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Fertility in Beef Cows.

F. Phocas
INRA, UR337 Station de génétique quantitative et appliquée, F-78352 Jouy-en-Josas
Email : Florence.Phocas@jouy.inra.fr

SUMMARY

Genetic parameters were estimated for three traits for assessing fertility of artificially inseminated (AI) heifers and primiparous cows: calving success to first A.I. (CS1), overall calving success (CS), either from the initial AI or a backup bull mating, and the number of days from initial AI to calving (DC), dealing with censored data. Records were registered from 1998 to 2005, in 292 herds dedicated to the on-farm French Charolais progeny test. Data consisted of 85,397 cow-year records, including 30,460 inseminated heifers that were bred by 1,844 sires. The average heifer CS1 and CS rates were 56.4% and 85.3%, respectively; for primiparous cows, the corresponding means were 51.8% and 84.9%. Strong unfavourable environmental effects were estimated: heifers inseminated before 19 months had 6% less chance to calve to first AI; primiparous cows had 30% less chance to calve to first AI when their first calving was a caesarean; they had also 14% less chance to calve to first AI after a heat synchronization treatment. Heritability estimates were very low, ranging from 0.01 for CS1 to 0.02 for DC under linear models and from 0.02 to 0.03 under threshold models. No significant genetic correlations were estimated between heifer and corresponding primiparous cow traits. It made it difficult to propose an efficient way of selection for high female reproductive performance.

Keywords: beef cattle, fertility, heritability, heifer, primiparous cow, heat synchronization

INTRODUCTION

Reproductive performance is one of the most important components of efficiency in beef production systems. However, due to the difficulty of reporting, only a limited number of beef bulls, used for artificial insemination (AI), are evaluated for heifer fertility in progeny test stations in French beef breeding schemes. The number of beef bulls evaluated for female fertility must be increased through on-farm genetic evaluation. To base a criterion for such an evaluation, fixed effects and genetic parameters were estimated for 3 traits measuring fertility of artificially inseminated French Charolais cows: calving success to first AI (CS1), calving success (CS) either from the initial AI or a backup bull mating, and the number of days from initial AI to calving (DC).

MATERIAL AND METHODS

Data. Records were extracted from the database of 292 French Charolais herds located in Burgundy and Vendée that started a progeny test on farm for female traits (growth and morphology at 2 years, heifer reproductive performance, calving ease and suckling ability) since 1998. The total dataset included 85,397 records (number of females inseminated across 8 breeding years from 1998 to 2005) with 30,460 inseminated heifers bred by 1,844 sires. A first edit consist of looking only at heifer or primiparous records. Another edit consisted of selecting records from sires with at least 10 heifers inseminated. The final research dataset included data of 25,016 heifers and 12,710 primiparous cows bred by 690 sires, in 285 herds with contemporary group size over 4.

Traits. Three different measures of fertility were studied. Success was measured by a end of term gestation. For the 3 traits, the starting point was the first AI during a given breeding year (starting the 1st of September). The end point was calving (success) or its absence either due to the first insemination (CS1) or due to any later mating event within the breeding year (CS and DC). CS1 and CS were binary data, while DC was defined as the difference, in days, between the date of first AI and calving date for each breeding season. Cows not calving were assigned a censored value for DC equal to 392 days.

Statistical analyses. Traits CS1 and CS were analyzed under threshold or linear models using ASREML software (Gilmour et al, 2000). Survival analysis of DC was implemented with the SURVIVAL KIT (Ducrocq and Sölkner, 1998) through a Weibull model. For all traits, a univariate sire model was fitted with a relationship matrix across sires including three generations of ancestors. The pedigree included 7,015 sires in total. Other random effects were AI service agent and mating bull effects. The fixed effects were the herd-year effect (or separate herd and year effects, the interaction being considered as random for threshold or Weibull models), the female age class (12-18 months and 19-31 months for heifers; below or above 31 months for cows), heat synchronization treatment (2 levels: yes or no), breeding season (7 levels: September-October, November, December, January, February, March-April and May to August), and, for cows, 1st calving condition and length of time between 1st calving date and 1st AI (5 levels: 30-49 days, 50-59 days, 60-99 days, 70-89 days, 90 days and over).
In order to easily derive genetic correlation across heifer and cow traits, the 3 traits were analyse under a linear bivariate animal model, knowing that estimates of genetic correlations are not affected by the statistical treatment (linear or threshold model) of the categorical trait (Kadarmideen *et al.,* 2003). Moreover, no advantage in terms of EBV ranking is expected from a threshold model for binary trait with intermediate incidence (Meijering and Gianola, 1985).

