Genetic Analysis of Pre-weaning and Post-weaning Growth Traits of Mecheri Sheep under Dry Land Farming Conditions

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ABSTRACT : Data on 2,365 Mecheri sheep (1,201 males and 1,164 females), maintained at the Mecheri Sheep Research Station, Pottaneri, India, and recorded between 1979 and 2006, were analysed to study the growth related traits and their genetic control. The body weights at different ages (i.e. at birth, weaning (3 months), 6, 9 and 12 months) were recorded and collected from the birth and growth registers maintained in the farm. The average weights of Mecheri sheep at birth, and at 12 months of age were 2.24±0 .01 and 16.81±0.15 kg respectively. The pre- and post-weaning average daily weight gains were 63.84±0.75 and 29.52±0.43 g respectively. Study revealed a significant difference with the period of lambing on body weight, weight gain and efficiency in weight gain at different stages of growth. Males were heavier and had a higher weight gain than females at almost all stages of growth and the differences tended to increase with age. The direct heritability estimates increased from birth to six months of age and then decreased. The direct heritabilities of all body weights at different stages of growth were low to moderate in magnitude and the values at birth, weaning, six, nine and 12 months of age were 0.08, 0.17, 0.21, 0.13 and 0.10 respectively. For the estimation of heritability at birth and three months body weights, the direct additive genetic and maternal additive genetic effects have to be taken into account and for the estimation of six months weight, the direct additive genetic and maternal permanent environmental effects have to be included in the model. The estimates of heritability, phenotypic and genetic correlations among the different body weights indicated that the selection for improving the body weights at different traits should be done on the basis of three or six months weight because of higher heritability estimates and having higher genetic correlations with other traits. (**Key Words :** Mecheri Sheep, Growth Rate, Heritability, Repeatability)

INTRODUCTION

Growth potential of the lambs is one of the most important traits in a genetic improvement scheme for meat sheep. A number of non-genetic factors affect these growth traits and directly obscure recognition of the genetic potential. Adjustment of data for non-genetic factors and estimation of genetic parameters for the various traits are necessary to obtain reliable estimates for important economic traits and to increase the accuracy of selection of breeding animals. An effective breeding plan can only be devised after thorough knowledge has been obtained about the inheritance of economically important traits. Estimates of heritability and genetic and phenotypic correlations form the basis of such information. This knowledge is required to formulate optimum breeding objectives and an effective genetic improvement programme. The Mecheri sheep is one among the recognised mutton breed of sheep in India and is widely distributed in semi-arid region of north-western part of Tamil Nadu namely Salem, Erode and parts of Dharmapuri and Namakkal districts. The Mecheri sheep is known for its relatively good growth rate (Ganesakale and Rathnasabapathy, 1973; Acharya, 1982), higher dressing percentage (Arumugam et al., 1978) and better skin quality (Karunanithi et al., 2005). The study on production performances of this breed over the years in a semi-intensive system of management, which is similar to the management of the flock by the farmers, is lacking. In addition, the effects of various factors such as period and season of birth, sex of the lamb and parity of the dam have not been studied. Hence, the present study was undertaken

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to identify various factors influencing the growth traits and to estimate the genetic and phenotypic parameters of these traits in Mecheri sheep. The information thus collected will be useful to identify the most important environmental factors influencing the genetic potential of the animals, which in turn will be useful for formulating a suitable breeding programme and genetic evaluation of the breed for implementing breed improvement programmes at the farmer and institutional levels.

MATERIAL AND METHODS

Data and pedigree information on 2,365 Mecheri sheep (1,201 males and 1,164 females), maintained at Mecheri Sheep Research Station (MSRS), Pottaneri, Salem, Tamil Nadu, India were collected over a period of 28 years (1979-2006). The MSRS is located in the dry land farming situation of Tamil Nadu where the climate is generally hot, semi-arid and tropical in nature. Mean annual maximum and minimum temperatures are 34.3°C and 21.9°C respectively. The tract receives an average annual rainfall of 1,112.5 mm. Mecheri sheep were reared under semi-intensive system of management and all animals grazed during the day (7 to 8 h) on natural pasture with supplementation depending upon the status and age category of the animals and were penned at night. At birth each lamb was identified and date of birth, sex, type of birth and weight were recorded. Lambs were normally weaned at three months of age. The body weights at different ages (i.e. at birth and at weaning (i.e. three months), 6, 9 and 12 months) were collected from the birth and growth registers maintained on the farm. The body weights of the animals were measured using a circular suspended spring balance (Salter, New Delhi, India) of 100 kg capacity with an accuracy of 200 g. The average daily gains in live weights from birth until weaning (i.e. three months) and from weaning until the age of 12 months were calculated. The efficiency of growth was assessed as the gain in body weight per kg of initial weight. The growth efficiency at the weaning and post-weaning stages of development was also estimated. The data were classified according to period, season, parity of dam and sex. The years of lambing were divided into seven periods and the different periods considered were period 1 (1979-1982), period 2 (1983-1986), period 3 (1987-1990), period 4 (1991-1994), period 5 (1995-1998), period 6 (1999-2002) and period 7 (2003-2006). Each year of lambing was also divided into two seasons i.e., season 1 (September to February) and season 2 (March to August).

