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Estimation of genetic parameters for early growth traits in the Lori-Bakhtiary lambs

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Abstract

A research was conducted on records of a Lori-Bakhtiary lambs flock over a period of nine years(1989-1997). Genetic parameters were estimated for birth weight (BWT), weaning weight (WWT) and pre-weaning average daily gain (ADG) using Restricted Maximum Likelihood (REML) procedures. Six different models were fitted with or without maternal (genetic or permanent environment) effects. The direct heritability estimate (h^2) was ranged from 0.22-0.55, 0.09-0.28, 0.08-0.24 for BWT, WWT and ADG, respectively. The estimates were higher when maternal effects (genetic or environmental) ignored from the model. The maternal heritability (m^2) for BWT was 0.20 when maternal genetic effect fitted in the model, but decreased to 0.15 when maternal permanent environmental effect (c^2) was fitted. The m^2 for both WWT and ADG was from 0.05-0.10 and from 0.02-0.11, respectively. The c^2 estimate ranges from 0.07-0.19 and 0.07-0.13 and 0.09-0.13 for BWT, WWT and ADG, respectively. The genetic correlation between direct and maternal genetic effects were 0.04-0.05, 0.03 and 0.01-0.02 for BWT, WWT and ADG, respectively. The direct and maternal genetic correlation estimates were 0.22-0.26, 0.33-0.87 and 0.14-0.45 for BWT, WWT and ADG, respectively. These results indicate that the maternal component should be considered in selection of Lori-Bakhtiary lambs (males and females).
Key words: Early growth, direct heritability, maternal effects, Lori-Bakhtiary sheep

Introduction

The genetic characteristics of native breeds are important, not only for conservation purposes but also for definition of breeding objective and breeding programs. When records are nonexistent and breeds are not well defined in the field, information could be obtained from research station information where pedigree and performance records have been kept. Growth rate and leanness are major economic traits for both terminal sire and dual purpose breeds.

When body weights and growth rate to weaning in sheep are included in the breeding goal, it is usual to distinguish between genetic and permanent environmental components due to the dam in order to achieve optimum genetic progress.

Lori-Bakhtiary is an Iranian fat-tailed sheep breed and its most incomes came from mutton production under extensive conditions.

Nevertheless, in this breed there are very few studies using appropriate models to estimate the importance of direct and maternal additive effects on early growth traits.

Recent developments in statistical methods for estimation of variance components have simplified the partitioning of variance into direct and maternal effects and as

linear models used in animal genetic evaluation make these effects can be included in animal model analysis (Meyer, 1992; Ligda, 2000; Snyman, 1995).
Genetic and environmental relationships between direct and maternal effects for growth and most other traits have often been found to be negative (Nasholm and Danell, 1994). Several studies have also attributed most variation in lamb weights to maternal effect (Burfening and kress, 1993; Maria et al., 1993, Van Wyk et al., 1993; Snyman et al., 1995).
However, There is still much conflicting information about the direct maternal genetic correlation.
The sign and magnitude of this correlation for Lori-Bakhtiary sheep are still unknown. When maternal genetic effects are of importance, but not accounted for, direct heritability estimates are biased upwards and realized selection-efficiency reduced (Nasholm and Danell, 1994).
The existence of multiple births in sheep, as opposed to cattle, give rise this question of what influence of a permanent environmental effect of the dam would be on traits such as birth weight, weaning weight and average daily gain to weaning.
Recently, published heritability estimate for lamb's birth (BWT), weaning weight (WWT) and average daily gain to weaning (ADG) are summarized in Table 1.

