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Analysis of the Environmental Factors Affecting the Growth Traits of Iran-Black Sheep

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***Abstract*—*A study was conducted to evaluate the effects of non-genetic factors on the growth behavior of Iran-Black sheep. The data of growth performances, birth weight (BW), weaning weight (W3), weight at 6, 9and 12 months of age (W6, W9 and W12, respectively), were taken from 1522 lambs belonging to data bank from Abbas Abad Sheep Breeding Station located at the North-east of Iran during a period of five years. Statistical analyses were performed using a general linear model including non-genetic factors: lamb sex, birth year and litter size as main effects, the lamb's age when weighed as covariate, and the interactions between these factors. Results showed that all traits were significantly (P<0.001) affected by all factors. However, no interaction between the factors was found for all traits. Environmental factors have very important roles in the development and growth of Iran-Black sheep at different ages. Therefore, a correction is necessary to increase the accuracy of direct selection on lamb weight at different growth stages.*

Keywords*—*Iran-Black sheep, Growth traits, Environmental factors.

I. INTRODUCTION

Sheep breeding is important of livestock production in Iran as there are about 50 million heads of sheep in this country (FAOSTAT, 2016). The Iran-Black is a new composite sheep that has been developed by cross breeding of Chios and Balouchi breeds in Abbas Abad sheep breeding station in Iran. This breed is more resistant to diseases and arid condition with more meat tendency and reproducibility. There are various production traits of this breed which suggest that there is a potential for improvement of economic traits. However, growth performances are preferred traits to improve due to low economic value of wool compared to meat production. In this situation, more emphasis should be placed on growth traits and carcass quality as well as reproductive traits (Snyman*et al*., 1995).Estimation of heritability indicates the potential of genetic improvement. The amount of heritability depends on both genetic and environmental variation in growth performance. Any selection program to improve growth traits should be designed based on the genetic and environmental effects on the objective traits (Yazdi*et al*., 1999). Non-genetic factors must be corrected before starting genetic analysis. Some environmental factors can be adjusted before any statistical analysis, however, there are still unknown environmental differences between animals, known as residual error. An adjustment should be made for environmental and physiological sources of variation such as age, sex, birth type or litter size, years, seasons and such other environmental variables that can be evaluated (Babar *et al*., 2004).The effect of non-genetic factors on growth performance in sheep has been investigated in several studies. These factors in different areas have their own specific effects regarding the environmental characteristics of corresponded areas (Gbangbochee*t al*., 2006; Momohe*t al*., 2013). Therefore, the present study was carried out to investigate the effect of sex of lamb, year of birth and litter size on body weight of Iran-Black lambs at different ages.

II. MATERIALS AND METHODS

2.1 Animals and location of study area

The data on 1522 lambs born from 547 Iran-Black ewes sired by 60 rams kept at the Abbas Abad sheep breeding station located at a semi-arid area in the North-east of Iran during 2005-2009 were utilized to estimate the effect of environmental factors affecting BW, W3, W6, W9, and W12.The animals were raised in a closed system and fed with alfalfa, barley and straw. Sheep were supplemented in the last month of gestation and during lactation (usually barley), and births occurred mainly in April and May. Lambs were left with dams until age90 days, from this age they were kept to fatten until reaching slaughter age.

2.2 Data and analyses

The data file contained information on individuals, sire and dam identification code, sex, litter size, birth date, date of weighing and measure of body weight. The data were analyzed to estimate the effect of year of birth, litter size and sex of lamb born on the lamb growth. The mathematical model assumed for the Least-Squares Analysis was:

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$$Y_{ijklm} = \mu + S_i + A_j + L_k + (SA)_{ij} + (SL)_{ik} + b(Age - \overline{Age}) + \varepsilon_{ijklm} \quad (1)$$

where Y_{ijklm} is the weight of a lamb; μ is the overall mean; S_i is the sex of lamb; A_j is the year of birth of a lamb; L_k is litter size; $(SA)_{ij}$ is the interaction between sex and year of birth; $(SL)_{ik}$is the interaction between sex and litter size; b is regression coefficient, Age is age of lamb at weighing time, ε_{ijklm} is residual error.A statistical analysisusing the univariate general linear model from the statistical package Minitab v.16 was used to analyze the effect of the fixed factors and interaction between them on the total variance of the records.

Thelamb's age at weighing time was used as covariate to correct the record of W3, W6, W9 and W12. Comparison of means was performed by Tukeytest, setting P<0.05 to identify significant differences between treatments.

