Genotype x Environment Interaction in the Greek Holstein Population

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Abstract

Genetic improvement of dairy cattle in the Greek dairy industry is based mainly on the use of imported semen of progeny tested bulls or direct importation of 7 month pregnant heifers. As there are major differences from the exporting countries in the production system, i.e. herd management and feeding system, the study of the magnitude of genotype x environment interactions (GxE) on milk yield is of significant importance. The data set for this study was provided by the Holstein Association of Greece covering a time period from 1999 to 2008 and comprised of 11459 completed lactations from 45 dairy farms. The sires under study originated from 12 countries. Breeding values for the bulls under study were estimated in Greece using an animal model. The fixed factors included were herd, herd production group, year – season of calving and number of lactation. Repeated milk records of 7079 cows having completed at least the first three consecutive lactations were used in the analysis. The heritability of 305 days milk production was 0.23. The determination of any possible GxE interaction was based on the ranking correlation of the bulls breeding values, as estimated from the responsible organizations in each of the sire's origin with the corresponding breeding values estimated from the Greek dairy population. The correlation coefficients were between -0.32 and 0.45 depending on the bull's country of origin. All of them were non significant. A comparison of the mean values of the production traits in Greece and the bulls' countries of origin indicates the factors that could explain the lack of significant correlations.

Keywords: genotype by environment interaction, dairy cattle, Greece

Introduction

Genetic improvement of dairy cattle in the Greek dairy industry is based mainly on the use of imported semen of progeny tested bulls or direct importation of 7 month pregnant heifers from counties with progeny tested of A.I. bulls. As there are major differences with the exporting countries regarding the production system, i.e. herd management and feeding system, the study of the magnitude of genotype x environment interactions (GxE) on milk yield in the Greek dairy industry is of significant importance. The interaction between an animal's genotype and the environment can play a major role in the expression of the phenotype of a productive trait and is very important when estimating breeding values (Kang, 2002).

The aim of this study was to investigate the existence of genotype x environment interaction on milk yield in the Greek dairy industry. For this purpose the breeding values of the bulls used in the Greek population were estimated and were correlated with the breeding values as estimated from the responsible organizations in each of the sire's country of origin in order to examine if there was any change either in scale or rank. Additionally the production traits of the population, with differences in their mean values between the countries of bulls' origin and Greece were investigated in order to study if they can create the changes in the rank of the bulls' breeding values.

Material and Methods

The data were provided by the Holstein Association of Greece (H.A.GR.) covering a time period from 1999 to 2008, and comprised of 11459 completed lactations from 45 dairy farms. The data used in the analysis were production records from completed lactations of cows with pedigree records. The data were apprehended using Oracle Discoverer (Armstrong, M., 2006) from the IRIS database kept by H.A.GR. in collaboration with CR Delta (CR Delta, product division NRS,2002). The data were inspected for errors and outliers and all the necessary new variables were created using SPSS 16 software (SPSS Institute INC., 2006).

For all the bulls used as parents in the Greek population their estimated breeding values were collected from the breeding organisations in each bulls' country of origin. The breeding values were collected from the corresponding databases in each country. REML analysis has been applied for variance component estimation (Meyer, K., 2007) and BLUP breeding values have been estimated using the following model:

$$Y_{klmnopq} = \mu + ys_k + age_l + par_m + herd_n + G_o + PE_p + e_{klmnopq}$$ Where:

$Y_{klmnopq}$ is the 305 days lactation. Only lactation and pedigree data from cows having all the first three consecutive lactations were used in the selected model. μ is the mean value of the population, ys_k is the fixed effect of year-season of the calving, age_l is the fixed effect of the age at calving, par_m is the fixed effect of the parity number, $herd_n$ is the fixed effect of the production class, G_o is the random additive genetic effect, PE_p is the random effect of the permanent environment and $e_{klmnopq}$ is the random residual effects.

The determination of any possible GxE interaction was based on the ranking correlation of the bulls' breeding values as estimated from the responsible organizations in each of the sire's origin with the corresponding breeding values estimated from the Greek dairy population. Only bulls with more than 5 daughters in the Greek dairy population were used in the analysis.

Results

The sires in the study originated from 12 countries, in alphabetical order these were Belgium (3 bulls), Canada (36), Czech Republic (1), Denmark (8), France (118), Germany (494), Hungary (16), Italy (27), Luxemburg (1), Netherlands (228), New Zealand (6) and USA (252).

In Table 1 the mean values and the standard deviations of some production traits are presented and compared to the values in the countries of bulls' origin. As we see in Table 1 it is apparent that the Greek farmers have satisfactory results in comparison to other countries (W.H.F.F., 2008), however longevity issues have arisen. As it can be seen in Table 1 the cows fail to produce for more than 3 consecutive lactations in average. Moreover, age at first calving is 27.4 months and thus 3.4 months more than the ideal age at first calving of 24 months (Pirlo *et al.,* 2001). Additionally there is a high somatic cell count indicating problems with mastitis. In Table 2 the variance components and the heritability estimation for the 305 days lactation are presented.

The ranking correlations of the bulls' breeding values as estimated from the responsible organizations in each of the sire's origin with the corresponding breeding values estimated from the Greek dairy population are presented in Table 3. The correlation coefficients were between -0.32 and 0.45 depending on the country of the bull's origin. However, none of the correlations were significant. Moreover, the further analysis using the level of the average herd milk production indicate possible genotype x environment interaction regardless of the origin of the bull and of the management level of the dairy farm.

Discussion

The means of some production traits in the Greek dairy population together with their respecting values in the bulls' countries of origin are shown in Table 1. According to this Table some means are comparable between the different countries while other such as longevity, age at first calving, somatic cell

count and calving interval, exhibit in Greece pour values. These traits are usually showing low heritabilities (Abubakar, 1986, Dong, 1988).

As far as the trait of the lactation is concerned the effect of the high temperatures in the summer months where most calvings occur must be taken into account. Although these effects are not as extreme as in tropical and subtropical areas concerned (Ojango, 2002) they should be taken into account both as the management practices is concerned (e.g. spraying, fans etc.) and as well as in terms of genetic evaluation of the animals.

Heritability (0.23) and variance components estimates for the lactation trait (Table 2) are within the range estimated by other investigators (Calus, 2002, Johansson, 2005).

None of the ranking correlations, between estimated breeding values within the H.A.GR. population and the estimated breeding values of the corresponding organizations of the bulls, was significant (Table 3). These results in some cases could be explained by the low numbers of bulls in terms of their daughters within the H.A.GR. population, while for bulls from countries which have sufficient numbers of daughters within the Greek dairy population could create problems in managing the dairy herds breeding programme.

These low and non significant ranking correlation coefficients could raise concerns within the Greek dairy farmers' community concerning the choice of the best A.I. bulls to be used for breeding and the marketing of bulls' semen. More consideration should be put on the strategy of planned matings firstly on organisational level and subsequently on farm level. The breeding value estimation of all animals within H.A.GR. for all the traits of interest and the application of a strategy for the planning of the matings could help for the improvement of the correlation coefficients. Furthermore, as mentioned above (Table 1), the animals exhibit pour longevity. The fact that the animals fail to produce more than 3 lactations in average might have an effect on the expression of their full genetic potential. Improved management practices could increase the longevity of the animals and consequently have an impact on the ranking correlations of the bulls.

Further analysis using EBV's from M.A.S.E. and EBV's of H.A.GR. could give a better insight on the ranking correlations of bulls with high numbers of daughters in the population.

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