ENVIRONMENTAL AND GENETIC INFLUENCES ON PRE-WEANING DAILY WEIGHT GAIN IN TEDDY GOAT KIDS

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ABSTRACT

Records belonging to 1248 Teddy goats kept at the Livestock Production Research Institute, Bahadurnagar, (Okara), Pakistan were analyzed to identify genetic and environmental factors affecting pre-weaning average daily weight gain. Sex of kid, season and year of kidding affected average daily weight gain significantly ($P<0.01$). Male kids gained at a faster rate (111.00 ± 6.01 g/day) than female kids (106.00 ± 6.06 g per day). The kids born in summer gained 108.90 ± 1.3 g per day, which was lower ($P<0.01$) than winter born kids (115.4 ± 1.4 g per day). Different years of birth had shown gradual decrease in pre-weaning average daily gains. The effects of parity of dam and birth type were found to be non-significant. Heritability estimate for daily weight gain was 0.12 ± 0.06. The phenotypic and genetic trends were negative.

Key Words: Pre-weaning average daily gains, goats, year, season, sex, parity, birth type, genetic trend

INTRODUCTION

The goat is one of the smallest domesticated ruminants, which has served humankind earlier and longer than cattle and sheep. There are more than 0.6 billion goats worldwide presently producing more than 1.9 million tons of meat besides mohair, cashmere, skins and dung; and a large number of people consume meat, milk and milk products from goats worldwide. Goat herds, on the other hand low producing though, are an expression of capital assets and wealth in Africa and Asia where they are found in large numbers (Haenlein, 1999). In Pakistan, there are about 48.5 million goats (FAO, 1999).

Teddy goat is preferred because of having early maturity, rapid growth rate, better feed efficiency and high prolificacy coupled with disease resistance and adaptability to the local environmental conditions. The survival of Teddy goat on remnant of the large animals is another plus point for its herdsmen. This leads to cheaper and quality mutton production, which is very necessary to fulfill our national animal protein deficiency.

High pre-weaning average daily gain is indicator of cost-effectiveness of commercial level production. Nevertheless, haphazard breeding, irrational feeding and unmanaged flocks are the present status, which need attention and careful studies to propose measures for future breeding. Thus, the present study has been planned to evaluate the environmental and genetic influences on pre-weaning average daily gain in Teddy goat kids.

MATERIALS AND METHODS

Data on pre-weaning average daily gain of Teddy goat kids maintained at the Livestock Production Research Institute, Bahadurnagar, Okara during the period from 1975 to 1999 were used. Data on individual kid for identity, date of birth, sex, birth type, date of weaning, and pre-weaning average daily gain were collected. Pedigree and performance records of kids were also collected from the relevant registers. History sheets of dams were also used to match these records. In addition to the basic edits of consistency, checks for dates and animal identities, records of goats that had aborted, missed a period due to sickness or other reasons were eliminated. The records outside ±3 phenotypic standard deviations from the mean were excluded.

Data were analysed to evaluate the influence of year of birth, season of birth, birth type, sex of kid and the parity on pre-weaning average daily weight gain of Teddy goat kids. The year of birth was divided into two seasons i.e., summer (April–September) and winter (October–March). The mathematical model assumed for study of non-genetic influences was:

$$Y_{ij} = \mu + F_i + e_{ij} \qquad \text{(Model I)}$$

Where,

Y_{ij} = measurement of a particular trait

μ = population mean

F_i = the effect of all fixed effects with the restriction that $\Sigma F_i = 0$

e_{ij} = the random error associated with each observation.

These analyses were performed using Harvey's Mixed Model Least Squares and Maximum Likelihood Computer Program (Harvey, 1990).

Heritability estimates were computed for the pre-weaning average daily gain. The mathematical model assumed for this purpose was as follows:

$$Y_{ijk} = \mu + A_i + F_j + e_{ijk} \qquad \text{(Model II)}$$

Where,

Y_{ijk} = measurement of a particular trait;

μ = population mean;

A_i = random additive genetic effect of i^{th} animal with mean zero and variance σ^2_A;

F_j = fixed effects observed to be significant from the initial analyses (Model 1)

e_{ijk} = random error with mean zero and variance σ^2_E

The heritability was calculated by the following formula:

$$\text{Heritability } (h^2) = \sigma^2_A / \sigma^2_P$$

Phenotypic variance (σ^2_P) = Additive genetic variance (σ^2_A) + Residual Variance (σ^2_E)

Breeding values of animals for various performance traits were estimated by Best Linear Unbiased Prediction (BLUP) procedure, as outlined by Henderson (1973). Model used for this purpose was an animal model. In matrix notation, model assumed can be written as follows:

$$y = X\beta + Z\mu + e \qquad \text{(Model III)}$$

Where,

y is the vector of observations of the animal for a trait (No. of records x 1)

X is the known design matrix relating fixed effects to y (No. of records x total No. of fixed effect levels)

β is the vector of unknown fixed effects including the covariables (total No. fixed effect levels)

Z is the known design matrix relating animals direct additive genetic effects to Y (total No. of records x total No. of animals)

μ is the vector of random animal solutions i.e. breeding values (total No. of animals x 1)

e is the vector of unknown random residual effects (total No. of records x 1)

The random effects were assumed to be normally distributed with mean zero and (Co) variances:

$V(\mu) = A\,\sigma^2_A$

$V(e) = I\,\sigma^2_E$ and $Cov(\mu, e) = 0$

$V(y) = Z\,A\,Z\,\sigma^2_A + I\,\sigma^2_E$

Where,

A is the numerator relationship matrix (total No. of animals x total No. of animals)

I is the identity matrix (total No. of records x total No. of records)

σ^2_A is the estimate of direct additive genetic variance

σ^2_E is the estimate of residual variance.

