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Study of the environmental, genetic and phenotypic trends for pelt traits and body weight traits in Zandi sheep

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In this study, the data of body weights and pelt records of Zandi sheep kept at the Khojir national park breeding station of Iran were used to estimate phenotypic, genetic and environmental trends for birth weight (BW), 3 months weight (3MW), 6 months weight (6MW), yearling weight (YW), curl type (CT), pattern score (PS) and Luster (Lu) of pelt. Data were analyzed for each trait using derivative-free REML procedures under a univariate animal model. Genetic, phenotypic and environmental trends were estimated by regression of the estimated mean of breeding values, phenotypic mean and difference between estimated mean of breeding values and phenotypic mean on birth year, respectively. The average additive direct genetic trends for BW, 3MW, 6MW, YW were 0.001 ± 0.001 , 0.034 ± 0.004 , 0.028 ± 0.007 and 0.024 ± 0.004 g/year and for CT, PS and Lu were $0.006 \pm .002$, 0.001 ± 0.002 and 0.002 ± 0.004 , respectively. Although selection for body weight traits was effective and significant genetic improvements were obtained, limited genetic improvement in the pelt traits were detected.

Keywords: Zandi sheep; breeding value; body weight; pelt quality; response to selection

1. Introduction

Accurate prediction of breeding value of animals is one of the best tools available to maximise the response to selection programs. Success of a breeding program can be assessed by actual change in breeding value expressed as a proportion of expected theoretical change of the breeding value mean for the trait under selection (Jurado et al. 1994). Estimation of genetic trend is important to test the efficiency of applied breeding schemes and to provide breeders with information to develop more efficient selection programs in the future. Native Sheep populations of Iran mainly include fat tailed and carpet-wool breeds. Zandi sheep is known as a dual-purpose breed (meat and pelt) that is kept in the central region of Iran. The origin of Zandi sheep is traced to the Karakul sheep breeds of Shiraz. Karakul and Zandi sheep are similar in many ways, but the main resemblance between them is a beautiful pelt in the newborn lambs.

The pelts of newborn lambs are often used for clothing and coats. In recent years, the development of the textile industry has led to the mass production of favorite garments. This coincided with an increase in meat prices in Iran. Therefore, sheep breeders mostly tend to produce meat and improve the growth traits and these changes has led to a downturn of pelt industry. All efforts should be placed on the production of outstanding quality pelts, making it an

exclusive industry (Schoeman 1998). In 1986, Khojir breeding center was established in Iran, for preservation and improvement in the Zandi sheep breed. From 1986 up to now, breeders recorded some of the most important production and reproduction traits in this flock. Zandi is a dual-purpose breed, and both pelt and growth traits are important in this breed. In the earlier study on Zandi sheep, at this flock (Khojastehkey et al. 2006) and in the some other studies on Karalul sheep (Ashirov 1994; Schoeman 1998), it is reported that the genetic relationship between pelt and growth traits is negative and maybe genetic potential for pelt traits is lost because of recurrent selection for growth traits at the same flock.

This study was conducted to estimate the environmental, genetic and phenotypic trends of some important pelt traits and body weight traits and to evaluate the previous efforts for improving and preserving the genetic potential for those traits. This information could be useful to determine the next strategies and future work on this breeding flock.

2. Materials and methods

2.1. Data and management

Data were collected from the Zandi Sheep Breeding center located in Khojir National Park between

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Tehran and Abali (1200 m above zero sea level and 35°35'E and 47°15'N with a moderate climate). The flock was established in 1986, as a nucleus source to improve other flocks in the region. The founder animals were purchased from different sheep farms within the region. The flock is generally reared by following conventional industry practices. Controlled mating is practiced. The mating season commences in August. In earlier years, controlled natural mating was applied. However, in recent years, artificial insemination (AI) is employed during the breeding season and ewes that do not conceive by AI are allocated to natural mating. In this case, ewes are assigned to ram breeding groups with an average mating ratio of 10–15 ewes per ram. Lambing commences in January. At birth, each lamb is identified, and date of birth, sex, type of birth, and weight are recorded. On day 2 or 3 after birth, all lambs were characterised for pelt traits. Weaning occurs at an average of 90 days after lambing. Ewes and weaned lambs are kept on natural pasture during the day and penned at night. Quantity and quality of the pasture are low during the winter and therefore animals are kept indoors and receive supplemental feed during winter according to NRC (1985) recommendation.