The data were analysed to examine the effects of period, season, sex and parity on body weights at different ages using least-squares analysis of variance (Harvey, 1990) by fitting constants, including all main effects and interactions.

In the initial model, all interactions were found to be non-significant and hence all interactions were ignored in the final model, which was $Y_{ilklm} = \mu+P_i+S_j+T_k+U_l+e_{ijklm}$. Where, Y_{ijklm} = observed body weight at different ages, μ = population mean, P_i = effect of ith period ($_i$ = 1 to 7), S_j = effect of jth season ($_j$ = 1 to 2), T_k = effect of kth sex ($_k$ = 1 and 2), U_l = effect of lth parity ($_l$ = 1 to 4) and e_{ijklm} = random errors. The comparison of the means of the different subgroups was made by Duncan's multiple range test as described by Kramer (1957).

(Co)Variance components and corresponding genetic parameters for the studied traits were estimated by applying restricted maximum likelihood (REML) method fitting an animal model using DFREML 3.1 computer program (Meyer, 2000). The model used to estimate genetic parameters included random effect (sire effect) and all fixed effects that were found significant in least-squares analysis. The following animal models by ignoring or including various combinations of maternal genetic and permanent environmental effects were fitted to estimate genetic parameters for each trait:

$$y = Xb+Z_1a+e \qquad\qquad \text{Model 1}$$

$$y = Xb+Z_1a+Z_3pe+e \qquad\qquad \text{Model 2}$$

$$y = Xb+Z_1a+Z_2m+e \quad cov(a, m) = 0 \qquad \text{Model 3}$$

$$y = Xb+Z_1a+Z_2m+e \quad cov(a, m) = A\sigma_{am} \qquad \text{Model 4}$$

$$y = Xb+Z_1a+Z_2m+Z_3pe+e \quad cov(a, m) = 0 \qquad \text{Model 5}$$

$$y = Xb+Z_1a+Z_2m+Z_3pe+e \quad cov(a, m) = A\sigma_{am} \text{ Model 6}$$

Where y is a vector of observations of the growth traits; b, a, m, pe and e are the vectors of fixed effects, direct additive genetic effects, maternal additive genetic effects, maternal permanent environmental effects and the residual effects, respectively. X, Z_1, Z_2 and Z_3 are corresponding design matrices related to the fixed effects, direct additive genetic effects, maternal additive genetic effects and maternal permanent environmental effects to vector y. It is assumed that direct additive genetic effects, maternal additive genetic effects, maternal permanent environmental effects and residual effects to be normally distributed with mean 0 and variance $A\sigma^2_a$, $A\sigma^2_m$, $I_d\sigma^2_e$ and $I_n\sigma^2_{pe}$, respectively. Where σ^2_a, σ^2_m, σ^2_{pe} and σ^2_e are direct additive genetic variance, maternal additive genetic variance, maternal permanent environmental variance and residual variance, respectively. *A* is the additive numerator relationship matrix, I_d and I_n are identity matrices that have order equal to the number of dams and number of records, respectively, and σ_{am} denotes the covariance between direct

additive genetic and maternal additive genetic effects. In univariate analysis, log likelihood ratio tests were applied to choose the most appropriate model for each trait (Meyer, 1992). Genetic and phenotypic correlations were estimated using multi-trait analysis applying the most appropriate model, which was determined in the univariate analysis.