Table-1 Summary of reported direct (h^2), maternal genetic (m^2), permanent environmental(c^2), estimates and correlation between direct and maternal genetic effects (r_{am}) for birth weight and weaning weight of lambs

a) birth weight					b) weaning weight				
Breed	**h^2**	**m^2**	**c^2**	**r_{am}**	**h^2**	**m^2**	**c^2**	**r_{am}**	**Ref. No.**
Chios	0.13-0.38	0.13-0.33	0.16-0.28	0.00-0.44	0.15-0.29	0.05-0.16	0.08-0.12	-0.22 to –0.26	2
Romanov	0.07	0.13	0.32	-0.13	0.14	0.02	0.12	0.43	13
Polled Dorset	0.12	0.31	0.27	-0.35	0.25	0.08	0.19	-0.31	13
Dorper	0.11	0.10	0.12	0.35		0.10	0.08	-0.58	8
Merino	0.30	0.29		-0.43	0.28	0.41		-0.59	13
Afrino	0.22	0.09	0.12		0.33	0.17			10
Swedish Finewool	0.07	0.30		0.11	0.12	0.13		0.47	7

The aims of this study were to obtain first, determine the suitable model for analysis for body weights and ADG and estimation of (co) variance and genetic parameters for each of these traits.

Material and Methods

Data used in this study were obtained from the Development and Breeding Station of Lori-Bakhtiary sheep in Chaharmahal va Bakhtiary province, Iran during a period from 1989 to 1997. An extensive management system, on summer rainfall mix grassland pasture practiced.
The lambing was restricted in winter. The birth weight of lambs and ewe weight was recorded at 24 h of lambing. Subsequent weight of the lambs was recorded at 1, 3(at weaning), 6, 9, 12, 18 months of age. Sires were used for a maximum two or three years for avoiding inbreeding. In this flock, weaning weight was the most important selection criterion.

Statistical Analysis

Traits considered were birth weight (BWT,kg), weaning weight (WWT,kg) and average daily gain (ADG, Kg/day) the description of these traits are summarized in Table 2.

Table 2 Summary structure data for each trait

Data structures	BWT	WWT	ADG
Number of records	2787	2612	2313
Mean	4.87±0.73	27.38±5.33	0.249±0.05
Standard deviation	0.611	4.1	0.043
%C.V	12.55	15.16	17.46
No. animals in pedigree	3174	3174	3174
No. sires	122	122	122
No. dams	857	843	843
Mean of age (day)	-	90	-
FIXED EFFECTS:			
Year	×	×	×
Birth or weaning status	×	×	×
Sex	×	×	×
Age of dam	×	×	×

Variance and covariance components were estimated by the DFREML 3.1 program (Meyer, 2000). By ignoring or including maternal genetic or environmental effects, six different models of analysis were fitted for each trait:

$y = Xb+Z_1a+e$ (1)

$y = Xb+Z_1a+Z_3C+e$ (2)

$y = Xb+Z_1a+Z_2m+e$ with $cov(a,m)=0$ (3)

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

$y = Xb+Z_1a+Z_2m+Z_3C+e$ with $cov(a,m)=0$ (5)

$y = Xb+Z_1a+Z_2m+Z_3C+e$ With $cov(a,m)=A\sigma_{am}$ (6)

Where y is a vector of observed traits of animals, b, a, m, c are vectors of fixed effects, direct additive genetics effects and maternal permanent environmental effects, respectively, and X, Z1, Z2 and Z3 are the corresponding incidence matrices relating the effects to y, e is the incidence vector of residuals. A is the numerator relationship matrix and σam is the covariance between direct additive genetics and maternal additive genetics effects. It was assumed that $V(a)=A\sigma^2_a$, $V(m)=A\sigma^2_m$, $V(c)=I\sigma^2_c$ and $V(e)=I\sigma^2_e$.

Log Likelihood Ratio tests were performed among all six models to determine the most suitable model for each trait. An effect was considered to have a significant influence when its inclusion caused a significant increase in log likelihood, compared to the model in which it was ignored. When minus 2-times the difference between the log likelihood was greater than values of the chi-square distribution with one degree of freedom, the effect was concluded to have a significant influence.

RESULTS AND DISCUSSION

Estimates of direct and maternal heritabilities and correlation between them for all six models using univariate analysis and total heritabilities are presented, In table 3.

