REPRODUCTION TRAITS IN HOLSTEIN COWS: TOWARDS THE DEVELOPMENT OF A GENETIC EVALUATION SYSTEM FOR COW FERTILITY

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SUMMARY

Profitable milk production and genetic improvement in dairy herds depend largely on an efficient reproduction programme. The fertility in dairy herds is becoming a major issue as several studies indicate declines in the reproductive performance of dairy cows. Farmers use calving interval (CI) and number of inseminations per conception (AIPC) as indicators of reproduction management efficiency. Using these traits as cow fertility indicators is problematic as CI is dependant on subsequent calving dates while AIPC is strongly linked to inseminator proficiency. In this paper non-genetic factors affecting alternative reproduction traits to CI in Holstein cows are discussed. Means±sd for interval traits, calving to first insemination, breeding period, calving to conception were 79±30, 118±83 and 133±72 days, respectively. First insemination success rate, first insemination within 80 days after calving, pregnancy rate within 100, 150 and 200 days after calving and overall success rate was 0.39, 0.61, 0.42, 0.68, 0.83 and 0.85, respectively. While lactation number, calving year and calving month affected reproduction traits significantly, herds (managers) had the largest effect. Genetic parameters have been estimated for these fertility traits showing a genetic effect on reproductive performance.

INTRODUCTION

Breeding and selection programmes in dairy herds in South Africa have always focused mainly on the improvement of milk yield and conformation traits. Although the reproductive performance of dairy cows affects a herd's profitability, local dairy farmers have put little emphasis into the improvement of cow fertility. At best, non-pregnant cows will be culled because of reproductive failure after a considerable number of inseminations, hormonal treatment sessions and natural service resulting in a protracted breeding period. In South African Holsteins, calving interval (CI) increased from 386 days in 1986 to 412 days in 2004 (Makgahlela 2008). Recently, Mostert *et al.* (2010) reported on genetic parameters for calving interval for the four major dairy breeds in South Africa. Haile-Mariam and Goddard (2007) pointed out that while CI is used for the genetic evaluation of dairy cow fertility, cows not calving again or cows culled for poor fertility, are excluded from the evaluation. This means that information on the least fertile group of cows is excluded possibly leading to inaccurate estimated breeding values for their sires. Using AI dates and the results of pregnancy examinations, additional information regarding the reproductive performance of dairy cows is obtained. From such information, genetic parameters for some fertility traits have been estimated for a small data set, i.e. 3642 lactation records of 1375 Holstein cows (Muller *et al.* 2006). Heritability estimates for key fertility traits were within the range of estimates from overseas studies. Recently, breeding values for a number of alternative reproduction traits have been published for Holstein cows (Muller *et al.* 2010) using a larger data set. Non-genetic factors affecting alternative reproduction traits to CI in Holstein cows are presented in this paper.

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MATERIAL AND METHODS

Data. This study was based on *ca*. 68590 AI records and pregnancy examination results of 24726 lactation records of 7980 Holstein cows calving down between 1983 and 2008 in 15 South African Holstein herds. Pregnancy diagnosis was based on rectal palpation by a veterinarian, usually on a monthly farm visit making it possible to determine the outcome of each AI event. Using all AI records for each cow and the result of following pregnancy tests, reproductive traits were determined for each cow: the interval from calving date to first AI date (C-1st AI), whether first AI occurred within 80 days after calving (yes = 1 and no = 0), the interval from calving date to conception date (DOPEN), number of inseminations per conception (AIPC), whether cows became pregnant within 100, 150 or 200 days after calving (yes = 1 and no = 0 for all traits), first AI success rate, breeding period (the interval from calving date to last AI date minus a voluntary waiting period of 32 days), the average number of days between heats, heat detection rate (HDR%) and AI success (all AI's resulting in a pregnancy). Reproduction records exceeding accepted biological norms for various parameters were not used.

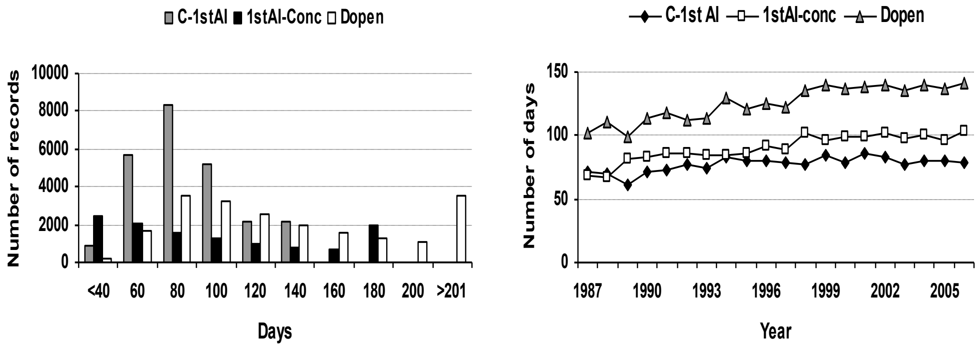
Statistical analyses. Reproduction traits were analysed using the GenStat Seventh Edition software (Lawes Agricultural Trust 2007). The REML Linear Mixed Models (LMM) procedure was implemented for continuous traits and the Generalized Linear Mixed Model (GLMM) procedure was used for binomial traits via a LOGIT link back transformation. Significant ($P<0.05$) fixed effects that were subsequently incorporated into the final model were herd (15 levels), year of calving (26 levels), month of calving (12 levels) and lactation number (13 levels). The GLMM models included herd as a random factor (De Vries and Risco 2005). Least square mean estimates and REML solutions for the significant fixed effects were also derived.

