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GENETIC PROGRESS EVALUATION OF GROWTH TRAITS IN MOGHANI SHEEP

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Abstract: For evaluation of growth traits' genetic progress, pedigree information of 39408 Moghani sheep, between 1986 to 2016, at the breeding station of Moghani sheep was used. Studied traits included birth weight, weaning weight, six months weight, nine months weight, and one yearling weight. Variance components and genetic parameters of traits were estimated by restricted likelihood and six animal models using Wombat software. Direct heritability of birth weight, weaning weight, six months weight, nine months weight, and one yearling weight was (0.07, 0.09, 0.15, 0.13, and 0.20 respectively). Breeding values for the calculation of genetic trends for each trait were estimated by using the univariate best animal model. Phenotypic, genetic, and environmental trends of traits were estimated via regression of phenotypic average, breeding value average, and difference of breeding value from phenotypic value divided by birth year. The calculated genetic trends of birth weight, weaning weight, six months weight, nine months weight, and yearling weight were 0.008, 0.012, 0.054, 0.74, and 0.145 kg/year respectively, except for birth weight, the others were significant ($p<0.01$). The genetic gain of traits including birth weight, weaning weight, six months weight, nine months weight, and one yearling weight was estimated (0.213, 1.071, 1.171, 1.164, and 1.324 kg respectively). At evaluated years, many fluctuations were observed in the genetic trend of traits. In other words, it seems at the studied years, there wasn't a comprehensive plan for genetic breeding and improvement of body weight traits in Moghani sheep.

Key words: breeding value, genetic progress, genetic trend, phenotypic value, phenotypic trend

Introduction

Moghani sheep is one of the most valuable breeds of Iranian sheep and is the most populous breed of Iranian sheep after the Baluchi breed (about 2.5 million) *(Jafaroghli et al., 2010).* Moghani sheep is one of the most important meat breeds among tail sheep, of which in terms of large body size, resistance to climate change, the production capacity of heavy lambs, high growth rate, ability to triple lambing in two years, higher lamination rate, lower lamb mortality, and high genetic potential, it is known to be suitable for meat production (*Savar Sofla et al., 2011*).

The main center of maintenance and breeding of this breed is Moghan plain, but it exists in other areas such as Meshginshahr, Sarab, Ardabil, and even in some other provinces. The breeding system of these sheep is mainly decentralized and is done through migration between summer and winter pastures in mountainous and plain areas (*Ghavi Hossein Zadeh, 2015*).

Meat production is one of the most important criteria for determining the economic profit of sheep breeding in Iran. To examine ways to increase the income of sheep herds and select animals for proper production, we must first define economic traits as selection goals, then suggest appropriate selection methods to improve those traits according to the prediction of response to selection (*Matika et al., 2003*).

Selection of animals based on breeding values and estimation of genetic parameters and important economic traits are essential for designing optimal breeding strategies for farm animals (*Kosgey et al., 2006*). Therefore, estimating genetic parameters and the relative importance of the effect of various genetic factors is necessary not only for the preservation of indigenous breeds but also for setting goals and designing breeding programs. It is also necessary to better understand the genetic mechanism of different traits, determine the criteria and goals of selection, breeding value and use it in selection programs and predict the expected response of selection programs based on one or more traits (*Mohammadi et al., 2013*).

One of the main goals of breeding programs is to change the average value of breeding important economic traits in the shortest possible time and the right direction. Genetic improvement is possible by selecting parents with higher breeding values (*Kosgey et al., 2006*). In a society where selection is made and mating between animals is planned, it is necessary to examine the resulting changes in the average breeding value of the population as a result of selection to determine the effectiveness or inefficiency of that breeding program (*Rashidi and Akhshi, 2007*).

Therefore, the genetic trend is usually estimated for the stage at which the selection was made. Estimation of genetic and environmental trends in a population makes it possible to evaluate selection methods and reveals the role of environmental factors such as nutrition, health, and reproduction (*Hanford et al., 2005*). Because animal breeding values are cumulative over time, therefore, the average breeding value of animals each year shows the genetic level in that year (*Sargolzaei and Edriss, 2005*).

Since the evaluation of breeding programs is determined by estimating the genetic and phenotypic trends of the studied traits in a specific time frame and the genetic trend indicates an improvement in the average breeding value of the animals, this study aimed to estimate the parameters, genetic trends, and the rate of genetic progress related to growth traits in birth weight, weaning weight, six months weight, nine months weight, and one yearling weight Moghani sheep.

Materials and Methods

To estimate the genetic parameters of the growth traits of Moghani sheep, pedigree information and growth traits (birth weight, weaning weight, six months weight, nine months weight, and yearling weight) available in the Moghani sheep breeding station were used. This station is located 30 km southeast of Pars Abad city, Ardabil province. At this station, male and female lambs at the age of 18 months are ready to mate. Rams are used for one year, but ewes can be used for up to 6 years depending on their physical condition and reproductive function. Male and female lambs are kept in separate herds from six months of age.

In this study, 4859 birth weight records, 3450 weaning weight records, 2028 six months weight records, 1955 nine months weight records, and 1865 one yearling weight records collected during 30 years (1986 to 2016) were used. Pedigree information was used after initial editing (including correction and removal of duplicate records related to different periods of animal production and error). The pedigree characteristics of the present study data obtained using CFC 1.0 (*Sargolzaei et al., 2006*) software are given in Table 1.

Table 1. Pedigree information of Moghani sheep breed

Description	Number
No. of animals in the whole population	39408
No. of animals with both known parents	19034
Dams	13399
Sires	1481
No. of animals with no progeny	24528
No. of animals with progeny	14880
No. of base population	3492

Data was edited using Excel and Microsoft Visual FoxPro 9.0 software. During the data editing phase, due to the small number of triple lambs, the records of these lambs and other records whose information was not accurate or complete were deleted from the data file.