III. RESULTS AND DISCUSSION

The data were used in the present study belonging to Abbas Abad sheep breeding station that Iran-Black breed has been created over there. As shown in Fig. 1, there was not such a big variation for all traits among different years, however, it was significant. Two reasons are supposed for this result, first, a scientific selection program has not been applied and second, environmental factors significantly influence the traits.

The effects of sex, birth year and litter size are shown in the Tables one to three, respectively. All non-genetic factors that have been investigated in this study significantly influenced on lamb weights in all ages (P< 0.001). However, the interaction between these factors had non-significant effect on growth performances. Male animals were heavier than females as shown in Table 1. This fact has been reported in the other studies (McManus *et al*., 2003; Babar *et al*., 2004; Macedo and Arredondo, 2008;Baneh and Hafezian, 2009; Ulutas*et al*., 2010;Gbangboche*et al*., 2011; Momoh*et al*., 2013; Lupi*et al*., 2015). Differences in physiological functions in both sexes cause such a tendency in body weight. The nature of testosterone, a steroid hormone whose anabolic effects act as growth promoter, attributes in postnatal growth in males (Lupi*et al*., 2015).

The variation in lamb weights at different ages observed in different years (Table 2) may be due to variation in the environment, resulting primarily from differences in the amount of rainfall and the quantity and quality of herbage available. The management includes farmer manager, his ability to supervise the staff, availability of financial resources and selection strategies. Climate and environmental changes affect the quality and quantity of pasture forages, which affect the provision of food(Assan and Makuza, 2005; Momoh*et al*., 2013).Adequately fed ewes are expected to produce heavy lambs.

Litter size (single or multiple) had significant effects on living weight at different ages of lambs,single born lambs were heavier than multiple born lambs (Table 3). This result is according to the earlier studies (Dimsoski*et al*., 1999; Assan and Makuza, 2005; Hinojosa-Cuéllar*et al*., 2012; Gavojdian*et al*., 2013). The low birth weight and subsequent growth rate of twin born lambs can be attributed to competition for nutrients in utero. This could be due to uterine space and thelimited capacity of ewes to provide more nourishmentfor the development of multiples fetuses and more milkfor lambs (Gbangboche*et al*., 2006; Momoh*et al*., 2013). However, the multiple born lambs may demonstrate compensatory growth after weaning. Low birth weight was found to be leading cause of reduced lamb viability (Wilson, 1986). Therefore particular nutritional attention should be given to ewes lambing twins. Nutritional stress limits the lambs from expressing their full genetic potential (Chang and Rae, 1972) for birth weight and weaning weight.

Table 4 presents the coefficients of phenotypic correlation between body weights and corresponded Pearson correlation P-value. Although, all correlation coefficients are significant, the phenotypic correlations of birth weight with the body weights at subsequent ages ranged from low to intermediate and were positive. Similar results were observed in previous studies for the Tellicherry goats, Iran-Black and Lori-Bakhtiari sheep (Thiruvenkadan*et al*., 2009; Rashidi, 2013; Vatankhah, 2013, respectively). The W3 body weight had a significant, positive and moderate to high genetic correlation with the subsequent body weights (0.356 – 0.732). This indicated that selection for increased bodyweight at this age would result in genetic improvement in the subsequent ages.Phenotypic correlation between two traits includes both the genetic and environmental correlations. With appropriate design, the genetic correlation can be separated from the environmental correlation (Momoh, 2013). Therefore, in this study the environmental correlation between WW and post-weaning weights may be higher than pre-weaning weights.

IV. CONCLUSION

The results obtained in the present study revealed that environmental factors cause differences in live weight of Balouchi sheep from birth to 12 months of age.A breeding program needs to adjust records according to non-genetic effects to estimate breeding values of animals accurately. Sex of lamb, year of birth and litter size influenced body weight of Balouchi lambs. Hence, the effect of these factors should be considered in mixed model approaches to find pure genetic values of animals.

