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GENETIC PARAMETERS AND SIRE EVALUATION FOR GROWTH TRAITS IN EGYPTIAN RAHMANI LAMBS.

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ABSTRACT

Data on 2417 Egyptian Rahmani lambs progeny of 114 sires collected over a 11-years period (1989 to 1999) were used in this study. The average number of lambs per sire was 19.01 . Lamb traits studied were weights at birth (BWT), 3 (WT3) and 6 (WT6) months of age and averages daily weight gain (ADG) from birth to 3 (ADG0-3), from birth to 6 (ADG0-6) and from 3 to 6 (ADG3-6) months of age. Data were statistically analyzed utilizing the least squares mixed model and maximum likelihood (LSMLMW) computer program of Harvey (1990). The effects of sire as random effect, year and season of birth, sex of lamb (SL), type of lambing (TL) and SL X TL interaction as fixed effects on lamb traits. Birth weight of lamb was included in the model as linear and quadratic covariate when analyzing all studied traits except BWT trait. Least squares means (±SE) of BWT, BW3, BW6 ADG0-3, ADG0-6 and ADG3-6 were 2.97 ± 0.033, 16.6 ± 0.190, 24.4 ± 0.294 kg, 151 ± 2.10, 119 ± 1.63 and 86 ± 2.16 g/d, respectively. Sire of lamb, year of birth and sex of lamb had highly significant (P<0.001) effects on all traits studied. Season of birth significantly (P<0.001) affected only WT3, ADG0-3 and ADG3-6. Type of lambing had highly significant (P<0.001) effects on all traits studied except ADG3-6. The effect of SL X TL interaction on all studied traits was not significant except WT3 and ADG0-3. The linear regression coefficients of all studied traits on BWT were positive and significant (P<0.05, 0.01or 0.001), meanwhile the quadratic regression coefficients were not significant except for ADG0-6 (P<0.05) and ADG3-6 (P<0.001) the coefficients were negative and significant. The proportions of sire variance components (δ2s) for all studied traits were 8.04 to 11.94%. Heritability estimates (±SE) for BWT, WT3, WT6 ADG0-3, ADG0-6 and ADG3-6 were 0.325±0.06, 0.363±0.07, 0.418±0.07, 0.383±0.07, 0.447±0.07, and 0.478±0.08, respectively. The genetic and phenotypic correlation coefficients among studied traits were high and positive (0.712 to 0.992) except between BWT and other traits were very weak or moderate and genetically negative with all averages daily gain (0.008 to -0.242) and between ADG3-6 and both ADG0-3 and WT3 were low and positive (0.122 to 0.188). Percentages of sires that had negative ETA estimates for studied growth traits were 47.6 to 54.0%. Estimates of estimating sire-transmitting ability (ETA's) as deviations from the overall means estimated using Best Linear Unbiased Predictors (BLUP) method for sires have 10 lambs at least ranged from -0.439 to 0.308, -1.684 to 2.735, -2.742 to 3.542 kg, -18.82 to 29.93, -13.76 to 19.65 and -15.46 to 31.57 g/d for BWT, WT3, WT6, ADG0-3, ADG0-6 and ADG3-6, respectively. Spearman rank correlation coefficients among values of sire transmitting abilities were generally high and positive (ranged from 0.311 to 1.00) except between BWT and each of BT3 and ADG0-3 were low (0.120 and 0.120, respectively) and between BWT and each of BT6, ADG0-6 and ADG3-6 were negative (ranged between -0.096 to -0.360). It is concluded that the traits can be improved by selection with no serious antagonisms among traits studied.

Keywords: sheep, growth rate, genetic parameters, sire evaluation, Egypt.

INTRODUCTION

The main breeding objective in the Egyptian sheep breeds and their crosses with exotic breeds is to obtain genetic improvement especially in growth traits. The total number of sheep in Egypt estimated by 4,450,000 heads (FAO, 2001). More than 90% of Egyptian livestock are raised under smallholder production systems (Metawi, 2001b). Hence, Galal *et al.* (1996) pointed out that it seems imperative that any substantial national improvement in livestock will have to come from the smallholders, at least in the short and medium terms. Rahmani sheep is one of the Egyptian purebred breeds kept mainly for meat production and has a good reputation for its adaptability to environment and more acceptable for the Egyptian consumer compared with its crossbreds with exotic breeds such as Finnsheep or Romanov.