Significance testing of fixed effects, included in the operational model for each trait, was carried out using the general linear model (GLM) procedure (SAS 9.2), and the least-squares means of the traits were determined (*SAS, 2008*). Considered fixed effects in the model were the gender of lamb (male and female), birth year in 20 classes (1993-2013), damage at lambing in 6 classes (2-7 years old), and birth type in 2 classes (singletons and twins), respectively. The interactions between fixed effects were not significant and therefore excluded. The statistical model used was as follows [1]:

$$Y_{ijklm} = \mu + Y_i + A_j + S_k + LS_l + e_{ijklm} \quad [1]$$

in which Y_{ijklm} is the record of the desired traits, μ is the population mean, Y_i is the effect of the year of birth, A_j is the effect of damage at lambing, LS_l is the birth type, and e_{ijklm} is the residual effect.

(Co) variance components and corresponding genetic parameters for the various traits were estimated by restricted maximum likelihood (REML) method fitting an animal model. Wombat 1.0 software was used for this purpose (*Meyer, 2006*). Initially, six univariate models (shown below) were used to estimate genetic parameters.

$$\mathbf{y} = \mathbf{Xb} + Z_1 a + e$$

Model 1

$$\mathbf{y} = Xb + \mathbf{Z}_1 a + Z_2 \mathbf{c} + \mathbf{e}$$

Model 2

$$\mathbf{y} = Xb + \mathbf{Z}_1 a + Z_3 \mathbf{m} + \mathbf{e} \qquad Cov\,(a, m) = 0$$

Model 3

$$\mathbf{y} = Xb + \mathbf{Z}_1 a + Z_3 \mathbf{m} + \mathbf{e} \qquad Cov(a, m) = A\sigma_{am}$$

Model 4

$$\mathbf{y} = Xb + \mathbf{Z}_1 a + Z_2 \mathbf{c} + Z_3 \mathbf{m} + \mathbf{e} \qquad Cov\,(a, m) = 0$$

Model 5

$$\mathbf{y} = Xb + \mathbf{Z}_1 a + Z_2 \mathbf{c} + Z_3 \mathbf{m} + \mathbf{e} \qquad Cov(a, m) = A\sigma_{am}$$

Model 6

Where is a vector of records on the different traits; , , , , and are vectors of fixed effects, direct additive genetic effects, maternal additive genetic effects, maternal permanent environmental effects, and the residual effects, respectively. , , , and are corresponding design matrices associating the fixed effects, direct additive genetic effects, maternal additive genetic effects, and maternal permanent environmental effects to the vector of . Also, refers to the covariance between maternal and indirect genetic effects. An Akaike's information criterion (AIC) test was used to determine the most appropriate model according to the following formula [2]:

$$AIC_i = -2\ Log\ L_i + 2P_i \quad [2]$$

in which, log L_i is the maximized log-likelihood of the respective model i at convergence and P_i is the number of parameters obtained from each model; the model with the smallest AIC was chosen as the most appropriate model.

The total heritability ($h^2{}_t$) of the studied traits was calculated from the following formula [3]:

$$h^2{}_t = \frac{\sigma_a{}^2 + 0.5\,\sigma_m{}^2 + 1.5\,\sigma_{am}}{\sigma_p{}^2} \qquad [3]$$

in which $\sigma_a{}^2$, $\sigma_m{}^2$, σ_{am}, and $\sigma_p{}^2$ are direct additive genetic variance, maternal additive genetic variance phenotypic variance, the covariance between direct, and maternal additive genetic variance and phenotypic variance, respectively.

Breeding values for the calculation of genetic trends for each trait were estimated by using the univariate best animal model. Phenotypic, genetic, and environmental trends of traits were estimated via regression of phenotypic average, breeding value average, and difference of breeding value from phenotypic value divided by birth year. Genetic progression for each trait was estimated from the difference between the mean population breeding values at the end of the period and its value at the beginning of the period.

Results and Discussion

Table 2 shows the descriptive statistics of the examined traits. The number of records of growth traits studied decreased with the increasing age of lambs (4859 records for birth weight compared to 1145 records for yearling weight), which could be due to mortality, data editing, deletion of some lambs, or failure to record records, and the sale of lambs at older ages.

Table 2. Descriptive statistics of growth traits in the Moghani sheep breed

Traits	Birth weight	Weaning weight	6 months weight	9 months weight	Yearling weight
No. of records	4859	2145	2028	1319	1145
Mean (kg)	4.47	21.26	33.12	39.82	40.32
S.D (kg)	1.79	5.11	5.61	4.30	14.75
C.V (%)	40	24	17	11	36
Min (kg)	1.85	10	24	28	31.50
Max (kg)	5.94	39	52	53.50	65.01

The effect of birth year on all studied traits was significant ($p < 0.01$). Climatic factors, management, nutrition, and health vary over the years. Variable climatic conditions such as rainfall and ambient temperature affect the quality and quantity of forage, which leads to significant changes in the amount of food available to the animal and the provision of necessary needs, and ultimately the weight of lambs at different ages (*Rashidi et al., 2008; Mohammadi and Sadeghi,* *2010*). Therefore, differences in the management systems and fluctuations of weather conditions in different years can be the main reason for the significant effect of the year of birth on the studied traits. Which was consistent with the results reported in the Sakiz, Moghani, Lori, and Kordi breeds (*Jafaroghli et al., 2010; Ceyhan et al., 2011; Yeganehpor et al., 2015; Shahdadi and Saghi, 2017*).

The effect of maternal age on all studied traits was significant ($p < 0.01$). Differences between maternal behavior and how lambs are cared for at different ages of ewes can be a reason for this effect. The rate of development of physical growth, especially the environment of the uterus, body weight, reproductive system, and more milk production by the mother at an older age can also be related to this effect. In addition, increasing the age of the ewes affects the amount of milk produced, and despite providing enough milk to feed the lambs, the birth weight increases (*Rashidi et al., 2008; Jiang et al., 2011*), which was consistent with the results reported in the Iran-Black, Lori, Kordi, and Kermani breeds (*Kamjoo et al., 2014; Kargar et al., 2014; Yeganehpor et al., 2015; Shahdadi and Saghi, 2017*).

