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ESTIMATION OF VARIANCE COMPONENTS OF SOME GROWTH AND REPRODUCTIVE TRAITS IN RAHMANI AND OSSIMI SHEEP

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SUMMARY

This investigation was carried out to estimate the variance components, heritabilities and genetic correlations for some Rahmani and Ossimi ewe production traits. These traits were lamb weights at weaning (WW) and at 12 month of age (WT12) as traits of the ewe lambs, in addition to kilograms weaned at 1st parity (KGW1) and total kilograms weaned (TKGW) for the first three seasons as ewe traits.

Estiamtes of heritability were 0.28, 0.11 for WW, KGW1 and 0.72, 0.27 for WW, TKGW and 0.32, 0.08 for WT12, KGW1 and 0.26, 0.28 for WT12, TKGW in Rahmani, and were 0.24, 0.10; 0.36, 0.47; 0.50, 0.09; 0.54, 0.45, in Ossimi sheep, respectively. Estimates of genetic correlations among the studied traits were positive, being 0.87 and 0.52 for WW with KGW1 and TKGW in Rahmani, respectively, and those for WT12 with KGW1 and TKGW were 0.72 and 0.53, respectively, while the estimates of genetic correlation for WW with KGW1 and TKGW were 0.46 and 0.10 and that of WT12 with KGW1 and TKGW were 0.43 and 0.64, in Ossimi, respectively.

Keywords: Sheep, lamb body weights, productivity, variance components

INTRODUCTION

Lamb growth performance and reproduction efficiency, measured under a given production system, are major components in determining the productivity and economic return of sheep flocks. The Egyptian Ministry of Agriculture has maintained an accelerated lambing system of a crop every 8 months. Under this production system the lambs were weaned at the age of 8 wk. Most of these lambs are marketed at weaning time. Thus weaning weight has a great economic importance under this prevailing management system. Mousa (1989) reported that Ossimi and Rahmani sheep reached 69.1 and 61.1% of their mature body weight at yearling age, respectively. Measuring ewe reproductive performance early in its lifetime would decrease the generation interval and enhance genetic return in the selection program. From the economic perspective, kilograms weaned per ewe joined is an important trait compared with other reproductive traits. The objective of this study was to estimate the variance components and genetic parameters for ewe lamb weaning and yearling weights when estimated in a multiple trait model with kilograms weaned at 1st parity or with total kilograms weaned for local Rahmani and Ossimi sheep.

MATERIALS AND METHODS

Data used in the present study were collected from four experimental stations belonging to the Ministry of Agriculture during the period 1970-1993. Rahmani flocks were raised in Mehallet-Mousa and El-Serw stations, while Ossimi flocks were raised in Mehallet-Mousa, El-Gemmiza and Sids stations.

The total number of Rahmani and Ossimi ewes utilized in this study were 1437 and 1277, respectively.

Management

Generally, the system of three matings in two years was practiced (May, January and September). Lambs were weaned at eight weeks of age. From December to May sheep grazed on Egyptian clover *(Trifolium alexandrinum)*. From June to November ewes were fed on crop stubbles and green fodder if available, besides a concentrate mixture (24% corn, 38% cotton-seed meal, 37% wheat barn and 1% salt), clover hay and rice straw. Ewes were fed about ¼ kg $ewe^{-1}d^{-1}$ supplementary concentrate before mating, during late pregnancy and throughout lactation.

Individual body weights

As a measurement of growth, weight at weaning (WW) and body weight at 365-day (WT12) were included in this study. WW and WT12 were linearly adjusted to 60 and 365 days of age, respectively.

Reproductive traits

As a measurement of ewe fertility, kilograms weaned at first parity (KGW1) and total kilograms weaned (TKGW) were considered in this study. Total kilograms weaned for the ewe was calculated by summing up the first three records of the ewe after making appropriate non genetic adjustments as will be explained later. Therefore, only ewes that were allowed to have three records or more were included in the analysis of TKGW.

Statistical analysis

1- Correction for fixed effects

Correction for sex of lamb

Weaning weight of lambs was analyzed to obtain constants for sex of lamb to adjust KGW of the ewe. Lamb data were divided into two sets, the first set included single lambs and the second included twin lambs to avoid adjusting for type of birth effect.

Correction KGW for other fixed effects

Analysis was conducted to obtain constants for location, block (each block consists of two consecutive years included three lambing seasons), season of lambing, parity and all possible interactions to adjust kilograms weaned of records that were previously adjusted for sex of lambs. Total kilograms weaned for the ewe were calculated by summing up first three adjusted records of the ewe.

Harvey's Mixed Model Least-squares and Maximum Likelihood Computer Program (LSML 90) was used for these analyses.

2- Estimation of variance-covariance components and genetic parameters for Rahmani and Ossimi

The second part of statistical analysis was concerned with analyzing the studied traits bivariatly within each breed separately to estimate the variance-covariance components and genetic parameters for WW with KGW1 (first model); WW with TKGW (second model); WT12 with KGW1 (third model); WT12 with TKGW (fourth model).