2.2. Traits of study

The data included the pelt and body weight records. Body weight traits were birth weight (BW) and body weights at 3 months (3MW), 6 months (6MW) and yearling age (YW). Weaning weight was adjusted to 90 days of age by adding 90 times the pre-weaning average daily gain to birth weight. Adjusted 6-month weight (180 days) was obtained by adding t times the post-weaning daily gain to weaning weight, where t is the number of days between weaning and 6 months of age. Adjusted yearling weight (365 days) was also calculated in a similar way. The pelt traits were curl type (CT), pattern score (PS) and luster (Lu). Pelt traits were evaluated by the allocation of scores.

Score allocation was done on an ordinal scale. Curl type refers to the degree of curl development which varies from a smooth type to a curly type (pipe curl). Curl type was scored on a linear scale from 1 to 12. The lower values were assigned to the worst curl types (e.g. smooth) and the higher values were assigned to the best ones (e.g. pipe). Pattern score describes the attractiveness of the pelt which in the result of a complex interaction between some pattern-forming features. Pattern was scored on a scale from 5 to 20. This means that the 10 was taken as the mid value, and 5 and 20 as the minimum and maximum values, respectively. A pelt with attractive pattern covered by the uniform curls in the same direction and takes higher values (e.g. 20). Luster score gives expression to the brightness and brilliance of the pelt. Luster was scored on a scale from 5 to 10. This means that the 8 was taken as the mid value, and 5 and 10 as the minimum and maximum values, respectively. Description of data structure of the studied traits is shown in Tables 1 and 2.

2.3. Statistical analysis

It is not possible for human eye to distinguish small differences in the expression of the pelt traits. These traits are among those which Harvey (1982) suggested that a least square analysis of discrete variable is valid if these scored values are an indication of quantitative differences between classes (Lourens et al. 1998). Important fixed effects for all traits were identified from preliminary analysis using the GLM procedure of SPSS (16). The fixed effects which were found to be significant ($P < 0.05$) are included in the models for estimating genetic parameters (Table 3).

By excluding or including direct and maternal genetic effects or maternal permanent environmental effects, different models were fitted for each trait and Log-likelihood ratios tests were carried out to test the significance of random effects and identify the most appropriate model for each trait. The

Table 1. Description of pedigree information for studied traits.

Traits	Pelt			Body weight			
	CT	PS	Lu	BW	3MW	6MW	YW
No. of base animals	453	453	453	491	453	453	453
No. of records	3721	3721	3721	5575	4162	2461	1285
No. of animals without known sire	571	571	571	921	436	177	102
No. of animals without known dam	0	0	0	40	0	0	0
No. of sires with progeny record	135	135	135	183	183	156	131
No. of dams with progeny record	1157	1157	1157	1516	1455	1181	782
No. of grand sires with progeny record	221	221	221	239	238	211	166
No. of grand dams with progeny record	836	836	836	906	903	751	521

Table 2. Description of data-set for studied traits.

Traits	Pelt			Body weight(kg)			
	CT	PS	Lu	BW	3MW	6MW	YW
Mean	5.8	17.39	8.16	4.14	20.13	32.96	34.15
SD	2.2	4.66	1.73	0.73	4.35	5.33	7.09
CV,%	38	27	21	18	22	16	21

most appropriate models for these traits were as follows:

$$\text{Model 1 : } y = Xb + Z1a + Z2c + e$$

Model 2 :

$$y = Xb + Z1a + Z2c + Z3m + e, \text{Cov}(a, m) = 0$$

where y = A vector of records for individuals, b = Vector of fixed effects, a = Vector of direct additive genetic effects, c = Vector of maternal permanent environmental effects, m = Vector of maternal genetic effects and e = Vector of residual effects.