Genetic improvement for growth traits of Rahmani sheep is major goal for sheep breeders because the efficiency of mutton production depends primarily upon growth of lambs. Growth of lamb, indicated by body weights and rate of gain at different phases of growth among the most economically important and easily measured traits. Accordingly, genetic and phenotypic parameters for economic traits should be appraised regularly to enable breeders to determine the breeding tools of choice for genetic evaluation and selection, for planning efficient breeding programmes and for predicting response to selection. This response can be predicted a priori by using estimates of genetic and phenotypic relationships between all traits of economic importance. On the other hand, the effective way to increase meat output or achieve rapid growth and heavy market weight for lambs is by using tested sires.

In spite of there is a few number of recent studies have reported the performance of Rahmani sheep and their crosses with Finnsheep or Romanov (e.g. Elshennawy *et al.*, 1998 and Metawi, 2001 a&b). There is an extreme paucity of information regarding the recent evaluation for genetic parameters of growth traits of Egyptian Rahmani purebred lambs and sire evaluation. Hence, these parameters were included into our consideration. The purpose of this study was to investigate some environmental sources of variation influencing six growth traits in a governmental flock of Rahmani sheep at various stages of growth, from birth to 6 months of age as well as sires evaluation.

MATERIALS AND METHODS

Date on 2417 Egyptian Rahmani lambs progeny of 114 sires (the average number of lambs per sire was 19.01) collected over a 11-years period (1989 to 1999) from El-Serw Experimental Research Station, Animal Production Research Institute, Ministry of Agriculture were used in this study. The farm located at the eastern north part of the Delta (about 20 km south of Damietta city), Egypt.

Management of the Flock: Lambs were nursed by their dams up to weaning at 8 weeks of age. Each lamb record included sire, dam and lamb identifications, type of birth and sex. Lambs were weighed within 24 hours after birth and monthly thereafter until 18 months of age. Three seasons of birth were defined based on the monthly lambing distribution. The breeding system applied in this farm was three lambing seasons per two years (in January, September, and May). The flock was compelled to the schedule applied under the feeding and management system of Animal Production Research Institute (APRI). The feed was offered twice daily at 7 a.m. and 4 p.m. where the ewes were classified to groups according to their body weights. From December to May, the flocks grazed on Egyptian clover (*Trifolium alexandrinum*), from June to November ewes were fed on crops stubbles and green fodder when available in addition to concentrate mixture, clover hay and rice straw. The concentrate mixture consists of 25% undecorticated cotton seed, 17% yellow corn, 11% soybean meal, 15% rice bran, 25% wheat bran 3% molasses, 2.5% limestone and 1.5% salt. Two weeks before the beginning of mating season and during the last 2-4 weeks of pregnancy, 0.25 kg concentrate mixture supplement were fed each ewe/day.

Statistical analysis: The absolute rate of gain for each lamb was calculated over three growth periods namely: Birth to 3 month (ADG0-3), birth to six months (ADG0-6) and three to six months (ADG3-6). These, together with the body weights at birth (BWT), 3 month (BT3) and 6 months (BT6) of age, constitute the six lamb growth traits analyzed in this study. The absolute average daily gain was derived by taking the difference in weight within the period and dividing it by the time interval in days. Data were statistically analyzed utilizing the least squares mixed model and maximum likelihood (LSMLMW) computer program of Harvey (1990). The fixed effects (beside the sire of the lamb as random effect) fitted included year of birth (11 years from 1989 to 1999), season of birth (January, May and September), Type of lambing (TL) (single and twin), sex of lamb (SL) (male and female) and interaction between TL X SL. The statistical model used to relate observations (lamb growth traits) with independent variables (the random and fixed effects) was as follows:

$Y_{ijklmn} = U + S_i + Yr_j + Se_k + T_l + F_m + TF_{lm} + e_{ijklmn}$ where:

Y_{ijklmn}=the individual's animal observation in relation to independent variables,

U = the overall mean of the trait in the population,

S_i = effect of the th sire (i= 1, 2, ..., 114), assumed random effect,

Yr_j = effect of the j^{th} year of birth (j = 1, 2, ... 11), 1=1989, ..., 11=1999,

Se_k = effect of the k^{th} season of birth (k= 1, 2, 3), 1= Jan., 2=May, 3=Sep.,

T_l = effect of the l^{th} type of lambing (1=single, 2=twins)

F_m = effect of the m^{th} sex of lamb (1 =male, 2=female),

TF_{lm} =the first degree interaction effect of l^{th} lambing type and m^{th} sex of lamb

e_{ijlkmn} = random error associated with the $ijklmn^{th}$ observation with mean = 0 and variance $\delta 2$ e.

