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Alternative contemporary group structure to maximize the use of field records: Application to growth traits of composite beef cattle

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ABSTRACT

The objective of the present study was to define an alternative contemporary group structure that would permit an increase in the number of records to be included in genetic evaluations with minimal bias. For this purpose, using different criteria as goodness of fit measured by percentages of squared bias, correlations between predicted and observed records, residual variances, genetic trends, rank correlations, and a practical situation of genetic evaluation, an animal model with standard contemporary group structure was compared with a model with alternative contemporary group structure including weaning management group (WMG) as an additional uncorrelated random effect for postweaning growth traits of composite beef cattle. The present study showed that the inclusion of WMG as a random effect in the statistical model for postweaning growth traits has only a small impact on animal ranking and a small or no impact on the estimation of genetic parameters and genetic trends. On the other hand, this approach leads to an important increase in the number of records available for the prediction of genetic merit with minimal or even no bias. Therefore, the model proposed here can be recommended to overcome problems related to loss of data of model with standard contemporary group structure.

1. Introduction

The formation of contemporary groups (CGs) is one of the factors that determine the quality of a statistical model for genetic evaluation since these groups permit to eliminate bias caused by differential environmental effects (Van Vleck, 1987). In genetic evaluations of beef cattle, CGs are generally modeled as fixed effects and are formed by a combination of data such as herd, year, season of birth, sex, and management group. The inclusion of CG as a fixed or random effect is relevant to breeders and has encouraged studies involving different domestic populations of pigs (Frey et al., 1997), dairy cattle (Schaeffer et al., 2001), beef cattle (Phocas and Laloë, 2003), and sheep (Legarra et al., 2005). In general, considering CG effects as fixed permits to eliminate bias due to the association between effects corresponding to sires and CGs (Van Vleck et al., 1987), or in situations in which a non-random relationship exists between sires and CGs (Visscher and Goddard, 1993). When CGs are treated as random effects, the effective number of information with which animals will be evaluated increases at the expense of possible bias if the distribution of sires across CGs is not random (Ugarte et al., 1992). In the latter case, CG effects should preferentially be treated as fixed (Visscher and Goddard, 1993).

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In beef cattle production systems that are based on large pasture areas, farm information included in the formation of CGs for genetic evaluation is somehow vague because of the considerable environmental variability in these large properties. Within this context, information of the management group to which the animal belongs is useful to discriminate environmental specificities between groups of animals on the same farm. The inclusion of management group information in the formation of CGs would be desirable; however, some genetic evaluation programs omit this information since it markedly increases the number of small CGs formed. The reduction in CG size is greater in the case of formation of CGs for postweaning traits. In many cases, the selection practice that commonly occurs at weaning leads to the distribution and reorganization of animals from weaning management groups (WMG) into new groups, called postweaning management groups. The use of small CGs may better reflect the true environmental conditions to which the animals are subjected; however, the estimates may not be representative or of low accuracy (Legarra et al., 2005).

Within this scenario, the objective of the present study was to define an alternative model that would permit an increase in the number of records to be included in genetic evaluations with minimal bias. For this purpose, using different criteria and a practical situation of genetic evaluation, an animal model with standard contemporary group structure was compared with a model including WMG as an additional random effect for postweaning traits of beef cattle participating in a breeding program of composite cattle in Brazil.

2. Material and methods

2.1. Data

Data from animals (purebred, crossbred, and composite) born between 1980 and 2010 on 58 farms located in the Brazilian states of São Paulo, Mato Grosso do Sul, Mato Grosso, Goiás, Minas Gerais, Pará and Rio Grande do Sul were used. These animals participate in the Montana Tropical Composite Breeding Program, from partners of the CFM-Leachman Pecuária Ltda.

In the formation of the composite cattle used in the this study the breeds were pre-grouped according to their genetic similarity and general performance into four large and general biological types, which are identified by the abbreviation NABC: group N (*Bos indicus*) represented by Zebu breeds and breeds of African origin; group A (*Bos taurus*) represented by breeds adapted to tropical climates; group B (*B. taurus*) represented by European breeds of British origin and group C (*B. taurus*) represented by European breeds of continental origin (Ferraz et al., 1999). In this population, an animal (composite beef cattle) should be composed of at least three different breeds, 12.5% adapted breed to the tropical environment and 25% of Zebu breed (N) plus breeds adapted to tropical climates (A). The maximum acceptable values are 37.5% group N, 87.5% group A, 100% group N plus A, 75% for groups B, C and B plus C. Further information about the formation of the present composite beef cattle can be found in Santana et al. (2012a).

The animals were kept on pasture with or without supplements in the dry season (April to September). In general, the pastures were composed of *Brachiaria brizantha*. Especially in the Pantanal (Midwest) and Pampa (Southern Brazil), the native pasture plays an important role in animal feeding. All farms provided mineral supplements, and some protein. About 60% of cows were inseminated and 40% were placed in lots with a group of bulls. The cow-to-bull ratio was 30:1 or 25:1. Calves born between September and December remained with their dams up to 7 months of age.

Weaning weight (WW) was measured at around 205 days of age. The post-weaning weight gain (PWG) was defined as weight gain from weaning to 420 days of age, i.e. weight gain over 215 days. Scrotal circumference (SC) was measured by placing a tape around the scrotum at the point of maximum diameter. The muscling score (MUS) was evaluated by attributing visual scores of muscle mass ranging from 1 to 6, with 6 corresponding to more muscular animals. Scores were attributed to observations made within the contemporary groups. The post-weaning traits SC and MUS were measured at around 420 days of age.

Records of animals in CGs with fewer than 20 animals, CGs with all progeny of a single sire, sires with fewer than five progeny records, records of animals with unknown sire or dam, and data exceeding 3.5 standard deviations above or below the overall mean of the trait were excluded to estimate variance components. Additionally, the data set used for the genetic evaluation considered records of animals in CGs with at least five animals. In the latter case, no restriction was required to number and distribution of progeny per sire.

2.2. Model, CG definition, and parameter estimation

Two models were used: an animal model with standard CG structure (A) and a model with alternative CG structure (B) that included WMG as an additional random effect for postweaning traits. Thus, for WW only model A was used and CG was defined as follows:

$$\text{CG} = \text{year of birth} + \text{weaning farm} + \text{WMG} + \text{sex}.$$

In model A, the CG for postweaning traits (PWG, SC, and MUS) was defined as:

$$\text{CG} = \text{year of birth} + \text{weaning farm} + \text{WMG} \\ + \text{postweaning farm} + \text{postweaning management group} \\ + \text{sex (except for SC)}.$$

In model B, CG for postweaning traits was considered as described for model A, but without WMG. In this case, WMG was included as an additional uncorrelated random effect.

Age at measurement (linear) and age of dam at calving (linear and quadratic) were included as covariates for all traits in the two models (A and B). In addition, the models included the following effects based on NABC definition: individual and maternal breed composition, individual and maternal heterozygosis (outcrossing percentage) as linear