RESULTS

Body weight

The least-squares means and standard errors for the various traits are presented in Table 1. The number of individuals observed at the age of one year was 49.9 per cent lower than the number of lambs observed at birth. The reasons for this reduction were mortality and culling of unproductive animals and sale or transfer of animals. The period of lambing had highly significant (p<0.01) effect on body weight of the lambs at all developmental stages. In general, the body weight at different ages was higher in the first period (1979-1982) and the difference was highly significant (p<0.01) when compared with the rest of the periods except for period 2 (1983-1986). The lambs born in season 1 had higher body weight than those born in season 2 and there was a highly significant (p<0.01) difference at birth and nine months of age. The sex of the lamb had a highly significant (p<0.01) effect on all the growth traits. Comparison of the least-squares means for lamb weights at different age showed that the difference between male and female lambs increased from 0.18 kg at birth to 2.84 kg at

12 months of age. In general, parity had highly significant (p<0.01) effect on body weight at different age groups. The body weight increased with the advancement of parity and the lambs born at 4th and above parities had higher body weight at different ages.

Weight gain

The pre-and post-weaning average daily weight gains were observed as 63.84±0.75 and 29.52±0.43 g respectively. The fixed effects namely period of lambing and sex of the lamb were significant (p<0.01) for pre-weaning average daily weight gain and post-weaning average daily weight gain. The highest pre-and post-weaning average daily weight gains were observed in period 1 (1979-1982) and period 3 (1987-1990) respectively (Table 2). The daily weight gain of lambs born to ewes in their 3rd parity was higher than that of lambs from younger or older ewes during pre-weaning stages. The daily pre-weaning weight gain of lambs increased from the first to 3rd parity and thereafter decreased substantially, whereas, the post-weaning average daily gain increased up to 4th and above parities. Lambs born in season 2 had higher pre-weaning daily weight gain than lambs born in season 1, however lambs born in season 1 had higher post-weaning daily weight gain then lambs born in season 2.

Efficiency of growth

The average pre- and post-weaning growth efficiencies of the breed were 2.57±0.03 and 1.02±0.02, respectively.

Table 1. Least-squares means with standard errors of different body weights (kg) at different ages in Mecheri sheep

Effect	Birth	Weaning	Six months	Nine months	12 months
Overall	2.24±0 .01(2,365)	8.02±0.07 (2,098)	11.37±0.11 (1,814)	13.99±0.13 (1,503)	16.81±0.15 (1,185)
Period	**	**	**	**	**
P_1 (1979-1982)	$2.42±0.03^d$ (220)	$9.38±0.16^e$ (187)	$12.04±0.26^d$ (146)	$15.40±0.35^e$ (100)	$18.96±0.40^g$ (73)
P_2 (1983-1986)	$2.42±0.03^d$ (235)	$9.25±0.15^e$ (213)	$12.54±0.24^e$ (163)	$13.65±0.27^c$ (158)	$16.26±0.27^c$ (150)
P_3 (1987-1990)	$2.12±0.03^a$ (294)	$6.73±0.15^a$ (241)	$10.85±0.24^b$ (192)	$13.20±0.32^b$ (134)	$16.69±0.33^d$ (116)
P_4 (1991-1994)	$2.20±0.03^b$ (186)	$7.82±0.18^c$ (160)	$10.34±0.28^a$ (138)	$12.80±0.34^a$ (117)	$15.23±0.37^a$ (92)
P_5 (1995-1998)	$2.14±0.02^a$ (469)	$7.29±0.12^b$ (418)	$10.12±0.18^a$ (383)	$13.09±0.22^{ab}$ (328)	$15.74±0.23^b$ (269)
P_6 (1999-2002)	$2.33±0.02^c$ (505)	$8.45±0.10^d$ (486)	$12.34±0.16^d$ (432)	$15.43±0.19^e$ (381)	$17.67±0.21^b$ (290)
P_7 (2003-2006)	$2.08±0.02^a$ (456)	$7.23±0.11^a$ (393)	$11.36±0.17^c$ (360)	$14.37±0.21^d$ (285)	$17.12±0.25^e$ (195)
Season	**			**	
First (September-February)	$2.29±0.01^b$ (1,894)	8.01±0.06 (1,705)	11.49±0.10 (1,486)	$14.48±0.12^b$ (1,224)	16.98±0.13 (990)
Second (March-August)	$2.20±0.02^a$ (471)	8.03±0.12 (393)	11.25±0.18 (328)	$13.51±0.22^a$ (279)	16.64±0.25 (195)
Sex of the lamb	**	**	**	**	**
Male	$2.30±0.02^b$ (1,201)	$8.30±0.08^b$ (1,064)	$12.00±0.13^b$ (884)	$14.87±0.16^b$ (667)	$18.23±0.19^b$ (447)
Female	$2.18±0.02^a$ (1,164)	$7.74±0.08^a$ (1,034)	$10.74±0.13^a$ (930)	$13.11±0.16^a$ (836)	$15.39±0.17^a$ (738)
Parity	**	**	**	*	**
First	$2.09±0.02^a$ (714)	$7.79±0.10^a$ (599)	$10.87±0.15^a$ (518)	$13.66±0.19^a$ (406)	$16.31±0.21^a$ (325)
Second	$2.21±0.02^b$ (568)	$7.92±0.10^{ab}$ (524)	$11.19±0.15^b$ (463)	$13.65±0.19^a$ (381)	$16.86±0.21^b$ (292)
Third	$2.27±0.02^{bc}$ (470)	$8.16±0.11^b$ (420)	$11.44±0.17^{bc}$ (359)	$13.95±0.21^{ac}$ (304)	$16.95±0.23^b$ (238)
Fourth and above	$2.31±0.04^b$ (613)	$8.19±0.24^b$ (474)	$11.67±0.31^c$ (474)	$14.34±0.31^b$ (412)	$17.16±0.36^c$ (330)

