Genotype-Environment Interaction For Milk Production In The Gyr (*Bos Indicus*) Dairy Cattle In Brazil

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Introduction

According to Falconer and Mackay (1996), genotype-environment interaction (G-E) means that the best genotype in one environment is not necessarily in another environment, in other words, a trait measured in two different environments is to be regarded not as one trait but as two. Genetic correlations between milk productions of progeny of the same sire in different environments may reveal the existence of G-E interaction. The magnitude of the correlation coefficients suggests an evidence of G-E interaction presence and importance. Specific differences of environment may have a greater effect on some genotypes than on others and cause changes in the ranking of genotypes merit in different environments (Falconer and Mackay, 1996). Otherwise, differences in phenotypic expressions of different genotypes can be identified in different environments, without changing the order of genotype merit. In this case, there is only change in genetic variance. The artificial insemination allows progeny of sires to be spread over different regions with different livestock management which may bias the estimate of genetic merits of the animals if genotype by environment interaction is not considered in the genetic evaluation (Buchanan and Nielsen, 1979). Furthermore, the use of a sire in an environment in which the variance is smaller than the variance where their relatives were evaluated limits the performance of its progeny and the economic return they can offer (Blake et al., 1988, Stanton et al., 1991). Therefore, in genetic evaluations, genotype by environment interaction effect should be considered to allow larger average genetic gains over the environment (Costa, 1999). In Zebu cattle, Freitas et al. (2009), in a preliminary study involving Gyr dairy cattle, observed the effect of herd on milk production of daughters of sires with different breeding values, pointing out for the possibility of G-E interaction. The objective of this research is to assess G-E interaction for milk yield in Gyr dairy cattle in Brazil.

Material and methods

Dairy records for this study are from the database of the National Program for the Improvement of Gyr Dairy Cattle, executed by the Embrapa Dairy Cattle Research Center, in partnership with the Brazilian Gyr Dairy Cattle Breeders Association.

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Data on total milk production of the first three lactations from 1960 to 2008 were used in the analyses. Two calving seasons were considered: rainy season (from October to March) and dry season (from April to September). In the genotype-environment interaction analyses (G-E), two approaches were considered. In the first, herds were classified according to average milk production into three levels: low (<2,580 liters), medium (2,581 to 2,670 liters) and high (> 3,671 liters). It was considered that low production herds have poor management conditions. In each herd, animals were grouped into three production categories. Fixed effects were calving year, calving season and production category. For each effect only categories with at least four individuals were considered in the analyses. Data set comprised a total of 28,408 observations. Calving age effects (linear and quadratic) were considered in the model as covariates. Genetic additive and permanent environment and the residual were considered random effects.

In the second approach, herds were grouped according to geoclimatic particularities of each Brazilian region, defined by the Brazilian Institute of Geography and Statistics (IBGE) as biomes. Herds in the database were designated to Savanna-like and Atlantic forest biomes. A total of 155 herds are located in the Savanna-like and 123 herds in the Atlantic Forest biome. Some herds included in the previous analysis were excluded because they came from other and low representative biomes. Data comprises a total of 28,198 observations. Fixed effects were calving year and season. Random effects were similar to the first analysis.

For genetic evaluations the MTDFREML algorithm (Boldman et. al. 1995) was used. Multiple trait analyses were carried out to estimate genetic correlations. Spearman correlations were used to evaluate changes in genetic merit rankings of the 20 top sires in different production levels and biomes.

Results and discussion

Estimates of genetic correlations between milk production in different production levels or biomes are presented in table 1. Independent of the approach, the correlations were considered of low to moderate magnitude, suggesting the occurrence of genotype-environment interaction (G-E) for milk production. Rorato et al. (2000) also evaluated G-E interaction for milk production in Holstein Brazilian cows grouped in three production levels, and found correlations between the low and medium levels of 0.42, and between low and high level of 0.26. These estimates were smaller than those obtained with Gyr cows in the present study and suggested a stronger possibility of G-E interaction. However the G-E interaction estimates were obtained by the authors for taurine cows, that are less adapted to tropical conditions. Falconer and Mackay (1996) stand out, in an example, that the breed with the highest milk production in temperate regions is unlikely to have the same production performance in tropical regions. But, despite Gyr is originated from India, a country with environment conditions similar to Brazil, Gyr dairy cattle should be facing here some environmental challenges. Probably, genes responsible for variation in milk production trait in some Brazilian environments are different from those responsible for the expression of the trait in other ones.

Spearman correlations between the rankings of 20 top sires resulted in low estimates (table 2). Thus, changes in genetic variance implied in changes in genetic merit order. Since the best sires in one of the levels are not necessarily the best in others. G-E interaction is an important effect to be considered to obtain accurate genetic breeding value estimates for milk

production of the Gyr dairy cattle and to avoid economic losses with the use of inadequate sires to certain environments.

Table 1: Genetic correlations between milk production levels or between biomes

	LOW	MEDIUM	HIGH	BIOME ATALNTIC FLOREST
LOW	-	0.53	0.46	-
MEDIUM	0.53	-	0.39	-
HIGH	0.46	0.39	-	-
BIOME SAVANNA	-	-	-	0.58

Table 2: Spearman correlations between rankings of 20 top sires in different milk production levels and biomes

	LOW	MEDIUM	HIGH	BIOME ATALNTIC FLOREST
LOW	-	0.34	0.23	-
MEDIUM	0.34	-	0.18	-
HIGH	0.23	0.18	-	-
BIOME SAVANNA	-	-	-	0.33

Conclusion

In spite of the existence of other methodologies to estimate G-E interaction, the results of this study suggest the importance of considering G-E effect in genetic evaluations for milk production of the Gyr dairy cattle in Brazil. Further studies should be carried out to evaluate the best way of including this effect in the genetic evaluation model.

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