The effect of birth type on all growth traits was significant ($p < 0.01$), which was consistent with the results reported in Sakiz, Moghani, Lori, and Kordi breeds (*Kamjoo et al., 2014; Kargar et al., 2014; Yeganehpor et al., 2015; Shahdadi and Saghi, 2017*). Due to the use of all uterine and maternal conditions, single lambs have more birth weight, while in twin lambs the energy and nutrients required by the fetus are divided between the twins. In this case, fewer facilities for the mother environment will be available to each of the twin lambs (*Rashidi et al., 2008*).

The effect of lamb sex on all traits was significant ($p < 0.01$), which was consistent with the results reported in Kordi and Moghani breeds (*Jafaroghli et al., 2010; Shahdadi and Saghi, 2017*). In all traits, male lambs had higher averages than female lambs. This significant effect can be due to differences in the type and amount of sex hormones secreted that cause animal to grow. For example, estrogen has a limiting effect on long bones in females, which can be one of the reasons why female lambs are smaller and weigh less than male lambs (*Jafaroghli et al., 2010*). Due to the insignificance of the interactions on the fixed factors, none of them was used in the final model.

Table 3 shows the average performance of traits by different levels of fixed effects.

Table 3. Average growth traits based on different fixed effects (kg)

Fixed effects	Traits				
	Birth weight	Weaning weight	6 months weight	9 months weight	yearling weight
Birth year	**	**	**	**	**
Dams age	**	**	**	**	**
2	4.00 ± 0.001^{f}	20.35 ± 0.041^{f}	32.33 ± 0.037^{f}	39.01 ± 0.009^{f}	39.47 ± 0.007^{e}
3	4.14 ± 0.032^{e}	20.47 ± 0.029^{e}	32.75 ± 0.018^{e}	39.27 ± 0.055^{e}	40.07 ± 0.082^{d}
4	4.32 ± 0.027^{c}	20.79 ± 0.071^{d}	32.89 ± 0.004^{d}	39.49 ± 0.019^{d}	40.32 ± 0.034^{c}
5	4.26 ± 0.013^{d}	21.52 ± 0.054^{c}	33.37 ± 0.041^{c}	39.76 ± 0.061^{c}	40.36 ± 0.063^{c}
6	5.00 ± 0.037^{b}	21.79 ± 0.014^{b}	33.57 ± 0.075^{b}	40.29 ± 0.005^{b}	41.00 ± 0.005^{b}
7	5.12 ± 0.069^{a}	22.12 ± 0.017^{a}	33.76 ± 0.038^{a}	41.13 ± 0.007^{a}	41.12 ± 0.074^{a}
Birth type	**	**	**	**	**
Single	5.00 ± 0.033^{a}	22.03 ± 0.045^{a}	33.68 ± 0.053^{a}	40.10 ± 0.029^{a}	40.96 ± 0.068^{a}
Twine	3.94 ± 0.072^{b}	20.49 ± 0.071^{b}	32.56 ± 0.017^{b}	39.54 ± 0.008^{b}	39.68 ± 0.073^{b}
Sex	**	**	**	**	**
Male	4.56 ± 0.037^{a}	21.56 ± 0.049^{a}	33.42 ± 0.083^{a}	40.00 ± 0.061^{a}	40.99 ± 0.067^{a}
Female	4.29 ± 0.007^{b}	20.96 ± 0.026^{b}	32.82 ± 0.054^{b}	39.64 ± 0.030^{b}	39.65 ± 0.017^{b}
** $p<0.01$;similar letters for levels of each fix effect indicate a non-significant difference at $p<0.01$					

The components of (co) variance and genetic parameters of the studied traits are shown in Table 4. The results showed that with increasing age, the amount of direct heritability of traits increased, which may indicate a decrease in maternal effect with age on the studied traits. Reasons for increasing the heritability of traits with age include factors such as increased expression of genes that have an increasing effect on body weight and also a decrease in variance due to maternal effects relative to the direct genetic variance of the animal (*Ahteghadi et al., 2015*).

Table 4. (Co) variance components and genetic parameters estimates for the studied traits

Parameter	Traits				
	Birth weight	Weaning weight	6 months weight	9 months weight	Yearling weight
Model fitted	3	3	2	1	1
σ_a^2	0.25	1.23	2.44	2.54	3.83
σ_m^2	0.54	0.96	-	-	-
σ_{pe}^2	-	-	0.75	-	-
σ_e^2	2.78	10.59	12.32	17.00	17.45
σ_p^2	3.57	12.78	15.51	19.54	21.28
σ_{am}	-	-	-	-	-
$h_d^2 \pm SE$	0.07 ± 0.01	0.09 ± 0.04	0.15 ± 0.03	0.13 ± 0.01	0.20 ± 0.02
$h_m^2 \pm SE$	0.15 ± 0.03	0.07 ± 0.01	-	-	-
$c^2 \pm SE$	-	-	0.05 ± 0.05	-	-
h_t^2	0.15	0.13	0.15	0.13	0.20

σ_a^2: direct genetic variance, σ_m^2: maternal additive genetic variance, σ_{pe}^2: maternal permanent environmental variance, σ_e^2: residual variance, σ_p^2: phenotypic variance, σ_{am}: covariance between direct genetic and maternal additive genetic, h_d^2: direct heritability, h_m^2: maternal heritability, c^2: ratio of maternal permanent environmental effect to phenotypic variance, h_t^2: total heritability.

Direct heritability of birth weight was estimated to be 0.07, which was consistent with the results reported in the Moghani breed by *Jafaroghli et al. (2010).* Also, compared to the reported values of 0.1 and 0.11 in the Kordi breed (*Naghavian et al., 2015; Shahdadi and Saghi, 2017*), 0.36 and 0.34 in the Lori breed (*Beyranvand et al., 2013; Shahdadi and Saghi, 2017*), 0.14 and 0.23 in the Kermani breed (*Kargar et al., 2014; Khosravi et al.,2018*), 0.36, 0.24 and 0.31 to 0.54 in Makooei, Zandi and Moghani breeds, respectively (*Hoque et al., 2009; Jiang et al., 2011; Mohammadi et al., 2012*) were less than and higher than the reported value of 0.007 in Makooei breed (*Azizi et al., 2015*). The high heritability of this trait compared to a similar study might indicate an increase in the genetic efficiency of the selection because the true breeding value of the animal has been more accurately estimated through its phenotype.

