other traits show that increasing the proportion of cows with AFC close to 24 months may be advantageous particularly in seasonal calving herds. Genetic correlations between AFC and other traits are favourable but the correlation with pregnancy rate needs to be monitored.

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