While X , $Z1$, $Z2$ and $Z3$ are corresponding design matrices associating the fixed effects, direct additive genetic effects, maternal genetic effects and maternal permanent environmental effects to vector of y . Except the birth weight, all traits were analyzed using model 1.

Variance components were estimated by the restricted maximum likelihood (REML) procedure using derivative-free algorithm (DFREML 3.0) fitting univariate animal model (Meyer 1998). Convergence was considered to be reached when the variance of function values in the Simplex was less than 10^{-8} . Breeding values of individual animals were predicted with Best Linear Unbiased Prediction methodology. In order to estimate the genetic trends, means of predicted breeding values for lambs in year of birth were calculated. Genetic, phenotypic and environmental trends were estimated by regression of the estimated mean of breeding values, phenotypic mean and difference between estimated mean of breeding values and phenotypic mean on birth year, respectively.

3. Results and Discussion

The phenotypic, environmental and genetic trends for body weight traits are presented in Figures 1 and 2. Also Figures 3 and 4 show phenotypic, environmental and genetic trends for pelt traits.

3.1. Body weight traits

Direction of phenotypic and environmental trends of body weight traits, from 1992 to 2007, was irregular and not significant, except for the birth weight ($P < 0.05$). It could be associated with the drastic changes in the pasture conditions in different years. The fluctuations could have been associated with the pasture condition in different years. The poor environmental conditions, from 1993 to 1997, caused to slump in the environmental and phenotypic means (Figure 1).

Estimated genetic trends for birth weight and body weights at 3 months, 6 months, and yearling age were 1, 34, 28 and 24 g/year, respectively. Except for the birth weight, there were significant and positive genetic improvements in all body weight traits (Figure 2). The genetic trend for birth weight was irregular and not significant (the mean close to zero) and was in accordance with the findings of Hassani et al. (2010) in Baluchi sheep (0.7 g/year), Bahreini and Aslaminejad (2010) in Kermani sheep (1 g/year), and Zishiri et al. (2010) in Ile de France sheep (1 g/year). However, estimates reported by Shrestha et al. (1996) in Suffolk sheep (13 g/year) and Dorostkar et al. (2011) in Moghani sheep (5.5 g/year) were higher than the estimates of the present study. Maternal effects had a significant effect on birth weight. Due to the possibly negative correlation between direct and

Table 3. The fixed effect used in the models for different traits.

	Birth type (single, twine, triplet)	Age of dam (2–11 years old)	Gender of lamb (male and female)	Month of birth (with 8 subclasses)	Year of birth
Birth weight	✓	✓	✓	✓	✓
3M weight	✓	✓	✓	✓	✓
6M weight	✓	✓	✓	✓	✓
yearling weight	✓	✓	✓	✓	✓
Curl type	✓	✓	–	✓	✓
Luster	–	–	–	✓	✓
Pattern	–	–	✓	✓	✓

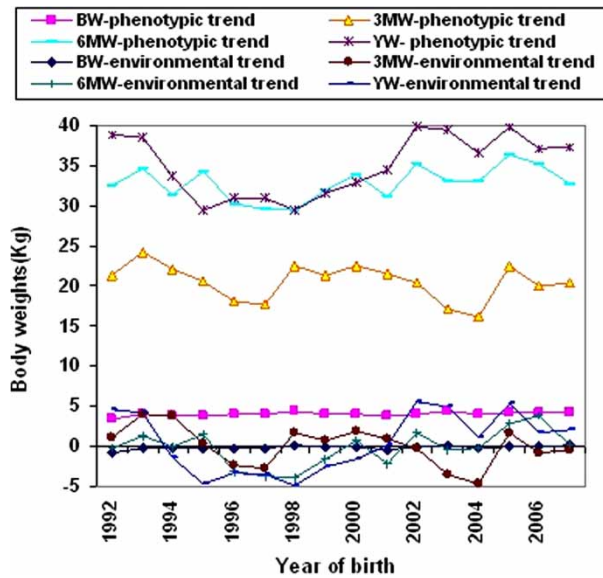


Figure 1. Phenotypic and environmental trends for body weight traits.

