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Genetic parameters for reproduction and growth traits in Boer goats in Brazil

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ABSTRACT

Data collected over a period of 15 years in a herd of Boer goats in Brazil were used to estimate genetic parameters for reproductive and growth traits. The analyses included weights of about 1300 kids and nearly 750 reproductive records by 345 goats. The mixed model analyses of reproductive traits (kidding interval, litter size, litter weight at birth and weaning, doe weight at parturition) included the fixed effects of contemporary group and parity, and the random effects of additive genetic and permanent environmental effects. For growth traits (birth weight, weaning weight, average daily gain and relative growth rate) the fixed effects considered were contemporary group, sex, number born and parity, while the random effects were the direct and maternal genetic effects (allowing for their covariance), permanent environmental effect of the dam and litter common environmental effect. The mean performance in the Boer goats included in our study was 56.4 ± 11.5 kg for live weight at parturition, 456 ± 198 days for kidding interval, 1.70 ± 0.66 kids for litter size, 5.8 ± 2.2 and 23.4 ± 9.7 kg for litter weight at birth and weaning, respectively, while the kids had means for birth and weaning (112 days) weight of 3.4 ± 0.8 and 15.2 ± 4.7 kg, with average daily gain and relative growth rate of 105.2 ± 40.0 g and 1.3 ± 0.3%, respectively. The heritability (h^2) estimate for reproductive traits was near zero for litter size and litter weight at birth, about 0.1 for kidding interval and litter weaning weight, and close to 0.4 for doe weight at parturition. The estimated repeatability was about 0.5 for doe weight at parturition and near 0.1 for all the other reproductive traits. The h^2 of direct effects for growth traits was consistently higher than h^2 of maternal effects. For birth weight, h^2 estimates of direct and maternal effects were smaller than for the other traits, in the range of 0.05 to 0.08. For growth and weight traits measured after birth, h^2 of direct effects ranged from 0.23 to 0.31, and h^2 of maternal effects was about 0.13 for the various traits. There was a strong antagonism between direct and maternal effects, with a genetic correlation of −0.67 for birth weight, and about −0.8 to −0.9 for the other traits. Relative to the phenotypic variance, the influence of the permanent environmental effect of the dam represented about 0.11–0.15 and the common environmental effect of the litter corresponded to 0.32 for birth weight and ranged from 0.13 to 0.18 for the other traits. These results indicate that selection for some reproductive traits such as litter size may be difficult, given the low levels of genetic variability, but could be more successful for other traits like litter weaning weight and kidding interval. Selection for weight at and growth rate up to weaning should take into account the importance of direct and maternal genetic effects as well as the genetic antagonism between these two components. Factors which are seldom considered in mixed model analyses, such as the common litter effect, were found to be of major importance, and must be considered in the linear models used to estimate genetic parameters and predict breeding values in meat goats.

1. Introduction

With a herd of around 9 million animals, goat production has gained a prominent position in the Brazilian agribusiness sector, particularly in the Northeast region, where over 90% of the total goat population is found (IBGE, 2013). Goat production in this

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region is mostly extensive, based on local native breeds that use the bushes and scrub available in the Caatinga eco-system (Leal et al., 2005) as their major source of feedstuffs. Currently, efforts have been developed towards the development of a well-structured supply chain, which can give support to a specialized activity and thus respond to the increased market demand for goat meat products. While native breeds are the ones that are better adapted to the harsh environmental conditions of the Caatinga biome, other breeds may be more suitable under a scenario of intensification of the production system.

In extensive systems, poor reproductive performance is one of the major factors affecting the efficiency of production in goats, and represents one of the main limitations towards the optimization of production systems (Fonseca, 2006; Sousa, 2002). Several measures of reproductive efficiency have been used in goats, but the more common are litter size, fertility (often assessed by parturition interval) and litter weight at standard ages (Santos et al., 2013; Simplício et al., 2005; Sousa, 2002).

In addition to reproductive characteristics, growth traits are important factors influencing the profitability of any meat goat production system (Zhang et al., 2009a), because rapid growth during the early part of life reduces maintenance costs and can be considered as an early indicator of post-weaning animal growth (Portolano et al., 2002; Hanford et al., 2006).

