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Specificities of the Local Kids' Genotypes Expression Towards Arid Conditions in Southern Tunisia

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Abstract: About 5000 kid's weights registered during four years in 9 herds raised in the Tunisian arid area were used in the aim to identify some genetic specificities of the local population productive behaviour towards harsh conditions. The analysis of kid's growth under arid regions conditions shows a particular aspect of the genotypes expression in arid environment. The nature of the non-genetic factor effects on kid's phenotypes distribution and parameters reveals a direct impact on the application of quantitative genetic methodologies for animal improvement. The expression of the "best" genetic potentialities seams to be limited by a maximum level defined by environmental factors. The normal distribution of kid's performances is not verified, especially in dry years, where the right tail of the bell curve disappeared. The statistical importance of certain parameters such as the means and the variance is modified. The construction of the mixed model could, in this special case, induce a bias or increase the variance of the prediction error. These considerations impose a revision of hypotheses and methodologies of the quantitative genetics for the livestock improvement in arid regions.

Key words: Local goat, genetic specificities, kid's growth, environmental factors, Southern Tunisia

INTRODUCTION

Since about 10 000 B.C., the caprine specie was domesticated and raised under various ecological systems (Fabre-nys, 2000). Thus, goat has varied its breeds and products during this long husbandry period to adapt towards various production circumstances and modes (Alexandre *et al*., 1997a). After a long period of marginalisation due to some false prejudices, goat breeding knows actually an increasing interest because of the high caprine productivity and the quality of goat products. Rather than goat contribution in intensive systems, its role is crucial in marginal zone where the production factors constrain seriously the productivity improvement. Even though when organisational aspects of improvement plans can be controlled, some serious methodological constraints can explain the failure of improving plans application (Najari *et al*., 2007a).

During the last century, the application of quantitative genetic methodologies has increased the animal production with numerous successes, mainly in rainy and favourable zones (Alexandre *et al*., 1997b; Najari *et al*., 2007b). Under such production conditions, the environmental resources permit the full expression of the animal genotype; which is not the case, however, in arid and semi-arid zones (Gaddour, 2005). In addition to other structural and socio-economic aspects of the traditional breeding systems (Owen, 1987; Gaddour *et al*., 2007) the nature of the non genetic factors effects can be, in part, responsible of the failure of the application of selection methodologies in the arid zones (Najari, 2005). The necessary decisions for genetic improvement and the application of the selection scheme require an adequate knowledge of the additive and non-additive genetics parameters of the population involved (Steinbach, 1987). The complex ity of the factors intervening in animal production under severe conditions makes difficult a suitable phenotype modelling. In fact, some genetic quantitative hypothesis can be not verified under harsh conditions when animals were constrained by environment to express correctly their genetic potentialities (Najari *et al*., 2007b). Indeed, the genetic improvement of the quantitative characters starts by assuming that the animal performance represents a synthesis of the gene pool action added to the effects of non genetic factors representing the production environment (Pollak and Van Vleck, 1992; Gaddour *et al*., 2007). Since the first genetics indexes, the evolution of the genetic value prediction is mainly related with the modality and the quality of the non genetic factors correction. Each genetic methodology is characterized by an additive contribution in this special stage with a direct impact on the efficiency and accuracy of genetic value predicted or genetic parameters estimated (Ball and Banks, 2000).

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In arid regions, the nature of non genetic factors action on the genotype expression can prevent the verification of the quantitative genetic hypothesis and the methodologies application. The severe conditions, especially insufficient feeding resources, do not allow the animals to express their real genetic potential. Thus, performances are essentially varying according to a variation margin "fixed" by non genetic factors (Najari, 2005; Gaddour *et al*., 2007). The highest genetic potentialities could be overlooked and apparently confounded with contemporaneous having lower genetic potentialities (Najari *et al*., 2006; Shrestha and Fahmy, 2007).

In this study, we try to illustrate some aspects of the environmental factors action upon kids' performances in the arid regions of southern Tunisia. The study aims to discuss these specificities and their impacts on genotypic and phenotypic distributions. The kids' weights variability, their distribution, the parameters and the phenotypic modelling will be used to illustrate the typically animal genotypes responses towards the restraining action of these factors. Also, we will try to identify the impact of these specificities and their considerations to optimise the selection program in arid lands with respects to local population genetic expression mode.

MATERIALS AND METHODS

Data used in this study is relative to the local goat characterization project executed in the arid region of the southern Tunisia.

