GENETIC PARAMETERS FOR FERTILITY TRAITS IN SOUTH AFRICAN HOLSTEIN COWS

C.J.C. Muller [*], S.W.P. Cloete [†], J.P. Potgieter[†*] & O. Zishiri[†]

Introduction

Breeding and selection programmes in South African Holstein herds have for many years focused on milk yield and conformation. Several studies worldwide have reported declines in the reproductive performance of dairy cows (Royal *et al.*, 2002; Berry *et al.*, 2003). Similarly, in South African Holsteins, calving interval (CI) increased from 386 days in 1986 to 412 days in 2004 (Makgahlela, 2008). Limited research in this regard has been conducted for the local dairy industry. Genetic parameters for some fertility traits have been estimated for small data sets for Jersey (Potgieter *et al.*, 2004) and Holstein (Muller *et al.*, 2006) cows. The number of lactation records used was 2639 and 3642 for 751 Jersey and 1375 Holstein cows respectively. Heritability estimates for key fertility traits were within the range of estimates from overseas studies. Recently, estimated breeding values for CI have been determined for local Holstein and Jersey cows and are presented in herd profiles to dairy farmers (Mostert, 2009). However, alternative traits to CI could be used to better indicate fertility in dairy cows. González-Recio & Alenda (2005) defined three groups of fertility traits, i.e. (1) days to first service, (2) traits that indicate pregnancy rate like number of inseminations per lactation, interval between first and last insemination, confirmed pregnancy within 56 or 90 days after first insemination and (3) composite traits like CI, days open and pregnancy rate. As farmers routinely record insemination dates and pregnancy examination results for management purposes, it is possible to determine these traits. In this study, genetic parameters for alternative reproduction traits to CI are presented.

Material and methods

Animals and location: All artificial insemination (AI) records (n=69 181) of cows that had calved down in the period between 1983 and 2008 in 14 South African Holstein herds were used. A total of 24 646 lactation records from 9 046 individual cows were available. The outcome of each AI event was recorded. Insemination records were linked to each cow's calving date, lactation number, dam and sire identification numbers. From calving and AI dates, the following traits were determined, i.e. the interval from calving date to first service date (CFS, days), the interval from calving date to conception date (DO, days), the number of inseminations per conception (AIPC) and success (cows becoming pregnant during a specific lactation irrespective of the number of inseminations). Before analyses, records with missing

Western Cape Department of Agriculture, Institute for Animal Production, Private Bag X1, Elsenburg 7607. South Africa

[†] Department of Animal Sciences, University of Stellenbosch, Stellenbosch 7600. South Africa

sire and dam identification number were removed from the data set, resulting in a data set of 19 200 records suitable for analysis.

Statistical analyses: The data were analysed using a four-trait threshold-linear animal model. The fixed effects that were fitted were herd-year-season and lactation number. The four traits analysed were CFS, DO, number of AI's per conception (AIPC) (all linear) and success (as a binary threshold trait, coded as 2=pregnant and 1=not pregnant. The model included the random effects of animal and animal permanent environment (PE). The software used was THRGIBBS1F90 (Misztal, 2008). A single chain of 300 000 cycles was run, with the first 70 000 used cycles as the burn-in period. This was followed by post Gibbs analysis, using POSTGIBBSF90 (Misztal *et al*., 2002). Posterior means were used to calculate the heritability and animal PE variance ratios for each trait. Genetic, animal PE and residual correlations were calculated accordingly.

Results and discussion

In Table 1 a summary of the records used in the analyses is presented. The study also provides a first time opportunity to get an overall description of the standard of reproduction management in dairy herds. Parameters could be compared to similar surveys from other countries. Cows became pregnant during most lactations (Success=0.85) although the interval from calving to conception was high and variable at 146.1±95.5 days. This means that CI would be long (>14 months). Only 41 and 82% of lactations resulted in a confirmed pregnancy within 100 and 200 days post calving.

Table 1. Number of records, means and SD, minimum and maximum values for interval from calving to first service (CFS), interval from calving to conception (DO), number of inseminations per conception (AIPC) and success rate

Trait	Number of records	Mean	SD	Minimum	Maximum
CFS	19200	79.1	35.5	32	560
DO	16765	146.1	95.5	32	727
AIPC	16307	2.60	1.91	1	10
Success	19200	1.85	0.36	1	2

The number of inseminations per conception for all cows was 2.60±1.91 indicating an insemination efficiency of 0.38. The interval from calving to first service was 79.1±35.5 days with 61% of intervals within 80 days post calving. From a survey conducted in Australia, most indicators show a poor reproductive efficiency. AIPC in the present study exceeded 2.32, which is an AI efficiency of 43% (Morton *et al*., 2003). De Vries & Risco (2005) showed that CFS increased from 84 days in 1983 to 104 days in 2001.

Heritability (h^2) estimates (Table 2) were 0.06±0.02, 0.08±0.02, 0.07±0.02 and 0.08±0.02 for CFS, DO, AIPS and success, respectively. González-Recio & Alenda (2005) found h^2 estimates of 0.05, 0.04, and 0.02 for similar traits, i.e. number of days to first service, days open and number of inseminations per service period. In a further study by González-Recio *et al*. (2006), similar h^2 estimates were found. These results are in agreement with a number of other researchers using different statistical models (Haile-Mariam *et al*., 2004; Veerkamp *et al*., 2001; Kadarmideen *et al*., 2003).

