

Estimates of genetic and phenotypic parameters for days to calving in Nelore cattle¹

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ABSTRACT: A set of data from 53,181 Nelore animals was used to estimate genetic and phenotypic parameters for days to calving (DC) and days to first calving (DFC) and their correlations with scrotal circumference (SC), age at first calving (AFC) and weight adjusted to 550 days of age (W550). Covariance components were estimated using restricted maximum likelihood method fitting bivariate animal models. For DC a repeatability animal model was applied. The fixed effects considered for DC and DFC were contemporary group (CG), month of last calving and age at joining season as covariable (linear and quadratic effects). Contemporary groups were composed by herd, year, season and handling group at joining; sex of calf and mating type (multiple sires, single sire or artificial insemination). Heritability estimates were 0.06 for DC and 0.13 for DFC. Genetic correlation estimate between DC and SC was low and negative (-0.10), between DC and AFC was high and positive (0.76) and between DC and W550 was almost null (0.07). Similar results were found for genetic correlation estimates between DFC and AFC (0.93) and DFC and W550 (-0.02). The favourable genetic associations with AFC indicate that selection for DC or DFC could promote desirable correlated responses in that trait.

Key Words: Beef Cattle, Days to Calving, Scrotal Circumference, Age at First Calving, Weight, Zebu Breeds

Introduction

The interest of incorporating Days to Calving (DC) in beef cattle selection programs requires the estimation of the genetic component that acts on the phenotypic expression of this trait, as well as its possible genetic association with other economic important traits. In general, studies correlating DC and productive and reproductive traits in beef cattle report favorable genetic correlations, but few studies are from Brazil.

The association between DC and age at first calving (AFC) is still unknown. The determination of this correlation would be useful for genetic improvement, since AFC has been emphasized as a trait indicating sexual precocity. Scrotal circumference (SC) has been used as a selection criterion since it shows favorable genetic correlations with sperm quality, age at puberty in males and females, and growth traits. The genetic correlations reported between SC and DC are in general negative (Meyer et al., 1990, 1991; Notter et al., 1993; Pereira et al., 2000), suggesting that the inclusion of DC in selection programs might increase genetic gain in fertility.

DC has shown favorable correlations with yearling weight (Meyer et al., 1991; Johnston and Bunter, 1996). However, the fact that Brazil has a dry season, which often represents a period of food restriction, might cause more marked differences in reproductive performance of animals of different sizes. Investigations on the genetic correlation between weight performance traits and DC in females reared in more restricted environments might help in the establishment of relationships between growth and reproduction.

The objective of the present study was to estimate (co)variance components between days to calving, and days to first calving (DFC), and traits: scrotal circumference, age at first

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calving and weight adjusted for 550 days of age (W550), and to determine the genetic correlation between these traits in a Nelore population.

Materials and Methods

The data used in the present study were provided by Agropecuária Jacarezinho Ltda. The company is dedicated to the rearing of beef cattle, mainly Nelore cattle in an extensive system, and the animals are periodically evaluated and selected.

After elimination of incomplete or biologically unacceptable records, a total of 53,181 calving records were evaluated, including 43,094 resulting from mating using multiple sires, 6,187 from artificial insemination and 3,900 from mating using single sires. Noncalvers were not considered in analyses, since an attempt to include them, attributing to them a penalty, did not improve the identification of genetic differences between animals (Forni and Albuquerque, 2003).

(Co)variance components were estimated using two-trait animal models with different sets of fixed effects for each variable. In DC analysis the permanent environmental effect was also included as a random effect. The sets of fixed effects were:

- DC: contemporary group, month of previous calving and age at joining season (linear and quadratic effects)
- AFC: contemporary group and cow's age at calving (mother of the animal analyzed - linear and quadratic effects)
- SC: contemporary group, age at measurement (linear and quadratic effects) and weight adjusted for 550 days of age (linear effects)
- W550: contemporary group

In the analysis of DFC the set of fixed effects was the same used in DC analysis excluding the month of last calving.

The (co)variance components were estimated by the restricted maximum likelihood method using the Multiple Trait Derivative Free Restricted Maximum Likelihood - MTDFREML program (Boldman et al., 1993).

Results and Discussion

The number of observations and contemporary groups, means, standard deviations and range for each trait are shown in Table 1. Means estimated are similar to those reported in other studies analyzing the same traits (Meyer et al., 1990; Johnston and Bunter, 1996; Dias et al., 2003; Dias et al, 2004; Pereira et al., 2001).

Table 1. Number of observations, contemporary groups, means, standard deviations, minimum and maximum values of days to calving (DC), days to first calving (DFC), scrotal circumference (SC), age at first calving (AFC) and weight adjusted for 550 days of age (W550)

Trait (unit of measurement)	N° of observations	N° of contemporary groups	Mean	Standard deviation	Minimum value	Maximum value
DC (days)	46,181	1,809	309	24	260	365
DFC (days)	17,824	2,070	308	23	234	365
SC (cm)	12,964	481	26	3	16	45
AFC (days)	18,615	1,324	1,064	80	757	1,197
W550(kg)	35,409	999	289	41	190	477

DFC mean was higher, approximately two days, than DC mean, probably because in

DC were records of a selected sample of the population, once females that do not become pregnant after one breeding season are culled. In addition, DFC is measured on average in younger animals and assessment of the effect of cow's age at the beginning of the breeding season on DC demonstrated that values tend to decrease with increasing age of the animal up to approximately four years old (Forni and Albuquerque, 2003).