Birth weight (BWT) of lamb was included in the previous mixed model as linear and quadratic covariate when analyzing all traits except BWT. Heritability estimates were computed by the method of paternal half-sib analysis according the formula: $h^2 = 4\ \delta^2\ s\ /\ (\delta^2\ s + \delta^2\ e)$, where: h^2 = heritability estimate, $\delta^2\ s$ = sire variance components and $\delta^2\ e$ = variance of records within sires (error variance components). Genetic and phenotypic parameters estimated included heritability estimates (along with standard errors) of each trait, and genetic (along with standard errors), phenotypic and environmental correlation coefficients among these traits as traits of the lamb were computed according to the formulas described by Harvey (1990) using computer program (LSMLMW) of Harvey (1990).

Estimation of sire transmitting ability (ETA's): The transmitting abilities of sires with at least ten lambs were examined. The total number of sires used in estimation of ETA's was only 63 sires. Sire-transmitting ability for different traits studied was estimated by Best Linear Unbiased Prediction method (BLUP). One set of cross-classified non-interacting random effect (sire) is absorbed according to Harvey (1990) where BLUP estimates for random sire effects absorbed by maximum likelihood were obtained.

RESULTS AND DISCUSSIN

Lambs growth performance:

Least squares means (±SE) of BWT, BW3, BW6 ADG0-3, ADG0-6 and ADG3-6 were 2.97 ± 0.033, 16.6 ± 0.190, 24.4 ± 0.294 kg, 151 ± 2.10, 119 ± 1.63 and 86 ± 2.16 g/d, respectively (Table 1). Live weights and gains at all ages in the present study are fall within the ranges reported earlier by Swidan *et al.* (1979), Khattabey *et al.* (1999) and Metawi (2001a) on Rahmani lambs.

Fixed effects:

Effect of year of birth: Data presented in Table 1 show least squares means of growth traits of Rahmani lambs from birth to 6 month of age according to year of birth indicating that no clear trend in growth traits from year to year. In the same time there is a great difference in ADG (113 g/d) during the period from 3 -6 month of age, the minimum ADG in the year 1999 (16 ± 9.87 g/d) and maximum ADG in the year 1991 (129 ± 7.26 g/d). Year of birth was a significant (P<0.001) source of variation for all studied traits (Table2). The highly significant effect of year of birth on growth traits may be attributed to changes in climatic conditions, plan of nutrition and management from one year to another causing the variation in these traits.

Effect of Season of birth: The effect of season of birth was significant (P<0.001) for all traits except BWT, WT6 and ADG0-6 (Table 2). The effect of season of birth on growth traits arises from seasonal variations in the environment resulting from changes in weather conditions and consequently affects feed availability directly. Seasonal influence on a trait such as BWT operates through its effect on the dam's uterine environment mostly in late pregnancy (Eltawil *et al.*, 1970). Such factors operating in seasons prior to lambing will be clear effect on BWT. This may explain the higher (albeit non-significant) BWT of lambs (3.00 kg) born in lambing season of May where the late months of gestation (March and April) fall in the Spring season where the Egyptian clover (*Trifolium alexandrinum*) is available during this period such as is the case in this study, the favorable prenatal nutrient availability for lambs via their dams during late gestation. Such lambs would be expected to weigh more at birth compared to those whose dams under a nutritionally stressful period during gestation (in the summer season where dry feedstuffs). On the other hand, season of birth plays an important role in growth performance of lambs indirectly through its influence on the dam's nutrition during suckling period (and hence amount of milk available to the unweaned lamb) and later, directly, through its effect on the feedstuffs availability and quality on which the lamb is subsequently weaned. This effect is manifested in the present study through the highly significant ($P<0.001$) effect of season of birth on WT3, ADG0-3 and ADG3-6. In the post-weaning period, the influence of season of birth is related also to its effect on the quality and quantity of feedstuffs available to the weaned lambs. Carrillo and Segura (1993) on hair sheep in Mexico reported that season of lambing was a significant source of variation on weaning weight and ADG. In Egypt, Elshennawy *et al.* (1998) on Egyptian Rahmani and Ossimi breeds and their crosses with Finnsheep reported that season of birth had a significant effect on BWT, WW, BT4, and BT6. They added that spring born lambs were heavier at BWT, WW, BT4, BT6, and BT18.

