GENETIC CORRELATION BETWEEN HEIFER PREGNANCY AND SCROTAL CIRCUMFERENCE IN NELORE CATTLE

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INTRODUCTION

In order to determine a trait of sexual precocity that might be included in the objectives of selection, Doyle et al. (1996) and Evans et al. (1999) evaluated heifer pregnancy (HP), defined as the probability that a heifer became pregnant after the end of the breeding season, when she was exposed to a bull or inseminated. It is a binary trait, with the value 1 attributed to pregnant heifers and the value of 0 attributed to non-pregnant heifers. Few studies on heritability (h²) of HP have been published. Koots et al. (1994), Doyle et al. (1996) and Snelling et al. (1996) reported h² values of 0.05 ± 0.01; 0.21 ± 0.11 and 0.30, respectively. Evans et al. (1999), in a single trait analysis, obtained a value of 0.14 ± 0.09 and in a two-trait analysis with scrotal circumference (SC), found 0.24 ± 0.12 for Hereford cattle, while Doyle et al. (2000) reported 0.21 ± 0.01 for the Angus breed. Higher h² estimates recently reported for HP may be attributable to the analytical procedures adopted, which may be more appropriate for the analysis of categorical data (Snelling et al., 1995). More recently, in the Nelore breed Eler et al. (2002), analyzing 11,487 records of heifers exposed to bull at around 14 month of age, reported an estimate of 0.57 ± 0.10 for the probability of pregnancy at 14 month (PP14).

As concerned to genetic relationship, Evans et al. (1999) reported an estimate close to zero for the correlation between heifer pregnancy and scrotal circumference for Hereford cattle. They suggested the relationship between the two traits would be non linear.

The objective of the present study was to analyze records of pregnancy of Nelore heifers exposed to bulls at 14 mo of age simultaneously with scrotal circumference in order to evaluate the genetic correlation between these traits and the viability of incorporating scrotal circumference on the prediction of EPD for heifer pregnancy at 14 mo in that breed.

MATERIAL AND METHODS

Pregnancy records of Nelore heifers exposed to bulls at about 14 mo of age during the breeding seasons of 1995 to 2001 in three herds were analyzed. The data came from Agro-Pecuária CFM Ltda and the herds were located in the northeast of the states of São Paulo and Mato Grosso do Sul, Brazil. The heifers were placed in lots, according to the month of birth, with a group of bulls (multi-sire pasture, MS), or in some cases in lots with a single bull, for a breeding season of about 90 d. Approximately 60 d after the end of the breeding season, the diagnosis of pregnancy was made by rectal palpation. Heifers with a positive diagnosis (pregnant) were scored as 1 and heifers with a negative diagnosis were scored as 0. The data set analyzed after elimination of CGs with no variation, consisted of the pregnancy records for 11 487 heifers born from 1993 to 1999 and divided into 234 CGs, with 2 266 records (19.8 %).
being scored 1 and 9,221 (80.2%) being scored 0. Of the 11,487 heifers in the file, all of them with a known dam, 8,957 were daughters of known sire and 2,530 were daughters of MS, considered to have unknown sires. The data set included 210 sires and 8,564 dams. To this data set, information on 28,520 records of scrotal circumference (SC) adjusted to 450 days of age, was added to estimate the genetic correlation among the traits. Pedigree data included all sires plus their relatives, in a total of 1,926 animals.

Mathematical model included fixed contemporary group effects (234 CGs for PP14 and 1,084 GCs for SC) and the effects of dam’s age class at calving - DAC (seven classes). The random effects included were animal additive genetic effect and residual effect. Variance components were estimated using method \( \Re \) (Reverter et al., 1994). It was used a two-trait sire model, where, for PP14 the residual variance was fixed as 1.0. As PP14 and SC were measured in different animals, the residual covariance was assumed as 0. Although genetic parameters were estimated by sire models, genetic values were predicted using an a posteriori maximum likelihood threshold animal model - MAP (Gianola and Foulley, 1983; Harville and Mee, 1984) on an underlying genetic scale. The tool DSCAT, from ABTK2.0 software (Golden et al., 1992) was used both for the estimation of variance components and for the solution of mixed models.

PP14 EPDs were computed by transforming MAP solutions for deviations from 50% probability according to the formula: 
\[
EPD_i = \left[ \Phi (MAP_i \times 0.5) - 0.5 \right] \times 100
\]
(Snelling et al., 1995), where :
- \( EPD_i \) = expected progeny difference for the \( i^{th} \) animal on the probability scale.
- \( \Phi \) = Standard accumulated distribution function.
- \( MAP_i \) = Solution for the \( i^{th} \) animal in the underlying scale.