Table 2 shows the (co)variance estimates for all traits. The results showed a high heritability for SC, with the values within the range reported in the literature for the Nelore breed, from 0.31 (Gressler et al., 1998) to 0.71 (Quirino and Bergmann, 1997).

The genetic correlation observed between DC and SC, and DFC and SC, were favorable, although its magnitudes were not very expressive, indicating that the selection for SC had a positive influence on female reproductive performance. Pereira et al. (2000) also found a favorable genetic correlation between DC and SC in the Nelore breed, and Meyer et al. (1991) reported higher negative correlations between these traits in Angus cattle. These results suggest that inclusion of DC in selection programs might increase genetic gains for sexual precocity and fertility.

The heritability estimates for AFC agreed with those reported in recent studies of this trait in Nelore cattle, with heritability coefficients ranging from 0.01 to 0.19 (Gressler et al., 1998; Dias et al., 2004; Pereira et al., 2000; Pereira et al., 2001; Talhari et al., 2003). The low heritability estimates could have been influenced by the fact that part of the females evaluated had been exposed to breeding only at 24 months of age. Exposure of 16 to 18 month-old heifers to breeding was started in the early nineties. Before this time, females entering heat before two years of age did not have the chance to demonstrate their genetic potential for sexual precocity. Another factor that might have contributed to the estimation of low coefficients is the short duration of the breeding season, which is 75 days for cows and 60 days for heifers.

The genetic correlations estimated between DC and AFC and between DFC and AFC were positive and high, indicating the possibility of obtaining a favorable correlated response in terms of reduction of age at first mating using DC as a selection criterion.

Studies using experimental data in which age at first mating is not predetermined as a function of management practices or in which breeding season is not limited should contribute to a more precise identification of the genetic variability in the AFC and its association with other fertility-indicating traits.

The correlations between DC and W550, and between DFC and W550, were close to zero. The genetic correlations between DC and weight performance traits reported in the literature have generally been negative.

The heritability estimates found for the DC ranged from 0.04 to 0.06 and repeatability ranged from 0.10 to 0.11, similar results were reported for European breeds (Meyer et al., 1990; Meyer et al., 1991; Johnston and Bunter, 1996) and Nelore herds in Brazil (Mercadante et al., 2002; Pereira et al., 2001). The heritability estimates for DFC were slightly higher, 0.06 and 0.13. In general, studies analyzing calving date have reported a reduction in heritability coefficients for the second calving date compared to the first one. According to Meacham and Notter (1987), this might be a reflection of culling females that did not become pregnant and/or of true changes in the magnitude of environmental genetic variances.

Table 2. (Co)variance components estimates for traits days to calving (DC), days to first calving (DFC), scrotal circumference (SC), age at first calving (AFC) and weight adjusted for 550 days of age (W550) in Nelore beef cattle

	DC x SC		DFC x SC	
σ_a^2	15.530	2.480	34.980	2.613
σ_c^2	16.620	-	-	-
σ_e^2	249.530	3.460	247.025	3.300
σ_p^2	281.700	5.950	282.005	5.913
h^2	0.060	0.420	0.120	0.440
c^2	0.059	-	-	-
e^2	0.890	0.480	0.880	0.560
σ_{a1a2}	-0.650		-0.876	
σ_{e1e2}	0.000		0.000	
σ_{p1p2}	-0.650		-0.876	
r_a	-0.100		-0.140	
r_e	0.000		0.000	
	DC x AFC		DFC x AFC	
σ_a^2	14.230	138.720	55.040	239.780
σ_c^2	17.190	-	-	-
σ_e^2	258.550	2,051.550	377.130	1,957.040
σ_p^2	289.980	2,190.280	432.180	2,196.820
h^2	0.050	0.060	0.130	0.110
c^2	0.059	-	-	-
e^2	0.890	0.940	0.870	0.890
σ_{a1a2}	33.610		106.700	
σ_{e1e2}	333.110		623.060	
σ_{p1p2}	366.720		729.760	
r_a	0.760		0.930	
r_e	0.460		0.730	
	DC x W550		DFC x W550	
σ_a^2	11.180	171.430	15.610	172.360
σ_c^2	17.330	-	-	-
σ_e^2	249.700	399.810	266.180	399.850
σ_p^2	278.210	571.250	281.790	572.210
h^2	0.040	0.300	0.060	0.300
c^2	0.062	-	-	-
e^2	0.900	0.700	0.940	0.700
σ_{a1a2}	3.050		-1.270	
σ_{e1e2}	-20.270		-17.270	
σ_{p1p2}	-17.220		-18.550	
r_a	0.070		-0.020	
r_e	-0.060		-0.050	

σ_a^2 = additive genetic variance, σ_c^2 = permanent environment variance, σ_e^2 = residual variance, σ_p^2 = phenotypic variance, h^2 = heritability, c^2 = fraction of phenotypic variance due to permanent environment, e^2 = fraction of phenotypic variance due to temporary environment, σ_{a1a2} = additive genetic covariance, σ_{e1e2} = residual covariance, σ_{p1p2} = phenotypic covariance, r_a = additive genetic correlation, r_e = residual correlation

Implications

The genetic correlations estimated indicate that the use of DC as selection criterion may promote favorable correlated responses in age at first calving.

Under the conditions of the present study selection for weight gain at young ages would not affect the reproductive performance of the matrices.

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