Effect of sex of lamb (SL): Least squares means (Tables 1) indicate that male lambs performed, in all growth traits, considerably better than their female counterparts did. On average, male lambs were 0.18 (5.88%), 0.80 (4.71%) and 2.70 (10.5%) kg heavier significantly ($P<0.001$) than female lambs at BWT, BT3 and BT6, respectively and grew faster significantly ($P<0.001$) by 10 (6.41%), 15 (11.9%) and 21 (21.9%) g/d for ADG0-3, ADG0-6 and ADG3-6, respectively (Tables 1 and 2). Consistent superiority of male lambs has been widely reported (Mavrogenis and Economides, 1980; Nivsarkar *et al.*, 1981; Dias *et al.*, 1983; Fitzhugh and Bradford, 1983; Barghout and Abdel-Aziz, 1986; Carrillo and Segura, 1993). Mavrogenis and Economides (1980) found that male lambs consumed significantly more milk than females thus grew faster and had heavier weaning weight. This has been attributed also to hormonal differences between sexes and their resultant effects on growth (Bell *et al.*, 1970).

Effect of type of lambing (TL): In the present study, type of lambing (single or twin) was a significant ($P<0.001$) source of variation for all traits except ADG3-6 which was not significant (Table 2). Least squares means (Tables 1) indicate that single lambs performed considerably better than twin lambs. On average, single lambs were heavier than twin lambs at BWT, BT3 and BT6 by 0.67 (20.3%), 1.60 (6.20%) and 1.50 (5.98%) kg, respectively and grew faster by 19 (11.8%) and 7 (5.74%) g/d in ADG0-3 and ADG0-6, respectively.

Carrillo and Segura (1993) on hair sheep in Mexico reported that single born lambs were heavier than twins and triplets. Robinson *et al.* (1977) reported that for lambs in utero, as the number of foetuses increases, the number of caruncles attached to each foetus decreases, thus reducing the feed supply to the foetus and hence reduction in the birth weight of the lambs. Elshennawy *et al.* (1998) on Egyptian Rahmani and Ossimi breeds and their crosses with Finnsheep reported that single lambs were significantly heavier than twin lambs at all ages.

Effect of interaction SL and TL: The interaction of sex of lamb and type of lambing had a moderate ($P<0.05$) effect only on BT3 and ADG0-3 (Table 2). Generally, in all traits (except ADG3-6) in the present study single born and male lambs were heavier in weights and grew faster than twin born and female lambs (Table 1). It would seem that birth type effects are commonly observed mainly because of competition for the limited supply of ewe milk. This is supported by Barghout and Abdel-Aziz (1986) who found a strong relationship ($P<0.01$) between the milk production of both the Turkish and Barki ewes and weaning weight and preweaning growth rate of their lambs. In the same trend, Norton and Banda (1993) found no differences in growth between single and twin born kids when subjected to artificial rearing of the kids.

Effect of birth weight: The relationship between BWT of lambs and their body weights and gains up to 6 month of age are shown in Tables 1 and 2. All linear regression coefficients of BT3, BT6, ADG0-3, ADG0-6 and ADG3-6 on BWT were significant and positive (1.30 ± 0.098, 1.50 ± 0.141 kg/kg, 3.44 ± 1.08, 2.77 ± 0.782, 2.13 ± 1.00, g/d per kg BWT, respectively). Meanwhile, the quadratic regression coefficients were not significant and positive except the regressions of ADG0-6 and ADG3-6 on BWT were significant and negative (-0.908 ± 0.47 and -1.99 ± 0.604 g/d per kg BWT, respectively) and regression of BT6 on BWT was not significant and negative. Barghout and Abdel-Aziz (1986) reported that the regression of preweaning daily gain and weaning weight of lambs on their BWT were 1.845 g and 1.129 kg, respectively. The heavier lambs at birth stimulate higher milk yield by more frequent and vigorous suckling thus grow faster and weigh heavier at weaning (Owen, 1976).

Sire effect:

The least squares analysis of variance for effect of sire of the lamb on growth traits are given in Table 2. The partitioning and proportions of the variance components due to sire are shown in Table 3. The proportions of sire variance components (δ2s) for all studied traits were 8.04 to 11.94%. Data given in Table 4 show that sire variance components increased with advancing of age, for body weights increased from 8.04% at birth to 11.4% at six months and for growth rate increased from 9.58% for ADG0-3 to 11.9% for ADG3-6, indicating that preweaning growth differences are expected to be more reflective of maternal traits, such as milk production, than sire effects. Differences in postweaning performance would most accurately reflect the genetic contribution from the sire. The highly significant effect ($P<0.001$) of

Table 1: Least squares means (± SE) of body weights and average daily gains of Rahmani lambs at different ages.