Direct heritability of weaning weight was 0.09, which was consistent with the results reported in the Moghani breed (*Jafaroghli et al., 2010*). Also, it was lower than the reported values of 0.33 and 0.57 in the Kermani breed (*Kargar et al., 2014; Khosravi et al., 2018*), 0.19, 0. 23, and 0.28 in the Kordi breed *(Mohammadi et al., 2009; Naghavian et al., 2015; Shahdadi and Saghi, 2017*), 0.20, 0.21, 0.27, and 0.47 in Makooi, Moghani, Baluchi and Shal breeds (*Hasani et al., 2009; Hossein-Zadeh and Ardalan, 2010; Jiang et al., 2011; Amou Posht-e Masari et al., 2015*), and it was higher than the reported value 0.024 in the Moghani breed (*Azizi et al., 2015*). The reason for these differences can be due to differences in records, breed, management, and nutritional conditions of the studied herds.

Direct heritability was obtained at six months weight of 0.15, which was lower than the reported values of 0.21, 0.26, and 0.32 in the Kordi breed (*Shokrollahi and Zandieh, 2012: Naghavian et al.,2015; Shahdadi and Saghi, 2017*), 0.16, 0.28, 0.30, 0.32, and 0.48 in Iran-Black, Baluchi, Iran-Black, Zandi, Shal and Makooei breeds (*Beygi Nasiry et al., 2005; Hossein-Zadeh and Ardalan, 2010; Jiang et al., 2011; Mohammadi et al., 2011; Amou Posht-e Masari et al., 2015*) and higher than the reported value of 0.05 in the Lori breed *(Beyranvand et al., 2013*), 0.009 and 0.13 in the Moghani breed (*Hossein-Zadeh and Ardalan, 2010; Azizi et al., 2015*). The reason for these differences can be related to the components of different genetic and phenotypic (co) variances, especially their ratio in different breeds, which change under the influence of selection, recording conditions, environmental fluctuations, and models used to analyze the studied traits.

The direct heritability of the nine months weight was estimated to be 0.13, which was higher than the values of 0.11 and 0.12 reported in the Moghani and Kermani breeds (*Hossein-Zadeh and Ardalan, 2010; Khosravi et al., 2018*), and lower than the reported values 0.181, 0.19, 0.22, 0.29, 0.31, 0.33, 0.37, and 0.41 in the Moghani, Iran-Black, Kordi, Baluchi, Zandi, Makooei and Shal breeds (*Beygi Nasiry et al., 2005; Jafari et al., 2012; Mohammadi et al., 2012; Kamjoo et al., 2014; Kargar et al., 2014; Azizi et al., 2015; Naghavian et al., 2015; Amou Posht-e Masari et al., 2015*). The lower estimate of the heritability of this trait in the current study may indicate that direct selection based on this trait does not significantly improve the production efficiency of this population.

Direct heritability for one yearling weight was 0.20, which was consistent with the values reported in the Kordi breed (*Shahdadi and Saghi, 2017*) which was lower than the reported values of 0.24 in the Kordi breed (*Naghavian et al., 2015*), 0.41, 0.36, 0.31, 0.28, and 0.28 in Makooei, Kermani, Baluchi, Shal and Zandi breeds (*Beygi Nasiry et al., 2015; Jafari et al., 2012; Mohammadi et al., 2012; Kargar et al., 2014; Amou Posht-e Masari et al., 2015*), and higher than the reported values 0.076, 0.1 and 0.18 in the Moghani and Iran-Black breeds (*Hossein-Zadeh and Ardalan, 2010; Jafari et al., 2012; Kamjoo et al., 2014; Azizi et al., 2015*), 0.16 in the Kermani breed (*Khosravi et al., 2015*). The heritability of this trait may be higher than in similar studies due to increased expression of genes that have an increasing effect on body weight and can also be due to reduced variance due to maternal effects compared to direct genetic variance of the animal.

Maternal heritability of birth weight and weaning weight traits were 0.15 and 0.07, respectively, which were consistent with the results reported in the Lori breed (*Beyranvand et al., 2013*). Maternal heritability decreases with age, which may be due to reduced lamb dependence on breast milk. The results of this study showed that maternal genetics, like animal genetics, have an effect on birth weight and weaning weight traits. Therefore, more attention should be paid to maternal effects to improve growth traits in the pre-weaning ages.

In general, it can be said that the estimated genetic parameters in each community for each economic trait are specific to that community and several factors may affect it. The structure and volume of available information, the degree of specificity of animal relationships in the pedigree, selection in the herd, method of estimating variance components and genetic parameters, livestock breed, and environmental conditions in the herd are different. Also, using different breeding programs makes a difference between different estimates (*Elfadilli et al., 2000; Hoque et al., 2009*).

Table 5 shows the results of the Akaike criterion for determining the most appropriate model. The studied models for the studied traits were compared using the Akaike criterion (AIC), and the model with the lowest Akaike criterion was selected as the most appropriate model. This criterion shows the extent to which the use of a statistical model causes data loss. In other words, this criterion establishes a balance between model accuracy and complexity (*Farhangfar et al., 2007*).

Table 5. AIC values for traits (AIC values for traits in bold numbers (as the best) had the highest values in other models)

Model	Traits				
	Birth weight	Weaning weight	6 months weight	9 months weight	Yearling weight
1	72763.602	-68936.241	-24443.830	**-1476.432**	**-921.341**
2	72765.602	-68938.412	**-24450.661**	-1474.813	-914.730
3	**72772.331**	**-68943.111**	-2445.325	-1470.326	-916.339
4	72742.836	-68938.274	-2447.871	-1472.713	-919.335
5	72764.137	-68940.337	-2445.885	-1476.012	-916.768
6	72764.033	-68931.023	-2446.323	-1473.756	-920.367

To genetically evaluate the growth traits (including birth weight, weaning weight, six months weight, nine months weight, and one yearling weight) of Moghani sheep, genetic, environmental, and phenotypic trends of these traits were investigated. Table 6 shows the genetic, environmental, and phenotypic trends of the traits.