RESULTS AND DISCUSSION

Although most (0.85) cows became pregnant, the interval from calving to conception (OPEN) was high and variable at 133±72 days. The number of AI's per conception was also high (2.48±1.80) indicating less than average insemination efficiency (0.40) (Table 1). The AIPC is higher than values (1.85) reported by Haile-Mariam *et al.* (2004). Although average values for some traits were acceptable, large variations were observed as indicated by high standard deviations, i.e. 0.38 and 0.73 for the interval trait C-1stAI and AIPC respectively. The interval from C-1stAI was 79.2±30.3 days with 61% of animals being inseminated for the first time within 80 days postpartum. The pregnancy rate from first AI was 39%. Only 42 and 83% of all cows were confirmed pregnant within 100 and 200 days postpartum. In comparison to an Australian survey (Little 2003), observed results indicate reproductive management problems in herds surveyed.

Table 1. Description of raw data based on AI records of cows in 15 Holstein herds

Variables	Number of records	Mean	SD	Range
Lactation number	24726	2.62	1.67	1-13
Age at first calving (months)	7451	27.6	3.3	18-42
Interval from calving date – first AI (days)	24454	79	30	21-240
Interval from calving date to conception (days)	20639	133	72	21-400
Number of inseminations per conception	20624	2.48	1.80	1-12
Breeding period (days)	23278	118	83	21-440
Average days between heats	24159	44	23	8-150
Heat detection rate (%)	24159	0.57	0.23	0.14-1.00



(a) (b)

Figure 1. The distribution of the number of records (a) and the annual trends for interval traits calving date to first insemination (C-1st AI), first insemination to conception (1stAI-Conc) and calving date to conception (DOPEN) with time (b)

While the interval C-1stAI was less than 100 days in 82% of cases, the first AI success rate was less than 40% resulting in a long 1stAI-conc interval resulting in a high number of days open. Only 42% of DOPEN intervals were concluded within 100 days post calving, while 17% dragged on for longer than 200 days after calving.

The effect of herd, year of calving, month of calving and lactation number on fertility traits is presented in Table 2. Herd had the largest effect on the variation within traits. This is probably related to management style and inseminator proficiency.

Table 2: The effect of herd, year of calving, month of calving and lactation number on fertility traits for Holstein cows (C-1stAI = interval from calving date to first AI date; 1stAI–conc = interval from first AI date to conception)

Traits	Fixed effects			
	Herd	Calving year	Calving month	Lactation number
Degrees of freedom	14	25	11	12
C-1st AI	4626.00**	325.43**	60.87**	186.66**
1st AI-conc	621.00**	139.75**	22.20*	5.17[1]
Days open	942.64**	255.88**	36.45**	10.83**
AI's per conception	1007.22**	250.25**	39.14**	91.77**
Breeding period	1218.63**	356.82**	28.93**	23.31*
Average days	3543.08**	270.58**	36.64**	138.17**
Heat detection rate (%)	7065.45**	487.56**	43.68**	104.59**

**P<0.01; *P<0.05; [1]Not significant

De Vries and Risco (2005) showed that the number of days from calving to first service for Holstein cows increased from 84 in 1983 to 104 days in 2001. In the present data set C-1stAI increased from 50 days in 1983 to 83 days in 1994 after which it remained at the same level (Figure 1b). Days open almost doubled from 72 days in 1983 to 140 days in 1999. From 1987 to 2007 interval traits C-1stAI, 1stAI-conc and DOPEN increased (P<0.01) by 0.6, 1.3 and 1.8 days per annum respectively. The number of inseminations per conception also increased from 2.00 to 2.55 showing less than 50% AI efficiency. According to an Australian survey (Little 2003), farmers would experience reproduction problems in their herds with average AIPC above 2.32. In the present study AIPC was higher than 2.32 in more than 50% of herds. A survey in Ireland (Mackey *et al*. 2007) of 19 Holstein-Friesian dairy herds showed that fertility performance was generally poor with the interval to first service being 84.4±35.4 days and the first insemination success rate 40.6±0.68%. The 100-day in-calf rate was 46.0±0.68% and CI 404±65 days. By back-calculation, i.e. the difference between CI and gestation length (González-Recio *et al*. 2006), the number of days open could be calculated. For a CI of 404 days DOPEN would be *ca*. 124 days which is slightly lower (133±72 days) than observed in the present study. Mackey *et al*. (2007) also noted that the major cause of poor reproductive performance in Irish dairy herds was the prolonged interval to first service and the poor AI success rate at first AI. Only 46% of cows were confirmed pregnant by 100 days-in-milk. This varied considerably between herds, i.e. 16.4 to 70.8%. In the present study first AI success rate varied between herds from 24 to 50%. Royal *et al*. (2000) and Grosshans *et al*. (1997) found first AI success rates of 39.7 and 48.5% respectively.

CONCLUSION

The study provides an initial analysis of the standard of reproduction management in South African Holstein herds. Reproduction traits were significantly affected by herd, calving year, calving month and lactation number. Interval traits showed an increased over time although reaching a plateau of 80 days for the interval C-1stAI and 140 days for DOPEN probably indicating a large management effect on these interval traits. Genetic parameters have been estimated for these fertility traits providing an indication of a genetic effect on reproduction performance.

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