Classification	Np.	Live body weights (kg)			Average daily gain (g)		
		BWT	WT3	WT6	ADG0-3	ADG0-6	ADG3–6
Overall mean	2417	2.97 ± 0.033	16.6 ± 0.190	24.4 ± 0.294	151 ± 2.10	119 ± 1.63	86 ± 2.16
Year of birth:							
1989	224	2.43 ± 0.173	11.4 ± 0.815	22.2 ±1.170	96 ± 9.03	106 ± 6.55	117 ± 8.44
1990	360	2.39 ± 0.145	15.4 ± 0.687	24.1 ± 0.996	138 ± 7.61	117 ± 5.53	97 ± 7.13
1991	87	3.12 ± 0.149	15.2 ± 0.699	26.8 ± 1.013	136 ± 7.75	132 ± 5.63	129 ± 7.26
1992	247	3.11 ± 0.111	17.2 ± 0.525	25.0 ± 0.765	158 ± 5.82	122 ± 4.29	87 ± 5.48
1993	137	2.92 ± 0.109	15.9 ± 0.519	24.0 ± 0.756	143 ± 5.75	116 ± 4.20	90 ± 5.42
1994	287	3.35 ± 0.089	17.6 ± 0.432	26.7 ± 0.632	162 ± 4.79	131 ± 3.51	101 ± 4.54
1995	242	2.95 ± 0.095	15.4 ± 0.454	25.9 ± 0.663	139 ± 5.03	127 ± 3.69	116 ± 4.76
1996	282	3.37 ± 0.106	17.7 ± 0.506	24.3 ± 0.737	163 ± 5.61	118 ± 4.10	74 ± 5.29
1997	214	3.08 ± 0.133	17.6 ± 0.626	22.7 ± 0.909	161 ± 6.94	109 ± 5.04	57 ± 6.51
1998	209	3.00 ± 0.152	18.5 ± 0.713	24.1 ± 1.034	173 ± 7.90	117 ± 5.74	62 ± 7.40
1999	128	2.91 ± 0.204	20.6 ± 0.955	22.1 ± 1.380	195 ± 10.6	106 ± 7.67	16 ± 9.87
Season of birth:							
January	1030	2.97 ± 0.042	16.3 ± 0.224	24.3 ± 0.341	147 ± 2.48	118 ± 1.90	89 ± 2.49
May	663	3.00 ± 0.045	17.6 ± 0.234	24.5 ± 0.354	163 ± 2.59	119 ± 1.97	76 ± 2.58
September	724	2.93 ± 0.045	15.9 ± 0.236	24.2 ± 0.358	143 ± 2.61	118 ± 1.99	92 ± 2.60
Sex of lamb (SL):							
Male	1097	3.06 ± 0.037	17.0 ± 0.202	25.7 ± 0.311	156 ± 2.36	126 ± 1.73	96 ± 2.28
Female	1320	2.88 ± 0.036	16.2 ± 0.199	23.0 ± 0.307	146 ± 2.19	111 ± 1.70	75 ± 2.25
Type of lambing (TL):							
Single	1520	3.30 ± 0.035	17.4 ± 0.197	25.1 ± 0.305	161 ± 2.18	122 ± 1.69	84 ± 2.23
Twin	897	2.63 ± 0.038	15.8 ± 0.211	23.6 ± 0.323	142 ± 2.33	115 ± 1.80	87 ± 2.36
(SL) x (TL) interaction:							
Male-single	648	3.39 ± 0.040	18.0 ± 0.220	26.5 ± 0.336	165 ± 2.44	131 ± 1.87	94 ± 2.45
Male-twin	449	2.71 ± 0.044	16.1 ± 0.233	25.0 ± 0.353	145 ± 2.57	122 ± 1.96	99 ± 2.57
Female- single	872	3.20 ± 0.038	16.9 ± 0.206	23.6 ± 0.317	154 ± 2.28	114 ± 1.76	75 ± 2.32
Female-twin	448	2.55 ± 0.044	15.5 ± 0.236	22.3 ± 0.357	139 ± 2.61	107 ± 1.99	76 ± 2.60
Regression on BWT:							
Linear		--------	1.30 ± 0.098	1.50 ± 0.141	3.44 ± 1.08	2.77 ± 0.782	2.13 ±1.00
Quadratic		--------	0.015 ± 0.059	-0.164 ± 0.09	0.123 ± 0.650	-0.908 ± 0.47	-1.99 ± 0.604

Table 2: Least squares analysis of variance for factors affecting live body weights and averages daily gain of Rahmani lambs at different ages.