Table 6. Estimates of genetic, phenotypic, and environmental trends (kg/year) for body weight traits at different ages

Traits	Phenotypic trend	Environmental trend	Direct genetic trend
Birth weight	$0.018 \pm 0.032^{*}$	0.010 ± 0.021^{ns}	0.008 ± 0.011^{ns}
Weaning weight	$0.067 \pm 0.014^{**}$	$0.055 \pm 0.017^{**}$	$0.012 \pm 0.012^{**}$
6 months weight	$0.139 \pm 0.006^{*}$	$0.085 \pm 0.003^{**}$	$0.054 \pm 0.003^{**}$
9 months weight	-0.111 ± 0.002^{ns}	$-0.185 \pm 0.002^{*}$	$0.074 \pm 0.081^{**}$
Yearling weight	$-0.274 \pm 0.014^{**}$	$-0.419 \pm 0.007^{*}$	$0.145 \pm 0.063^{**}$
ns: Non significant, * Significant at P<0.05, ** Significant at P<0.01			

The phenotypic trend of birth weight, weaning weight, six months weight, nine months weight, and one yearling weight was estimated to be 0.018, 0.067, 0.139, -0.111, and -274 kg/year, respectively. *Dorostkar et al. (2010)* in the Moghani breed reported the phenotypic trend of these traits of 0.0371, 0.0531, -0.0206, -0.3839, and -0.143 kg/year, respectively. A phenotypic trend of these traits was reported in Kordi breed 0.0371, 0.0531, -0.0206, -0.3839, and -0.143 kg/year, by *Shahdadi and Saghi (2017)* and 16, 328, 227, 298, and 405 g/year by *Naghavian et al. (2015)*. The observed differences between different estimates can be due to factors such as animal breed, genetic diversity within the population, management, and environmental conditions, and the method of estimating genetic parameters.

The negative phenotypic trend of the nine months weight trait was consistent with the results reported in the Lori, Zandi, and Kermani breeds (*Mohammadi et al., 2012; Naghavian et al., 2015; Yeganehpor et al., 2015*). This negative trend may be due to reasons such as poor management, fluctuations in environmental conditions, changes in weather conditions, and the level of health in the years under study. In unfavorable environmental conditions, the animal phenotype is affected by the environment, which prevents the emergence of animal genetic potential. It becomes difficult to predict breeding values in these conditions, which ultimately leads to an underestimation of the genetic progression per generation (*Hanford et al., 2005*). Therefore, it is necessary to provide suitable and optimal environmental conditions to maximize the genetic potential of the herd so that the phenotypic trend is aligned with the genetic trend.

The negative phenotypic trend of one yearling weight trait was consistent with the results reported in Moghani and Kordi breeds by *Dorostkar et al. (2010)* and *Naghavian et al. (2015).* The negative phenotypic trend indicates the negative trend of environmental factors. The average phenotype of animals is more influenced by environmental factors. The negative trend of environmental factors in the ages of nine months and one yearling can be due to inappropriate environmental factors at these ages.

The genetic trend of birth weight was estimated to be 0.008 kg/year which was not significant ($p>0.01$). The insignificance of the genetic process of birth weight indicates that no genetic change in the birth weight of this breed was observed during the studied years, which corresponds to the reported value of 117.01 g in the Lori breed (*Yeganehpor et al., 2015*). Also, it was higher than the reported values of 0.00014 and 0.0055 kg/year in the Moghani breed (*Dorostkar et al., 2010; Azizi et al., 2015*), -3, 2, and 53 g/year in Shal, Kermani, and Zandi breeds (*Sataei Mokhtari et al., 2009; Mohammadi et al., 2011; Amou Posht-e Masari et al., 2015*) and less than the reported values 20 g/year and 0.038 kg/year in Kermani and Menz breeds (*Grizw et al., 2007; Rashidi et al., 2008*). The reason for these differences may be due to different selection criteria in different breeds as well as the weight of lambs and different methods of estimating genetic trends in different breeds.

The genetic trend of weaning weight was 0.012 kg/year ($p <0.01$), which was higher than the values of 0.00213 and 0.0053 kg/year reported in the Moghani breed (*Dorostkar et al., 2010; Azizi et al., 2015*) and less than the reported values 125, 106, and 96.41 g/year in the Kermani breed (*Rashidi and Akhshi, 2007; Sataei Mokhtari et al., 2009; Mokhtari and Rashidi, 2010*), 64, 72.9, and 117.01 g/year in the Kordi breed (*Mohammadi et al., 2009; Naghavian et al., 2015; Shahdadi and Saghi, 2017*). The difference in the values obtained in the genetic trends of this trait in different studies depends on different structures such as the different genetic structures of the study population and different periods for evaluating herds.

The genetic trend of six months' weight was estimated to be 0.054 kg/year ($p < 0.01$), which was lower than the reported values of 0.388 kg/year in the Menz breed (*Grizw et al., 2007*), 88.24, 91, and 142 g/year in the Kermani breed (*Rashidi and Akhshi, 2007; Sataei Mokhtari et al., 2009; Mokhtari and Rashidi, 2010*), 59.63, 73, and 148.27 g/year in the Kordi breed (*Mohammadi et al., 2009; Naghavian et al., 2015; Shahdadi and Saghi, 2017*), 72 g/year in the Baluchi breed (*Mohammadi et al., 2011*) and higher than the reported values -18 g/year in the Shal breed (*Amou Posht-e Masari et al., 2015*), 0.00054 and 0.0052 kg/year in the Moghani breed (*Dorostkar et al., 2010; Azizi et al., 2015*) and 21 g/year in the Zandi breed (*Mohammadi et al., 2011*). The reason for estimating this trend more than some similar studies could be due to the use of rams with higher breeding values and the setting of controlled mating programs.