maternal genetic effect, it is expected that maternal effects have greater proportion in genetic variation of birth weight than direct genetic effects, and consequently a low direct genetic trend was estimated for birth weight. The genetic trends for 3 months weight (34 g/year) and 6 months weight (28 g/year), were greater than the ones observed by Dorostkar et al. (2011) in Moghani sheep (5.3 and 5.2 g/year, respectively), and Lotfi et al. (2011) in Arman sheep (7 and 8 g/year, respectively); however they were lower than that ones reported by Hassani et al. (2010) in Baluchi sheep (55 and 72 g/year, respectively), Shaat et al. (2004) in Rahmani sheep (92 and 135 g/year,

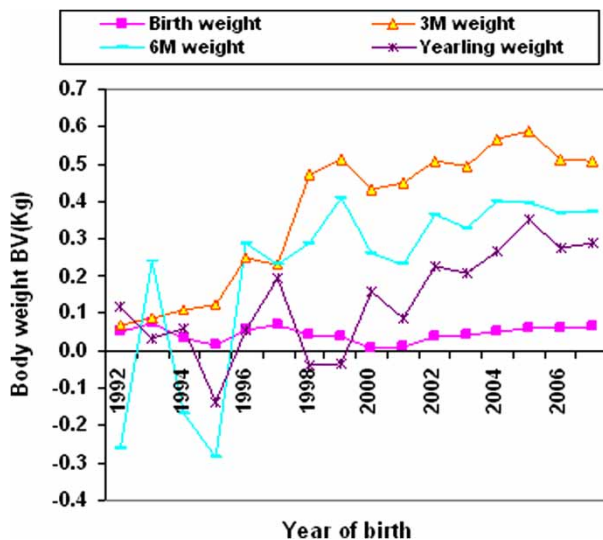


Figure 2. Direct additive genetic trends for body weight traits.

respectively), and Bahreini and Aslaminejad (2010) in Kermani sheep (82 and 76 g/year, respectively).

The estimation of direct genetic trend for yearling weight (24 g/year) was lower than those reported by Hassani et al. (2010) in Baluchi sheep (88 g/year) and Dorostkar et al. (2011) in Moghani sheep (84 g/year), while it was in accordance with the findings of Shrestha et al. (1996) in Suffolk sheep (23 g/year) and it was higher than the ones reported by Bahreini and Aslaminejad (2010) in Kermani sheep (16 g/year). The higher genetic trends for 3 month and 6 month weights, than other body weights, might be due to the relatively higher additive genetic variance in those traits. In general, results showed that selection for body weight traits was effective, and moderately significant genetic improvement was obtained. Selection for 3 months weight could be more effective than the other body weights in the breeding program of the studied flock.

3.2. Pelt traits

Phenotypic and environmental trends for curl type, pattern score and luster are presented in Figure 3. The curl type and luster exhibit the typical fluctuating nature owing to the environment. The year-by-year fluctuations could have been associated with years with good pasture condition (e.g. 2003 and 2007) and low pasture condition (e.g. 2002 and 2005). These environmental changes could lead to a moderate phenotypic variation (Figure 3). Martins and Peters (1992) reported that both seasonal pattern and pasture conditions have to be taken into consideration when deciding either to pelt or to rear a lamb.

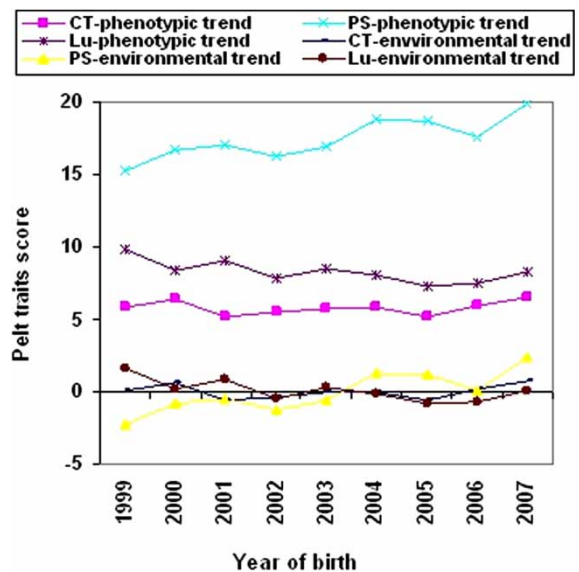


Figure 3. Phenotypic and environmental trends for pelt traits.