Source of variation	d.f +	M.S and significant ++					
		Live body weights (kg) at:			Average daily gain (g) from:		
		BWT	WT3	WT6	ADG0-3	ADG0-6	ADG3–6
Sire	113	1.11 ***	27.1 ***	63.7 ***	3317 ***	1967 ***	3404 ***
Year of birth	10	6.59 ***	143.7 ***	145.8 ***	17088 ***	4461 ***	25185 ***
Season of birth	2	0.45 NS	262.4 ***	7.28 NS	32848 ***	224 NS	22496 ***
Sex of birth (SL)	1	17.3 ***	400.3 ***	3954 ***	48196 ***	121962 ***	228565 ***
Type of lambing (TL)	1	202.1 ***	1081.8 ***	756.3 ***	132411 ***	23346 ***	3140 NS
(SL) x (TL)	1	0.13 NS	39.4 *	11.5 NS	5050 *	361 NS	1027 NS
Regression on BWT:							
Linear	1	-----	1576 ***	2098 ***	11039 **	7128 ***	4199 *
Quadratic	1	-----	0.613 NS	69.3 NS	39 NS	2125 *	10243 ***
Remainder	2288	0.412	8.874	18.4	1090	569	940

For abbreviations, see Table 1.
\+ d.f of remainder for birth weight is 2286., ++ *** $P<0.001$; ** $P<0.01$; * $P<0.05$.

sire of lamb on all studied growth traits suggesting that genetic improvement through the selection of rams for high live body weights as well as rapid pre- and postweaning average daily gain may be a key resource producers need to increase their economic income from lamb production systems.

Table 3: Estimation of sire variance components ($\sigma^2 s$) and error variance components ($\sigma^2 e$)* and proportion of variance (V %) due to random effect (sire) for different studied traits.

Trait **	Sire		Error	
	($\sigma^2 s$)	(V%)	$\sigma^2 e$	(V %)
Birth weight	0.036	8.04	0.412	91.96
Weight at 3-months of age	0.956	9.08	9.57	90.92
Weight at 6-months of age	2.25	10.44	19.3	89.56
ADG from birth to 3 months	115.9	9.58	1094	90.42
ADG from birth to 6 months	71.97	11.18	572.0	88.82
ADG from 3 – 6 months	128.1	11.94	944.4	88.06

* d.f of sires and error components were 239 and 1418, respectively.
**ADG = average daily weight gain.

Genetic parameters:

Heritabilities: Heritability estimates (± SE) of BWT, BT3 and BT6 were found to be 0.325 ± 0.06, 0.363 ± 0.07 and 0.418 ± 0.07, respectively. (Table 4). The medium heritability estimates reported in the present study fall within the range reported in the literature. According to the review by Fogarty (1995), the range of heritability estimates in different sheep breeds for BWT were 0.02 to 0.45, for weaning weight (2-5 months) were 0.03 to 0.57 and for postweaning weight (up to 9 months of age) were 0.03 to 0.49 . Heritability estimates (± SE) of ADG0-3, ADG0-6 and ADG3-6 were found to be 0.383±0.07, 0.447±0.07, and 0.478±0.08, respectively (Table 4). It should be noted that lower heritability estimates for lamb growth traits were reported by other others. For instance, Wolf *et al.* (1981), for lambs of mutton breeds and hybrids, showed heritability within the range from 0.02 for weight at the age of 4 weeks to 0.05 for weight at 8 weeks. Croston *et al.* (1983) for Suffolk ram lambs found heritabilities from 0.02 (weight at 4 weeks) to 0.20 for weight at the age of 124 days. Waldron *et al.* (1990) reported heritabilities of 0.07, 0.22 and 0.33 for gains from birth to 60 days, from birth to 120 days and from 60 to 120 days, respectively. Carrillo and Segura (1993) on hair sheep in Mexico who reported that heritabilities of BWT, weaning weight and ADG for Pelibuey breed were 0.16±0.04, 0.12±0.03 and 0.11±0.03, respectively and 0.04±0.07,, 0.17±0.09 and 0.15±0.08 for Barbados Blackbelly breed, respectively. Maria *et al.* (1993) for Romanov sheep lambs, where the estimated direct heritabilities ranged from 0.04 for BWT to 0.26 for weight gains up to 40 days. Jurado *et al.* (1994) studied growth traits in a Spanish Merino flock, found that heritabilities of BWT, WWT (30 d) preweaning daily gain, postweaning daily gain, and weight at 90 d, respectively, were 0.13, 0.09, 0.03, 0.15, and 0.11 . Olesen *et al.* (1995) found that direct heritability of weaning weight of the Norwegian breed lambs was 0.13. Shrestha *et al.* (1996) obtained heritabilities of 0.25 and 0.35 for BWT and weight at 91 days, respectively. Mousa *et al.* (1999) working on crosses of Columbia rams to Hampshire x Suffolk ewes found that estimates of direct heritability were 0.09 and 0.09 for BWT, WWT (7 weeks), respectively. Gut *et al.* (2001) on White-headed Mutton sheep in Poland found that direct heritability estimates for growth traits ranged from 0.0042 for ADG from 1-28 days of age to 0.1734 for BWT. In contrast, results obtained by Olson *et al.* (1976) and Mavrogenis *et al.* (1980) were higher than those presented above. They found that heritability of ADG from 14 to 22 and from weaning to 20 weeks of age were 0.46 and 0.56, respectively. Missohou *et al.* (1993) also found that heritability estimates were 0.50±0.14 for BWT, 0.52±0.15 for one-month weight, 0.71±0.18 for weaning, 0.44±0.13 for gain from birth to one month and 0.60±0.16 for gain from birth to weaning which were higher than those reported in the present study. It is worthy to mention that the values of heritability cited from the literature for the same trait may differ according to the used method for estimation where sire and dam models (e.g. paternal half sibs or regressions... etc.) ignoring existing relationships between parents compared with the animal model (Gut *et al.*, 2001).

As a result of increasing sire variance components with advancing in age for body weights and growth rates reported in the present study (Table 3), also the obtained heritability estimates had the same trend (Table 4). Heritability estimates progressively increased from 0.325±0.06 for BWT to 0.418±0.07 for BT6 and from 0.383±0.07 for ADG0-3 to 0.478±0.08 for ADG3-6. Similar trend also was found by Nasholm and Danell (1996) using Swedish fine wool sheep. They estimated genetic parameters for weights of lambs from birth to 1 day before slaughter and reported that Direct heritabilities increased with lamb age from 0.07 for birth weight to 0.21 for weight before slaughter and for daily gain during shorter periods, direct heritability increased from 0.07 for the period from birth until 3 wk of age to 0.14 for the period from weaning until 1 d before slaughter. The moderately higher heritability estimates for 6 months live weight and gain in this study indicate that to select lambs for their own genetic merit for weights and gains, it would be best to use body weight at 6 months of age as the selection criterion rather than weaning weight. The 6 months live weight gain should be superior to weaning weight and pre-weaning growth rate since it is much less influenced by maternal effects. It is clear from these and other results that post-weaning growth generally has higher heritability estimates than pre-weaning growth. This would indicate that environmental factors had more influence on early lamb gain than on gains later in the lamb's life. This may be attributed to the high maternal influence associated with lamb growth performance early in life. High maternal influence has a tendency to increase the component of variance environmental to the lamb thereby lowering heritability estimates (Thrift *et al.*, 1973). In this respect, wolf *et al.* (1981) concluded that the estimates of heritability of BWT and early growth rate generally low to medium, which is usually attributed to the importance of variation in dam effects, especially in milk production and to competition between littermates. So, the heritability estimates tend to increase with age. Another explanation also that should not be excluded herein for the causes of increasing heritabilities of body weights and growth rates with advancing in age was given by Shrestha and Heaney (1987) who mentioned that the low estimates of heritability of early growth rate (e.g. up to 70 days) may be due to absence of controlled environment and uniform condition and large differences in solid feed intake following initial restricted milk feeding before weaning. Hence, it is generally believed that more progress in WWT or gain can be made by selection on post-weaning weights and gains than on preweaning weights and gains.

