Livestock Science 132 (2010) 107–112

Contents lists available at ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Genetic associations between stayability and reproductive and growth traits in Canchim beef cattle

M.E. Buzanskas [a,b], D.A. Grossi [a,b], F. Baldi [a], D. Barrozo [a], L.O.C. Silva [c], R.A.A. Torres Júnior [c], D.P. Munari [b,*], M.M. Alencar [d]

[a] Pós-Graduação em Genética e Melhoramento Animal, FCAV/UNESP, Jaboticabal, São Paulo, Brazil
[b] Departamento de Ciências Exatas, FCAV/UNESP, Jaboticabal, São Paulo, Brazil
[c] Embrapa Gado de Corte, Campo Grande, Mato Grosso do Sul, Brazil
[d] Embrapa Pecuária Sudeste, São Carlos, São Paulo, Brazil

ARTICLE INFO

Article history:
Received 26 January 2010
Received in revised form 3 May 2010
Accepted 18 May 2010

Keywords:
Beef cattle
Genetic parameters
Heritability
Threshold model

ABSTRACT

Stayability is a trait that has a large impact on the costs of rural properties because it is directly related to the cow's ability to produce a certain number of calves over a given period of time. Thus, the objective of this study was to estimate the genetic variance of stayability (STAY) and its genetic associations with age at first calving (AFC), body weight of males and females at 420 days of age (BW420), and scrotal circumference at 420 days of age (SC420), in order to provide support for a genetic evaluation program on Canchim beef cattle. Genetic parameters were estimated by Bayesian inference using the THRGIBBS2F90 program, considering two-trait analysis between STAY and the other traits. A threshold model was established for STAY and a linear model was established for all other traits. The animal model included the contemporary group as the fixed effect and the genetic additive and residual effects as random effects. The heritability estimates and their respective standard deviations (in parentheses) obtained for STAY, AFC, BW420 and SC420 were 0.03 (0.01), 0.04 (0.01), 0.24 (0.04) and 0.24 (0.06), respectively. STAY presented genetic associations with AFC, BW420 and SC420 of −0.63 (0.20), −0.09 (0.11) and 0.45 (0.21), respectively. It had environmental correlations with AFC and BW420 of 0.02 (0.01) and −0.06 (0.04). For SC420, the environmental covariance was set at zero. Selection for BW420 would not contribute towards improving STAY because the genes that acted on one trait did not act on the other. However, selection to increase SC420 should result in changes in this trait and also favor STAY. Despite the favorable genetic correlation estimates between AFC and STAY, the selection response for both traits would be low. Changes in management and environmental conditions could improve both traits.

1. Introduction

In Brazil, beef cattle farming has become specialized in producing high-quality meat to supply national and international markets. Scientific and technological advances relating to management and nutrition have certainly been decisive for progress in this sector. However, much of this production progress has been due to constant genetic improvement of the animals (Alencar, 2004).

Growth traits are easily measured and have medium to high heritability (Alencar et al., 1993; Mascioli et al., 1996; Silva et al., 2000; Talhari et al., 2003; Castro-Pereira et al., 2007), thus suggesting that these traits are likely to respond to selection. Therefore, body weight measurements at different ages have been used as selection criteria in Canchim cattle to improve animal growth during certain periods. However, reproductive traits have major importance in determining the economic efficiency of beef cattle production systems (Ponzoni and Newman, 1989; Phocas et al., 1998).

Testis size is one of the main factors affecting the reproductive performance of sires, and it is commonly determined by scrotal

* Corresponding author. Tel.: +55 16 3209 2624; fax: +55 16 3220 4275.
E-mail address: danisio@fcav.unesp.br (D.P. Munari).

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doi:10.1016/j.livsci.2010.05.008

circumference measurements (Baker et al., 1981).This trait is also favorably correlated with physical semen traits (Trocóniz et al., 1991), production traits (Alencar et al., 1993), age at puberty (Vieira et al., 1988) and fertility (McCosker et al., 1989) in males; and is correlated with female fertility traits (Gianlorenço et al., 2003). In addition, the scrotal circumference is easily measured at young ages (e.g. at weaning, 365 days of age and yearling), thus favoring genetic evaluation for sexual precocity. Hence, scrotal circumference has been extensively used as a selection criterion for improving female and male reproductive traits in most beef cattle breeding programs.