Table 2: Variance components, posterior standard deviations (PSD) and variance ratios (±s.e.) for days from calving to first service (CFS), interval from calving to conception (DO), number of inseminations per conception (AIPC) and success on the underlying scale in Holstein cows

Parameter	CFS	DO	AIPC	Success
Direct additive variance	63.38	704.1	0.311	0.102
PSD	10.55	137.0	0.059	0.022
Animal PE	18.89	1099.0	0.477	0.090
PSD	7.66	160.3	0.068	0.026
Residual variance	954.30	7227.0	3.893	1.011
PSD	11.42	150.3	0.052	0.015
Heritability (h^2 ± s.e)	0.06 ± 0.02	0.08 ± 0.03	0.07 ± 0.03	0.08 ± 0.04
Animal PE (c^2 ± s.e)	0.02 ± 0.01	0.12 ± 0.03	0.10 ± 0.03	0.08 ± 0.04

The genetic correlation between CFS and DO was positive, indicating cows inseminated later into the lactation had a longer interval from calving to conception (Table 3). Similarly, the success rate was negatively correlated with CFS. As expected, the genetic correlation between AIPC and success was highly negative indicating that cows with a high number of inseminations would have a reduced change of becoming pregnant. The genetic correlations in the present study seem to be lower than correlations obtained by González-Recio *et al*. (2005). The genetic correlations of CFS with DO and of CFS and pregnancy rate were respectively 0.82 and -0.82, compared to 0.56 and -0.29 in the present study. The correlation between pregnancy rate and number of AI's per service period was -0.94 as compared to -0.85 in the present study. Kadarmideen *et al*. (2003) and Veerkamp *et al*. (2001) correspondingly reported high correlations among reproduction traits, ranging from absolute values of 0.70 to 0.98.

Table 3: Genetic, animal permanent environment (PE) and residual correlations among the fertility traits, interval from calving to first service (CFS), interval from calving to conception (DO), number of AI's per conception (AIPC) and success in Holstein cows

Trait 1	Trait 2	Genetic	PE	Residual
CFS	DO	0.56 ± 0.30	0.49 ± 0.44	0.28 ± 0.02
	AIPC	-0.01 ± 0.01	0.32 ± 0.40	-0.08 ± 0.02
	Success	-0.29 ± 0.16	-0.70 ± 0.22	-0.04 ± 0.03
DO	AIPC	0.81 ± 0.34	0.93 ± 0.25	0.83 ± 0.03
	Success	-0.79 ± 0.33	-0.90 ± 0.36	-0.56 ± 0.04
AIPC	Success	-0.85 ± 0.34	-0.87 ± 0.39	-0.05 ± 0.04

Conclusion

This study indicated that reproduction management of South African dairy cows is generally below expectations and variable. Low h^2 estimates for these traits were found, although these estimates were consistent with other studies. The genetic correlations among traits were consistent with expectations, i.e. positive between CFS and DO and negative between AIPC and success. Although low h^2 estimates were derived, it is expected that high levels of phenotypic variation will assist genetic progress if selection pressure is placed on reproductive traits. Worthwhile genetic progress may thus accrue if directed selection is applied consistently. A trait like DO may be considered, as it is favourably related to the other traits, like CFS, AIPC and eventual success.

References

Berry, D.P., Buckley, F., Dillon, P. *et al*. (2003). *J. Dairy Sci*., 86:2193-2204.

De Vries, A. and Risco, C.A. (2005). *J. Dairy Sci*., 88:3155-3165.

González-Recio, O. & Alenda, R. (2005). *J. Dairy Sci*., 88:3282-3289.

González-Recio, O., Alenda, R., Chang, Y.M. *et al*. (2006). *J. Dairy Sci*., 89:4438-4444

Haile-Mariam, M., Bowman, P.J. and Goddard, M.E. (2004). *Austr. J. Agric. Res*., 55:77-87.

Kadarmideen, H.N.R., Thompson, R., Coffey, M.P. *et al*. (2003). *Livest. Prod. Sci*., 81:183-195.

Makgahlela, L. (2008). National Milk Recording Scheme. Newsletter No 13. page: 20.

Misztal, I. (2008). *J. Anim. Breed. Gen*., 125:363 - 370.

Misztal, I., Tsuruta, S., Strabel, T. *et al*. (2002). In *Proc. 7th WCGALP*, volume 33: pages 743-744.

Morton, J., Larcombe, M. and Little, S. (2003). The InCalf book for dairy farmers. page. 28.

Mostert, B. (2009). National Milk Recording Scheme. ARC Irene. South Africa.

Muller, C.J.C., Cloete, S.W.P., Potgieter, J.P. *et al*. (2006). SASAS Congress, 3-6 April 2006. Bloemfontein. South Africa. page. 9.

Potgieter, J.P., Muller, C.J.C., Cloete, S.W.P. *et al*. (2004). 2nd Joint Congress of GSSA and SASAS, 28 June – 1 July 2004. Goudini. South Africa. page. 121.

Veerkamp, R.F., Koenen, E.P.C. and De Jong, G. (2001). *J. Dairy Sci*., 84:2327-2335.

Royal, M.D., Pryce, J.E., Woolliams, J.A. *et al*. (2002). *J. Dairy Sci*., 85:3071-3080.