The genetic trend of nine months' weight was 0.074 kg/year ($p < 0.01$), which was higher than the reported values of 26.4 and 72 g/year in the Zandi breed (*Mohammadi et al., 2011; Mohammadi et al., 2012*), 0.0345 and 0.0061 kg/year in the Moghani breed (*Dorostkar et al., 2010; Azizi et al., 2015*), 24.31, 27, and 71.6 gr/year in Kermani, Shal, and Kordi breeds (*Sataei Mokhtari et al., 2009; Naghavian et al., 2015; Amou Posht-e Masari et al., 2015*) and was lower than the reported values 0.076 g/year in the Lori breed (*Yeganehpor et al., 2015*), 77, 81, 110.01 and 136.52 g/year in Baluchi, Kermani and Kordi breeds (*Hasani et al., 2009; Mohammadi et al., 2009; Mokhtari and Rashidi, 2010; Shahdadi and Saghi, 2017*). The reason for the low estimate of this trend compared to some similar studies may be due to the lack of attention to this trait in the selection and removal of unwanted animals with high breeding value at the age of nine months.

The genetic trend of one yearling weight was estimated to be 0.145 kg/year ($p<0.01$), which was lower than the reported values of 0.849 kg/year in the Moghani breed (*Dorostkar et al., 2010*), 156 and 495 g/year in Kermani and Menz breeds (*Grizw et al., 2007; Mokhtari and Rashidi, 2010*), and was higher than the reported values 0.0058 kg/year in the Moghani breed (*Azizi et al., 2015*), -3, 41.5, 65, 88, 98.4, and 122.2 g/year in Shal, Zandi, Baluchi and Kordi breeds (*Hasani et al., 2009; Mokhtari and Rashidi, 2010; Mohammadi et al., 2012; Amou Posht-e Masari et al., 2015; Naghavian et al., 2015; Shahdadi and Saghi, 2017*). The highest genetic trend was related to one yearling weight trait, which also had the highest heritability. This was predictable given that more genetic trends could be due to more incremental genetic changes (*Shaat et al., 2004*).

Vatankhah et al. (2005), reported that the genetic trend of traits in the country's breeding herds decreased and, in some cases, negatively. The main reasons for the lack of expected genetic improvement can be considered as factors such as unclear breeding goals for the studied breeds, and failure to use appropriate animal models to predict the breeding values of animals and evaluate them. Also, the inaccuracy of recording production traits and pedigree registration and the incompleteness of the predicted programs in breeding herds can be a reason for this issue. In addition, managerial and environmental fluctuations can be another factor in preventing genetic progression to the expected level.

The genetic progress after 30 years for birth weight, weaning weight, six months weight, nine months weight and one yearling weight was estimated to be 0.213, 1.071, 1.171, 1.164, and 1.324 kg, respectively. *Amou Posht-e Masari et al. (2015)* in the Shal breed reported the genetic progress of these traits at 1, 316, 404, 522, and 60 g, respectively. *Hasani et al. (2009)* in the Baluchi breed reported the genetic progress of these traits as 0.011, 1.488, 2.066, 2.062, and 2.043 kg, respectively. The rate of genetic progress of these traits in the Kordi breed 36.09, 1040.15, 1357.27, 1067.27, and 1153.26 g by *Shahdadi and Saghi (2017)*, and 0.017, 0.089, 1.319, 0.727, and 1.199 kg by *Naghavian et al. (2015)* has been reported.

Development and completion of a selection index for important economic traits along with appropriate economic coefficients can be an important step in genetic development and increase profitability in this breed. On the other hand, since genetic growth in different flocks of sheep depends on predetermined selection goals, the selection criteria depend on those goals and the appropriate environmental conditions. Also, key factors affecting the genetic growth of herds in different environments are genetic diversity, selection accuracy, generation interval, and selection intensity, therefore, we cannot expect that genetic progress estimates for traits in different herds are consistent (*Piper and Ruviskey, 1997*).

Conclusion

In all traits, the genetic trend of the traits was positive, but the breeding values of the animals fluctuated in different years, which could indicate a weakness in determining the goals and criteria for the correct selection of the studied traits. To improve the breeding status of the study population, due to significant genetic progress for the studied traits, productive animals can be selected based on breeding values and wait for the effects of this selection in the coming years.

Procena genetskog napretka osobina porasta kod ovaca rase moghani

Maryam Esrafili Taze Kand Mohammaddiyeh, Reza Behmaram

Rezime

Za procenu genetskog napretka osobina porasta korišćeni su podaci iz pedigrea za 39.408 ovaca rase moghani u periodu od 1986. do 2016. godine u stanici za uzgoj ovaca Moghani. Proučavane osobine su uključivale masu na rođenju, masu nakon odbijanja, masu u uzrastu od šest meseci, masu u uzrastu od devet meseci i masu u uzrastu od jedne godine. Komponente varijanse i genetski parametri osobina procenjeni su korišćenjem ograničene verovatnoće i šest animal modela, korišćenjem softvera Wombat. Direktna naslednost mase na rođenju, mase pri odbijanju, mase u uzrastu od šest meseci, mase u uzrastu od devet meseci i mase u uzrastu od jedne godine bila je (0,07, 0,09, 0,15, 0,13 i 0,20 respektivno). Vrednosti uzgoja za izračunavanje genetskih trendova za svaku osobinu su procenjene korišćenjem univarijantnog najboljeg animal modela. Fenotipski, genetski i ekološki trendovi osobina procenjeni su regresijom fenotipskog proseka, proseka priplodne vrednosti i razlike priplodne vrednosti od fenotipske vrednosti podeljene sa godinom rođenja. Izračunati genetski trendovi mase na rođenju, mase pri odbijanju, šestomesečne mase, devetomesečne mase i mase u uzrastu od jedne godine bili su 0,008, 0,012, 0,054, 0,74 i 0,145 kg/god, respektivno, osim mase pri rođenju, ostali su bili značajni (p< 0,01). Procenjen je genetski napredak osobina, uključujući masu pri rođenju, masu pri odbijanju, masu u uzrastu od šest meseci, masu u uzrastu od devet meseci i masu u uzrastu od jedne godine (0,213, 1,071, 1,171, 1,164 i 1,324 kg, respektivno). U procenjenim godinama primećene su mnoge fluktuacije u genetskom trendu osobina. Drugim rečima, čini se da u proučavanim godinama nije postojao sveobuhvatan plan za genetski uzgoj i poboljšanje osobina telesne mase kod moghani ovaca.