Recently, breeding programs have been looking for new selection criteria in order to improve sexual precocity and longevity among the females, i.e. the age at first calving (Martin et al., 1992). Stayability was defined by Hudson and Van Vleck (1981) as the ability of the cow to remain in the herd up to a specific age, and this trait has been taken to be a measure of longevity in dairy cattle (Van Vleck, 1980). Currently, in beef cattle, stayability is defined as "success" for cows that have attained at least three calving times at 76 months of age, with the possibility of failure if they entered reproduction at 24 months of age; otherwise, "failure" was attributed to cows that did not satisfy these prerequisites (Silva et al., 2003). Formigoni et al. (2005) defined three calves produced by the time the cow has reached 76 months of age as the minimum number of calves that the cow must produce for the rearing costs to be discounted.

Several studies on beef cattle have reported genetic parameter estimates for stayability using Bayesian inference in Nelore (Silva et al., 2003; Marcondes et al., 2005; Van Melis et al., 2007), Canchim (Nieto et al., 2007) and Caracu (Queiroz et al., 2007). However, there are few studies that investigate relationships between stayability and body weight, scrotal circumference and age at first calving (Silva et al., 2006).

Thus, the objective of the present study was to estimate genetic parameters and variance components for stayability and its genetic associations with reproductive and growth traits in Canchim beef cattle, in order to provide support for a genetic evaluation program on this breed.

2. Methods

2.1. Canchim breed

The Canchim beef cattle has been developed in Brazil by crossings of Charolais and Zebu animals (mainly Nelore breed) at the Brazilian Agricultural Research Corporation (Embrapa) since 1940. Different mating schemes have been studied, with the aims of producing Canchim animals with different Charolais–Nelore compositions and obtaining individuals with higher genetic variability. In the genetic improvement program for the Canchim breed, parent groups have been used. MA animals are the offspring from matings between Charolais bulls and cows that resulted from previous matings between Canchim bulls and Nelore cows. The offspring of the MA × MA mating scheme are Canchim with a genetic composition of 65.6% Charolais and 34.4% Nelore, whereas those of the Canchim × Canchim mating scheme have a genetic composition of 62.5% Charolais and 37.5% Nelore (Andrade et al., 2008). Another two mating schemes have females with genetic compositions that range from 54.7% Charolais and 45.3% Nelore to 56.25% Charolais and 34.38% Nelore. These dams are mated with Canchim sires, resulting in Canchim animals (Alencar, 1988).

2.2. Data description

The data used in this study were obtained from the Brazilian Association of Canchim Breeders (ABCCAN). The traits analyzed included: stayability (STAY), age at first calving (AFC), body weight of males and females at 420 days of age (BW420) and scrotal circumference at 420 days of age (SC420).

Animals born between 1980 and 2001 (for STAY and AFC), between 1992 and 2006 (for BW420) and between 1995 and 2006 (for SC420) were included in the analysis. The animals were managed exclusively in a pasture regime, with mineral supplementation throughout the year. After data editing, the means and standard deviations for AFC, BW420 and SC420 were 40.28 ± 7.85 months, 254.92 ± 45.05 kg and 24.63 ± 3.84 cm, respectively. These means agree with those reported by ABCCAN (2008): 39.42 ± 8.17 months (for AFC), 274.76 ± 64.42 kg (for BW at 18 months of age), and 25.31 ± 3.99 cm (for SC at 18 months of age).

2.3. Data editing and contemporary groups

Preliminary analyses on all traits were performed to eliminate inconsistent data. For STAY, cows subjected to reproductive techniques (in vitro fertilization, embryo transfer or multiple ovulations) and cows with calving intervals smaller than 11 months were excluded. In addition to these criteria, contemporary groups (CG) with fewer than three records and sires with fewer than three offspring were also removed from the final data file. The number of animals, sires, dams, contemporary groups and farms for each trait are shown in Table 1.

To define the fixed effects included in the CG, statistical analyses were performed using the least-squares method, through the GLM procedure of the SAS 9.1 software (SAS Institute, Cary, NC, USA). The birth seasons were defined as spring, summer, fall and winter. For AFC, the farm of first calving and year and season of the cow's birth were included in the CG. For SC420, the CG consisted of farm of birth and, at 420 days of age, the season and year of birth. For BW420, the CG included the genetic group of the dam (five classes as described by Alencar, 1988, and Andrade et al., 2008), sex, farm of birth and, at 420 days of age, the season and year of birth.

Table 1
Number of animals, sires, dams, contemporary groups (CG) and farms (NF) considered in the analyses for stayability (STAY), age at first calving (AFC), body weight for males and females at 420 days of age (BW420) and scrotal circumference at 420 days of age (SC420).

Trait	Animals	Sires	Dams	CG	NF
STAY	13,835	890	10,377	447	149
AFC	13,835	890	10,377	429	149
BW420	7842	427	5811	1072	81
SC420	4522	352	3707	596	72