Table 2 Estimates genetic parameters[a] and heritability estimates for birth weight (BWT), weaning weight (WWT) and pre-weaning average daily gain (ADG)

Model	Trait	h^2	c^2	m^2	Log L	r_{am}
1	BWT	0.55			-46.31	
2		0.34	0.19		-8.38	
3		0.25		0.24	-2.51	
4		0.22		0.20	-1.85	0.22
5		0.26	0.08	0.15	0	
6		0.23	0.07	0.13	0.67	0.26
1	WWT	0.28			-20.86	
2		0.15	0.13		-1.09	
3		0.11		0.14	-4.64	
4		0.09		0.11	-4.23	0.33
5		0.13	0.10	0.05	0	
6		0.10	0.10	0.02	0.79	0.87
1	ADG	0.24			-19.92	
2		0.12	0.13		-1.01	
3		0.08		0.13	-4.65	
4		0.08		0.12	-4.58	0.14
5		0.10	0.09	0.04	0	
6		0.08	0.09	0.02	0.29	0.45

[a] h^2=direct heritability; c^2=ratio of maternal permanent environmental effect; m^2 = maternal heritability; σ^2p = phenotypic variance; Log L= log likelihood as deviation from model(5); r_{am} = direct-maternal genetic correlation; SE range for h^2=0.03-0.06; m^2 =0.02-0.05; c^2=0.02-0.03.

The best model for BWT, WWT and ADG was the model in which maternal genetic and permanent environmental effect were included.
Direct heritabilities estimates obtained for traits in this study were within the ranges of reported by various authors for several sheep breeds world wide (Table 1).
The h^2 estimates for BWT were ranged from moderately (0.23) to high (0.55). However, fitting one or both of the maternal effects reduce the h^2 estimates from 0.55 to 0.26. As BWT, h^2 estimates for WWT and ADG decrease when both the maternal effects were fitted in the model. This is evident that BWT is most influence by maternal genetic effect, but WWT and ADG are mostly affected by maternal permanent environmental effect.

Estimates of m^2 and c^2 were in range reported by several authors. m^2 decreases from birth(0.15) to weaning(0.05) and for ADG(0.05). This means that maternal effects plays an important role in BWT.

Estimate permanent environmental effect variance (c^2) was important for BWT, WWT and ADG was different from zero. The variance of permanent environmental effect on BWT was influenced due to of uterine capacity and the effect of multiple birth. Relatively large c^2 estimate for WWT and ADG are most likely reflected in

differences the rearing abilities of dams that might be influenced by environmental fluctuations between years of her birth/status (Duguma, et al., 2002).
Factors, which permanently influence the milk production of the ewe, such as udder defects, largely contributed to the c^2 value for WWT and ADG (Snyman, et al., 1995).

The correlation estimates obtained between direct and maternal genetic effects (r_{am}) for BWT, WWT and ADG were positive and lower than most of the estimates reported in the literature cited. These positive correlations were opposite of the results found by Tosh and Kemp (1994) in the sheep population (Hampshire, Polled Dorset and Romanov), Maria et al. (1993) in Romanov sheep.
These estimates may be considerable and could be influenced by small data size (Maria et al., 1993; Fadili et al., 2000; Al-Shorepy, 2001), the models fitted or poor pedigree structure that is inadequate for obtaining estimates of both direct and maternal hertabilities and the genetic correlation's between animal effects (Lee, et. al., 2000).

Conclusion
Genetic parameter estimates can be different from one population to another. This study showed the importance of implementing the correct model of analysis for estimation of (co) variance components and genetic parameters. In Lori-Bakhtiary sheep, ignoring the maternal effects leads to overestimation of the direct and total heritabilities. More over, the exclusion of the permanent environmental effect of the dam results in overestimation of the maternal hertability, especially for WWT and ADG, where the maternal genetic and environmental effects are of higher magnitude.

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