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Two-trait random regression model to estimate the genetic association of scrotal circumference with female reproductive performance in Nelore cattle

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ABSTRACT

In an attempt to determine when scrotal circumference (SC) could be a reasonable indicator of female reproductive performance, a series of two-trait random regression model (regression for SC on age at measurement) using Gibbs sampling was applied to field data of Nelore cattle raised in a tropical environment. The female traits evaluated were age at first calving (AFC), first calving interval (FCI), heifer pregnancy (HP), and stayability (STAY). The posterior means of heritability of female traits ranged from 0.15 for AFC to 0.46 for HP and were about 0.50 for SC. The posterior means of genetic correlations between SC and AFC, FCI, HP, STAY were up to −0.70, −0.25, 0.48, and 0.29, respectively. Genetically, SC could be a reasonable indicator of female puberty (e.g., HP) as long as it is measured at a young age (400–440 days). However, for female reproductive traits measured at an older age (e.g., STAY), SC is merely a modest or even poor indicator. The use of sire expected progeny differences for female reproductive traits will be more effective than the use of expected progeny differences for SC to improve the reproductive performance of female cattle.

1. Introduction

Several studies have shown that male traits can be indicators of the reproductive performance of female cattle [1,2]. In the case of *Bos taurus* cattle, studies [3–5] suggested that selection for scrotal circumference (SC) could positively contribute to female reproduction. The same observation was made for *Bos indicus* animals raised in tropical environments [6,7]. However, in a literature review, Cammack et al. [8] found wide variation in the genetic correlation estimates between SC and female reproductive traits. Furthermore, there are reports indicating that the use of SC as indirect selection criteria would not be as effective to improve female reproductive performance in beef cattle [9–11].

In view of these controversies, some authors reported that the relationship between SC and female reproductive traits may depend on the age when SC is measured in the animals [6,12,13]. This might be regarded as logical because the genetic parameters for SC change according to the animal's age at measurement [14–16]. In an attempt to determine when SC could be a reasonable indicator of female reproductive performance, a series of two-trait random regression model was applied to field data of beef cattle raised in a tropical environment. The changes that occur in the genetic correlations between SC measured at different ages and reproductive traits of Nelore females may help answer this question.

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2. Materials and methods

2.1. Data and animal management

The data used in this study were obtained from the Genetic Breeding Program of Agro-Pecuária CFM Ltda., stored, and analyzed since 1984 by the Animal Breeding and Biotechnology Group, College of Animal Science and Food Engineering, Pirassununga, State of São Paulo. Data from 45,314 Nelore females and 49,283 Nelore males born between 1980 and 2012 on 12 farms located in the Brazilian states of São Paulo, Mato Grosso do Sul, Goiás, and Bahia, were used. The farms included in this study belong to the same company, which uses basic standard procedures of data collection and storage. The animals were kept on high-quality pasture (40% *Brachiaria brizantha*, 50% *Panicum maximum*, and 10% others) and received only salt and mineral supplements. The breeding season, 90 days for heifers and 60 days for cows, ranged from October to January, depending on the beginning of the rainy season. About 40% of the females were artificially inseminated, and the remaining animals were placed in lots with a group of bulls or, in some cases, in lots with a single bull. The cow-to-bull ratio was about 35:1. Calves remained with their dams on high-quality pasture up to 7 months of age.

2.2. Traits evaluated

2.2.1. Scrotal circumference

This trait was measured only once, between 400 and 654 days of age, at the widest point of the scrotum using an appropriate metric tape.

2.2.2. Age at first calving

This trait was calculated as the difference in days between the dam's date of birth and the date of birth of her first registered calf. Because only part of the females of the present population had the opportunity to be exposed to a bull at about 14 months of age, the AFC data were divided into two traits: age at first calving (AFC) of heifers exposed to a bull at about 24 months of age (AFC1) and AFC of heifers exposed to a bull at about 14 months of age (AFC2).

2.2.3. First calving interval

This trait corresponds to the number of days between the birth of the first and second calf of each female.

2.2.4. Heifer pregnancy

About 60 days after the end of the breeding season, heifers (exposed to a bull at about 14 months of age, range 12–16 months) from three farms were submitted to rectal palpation or ultrasound for the diagnosis of pregnancy. Heifer pregnancy (HP) was analyzed as a categorical trait, with a value of 1 (success) being assigned to heifers that were diagnosed pregnant and a value of 0 (failure) being assigned to those that were not pregnant at that time.

2.2.5. Stayability

This trait was defined as successful (coded 1) when a cow stayed in the herd up to 6 years of age, given that it had the opportunity to breed (had a calf or a positive pregnancy diagnosis). Otherwise, stayability (STAY) was coded 0. According to the management system of the company, a cow is kept in the herd until 6 years of age if it is productive, i.e., calves every year. Cows that do not calve regularly or that wean very light weight calves are culled systematically.

2.3. Data selection

Records for the binary traits HP and STAY of contemporary groups in which all scores were the same, i.e., groups without variability, were eliminated. Additionally, for all traits, records of animals in contemporary groups with fewer than 10 animals, records of animals with unknown sires or dams, contemporary groups with all progeny of a single sire, sires with fewer than three progeny records, and data exceeding 3.5 standard deviations above or below the overall mean of the trait (except for AFC1, AFC2, HP, and STAY) were excluded (Fig. 1, Table 1).

2.4. Model and analysis

The model for SC, AFC, first calving interval (FCI), and HP included the respective fixed effects of contemporary group (year of birth, weaning and postweaning farms, and weaning and postweaning management groups) and the covariates of age of animals at recording (linear effect only for HP) and age of dam at calving (linear and quadratic effects, except for FCI). The model for AFC included the fixed effect of calf sex, and the model for FCI included the sex of the first and second calf. Furthermore, the model for FCI included the year and farm code of the second breeding in the respective contemporary group, and the AFC was included as a linear covariate. The model for STAY included only the effect of contemporary groups formed by combining the farm code, birth year of the cow, and farm of birth of each of her progeny.

The (co)variance components were obtained by Gibbs sampling using four two-trait models with random regression for SC on age. The two-trait animal model can be described as follows:

$$y = X\beta + Z_a u_a + e$$

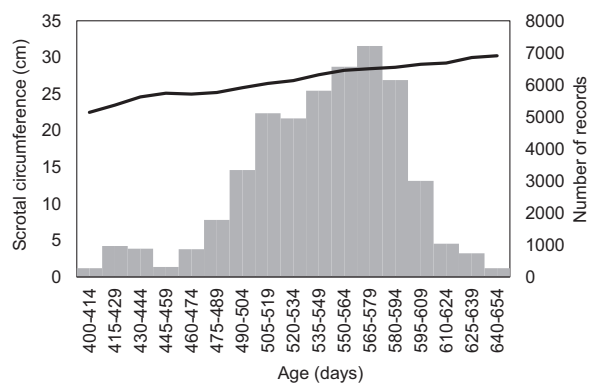

Fig. 1. Number of records (bars) and mean scrotal circumference (solid line) in Nelore cattle according to the age at measurement.