* Significant (p<0.05). ** Highly significant (p<0.01). Means bearing same superscript don't differ significantly.
Figures in parentheses indicates number of observations.

Table 2. Least-squares means with standard errors of different average daily weight gain and growth efficiency during pre-and post-weaning stages

Effect	Pre-weaning ADG (g)	Post-weaning ADG (g)	Pre-weaning growth efficiency	Post-weaning growth efficiency
Overall	63.84±0.75 (2,098)	29.52±0.43 (1,182)	2.57±0.03 (2,098)	1.02±0.02 (1,182)
Period	**	**	**	**
P₁ (1979-1982)	76.96±1.74[d] (187)	26.98±1.14[ab] (72)	2.86±0.07[d] (187)	0.69±0.05[a] (72)
P₂ (1983-1986)	75.48±1.58[d] (213)	24.95±0.76[a] (150)	2.81±0.06[d] (213)	0.76±0.03[a] (150)
P₃ (1987-1990)	50.95±1.62[a] (241)	34.09±0.95[c] (116)	2.25±0.06[a] (241)	1.34±0.04[d] (116)
P₄ (1991-1994)	62.25±1.93[bc] (160)	26.08±1.04[ab] (92)	2.59±0.08[c] (160)	0.95±0.04[b] (92)
P₅ (1995-1998)	56.50±1.27[ab] (418)	30.16±0.67[bc] (267)	2.39±0.05[b] (418)	1.19±0.03[c] (267)
P₆ (1999-2002)	67.92±1.13[c] (486)	31.71±0.60[bc] (290)	2.65±0.04[c] (486)	1.02±0.02[b] (290)
P₇ (2003-2006)	56.85±1.23[ab] (393)	32.66±0.71[c] (195)	2.47±0.05[b] (393)	1.19±0.03[c] (195)
Season			**	
First (September-February)	63.45±0.69 (1,705)	29.89±0.38 (987)	2.52±0.02[a] (1,705)	1.01±0.01 (987)
Second (March- August)	64.23±1.24 (393)	29.14±0.72 (195)	2.63±0.05[b] (393)	1.03±0.03 (195)
Sex of the lamb	**	**		**
Male	66.28±0.88[b] (1,064)	32.90±0.53[b] (445)	2.61±0.03 (1,064)	1.07±0.02[b] (445)
Female	61.40±0.91[a] (1,034)	26.13±0.50[a] (737)	2.54±0.03 (1,034)	0.96±0.02[a] (737)
Parity				
First	62.57±1.05 (599)	28.30±0.60 (324)	2.67±0.04 (599)	0.99±0.02 (324)
Second	63.27±1.08 (524)	29.58±0.61 (292)	2.61±0.04 (524)	1.04±0.02 (292)
Third	64.50±1.19 (420)	29.60±0.66 (237)	2.61±0.05 (420)	1.01±0.03 (237)
Fourth and above	64.38±1.60 (555)	29.94±0.87 (329)	2.52±0.08 (555)	1.01±0.03 (329)

* Significant (p<0.05). ** Highly significant (p<0.01). Means bearing same superscript don't differ significantly.

Figures in parentheses indicates number of observations.

The period and season of lambing had significant (p<0.05) effects on pre-weaning growth efficiency. The efficiency of pre-weaning growth decreased with the advancement of parity. Fixed effects of period of lambing and sex of the lamb had significant (p<0.05) effects on the post-weaning growth efficiency of lambs. Lambs born in the ewes' 2nd parity had higher post-weaning growth efficiency than lambs born in parities either younger or older. The post-weaning growth efficiency in lambs born in season 2 was 1.9% better than that of lambs born in season 1. Male lambs showed better post-weaning growth efficiency than females.