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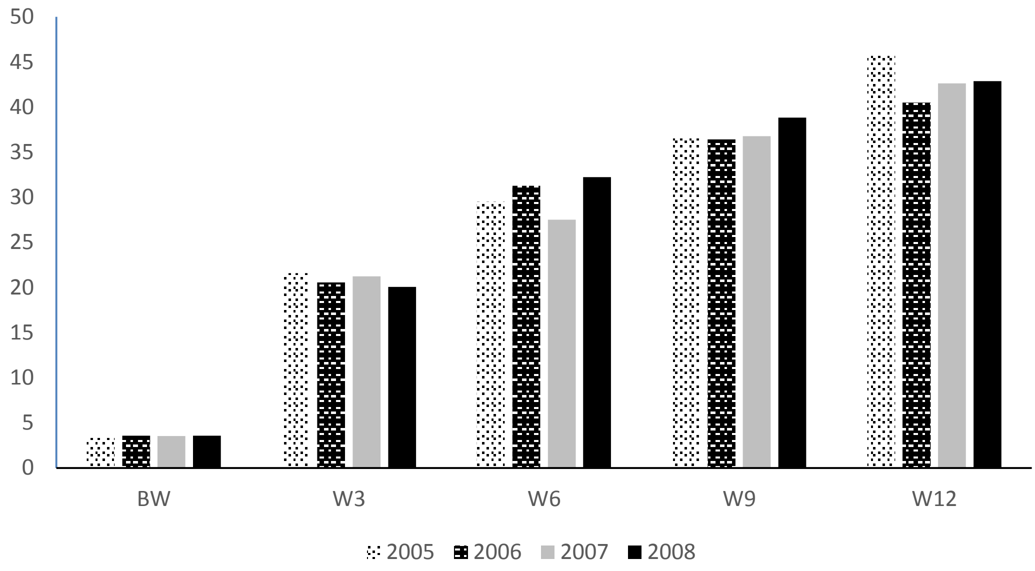

Fig.1: Least square means of growth traits according to year of birth of lambs.

Table.1: Least square means (LSM) and standard error (SE) of lambs live weights according to sex of lambs.

Trait	Sex[1]	N[2]	LSM[3]	SE
BW	M	656	3.618[a]	0.067
	F	746	3.346[b]	0.010
W3	M	423	21.970[a]	0.487
	F	531	19.750[b]	0.680
W6	M	341	32.780[a]	0.561
	F	479	27.540[b]	0.733
W9	M	266	39.250[a]	0.667
	F	316	34.520[b]	1.055
W12	M	257	45.750[a]	0.710
	F	284	40.070[b]	1.113

1 Sex of lambs; M: male, F: female

2 Number of records

3 Column with different superscripts within subclass indicate significant differences ($P < 0.001$)

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Table.2: Least square means (LSM) and standard error (SE) of lambs live weights according to year of birth of lambs.

Trait	Birth year	N[1]	LSM[2]	SE
BW	2005	150	3.331[c]	0.088
	2006	334	3.550[ab]	0.065
	2007	368	3.529[abc]	0.067
	2008	205	3.580[a]	0.074
	2009	347	3.419[bc]	0.067
W3	2005	135	21.580[ab]	0.628
	2006	306	20.550[ab]	0.447
	2007	335	21.250[a]	0.461
	2008	178	20.060[b]	0.518
W6	2005	129	29.510[b]	0.715
	2006	285	31.270[a]	0.492
	2007	242	27.520[c]	0.532
	2008	164	32.340[a]	0.573
W9	2005	91	36.540[ab]	0.807
	2006	201	36.700[b]	0.645
	2007	163	35.950[ab]	0.684
	2008	127	36.090[a]	0.702
W12	2005	112	45.66[a]	0.853
	2006	153	40.490[c]	0.696
	2007	158	42.630[b]	0.720
	2008	118	42.870[b]	0.751

1 Number of records
2 Column with different superscripts within subclass indicate significant differences ($P< 0.001$)

Table.3: Least square means (LSM) and standard error (SE) of lambs live weights according to litter size.

Trait	Litter size	N[1]	LSM[2]	SE
BW	1	451	4.386[a]	0.033
	2	842	3.786[b]	0.026
	3	100	3.311[c]	0.068
	4	11	2.445[d]	0.225
W3	1	325	24.610[a]	0.264
	2	548	20.870[b]	0.219
	3	70	19.820[b]	0.556
	4	11	18.130[b]	0.514
W6	1	293	34.870[a]	0.296
	2	466	31.330[b]	0.253
	3	50	30.450[b]	0.727

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	4	11	23.990[c]	1.624
W9	1	225	38.800[a]	0.286
	2	322	36.700[b]	0.250
	3	31	35.950[b]	0.741
W12	1	204	44.760[a]	0.310
	2	307	43.000[b]	0.269
	3	26	43.590[ab]	0.846

1 Number of records

2 Column with different superscripts within subclass indicate significant differences (*P*< 0.001)

Table.4: Estimates of phenotypic correlation (below diagonal) and corresponded Pearson correlationP-value (above diagonal) between lambs live weights

Trait	**BW**	**WW**	**W6**	**W9**	**W12**
BW		0.000	0.000	0.000	0.000
WW	0.486		0.000	0.000	0.000
W6	0.431	0.732		0.000	0.000
W9	0.228	0.429	0.535		0.000
W12	0.166	0.356	0.433	0.906	