Study zone: This Tunisian arid region, where the small ruminant pastoral husbandry remains with an important social and economic role, is situated in the south of country. This zone contain the major part of national range lands and is located in the lower arid bioclimatic stage; with an average annual rainfall of 188 mm. January is the coldest month of the year, with in average temperature of 10,7°C, whereas August is the hottest month with about 27.3°C average (Ouled Belgacem, 2006).

Animal material: The indigenous goat population shows a large variability both in morphology and performances (Najari *et al*., 2007b). The local goat population is characterised by its small size with an average height of 76 cm for the male and 60 cm for the female (Ouni, 2006; Gaddour *et al*., 2007). It is distinguished by the ability to walk long distances, water shortage resistance and good kidding ability. The native goat is hairy and basically black coat colored with spots on the head horned and has bread and dewlap on the neck. Fertility rate is about 87% and prolificacy rate varies between 110 and 130% (Najari *et al*., 2006). Kidding season begins in October and continues till February with a concentration in November and December when 69.2% of kid's are born (Najari *et al*., 2007a).

Data collection and processing: About 5000 kids' weights were used in the present study. Data is carried out, during four years, from a periodical weighing plan of 722 indigenous kids raised in eight ambulant herds under arid land conditions in the southern Tunisia. Since the start of the kidding period and till summer beginning, kids were weighed once every two or three weeks. The controlled herds are distributed on different ecological zones of the arid region. The survey protocol has been planned in order to intervene without misleading any modifications on the management system. Performances used in this study are weights of kids, estimated by intra or extrapolation and the daily growth averages.

Each kid records included goat mother and kid identification, type of birth, date of birth, sex, herd, natural region and kid's weights measured with the corresponding dates of controls.

These performances have been analyzed by statistical package (SAS, 1994).

RESULTS AND DISCUSSION

Phenotypic distribution: Figure 1 and 2 illustrate the kids' weights distribution during two climatically different years. Figure 1 shows phenotypic distribution of data collected during 1999 which is considered as a good year when the total rainfall reaches 307 mm. However, the data collected in 2001 when the total rainfall is less than 30 mm is presented on Fig. 2. The shape of the performances distribution changes considerably according to the year. These changes reflect a different expression of genotypes under different conditions. During the rainy year 1999 (Fig. 1), the recorded performances follow a normal distribution according to the statistical tests of normality. Each kid could have expressed its true genetic potential. But during the dry year 2001 (Fig. 2), weights of kids present a particular distribution shape and the bell curve loss its right tail which represents the highest records. The best kids' genotypes are unable to express their superiority and its records underestimate its real potential; the feeding resources were scarce and not enough to allow a full concurrence between genotypes (Shrestha and Fahmy, 2007). Thus, we can conclude that the non genetic "year" factor determines a maximum level of growth that can't be exceeded by all genotypes even though when genomic factors were favourable.

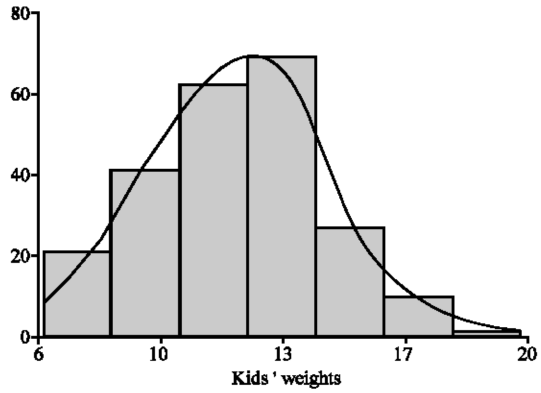

Fig. 1: Distribution of kids' weights (Kg) at 3 months age during favourable year (1999)

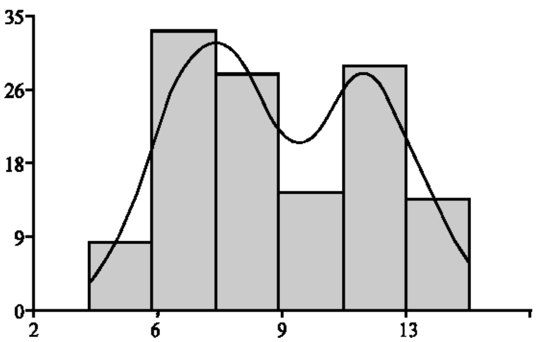

Fig. 2: Distribution of kids' weights (Kg) at 3 months age during a dry year (2001)