Genetic parameters

(Co)variance components and genetic parameters for the different growth traits estimated by fitting the most appropriate model are shown in Table 3. Direct heritability estimates for body weight at different ages were relatively low to medium ranging from 0.08 to 0.21. Maternal effects had substantial influences in pre-weaning traits. Direct heritability estimates of 0.08 and 0.17 obtained for birth and weaning weights, respectively, were lower than those of respective maternal heritabilities (0.15 and 0.23). The direct heritability estimates of body weight tended to increase with increasing age from birth to six months and then decreased. The most appropriate model for birth and weaning weights was model 3, which included direct and maternal additive genetic effects. Also, the most appropriate model for six months weight included direct additive

Table 3. Estimates of genetic, phenotypic and environmental correlations between body weight at different ages of Mecheri sheep

Traits	Model	σ^2_a	σ^2_m	σ^2_{pe}	σ^2_e	σ^2_p	h^2_d ±SE	h^2_m ±SE	pe^2 ±SE
Birth weight	3	0.34	0.62	-	3.20	4.16	0.08±0.041	0.15±0.062	-
Weaning weight	3	2.81	3.81	-	9.80	16.42	0.17±0.052	0.23±0.063	-
Six months weight	2	3.58	-	1.98	11.80	17.36	0.21±0.081	-	0.11±0.044
Nine months weight	1	2.08	-	-	13.48	15.56	0.13±0.06	-	-
12 months weight	1	1.48	-	-	13.68	15.16	0.10±0.09	-	-

σ^2_a = Direct additive genetic variance, σ^2_m = Maternal additive genetic variance, σ^2_{pe} = Maternal permanent environmental variance, σ^2_e = Residual variance, h^2_d = Direct heritability, h^2_m = Maternal heritability and pe^2 = Ratio of maternal permanent environmental effect.

genetic effects as well as maternal permanent environmental effects (model 2), whilst the most appropriate model for nine and 12-months weights had only the direct additive genetic effects (model 1). Multivariate analyses results are presented in Table 4. Genetic correlations between traits were positive, low to high and ranged from 0.21 (birth-nine months) to 0.77 (weaning to six months). The estimates of phenotypic and environmental correlations were generally lower than those of genetic correlation. The phenotypic and environmental correlations varied from 0.18 to 0.73 and 0.19 to 0.43 respectively among the different traits studied.

DISCUSSION

Body weight

The overall least-squares means for lamb weights at the different ages were lower than those observed by Ganesakale and Rathnasabapathy (1973); Acharya (1982) and Karunanithi et al. (2005). Most of the environment factors (period, sex of the lamb and parity) had significant ($p < 0.05$) to highly significant ($p < 0.01$) effects on body weights at the various ages. These factors have also proved to be important in other studies of lambs of various breeds (Yazdi et al., 1998; Mandal et al., 2003, Mokhtari et al., 2008; Banch et al., 2010; Jafaroghli et al., 2010; Mohammadi et al., 2010). The significant differences in body weight among lambs born in different periods may be attributed to differences in management, selection of rams and environmental conditions, such as the ambient temperature, humidity and rainfall. The seasonal changes in the climate were reflected as differences in body weights during different periods of the year.

The lower birth weight of lambs in second season may be due to the effect of ambient temperature, since the gestation period of the ewes would occur during hot period of the year. The significant effect of the season of lambing on the 9th month may be due to those lambs born in first season pass through a period with a favourable climate when grasses of good quality were available. Those born in second season spent the first months of their life in a hot rainy season (October to November), which was uncomfortable for them and in which the parasite challenge was high. The difference in body weight between male and female with the advancement of age might be due to the increasing differences in the endocrine system between males and females (Swenson and Reece, 1993). These sex differences are consistent with results from other investigations (Mandal et al., 2003; Mokhtari et al., 2008; Mohammadi et al., 2010).

The relative competition for nutrients between the still growing ewes and the developing foetus may be the reason for the depression in birth weight in lambs born to younger ewes. The maximum birth weight was observed in lambs born to ewes in 4th and above parities. A similar significant effect of the parity of the dam on the body weights of lambs was observed by Yazdi et al. (1998) in Baluchi sheep and Mandal et al. (2003) in Muzaffarnagari sheep. The effect of non-genetic factors indicated the performance records for body weight at different ages should be corrected for effects of period of lambing, sex of the lamb and parity of the dam.