RESULTS AND DISCUSSION

Factors influencing fertility. Cow parity had a larger influence on calving success to the 1st reproduction event of the breeding season than on the overall calving success (Table 1). Within parity, age effect is also more important for heifers than for cows (Table 2), the youngest females being less successful. The main effect is the herd effect with extreme range in average CS1 about 60%. Results are presented in Table 2 only for CS1, because effects had about the same magnitude whatever the trait of interest. For heifer traits, the other important fixed effect is the heat synchronization treatment concerning 17% of the heifers. The treatment had an effect twice to three times more important for cow traits than heifer traits (Table 2). Other important fixed effects for cow traits were the interval between 1st calving and 1st AI and calving condition score. Breeding year and season had little impact on fertility traits in comparison of the previous effects. Variance due the mating bull or the AI service agent accounted for less than 0.3% of phenotypic variance.

Table 1. Phenotypic means for the 3 fertility traits according to cow parity.

Trait	Heifer	Primiparous cow
Calving success to first AI (CS1, %)	56.4	51.8
Calving success (CS, %)	85.3	84.9
Days to calving (DC, days)	313	317

Table 2. Main fixed effects estimated for CS1 according to cow parity (in %)

Fixed effect	Heifer	Primiparous cow
Heat synchronization treatment *vs* no treatment	**-4.9**	**-13.5**
1st AI before 19 months (H) / before 31 months (P)	**-5.9**	**-3.4**
below 50 days after calving *vs* over 90 days		**-15.0**
between 50 and 59 days after calving *vs* over 90 days		**-8.4**
between 60 and 69 days after calving *vs* over 90 days		**-5.2**
between 70 and 90 days after calving *vs* over 90 days		**-2.3**
Easy pull at 1st calving *vs* no assistance		**-5.9**
Hard pull at 1st calving *vs* no assistance		**-10.2**
Caesarian at 1st calving *vs* no assistance		**-30.2**

Estimates of genetic parameters. Table 3 presents results for the 3 heifers traits under sire model taking into account the categorical nature of the trait (binary data or censored data). The heritability for all traits is small, accounting to less than 3% of the phenotypic variation in any case. For binary traits like CS1 and CS, these results are consistent with the literature. For days to calving, literature (Donoghue et al., 2004; Johnston and Bunter, 1996) tend to exhibit larger heritabilities (5 to 15%). The cited authors investigated the relationship between CS and DC either for heifers (Johnston and Bunter,1996) or cows (Donoghue et al., 2004). The genetic correlation estimates between the two traits were –0.66 and -0.75, respectively. The authors concluded that selection for reduced days to calving would result in correlated increases in calving success and will allow to distinguish between early and late calvers in the calving season.

Table 4 presents results for a linear bivariate animal model between heifer and cow CS1. Heritability for the cow trait is relatively similar to the heifer trait, but the genetic correlation across parities is close to zero. Similar results were observed for CS and DC. Very few results are found in the literature for estimates of genetic correlation across parities for beef cattle fertility traits, but they indicated large favourable genetic association. Meacham and Notter (1987) estimated a genetic correlation between days to calving in first and second parities equal to 0.66. Goyache et al. (2005) estimated a genetic correlation close to 1 between days open in first and second parity cows.

Table 3. Estimates of variance components (standard error in brackets) for heifer traits with sire threshold or Weibull models.

Parameter	CS1	CS	DC
Phenotypic variance	1.047	1.037	1.007
Heritability	0.018 (0.006)	0.028 (0.011)	0.026 (0.008)

Table 4. Estimates of genetic parameters (standard error in brackets) in a linear bivariate animal model of CS1.

Parameter	Heifer	Primiparous cow
Phenotypic variance	2,417 (21.2)	2,407 (29.7)
Additive genetic variance	34.5 (12.8)	24.9 (18.5)
Heritability	0.014 (0.005)	0.010 (0.008)
Genetic correlation across parity	0.12 (0.38)	

CONCLUSION

Very low heritabilities were estimated, ranging from 1 to 3%, whatever the fertility trait, the cow parity or the statistical model considered. No significant genetic correlations were estimated between any of the heifer fertility traits and the corresponding trait measured on the primiparous cow. Further investigation is needed to explain this biologically unlikely result and to propose an efficient way of selection for high female reproductive performance.

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