For all quantitative characters, such as animal productive phenotypes, performances follow often a normal or bell curve distribution (Chapuis *et al*., 1995). This aspect is one of the most important hypothesis for the genetic evaluation and the estimation of the genetic parameters of animal populations. However, such phenotypic distribution is not guaranteed under severe conditions. In this case, animals having the better genetic potential are often unable to express their genetic superiority compared to their contemporaneous (Morand-Fehr and Doreau, 2001). Due to environmental factors, this superiority can't be showed as a major phenotypic production. In such circumstances, performances of the genetically superior animals are constrained by non genetic factors and can be similar to phenotypes of other animals of minor genetic capacities (Caruolo, 1974; Pasquini *et al*., 1994). Hence, with different genetic potentialities, we register similar phenotypes.

This numerical specificity can affect some statistical parameters, such as the means or the variance of kids' performances, which have a basic role in the quantitative genetic methodologies. These parameters will change

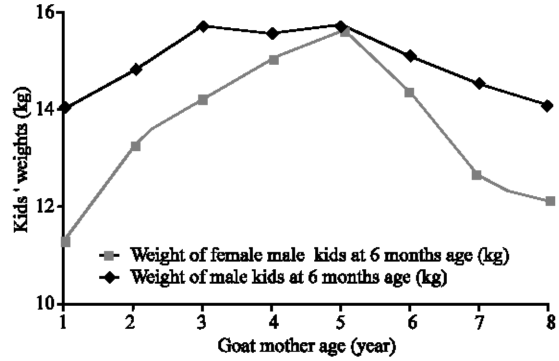

Fig. 3: Effect sex*mother age interaction on the kids' weight (Kg) at 6 months age (Year)

considerable by years for the same population and their general values can't represent rainy or dry years (Najari, 2005). So the numeric and statistical role of these parameters, in the genetic evaluation or the genetic parameters estimation, is seriously affected in arid conditions with regards to the hypothetical case. Assuming for numerous non genetic factor, the intrinsic levels as homogenous, risk to overestimate the prediction error variance and disturb the convergence of the iterative resolution of the mixed model equation system (Najari, 2005; Schinckel and De Lange, 1996; De Lange *et al*., 1998).

Numeric impacts upon the choice of the mixed model factors: The choice of factors and interactions to include in the equations of the mixed model for a genetic evaluation, or for genetic parameters estimation, represents a main and important stage related with the accuracy of the genetic animal ranking. If the model ignores a factor that has a significant effect, the evaluation will be biased; on an other hand, the inclusion of a factor with not significant action increases the prediction error (Ducroq, 1990). The determination of the mixed model factors and interactions, must represents the reality of the expression of the genotype under the specific conditions that affect the phenotype. Also the factors to include must be repeatable to have a connected model. Factors affecting the performance depend on the management system and the natural condition (Najari *et al*., 2007a, b). In arid conditions, this stage could not produce a correct modelling of phenotype due to the nature of the genotypes expression and overlook some environmental factors and interactions effects (Najari, 2000).

Figure 3 and 4 illustrate the effect of the sex*age of goat mothers interaction on kids weights at 6 months age and the effect of sex*year. Normally, the best kids'