The following bivariate linear model was fitted for WW and KGW1:

$$Y = X\beta + Zu + e,$$

where,

X is the incidence matrix for the studied fixed effects;

β is the vector including the overall mean and the fixed effects of location, age of dam, season of birth, year of birth and type of birth for ewe lamb weaning weight or the fixed effects of location, season of lambing, year of lambing and age at 1st parity for KGW1 of ewe;

Z is the incidence matrix for random effects;

U is the vector of random effects of animals additive and maternal genetic effects for ewe lamb weaning weight or animals additive genetic effects for KGW1 of ewe; and

e is a vector of random errors normally and independently distributed with zero mean and variance $\sigma^2_e I$.

The variance-covariance matrix of the random effects was as follows:

$$\text{Var}\begin{pmatrix} u \\ e \end{pmatrix} = \begin{pmatrix} G & 0 \\ 0 & R \end{pmatrix}$$

where,
G is the additive and maternal genetic variance-covariance matrix; and
R is the residual variance-covariance matrix.

A similar model was used for analyzing WW with TKGW but TKGW trait was adjusted for all the fixed effects as previously explained. Therefore, the $X\beta$ term in this model, included the overall mean and fixed effects for ewe lamb weaning weight only. Similar models, but not including the genetic maternal effect, were utilized for analyzing WT12 with KGW1 and WT12 with TKGW.

Animal model was applied to ewe data by using a Multiple Trait Animal Model Program (MTDFREML), the computer program of Boldman *et al.* (1993).

RESULTS AND DISCUSSION

1- Estimation of variance components

Genetic, environmental and phenotypic variance-covariance estimates for WW with KGW1 and WW with TKGW are presented in Table 1 for Rahmani and in Table 2 for Ossimi sheep. These tables also depicts the estimates of genetic, environmental and phenotypic variance-covariances of WT12 with KGW1 and WT12 with TKGW. Tables 1 & 2 indicate that genetic and environmental variances of WW and WT12 increase with age of lambs in both breeds. The genetic and environmental variances of KGW1 were lower than those of TKGW in the two breeds (Tables 1 & 2). According to this results, the genetic covariance of WW or WT12 with KGW1 was lower than that of WW or WT12 with TKGW in Rahmani and Ossimi (Tables 1 & 2). The genetic maternal variance of WW in Rahmani ewes had higher estimate than that of Ossimi ewes (Tables 1 & 2).

Generally, estimates of variance components for a trait by using MTDFREML are affected by the other traits included in the model.

2- Heritability

Heritability estimates (h^2) are presented in Tables 1 and 2 for Rahmani and Ossimi, respectively. Previous heritability estimates for WW on various breeds ranged from 0.03 (Stobart, 1983) by using paternal half sib in a sire model to 0.92 (Khalifa & Duafi, 1979) on Awassi sheep by using intra class correlation and from 0.03 (Aboul-Naga & Afifi, 1982) on Rahmani sheep, using sire model to 1.04 (Chaudhry & Shah, 1985) on Kachhi sheep, using sire model for WT12.

Differences in heritability estimates may be due to the difference in gene frequencies in the populations studied, the environmental and maternal effects included in the models and the method of estimation.

Table1. Genetic, environmental and phenotypic variances (on the diagonal) and covariance (off the diagonal) and heritability (h^2) (on the diagonal) and genetic correlations (r_G) (off the diagonal) for different models in Rahmani ewes

Model	Traits	Genetic			Environmental		Phenotypic		Heritability and genetic correlations	
		WW	KGW1	MWW[1]	WW	KGW1	WW	KGW1		
First Model	WW	2.03			4.99		7.20		0.28	
	KGW1	2.95	5.71		-0.69	47.40	2.45	53.11	0.87	0.11
	MWW	-0.13	0.38	0.38						
		WW	TKGW	MWW[1]	WW	TKGW	WW	TKGW		
Second Model	WW	5.38			2.87		7.45		0.72	
	TKGW	8.73	53.06		-3.03	141.64	5.34	194.70	0.52	0.27
	MWW	-2.99	-0.70	2.23						
		WT12	KGW1		WT12	KGW1	WT12	KGW1		
Third Model	WT12	10.20			21.68		31.87		0.32	
	KGW1	4.59	4.00		1.26	48.82	5.85	52.83	0.72	0.08
		WT12	TKGW		WT12	TKGW	WT12	TKGW		
Fourth Model	WT12	8.78			24.83		33.62		0.26	
	TKGW	11.70	54.81		0.27	140.15	11.97	194.96	0.53	0.28

1=Maternal effect for WW

Table 2. Genetic, environmental and phenotypic variances (on the diagonal) and covariance (off the diagonal) and heritability (h2) (on the diagonal) and genetic correlations (rG) (off the diagonal) for different models in Ossimi ewes