Best Linear Unbiased Prediction (BLUP) equations for the above mixed model can be represented as follows:

$$\begin{bmatrix} XX & XZ \\ ZX & ZZ+A^{-1}\lambda \end{bmatrix} \begin{bmatrix} b \\ \mu \end{bmatrix} = \begin{bmatrix} X\,y \\ Z\,y \end{bmatrix}$$

Where,

A^{-1} is the inverse of the numerator relationship matrix and

$$\lambda = \sigma^2_E / \sigma^2_A$$

The estimates of σ^2_A and σ^2_E used here were from the earlier analysis (Models II and III)

These analyses were performed using Derivative Free Restricted Maximum Likelihood (DFREML) set of computer programs (Meyer, 1997). Breeding values thus estimated were fitted in a fixed effect model having year of birth as the only fixed effect. The least squares solutions of breeding values were drawn against year of birth to depict the genetic trend. Least squares means of different performance traits were plotted against the year of birth to determine phenotypic trends.

RESULTS AND DISCUSSION

Data on pre-weaning average daily weight gain of Teddy goat kids maintained at the Livestock Production Research Institute, Bahadurnagar, Okara collected over a period of 25 years (1976-1999) were analysed in the present study.

The overall pre-weaning average daily gain was 113.69 ± 20.03 grams. Analysis showed that effects of season and year of birth and sex of kid were significant ($P<0.01$) on pre-weaning average daily gains of Teddy goat kids. The least squares means of pre-weaning average daily gains of kids for different seasons and years of birth have been presented in the Table 1.

The male (111.00 ± 1.01g) kids were faster growing than female (106.00 ± 1.06 g) kids ($P<0.01$). The kids born in summer gained 108.90 ± 1.33 g, which was lower ($P<0.01$) than winter born kids (115.36 ± 1.38 g). Different years of birth had shown gradual decrease in pre-weaning average daily gains. During the years 1976-1979 least squares means ranged from 124.49 ± 2.543 to 130.66 ± 3.384 g then it dropped to 103.31 ± 2.269 – 99.72 ± 2.82 g in the next four years of the study. During the years 1984 to 1993 it remained within the range of

100.53 ± 2.67 – 124.70 ± 1.96 g. Further decline was observed during the years 1998 (92.23 ± 20.03 g) and 1999 (87.46 ± 5.59 g), which is very low than first few years of research data.

Significant effect of season of kidding on pre-weaning average daily gains is also reported by Khan and Sahni (1982) in Jamnapuri goats. In a later study, Khan and Sahni (1983) observed that year was also a significant source of variation for pre-weaning average daily weight gains in Jamnapuri kids. Results of Mavrogenis (1983) were also in agreement with the findings of the present study, who studied Damascus goats and found that year and season of birth were independent variables, which significantly partitioned the variation in pre-weaning average daily gains. Baik *et al.* (1985) had reported significant influence of season of birth on pre-weaning average daily weight gains which is in line with the findings of the present study. However, Mavrogenis *et al.* (1984) reported non-significant influence of year and season of birth on pre-weaning average daily gains in Damascus goat kids.

The estimated breeding values ranged from +32.82 to –35.02 g. The overall phenotypic and genetic trend over the years for pre-weaning average daily weight gains of Teddy goat kids are presented in Fig. 1 which were either close to zero or negative. This may be attributed to the genetic homogeneity as a result of inbreeding as well as ease/disease of management as concerned availability of green grasses/forages for rearing of Teddy goats in different years and seasons which have significantly influenced their growth. This indicates that breeding program carried out during the period under study has not proved efficient and roughly the same trend could be expected from a random use of breeding animals.

Based on the results of the present study it can be concluded that the genetic variation in trait indicates improvement chances through selective breeding for improved average daily weight gain.

Table 1. Least square means (±SE) for pre-weaning average daily weight gains (g) of Teddy goat kids for different non-genetic factors

	Number of observations	Least square mean ± SE
Sex		
Male	647	111.00±1.01
Female	601	106.00±1.06
Season		
Summer	627	108.90±1.33
Winter	621	115.36±1.38
Year		
1976	58	124.83±2.63
1977	43	124.76±3.06
1978	35	130.66±3.38
1979	62	124.49±2.54
1980	44	113.01±3.04
1981	78	103.31±2.27
1982	80	110.37±2.24
1983	51	99.72±2.83
1984	48	116.95±2.92
1985	107	124.70±1.96
1986	110	116.04±1.91
1987	150	113.17±1.64
1988	104	107.37±1.97
1989	67	104.94±2.45
1990	62	119.77±2.57
1991	56	100.53±2.68
1992	47	112.92±2.98
1993	16	115.43±6.36
1998	18	92.23±20.03
1999	13	87.46±5.59

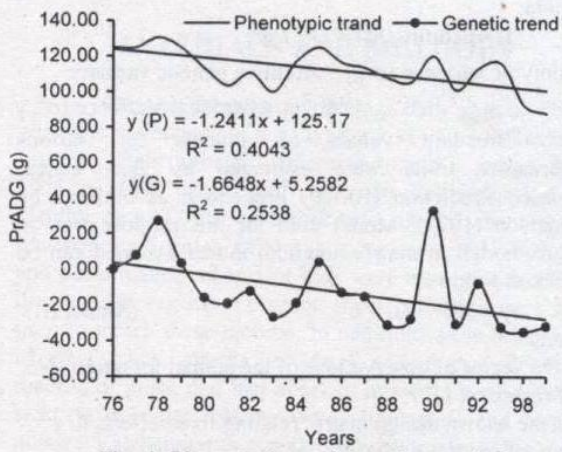

Fig. 1. Phenotypic and genetic trend of pre-weaning average daily gain (PrADG) of Teddy goat kids

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