Ključne reči: oplemenjivačka vrednost, genetski napredak, genetski trend, fenotipska vrednost, fenotipski trend

References

AHTEGHADI B., GHAVI HOSSEIN ZADEH N., SHADPARVAR A. A. (2015): Estimation of genetic parameters of daily gain and Kleiber ratios in sheep Guilan province. Iranian Journal of Animal Science Research, 7, 1, 104-112. (In Persian).
AMOU POSHT-E MASARI H., SHADPARVAR A. A., GHAVI HOSSEIN ZASEH N., HADI TAVATORI M. H. (2015): Estimation of genetic trend for body weight of Shal sheep. Animal Production Research, 4, 1, 47-58. (In Persian).
AZIZI P., GHADERZADEH M., AZIZI P., PURBAYRAMIAN F., ZANDI E. (2015): Genetic analysis of growth traits and Kleiber ratio in Moghani sheep breed. Journal of Animal and Poultry Research, 3, 3, 35-45. (In Persian).
BEYGI NASIRY M. T., FUROOZANMEHR M. R., AHMADI A. (2005): Estimation of genetic parameters for body weights in Nourth of Khorasan Kordi Sheep. Journal of Agricultural Research, 1, 37-48. (In Persian).
BEYRANVAND F., FAYAZI J., BEYGI NASSIRI M. T., ASADOLLAHI S. (2013): Estimation of genetic parameters for growth traits and genetic and

phenotypic trends of reproductive traits in the nomadic Lori sheep flocks. Animal Production Research, 2, 21-30. (In Persian).
CEYHAN A., KAYGISIZ A., SEZENLER T. (2011): Effect of inbreeding on pre-weaning growth traits and survival rate on Sakiz sheep. Journal of Animal and Plant Sciences, 21, 1-4.
DOROSTKAR M., RAFAT S. A., SHODJA J., PIRANU N. (2010): Study of Genetic and Phenotype Trends of Some of Growth Traits in Moghani Sheep. Journal of Animal Science Research, 4, 15-25. (In Persian).
ELFADILLI M., MICHAUX C., DETILLEUX J., LEROY, P. L. (2000): Genetic parameters for growth traits of the Moroccan Timahdit breed of sheep. Small Ruminants Research, 37, 203-208.
FARHANGFAR H., NAEEMIPOUR H., ZINVAND B. (2007): Application of random regression model to estimate genetic parameters for average daily gains in Lori-Bakhtiari sheep breed of Iran. Pakistan Journal of Biology Science, 10, 2407-2412.
GHAVI HOSSEIN ZASEH N. (2015): Genetic analysis of average daily gain and Kleiber ratios in Moghani sheep. Research on Animal Production, 6, 11, 108-119. (In Persian).
GRIZW S., LEMMA S., KOMEN H., VAN ARENDOK J. A. M. (2007): Estimates of genetic parameters and genetic trend for live weight and fleece traits in Menz sheep. Small Ruminant Research, 70, 145-153
HANFORD K. J., VAN VLECK L. D., SNOWDER G. D. (2005): Estimates of genetic parameter and genetic trend for reproduction, weight and wool characteristics of Poly pay sheep. Livestock Science, 102, 72-82.
HANFORD K. J., VAN VLECK L. D., SNOWDER G. D. (2006): Estimates of genetic parameters and genetic change for reproduction, weight, and wool characteristics of Rambouillet sheep. Small Ruminant Research, 57,175–186.
HASANI S., DELTANG SEFIDASNGHI H., RASHIDI A., AHANI AZARI M. (2009): Estimation of genetic, phenotypic and environment trends for some growth traits in Baluchi sheep. Journal of Agriculture. Science Natural Resources, 16, 1-8. (In Persian).
HOQUE M. A., HOSONO M., OIKAWA T., SUZUKI K. (2009): Genetic parameters for measures of energetic efficiency of bulls and their relationships with carcass traits of field progeny in Japanese Black cattle. Journal of Animal Science, 87, 99-106.
GHAVI HOSSEIN ZASEH N., ARDALAN M. (2010): Comparison of different models for the estimation of genetic parameters of body weight traits in Moghani sheep. Agricultural and Food Science, 3, 207-213.
JAFARI SH., HASHEMI A., MANAFIAZAR GH., DARVISHZADEH R., RAZZAGZADEH S., FARHADIAN M. (2012): Genetic analysis of growth traits in Iranian Makuie sheep breed. Italian Journal of Animal Science, 11, 18, 98-102.

JAFARROGHLI M., RASHIDI A., MOKHTARI M. S., SHADPARVAR A. A. (2010): (Co) Variance components and genetic parameter estimates for growth traits in Moghani sheep. Small Ruminant Research, 91, 170-177.

JIANG D., ZHANG Y., TINNA K., LIU L., XU X., ZHANG Y., ZHANG T. (2011): Estimation of (co)variance components and genetic parameters for growth and wool traits of Chinese superfine merino sheep with the use of a multi-trait animal model. Livestock Science, 138, 278-288.

KAMJOO B., BANEH H., YOUSEFI V., MANDAL A., RAHIMI G. (2014): Genetic parameter estimates for growth traits in Iran-Black sheep. Journal of Applied Animal Research, 42, 1, 79-88.