One breed that was successfully imported to Brazil and showed good adaptation to these improved conditions is the Boer goat, which is known for its fast-growing ability, excellent meat quality, high fertility and prolificacy, and good maternal ability (Erasmus, 2000; Greyling, 2000; Malan, 2000). The breed was developed in South Africa from local goat populations (Campbell, 2004), and was first imported to Brazil in the 1990's (Sousa, 2002). Boer goats quickly spread across the country, with the highest concentration of animals raised in the Northeast, where they are used in crossbreeding programs with local breeds of goats.

To capitalize on the benefits of crossbreeding, the breeds involved should continue to be selected for the traits of interest, to ensure that production efficiency is improved over time. In the particular case of meat goats, the selection goals generally used are those associated with reproductive efficiency, growth rate and meat quality, with relative importance depending on the production environment and the breeds involved (Kosgey, 2004; Kosgey et al., 2006; Shrestha and Fahmy, 2007).

Setting up a breeding program requires knowledge of the genetic parameters underlying the selected traits, to set up an appropriate genetic evaluation and selection program. However, estimates of genetic parameters for the different measures of productive and reproductive performance in meat goats, particularly for the Boer breed, are still limited and not always consistent (Schoeman et al., 1997; Al-Shorepy et al., 2002; Liu et al., 2002; Zhang et al., 2002; Matika et al., 2003; Bosso et al., 2007; Shrestha and Fahmy, 2007; Zhang et al., 2008; Zhang et al., 2009a; Zhang et al., 2009b).

This study aimed to estimate variance components and genetic parameters for characteristics related to reproductive efficiency (weight of dam at kidding, kidding interval, litter size, litter weight at birth and at weaning) and pre-weaning growth (birth weight, weaning weight, average daily gain and relative growth rate), in a population of Boer goats raised in Brazil.

2. Material and methods

2.1. Animals

The herd of Boer goats evaluated in this study was established in 1996 from a group of 92 live animals imported from the United States. Another importation took place in 2000, where 150 embryos of Boer goats were imported from South Africa. In addition, 11 Boer sires from private Brazilian herds were used as breeders in this population between the years 2007 and 2012. In the period of data collection described in this study (1997–2012), 1826 kids were born in the herd, offspring of 70 bucks and 345 goats used in reproduction.

2.2. Data and Pedigree files

The permission by the committee of animal welfare and ethics of animal use in experimentation was not required for this study, because the data were obtained from a data file already existing, belonging to the State Company of Agricultural Research of Paraíba—EMEPA/PB.

The animals in this herd were raised under semi-intensive conditions in native and cultivated pastures (*Andropogon gayanus* Kunth e *Cenchrus ciliaris* L.), with minerals and concentrate supplements, throughout the year, as well as supplementation with conserved forage (hay and silage) during periods of low availability of pastures. In this equatorial region, only two seasons exist, such that the months between February and June are classified as rainy season and the months between July and January as dry season.

Two mating seasons were used, i.e., in February–March and in September–October. The mating season lasted for 45 days, and goats were hand-mated by selected bucks after heat detection with vasectomized males. Therefore, sires were known for all registered offspring.

Our study included animals born between the years 1997 and 2012. For each animal included in the analyses, the information of sire, dam, sex and birth date, were available. For imported animals, the information about sire and dam, as well as any additional ancestors, were included in the data file, making the pedigree of animals born in Brazil progressively more complete. The data were edited and validated for the consistency of pedigree information, gender, date of birth and duplicate records.

Other sources of information were also available, including type of birth and the weight of kids at birth and at weaning, as well as the weight of breeding females at different stages of their life cycle. Kids were weaned at 112 days of age.

2.3. Reproductive performance

To evaluate the reproductive efficiency of Boer goats, the following traits were analyzed: litter size (LS), defined as the total number of offspring born per parturition; kidding interval (KI), computed as the interval between two consecutive parturitions; litter weight at birth (LWB), calculated as the sum of the weight of kids at birth; litter weight at weaning (LWW), calculated as the sum of the weight of kids at weaning; doe weight at parturition (DWP), corresponding to the weight of the goat on the day that it produced offspring.

2.4. Pre-weaning growth

To assess pre-weaning growth of young goats, the following traits were analyzed: birth weight (BW), weaning weight (WW), average daily gain (ADG) and relative growth rate (RGR). The ADG was calculated as:

$$\text{ADG} = \frac{(\text{WW} - \text{BW})}{\text{Ageat weaning}}$$

The ADG was used to compute by interpolation the estimated WW at 112 days of age for those kids where weaning took place before or after the standard age.