Unlike the body weight traits, the estimated genetic trends for curl type, luster and pattern were low, i.e. 0.006, 0.001 and 0.002, respectively (Figure 4). Except for the curl type, there was not significant genetic improvement for pelt traits. A mean annual response of 2.5% and 7.1% were obtained in selection for pattern and curl development, respectively, by Greef et al. (1993). These were slightly higher than the findings for Zandi sheep in the current study. Observed genetic trends for pattern and curl type by Schoeman and Albertyn (1992) were 0.011 and -0.02 that were not in agreement with the findings for Zandi sheep. In the present study, the mean of breeding values for pelt traits was closest to the zero (Figure 4). The breeding values for curl type, pattern and luster ranged from -0.03 to 0.03 , -0.09 to -0.04 and -0.09 to 0.02 , respectively. In pelt traits, data were analyzed from 1999 to 2007 due to lack of access to an electronic data file before 1999. This could lead to an absence of some breeding values before 1999, which might be a positive or negative. Nevertheless, the results showed a low genetic improvement in the studied pelt traits during the period of study. The main reason for this could be the absence of clear and effective selection criteria for pelt traits in the population. In the studied flock, lambs were recorded and selected for growth and pelt traits simultaneously.

Observed genetic correlations between birth weight with curl type, pattern and luster by Greef et al. (1991) were 0.36, -0.72 and -0.18 , respectively, and by Khojastehkey et al. (2006) were 0.34, -0.57 and -0.8 , respectively. Moderate-to-high negative genetic correlation of body weights with luster and pattern suggests that an increase in body mass, may have a negative effect on luster, and may also reduce

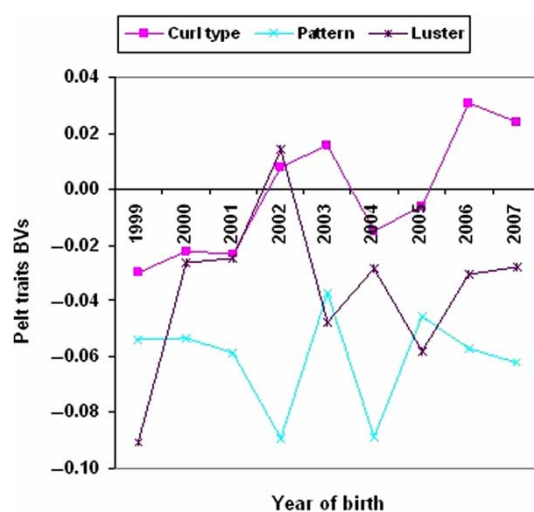


Figure 4. Direct additive genetic trends for pelt traits.

the pattern substantially. Schoeman and Albertin (1993) had reported that the genetic correlation between curl type with luster and pattern was -0.11 and -0.1 , respectively. Consequently, curl type is positively correlated with body weight traits, and negatively correlated with luster and pattern. Thus, it could be expected that increasing in genetic potential of body mass, leading to improvement of curl type, and decrease in pattern and luster, simultaneously. This fact is supported by the findings of Schoeman (1998) and Ashirov (1994) in Karakul sheep.

4. Conclusion

Positive and significant estimated genetic trends, for body weight traits in the studied flock, revealed that the overall, breeding programs in this station for body weight traits has been relatively effective, but this is not the case for pelt traits. The low genetic improvement estimated for pelt traits during the period of study could be due to the absence of clear and effective selection criteria for these traits. Although, the pelt marketing have been slumped extremely in recent years, but the preservation of genetic potential for pelt traits along with growth traits, must be noticed and considered in the breeding program of Zandi sheep. Negative genetic correlation between important pelt traits and body mass, might suggest that two selection lines should be established to have lambs with suitable weights and marketable pelts. In one line, body weight traits with curl type and in another line, luster and pattern could be set as selection goals.

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