KARGAR N., ABBASI M. A., SHAFIEI M. (2014): Estimation of genetic parameter and trends for some economic traits in Kermani sheep. Applied Animal Science Research Journal, 12, 11-22. (In Persian).

KHOSRAVI S., ASADI FOZI M., ESMAILI KOSHKOOYEH A. (2018): Evaluation of Genetic Progress of Growth Traits in Kermani Sheep Breeding Station. Research on Animal Production, 8, 18, 187-193.

KOSGEY L. S., BAKER R. L., UDO H. M. J., VAN ARENDOK J. A. M. (2006): Success and failures of small ruminant breeding programmes in the tropics: a review. Small Ruminant Research, 61, 13–28.

MATIKA O., VAN WYK J. B., ERASMUS G. J., BAKER R. L. (2003): Genetic parameter estimates in Sabi sheep. Livestock Production Science, 79, 17-28.

MEYER K. (2006): WOMBAT- A program for mixed model Analyses by Restricted Maximum Likelihood. User Notes Animal Genetics and Breeding Unit, Armidale, 55pp.

MOHAMMADI Y., SATAEI MOKHTARI M., BAHRAMI A. M. (2009): Estimation of genetic and environmental trends for some growth traits in Kordi sheep. Journal of Genetic, 4, 29-36. (In Persian).

MOHAMMADI H., SADEGHI M. (2010): Estimates of genetic parameters for growth and reproductive traits and genetic trends for growth traits in Zel sheep under rural system. Journal of Animal Science, 41, 231-241.

MOHAMMADI Y., RASHIDI A., MOKHTARI M. S., ESMAILIZADEH A. K. (2010): Quantitative genetic analysis of growth traits and kleiber ratios in Sanjabi sheep. Small Ruminants Research, 93, 88-93.

MOHAMMADI K., RASHIDI A., MOKHTARI M. S., BEIGI NASSIRI M. T. (2011): The estimation of (co)variance components for growth traits and Kleiber ratios in Zandi sheep. Small Ruminant Research, 99, 116-121.

MOHAMMADI H., MORADI SHAR BABAK H., SADEGHI M. (2012): Estimation of genetic, phenotypic and environmental trends for growth traits in Zandi sheep. Journal of Genetic, 6, 49-57. (In Persian).

MOHAMMADI H., MORADI SHAR BABAK M., MORADI SHAR BABAK H., BAHRAMI A., DOROSTKAR M. (2013): Model comparisons and genetic

parameter estimates of growth and the Kleiber ratio in Shal sheep. Archive Tierzucht, 56, 264-275.
MOKHTARI M. S., RASHIDI A. (2010): Genetic trends estimation for body weights of Kermani sheep at different ages using multivariate animal models. Small Ruminant Research, 88, 23-26.
NAGHAVIAN S., HASANI S., AHANI AZARI M., KHAN AHMADI A. R., SAGHI D. A. (2015): Estimation of Genetic and Phenotypic Trends for Some Growth Traits in Shirvan Kordi Sheep. Research on Animal Production, 6, 12,145-151. (In Persian).
PIPER L., RUVISKEY A. (1997): The genetics of sheep (Ed). Genetics of morphological traits and inherited disorders. New York: CAB International.
RASHIDI A., AKHSHI H. (2007): Estimation of genetic and environmental trends for growth traits in Kordish sheep. Iranian Journal of Agricultural Sciences, 38, 329-335. (In Persian).
RASHIDI A., SATATAEI MOKHTARI M., SAFI JAHANSHAHI A., MOHAMMADABADI M. R. (2008): Genetic parameter estimates for pre-weaning growth traits in Kermani sheep. Small Ruminant Research, 74, 165-171.
SARGOLZAEI M., EDRISS M. A. (2005): Estimation of phenotypic, genetic and environmental trends of some of the growth traits in Bakhtiari sheep. Journal of Agricultural Sciences and Technological and Natural Resources, 8, 125-132. (In Persian).
SARGOLZAEI M., IWAISAKI H., JACQUES COLLEAU J. (2006): A software package for pedigree analysis and monitoring genetic diversity.
SAS. (2008): User's Guide, Version 9.2., SAS Institute, Cary, NC.
SATAEI MOKHTARI M., RASHIDI A., MOHAMMADABADI M. R., MORADI SHAHR BABAK H. (2009): Estimation of genetic, phenotypic and environmental trends of growth traits in Kermani sheep. Iranian Journal of Agricultural Sciences, 40, 51-57. (In Persian).
SAVAR SOFLA S., ABBASI M. A., ABBASI M. A., NEJATI JAVAROMI A., VAEZ TARSHIZI R., CHAMANI M. (2011): Estimation of parameters and genetic and phenotypic trends of reproductive traits in Moghani sheep. Journal of Animal Science and Research, 6, 75-86. (In Persian).
SHAAT I., GALAL S., MANSOUR H. (2004): Genetic trends for lamb weights in flocks of Egyptian Rahmani and Ossimi sheep. Small Ruminant Research, 51, 23-28.
SHAHDADI A, R., SAGHI D. A. (2017): Estimation of variance components and genetic, phenotypic and environmental trends for body weights in Kordi sheep. Animal Science Journal (Pajouhesh & Sazandegi), 114, 183-194. (In Persian).
SHOKROLLAHI B., ZANDIEH M. (2012): Estimation of genetic parameters for body weights of Kurdish sheep in various ages using multivariate animal models. African Journal of Biotechnology, 11, 2119-2123.

VATANKHAH M., MARADI SHAHR BABAK M., NEJATI JAVAROMI A., MIRAEI ASHTIANI S. R., VAEZ TORSHIZI R. (2005): A review of sheep breeding in Iran. Proceedings of the first congress of Animal Science and Aquaculture country. Karaj Agricultural college. (In Persian).

YEGANEHPOR Z, ROSHAN FEKR H. A., FAYAZI J., BIRAN VAND M. H., GADER ZADEH M. (2015): Estimation of genetic, environmental and phenotypic body weight at different ages in Lori. Iranian Journal of Animal Science Research, 3, 7, 364-372. (In Persian).

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