Gain and efficiency of weight

The overall pre-weaning average daily weight gain observed was lower than the estimates reported by Karunanithi et al. (2007). The overall efficiency of growth during the pre-weaning stage was comparable with the findings of Mandal et al. (2003). The efficiency of growth measured in terms of the gain in body weight per kg of initial weight decreased with advancing age. The 1.55 kg

Table 4. Estimates of genetic, phenotypic and environmental correlations between body weight at different ages of Mecheri sheep

Traits	Genetic correlation (r_A)	Phenotypic correlation (r_P)	Environmental correlation (r_E)
Birth weight with			
Three months weight	0.36±0.081	0.33±0.120	0.28±0.021
Six months weight	0.28±0.092	0.24±0.131	0.24±0.051
Nine months weight	0.21±0.045	0.18±0.112	0.20±0.072
Twelve months weight	0.22±0.073	0.18±0.084	0.19±0.062
Weaning weight with			
Six months weight	0.77±0.101	0.73±0.314	0.42±0.063
Nine months weight	0.72±0.092	0.62±0.252	0.27±0.092
Twelve months weight	0.68±0.160	0.59±0.261	0.19±0.053
Six months weight with			
Nine months weight	0.74±0.061	0.70±0.222	0.42±0.021
Twelve months weight	0.69±0.120	0.61±0.241	0.27±0.072
Nine months weight with			
Twelve months weight	0.73±0.100	0.63±0.133	0.43±0.063

(61.1%) reduction in growth efficiency during post-weaning development as against the pre-weaning stage indicated that the maximum growth rate had occurred during the pre-weaning stage.

Estimates of genetic parameters

The estimated direct heritability of 0.08 for birth weight was in the range of the published values in other sheep breeds (Ozcan et al., 2005; Rashidi et al., 2008). Contrary to our findings, Safari et al. (2005) Gizaw et al. (2007) reported medium to high heritabilities for birth weight. Estimates of direct heritability were model dependant and ignoring of maternal genetic effects in the model leads to over-estimate of direct heritability for birth weight. The low heritability estimate for the birth weight may be explained by the poor nutritional level of the ewes creating a large environmental variation. Insufficient milk production by the ewe at the earlier developmental stage probably gave rise to the large fluctuations in the environmental effects and the resulting low heritability. In general, the heritability estimates for lambs observed at different body weights are low to moderate, they are within the range of estimates observed in other breeds (Mandal et al., 2003; Mokhtari et al., 2008; Mohammadi et al., 2010).

The increasing heritability of body weights at the later stages of developmental process indicates that environmental factors had more influence on birth weight than on the weights achieved later in the developmental stages which is in accordance with the report of Rashidi et al. (2008). An estimate of direct heritability for six months body weight in the present study (0.21) was the highest among the other growth traits studied and is comparable with the value of 0.23 by Yazdi et al. (1998) in Baluchi sheep and 0.18 by Abegaz et al. (2005) in Horro sheep. However, a higher heritability than the present estimate was also reported for Kermani sheep (Mokhtari et al., 2008).

The genetic correlation between various traits obtained in the present study is in general agreement with those reported in the literature (Mokhtari et al., 2008; Rashidi et al., 2008; Mohammadi et al., 2010). There was no antagonist relationship among these traits in terms of phenotypic, genetic and environmental correlations. Therefore, selection for any of these body weights will bring out positive response to selection for others. The estimates of phenotypic and environmental correlations observed among studied traits were in agreement with the range reported by several authors (Mokhtari et al., 2008; Rashidi et al., 2008; Jafaroghli et al., 2010). The phenotypic correlation estimates between traits indicated the presence of desirable associations among post-weaning traits and also with three months weight. The environmental correlation estimates between various traits in this study are

probably due to similarity of environmental and management conditions.

The present study revealed that environmental factors were a significant source of variation for body weight and average daily gain. Therefore, effects of environmental factors need to be accounted for in the estimation of best linear unbiased predicted value (BLUP) of Mecheri sheep. The maternal genetic effect was important for body weight at birth and weaning. Lamb weight at weaning and at six months was moderately heritable and had high positive correlation with later age groups and relatively low genetic correlation with birth weight. These results suggest that lamb weight at weaning or six months could be considered as an efficient selection criterion aiming at genetic improvement of growth rate without considerable changes in birth weight.

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