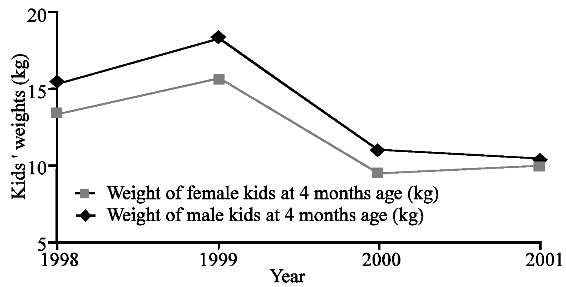

Fig. 4: Effect of sex*year interaction on the kids' weight (Kg) at 4 months age

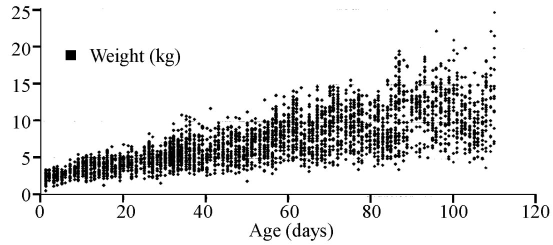

Fig. 5: Observed kids' weights (kg) distribution with respect to the kids' age

Table 1. Statistical parameters of kids' weight with respect to the age

Age (days)	Observations	Minimum	Maximum	Mean (kg)	Std. Deviation
1	203	0.60	3.40	2.25	0.43
10	17	2.50	5.00	3.84	0.79
30	36	2.70	7.70	5.22	1.18
50	33	2.00	11.32	6.25	2.10
70	38	4.50	15.60	10.00	2.84
90	24	6.50	14.24	11.78	2.82
110	64	7.12	24.74	14.66	5.27
130	63	6.50	19.76	11.48	3.95
150	54	10.50	14.00	12.50	2.47
170	54	6.18	12.00	9.08	3.38
190	59	8.96	15.56	11.54	4.32
210	65	14.50	25.00	17.70	4.28

performances were recorded when their mothers are aged between 3 and 6 years (Gaddour *et al*., 2007). Also, the male kids have superior weights to those of females (Ouni, 2006). However, the Figure 3 shows that the effect of the sex seems to disappear when the goat mother is 5 years old. For the male kids, the effect of the favourable mother ages was quasi suppressed because the severe conditions which don't permit them to express correctly their genetic potentialities. The same aspect is illustrated by the Fig. 4, representing interaction of sex*year on weights of kids to, the difference between the 2 sex performances varies from one year to other. During the dry years such as 2000 and 2001, the male kids could not have recorded superior performances to those of females compared to good years (Najari, 2005). Thus, the identification of the some fixed factors and levels of the mixed model of genitors' evaluation is conditioned by environmental action on genotypes expression (Morand-Fehr and Doreau, 2001).

Variability of kids' growth performances: Table 1 presents some statistics parameters of the kids' weights as registered at different kid's age. The variation interval and the standard deviation values become higher with the kid's age. Before 1 month age, the studied phenotype has often a reduced margin of variation and the variability tend to be higher especially after 3 months age.

Figure 5 shows the kids' weights evolution with respect to the age. Since the age of 3 months, the variation amplitude of the phenotype becomes largely beyond of the representatively of the average as a numerical parameter. Nevertheless, the phenotype average and the variance, remain a basically parameters for the individual genetic evaluation as well as for the calculation methodology for the genotypes evaluation.

The analysis of such cases of variability, when we consider such performances as homogenous data, risks to overestimate the variance especially of the prediction error. This situation makes difficult the convergence of the equation system of genetic evaluation model (Schinckel and De Lange, 1996; De Lange *et al*., 1998). This large variation represents the expression of the kid genotypes under irregular conditions. Indeed, it represents more especially the variation owed to non-genetic factors as the year. The kids' weights variability may be weaker and better presented by each factor.

CONCLUSION

Under arid regions conditions, non-genetic factors show a specific impact upon animal performances. Also, the expression of the "best" genotypes can be constrained by environmental factors and their phenotypic records will be comparable to other contemporaneous, even though for those having lower genetic potential. It seems that husbandry conditions fix a maximum level of production that can't be reached even when the genotype is favourable. The high variation of some parameters such as the mean and the variance, with a basic importance in quantitative genetic methodologies, can limit the numerical and statistical significance of these parameters. This aspect has to be considered when these parameters represent a wide set of data collected under arid conditions and during four years. In the arid regions, the non heritable environment appears as the most determining factor controlling the production and the individual genetic potential has only a secondary role. So, we can conclude that, the common situation in the favourable regions, where the phenotype and the different parameters represent the full competition of animal's genotypes, is not verified in dry zones.

Hence, the hypotheses and several selection methodologies of the quantitative genetics have been tested and realized its glorious success only under favourable conditions. The specificity of the arid environment action upon the genotypes' expression seems to have a direct effect on genetic methodologies application. The mixed model building for evaluation could not correctly estimate and corrects some factors and interactions effects. This situation can increase the prediction error, produce a biased evaluation and make not sure the convergence of the iterative resolution of equation systems.

To conclude, the genetic behaviour of rustic animals in arid zone should be analyzed as complex characters having various effects. Indeed, in extensive pastoral husbandry the animal genotype intervenes to optimize the favourable circumstances and to minimize negative effects during severe and harsh irregular periods. Quantitative genetic methodologies must be adapted to such conditions of genotypic expression mode.

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