RESULTS AND DISCUSSION

The mean heritability (and standard deviation) estimates were 0.73 ± 0.16 and 0.49 ± 0.08 for PP14 and SC, respectively. If the median is taken as a criterion for heritability estimation, the values would be 0.74 for PP14 and 0.48 for SC. The mean genetic correlation (and standard deviation) between the two traits was 0.45 ± 0.16 and the median was 0.46. The values were obtained from 296 repeated random sub-samples of 50% of the data with a sire model, and the graphic representation of the estimates is shown in figure 1.

The heritability estimate for PP14 (0.73) seems very high. As it is well known, the sire model does not account for the effect of mates. However, this result is a reflex of the real difference among sires for pregnancy rate that could be seen in the field data. Eler et al., (2002) reported an estimate of 0.57 ± 0.10 for the heritability (and standard deviation) of this trait, obtained from a single-trait animal model analysis of the same file.

Both estimates were higher than those published in the literature and may result from the adoption of appropriate analytical procedures for categorical data and from a higher genetic variability of PP14 for Nelore cows. The explanation for this difference is that all the results reported in the literature were obtained for populations of Bos taurus origin for which almost all animals reach puberty before or at 14 mo. The Nelore breed (Bos indicus) has late puberty and as puberty is an issue, genetic variability of PP14 appears to be much higher. An observation of the records shows, for example, a bull siring daughters with 0% pregnancy (1 pregnant out of 110 daughters) and another bull siring daughters with 55% pregnancy (66 out of 120 daughters).
The genetic correlation was also high. The mean genetic correlation was 0.45 and (0.19 – 0.70) was a 95 % confidence interval for the mean. This value indicates that we can use SC in a two-trait analysis to increase accuracy of predicting EPD for PP14.

In order to achieve the kind of relationship existing between PP14 and SC, an analysis of PP14 replacing the foundation animals with genetic groups based on EPDs for SC was processed and the results, shown in table 1, indicate a linear relationship between the traits.

Table 1. Genetic group for scrotal circumference (GG), scrotal circumference EPD (SC_EPD), number of founders replaced (N) and Probability of Pregnancy at 14 month EPD (PP14_EPD)

<table>
<thead>
<tr>
<th>GG</th>
<th>SC_EPD</th>
<th>N</th>
<th>PP14_EPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-3.09 to -0.57</td>
<td>9,464</td>
<td>-3.3</td>
</tr>
<tr>
<td>2</td>
<td>-0.56 to -0.32</td>
<td>11,809</td>
<td>-4.8</td>
</tr>
<tr>
<td>3</td>
<td>-0.31 to -0.01</td>
<td>8,209</td>
<td>+0.5</td>
</tr>
<tr>
<td>4</td>
<td>0.00 to +0.37</td>
<td>4,198</td>
<td>+3.3</td>
</tr>
<tr>
<td>5</td>
<td>0.38 to +3.31</td>
<td>1,889</td>
<td>+8.2</td>
</tr>
</tbody>
</table>

Based on the heritability of 0.57 for PP14 obtained by ELER et al. (2002) and heritability of 0.48 for SC from the present analysis and also using 0.45 for genetic correlation between the two traits, it was predicted the EPD for PP14 using a two-trait animal model incorporating SC.

Solutions were obtained for all animals in the pedigree file and were presented as the probability of a bull have daughters that will become pregnant when exposed at 14 mo of age during a given breeding season. In this method, solutions are deviate from 50 % probability. On this basis, if the overall heifer pregnancy rate for the data were 50 %, a 0.0 EPD bull has
50% probability to produce heifers that get pregnant at 14 mo. An EPD equal to 23.0 for a bull, for example, means that this bull has a 23 percentage points higher probability of siring daughters that will calve at 2 yr of age than a bull with 0.0 EPD, say 73%. In this study the overall pregnancy rate was about 20%, so that a bull with 20% of his daughters getting pregnant is a 0,0 EPD and a bull with a +23,0 EPD is expected to have about 50% probability of siring daughters that will calve at 2 yr of age (and not 43%), that means close to 30 percentage points higher than a bull with 0,0 EPD (and not 23% as would be expected for a 50% pregnancy rate population). In this Nelore population, the real difference between two extreme bulls from the genetic evaluation can be up to 60% in probability of siring daughters that calve at 2 years old.

CONCLUSION
The high heritability estimated in the present study confirms the indication of PP14 as a selection criterion for sexual precocity in the Nelore breed. The medium to high genetic correlation between PP14 and SC encourage the incorporation of SC in a two-trait analysis in order to increase accuracy of prediction for PP14 EPD.

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REFERENCES