Model	Traits	Genetic			Environmental		Phenotypic		Heritability and genetic correlations	
		WW	KGW1	MWW[1]	WW	KGW1	WW	KGW1		
First Model	WW	2.35			7.57		9.89		0.24	
	KGW1	1.52	4.10		-0.82	44.03	-0.72	49.03	0.46	0.1
	MWW	-0.03	0.03	0.001						
		WW	TKGW	MWW[1]	WW	KGW1	WW	KGW1		
Second Model	WW	3.36			6.30		9.35		0.36	
	TKGW	1.87	106.11		1.98	120.42	4.12	226.53	0.1	0.47
	MWW	-0.34	0.53	0.40						
		WT12	KGW1		WT12	KGW1	WT12	KGW1		
Third Model	WT12	11.69			11.81		23.50		0.5	
	KGW1	3.12	4.51		1.82	44.90	4.94	49.41	0.43	0.09
		WT12	TKGW		WT12	KGW1	WT12	KGW1		
Fourth Model	WT12	13.17			11.02		24.19		0.54	
	TKGW	23.60	102.50		-2.16	123.57	21.44	226.06	0.64	0.45

1=Maternal effect for WW

In general, heritability estimates for WW in the present study were lower than those for WT12 in both breeds, except that of the analysis of WW with TKGW in Rahmani

Mousa (1989) estimated the heritability of WW and WT12 in the same sheep flocks as this used in the present study as 0.83 and 0.45 in Rahmani and 0.28 and 0.87 in Ossimi sheep, repectively using sire model, while those estimates reported by Othman (1994) on the same data (ewes only) were 0.28 and 0.20 in Rahmani ewes, 0.39 and 0.37 in Ossimi ewes, respectively using sire model. The main reasons of the difference between the heritability estimates reported by Mousa (1989), Othman (1994) and that obtained in the present study is mainly due to the method of the analysis. In the present study, the MTDFREML program with an animal model was used. This method considerd all the available relationships among the lambs which in part improved the problem of connectedness of the data that faced Mousa (1989) and Othman (1994) in previous analyses. Also, the present method considered the covariances between all traits in the model, therefore the resultant estimates have taken in to account more realistic assumptions than those estimated previously. Fogarty *et al.* (1985) found similar estimates to those in the present study and estimated the heritability of KGW1 and TKGW as 0.03 and 0.16, respectively. However, Basuthakur (1973) obtained different estimates from the present results. He reported heritability estimates of kilograms weaned as average annual production as 0.18 and 0.09 in Targhee sheep and 0.50 and 0.14 in Columbia using paternal half-sib and daughter-dam regression, respectively, while the estimated heritabilities of TKGW were 0.09 and 0.08 in Targhee, 0.03 and 0.09 in Columbia by the two methods, respectively.

Clear difference was observed between heritability estimates of TKGW in both studied breeds. In Ossimi, the estimate was higher than that of Rahmani throughout the first three records. Othman (1994) estimated the heritability of TKGW (for nine parities) on the same ewes as 0.14 and 0.004 in Rahmani and Ossimi, respectively. The difference between the heritability estimate of TKGW in the present study and that obtained by Othman (1994) may be due to similar reasons as mentioned previously with heritability estimates of Mousa (1989) and Othman (1994) for WW and WT12 with the addition that the present TKGW was the total production of the first three parities, while that reported by Othman (1994) was the total production of nine parities.

Generally, the estimated heritability of WW and WT12 in the present study indicate that mass selection for weaning or yearling weight in both of Rahmani and Ossimi ewes could be effective. However, it should be borne in mind that these heritability estimates are for WW and WT12 for ewes that entered the breeding flock and had the chance to stay for one season or the first three seasons.

3- Genetic correlation

Genetic correlations between WW and each of KGW1 obtained from model (WW with KGW1) and TKGW obtained from model (WW with TKGW) and that of WT12 with KGW1 obtained from model

(WT12 with KGW1) and TKGW obtained from model (WT12 with TKGW) are presented in Tables 1 (for Rahmani) and 2 (for Ossimi) ewes on the lower diagonal. In both Rahmani and Ossimi, estimates of the genetic correlations between the studied traits from all models were positive. Shelton & Menzies (1968) obtained similar estimate to that found between WW and TKGW in Ossimi ewes. They estimated the genetic correlation between WW and TKGW as 0.11 and 0.13 of WT12 with TKGW. Stobart *et al.* (1987) estimated the genetic correlations of weight of lambs weaned and each of ewe weight at weaning and at 12 month as 1.26 and 0.91, respectively. Othman (1994) estimated the genetic correlations of total kilograms weaned with weaning weight as 0.30 and with yearling weight as 0.25 on the same Rahmani ewes data, while those in the Ossimi ewes were 0.76 and 2.05, respectively.

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