Genetic and phenotypic correlations: Genetic, phenotypic and environmental correlations among growth traits at various ages are presented in Table 4. The correlation coefficients among growth rates and various weights and among growth rates themselves ranged from very low and negative to high and positive. Additionally, all phenotypic correlations among weights and gains were all positive and generally high and the correlations mostly tended to decrease as the time interval separating the observed weights or gains increased. The genetic correlation between BWT and BT3 was low and positive (0.121 ± 0.144), indicating some expected correlated response. Similar results were found by Mavrogenis *et al.* (1980) who reported that BWT had low genetic correlations (0.16 – 0.21) with all weights (weaning, 5, 10, 15, and 20 weeks) and gains (from birth to weaning and from weaning to 20 weeks). Meanwhile Stobart *et al.* (1986) reported higher genetic correlation estimates than that obtained in the present study between BWT and both weaning weight (0.22±0.25) and various growth rates (0.68±0.20). The genetic correlation between BT3 and BT6 was 0.739 ± 0.063, and between BT3 and ADG0-6 was 0.712 ± 0.07 . The high and positive genetic correlation between the two traits suggests that selection-for any one of the two traits would result in considerable positive change in other trait. One could concentrate on traits with high heritability as long as there exist a high positive correlation with other traits of economic value. Meanwhile, the genetic correlations between BWT and each of WT6, ADG0-3, ADG0-6 and ADG3-6 were low and negative (-0.074 ± 0.142, -0.058 ± 0.145, -0.200 ± 0.138, -0.242 ± 0.135, respectively). Such negative estimates (although low) could be explained by the effect of compensatory growth obscuring underlying genetic relationships. It seems logical to suggest, in general, that the low negative correlations which appear between BWT and each of WT6, ADG0-3, ADG0-6 and ADG3-6 are consequences of compensatory growth and not antagonistic as such.

The estimates of genetic correlation (Table 4) show no genetic antagonisms between BWT and BT3, between BT3 and BT6 and among gains at different ages studied. There is, therefore, potential for exploiting correlated response for most of these traits. Moreover, selection directed towards weights at later age (6 months) would minimize response in BWT and decrease dystocia, which may result due to selection for increased BWT. In other words, the low and negative genetic correlations between BWT and other traits are of considerable importance since BWT, as a correlated trait could not pose any serious problem of increasing lamb difficulties.

Table 4: Genetic parameters of live body weights and average daily gains for Rahmani lambs.

Trait	BWT	WT3	WT6	ADG0-3	ADG0-6	ADG3–6
BWT	0.325 ± 0.06	0.258 (0.330)	0.188 (0.343)	0.056 (0.119)	0.044 (0.196)	0.008 (0.175)
WT3	0.121 ± 0.144	0.363 ± 0.07	0.771 (0.794)	0.979 (0.976)	0.747 (0.774)	0.119 (0.110)
WT6	-0.074 ± 0.142	0.739 ± 0.063	0.418 ± 0.07	0.758 (0.758)	0.989 (0.988)	0.720 (0.685)
ADG0–3	-0.058 ± 0.145	0.984 ± 0.005	0.760 ± 0.06	0.383 ± 0.07	0.763 (0.771)	0.122 (0.077)
ADG0–6	-0.200 ± 0.138	0.712 ± 0.07	0.992 ± 0.002	0.756 ± 0.06	0.447 ± 0.07	0.731 (0.688)
ADG3–6	-0.242 ± 0.135	0.133 ± 0.14	0.767 ± 0.06	0.183 ± 0.132	0.782 ± 0.05	0.478 ± 0.08

+ Heritability estimates ±SE (on diagonal), genetic ± SE (below diagonal), phenotypic (above diagonal) and environmental (between parentheses) correlations among studied traits.
For abbreviations, see Table 1.

Comparing our results with those in the literature, Maria *et al.* (1993) working on Romanov Sheep analyzed birth weight (BWT), weaning weight (approximately 40 d) (WW), 90-d weight (W90), and daily gain for the periods birth to weaning (DG1) and weaning to 90 d (DG2). They found that estimates of genetic correlations were 0.12 (BWT with WW); 0.24 (BWT with W90); 0.48 (WW with W90); 0.69 (DG1 with DG2); -0.01 (BWT with DG1); 0.05 (BWT with DG2); 0.59 (WW with DG1); 0.47 (WW with DG2); 0.67 (W90 with DG1); and .98 (W90 with DG2). They suggested that selection should be effective for WW, DG1, and DG2 but less effective for BWT and W90. Such negative and low correlation between BWT and DG1 (-0.01) was found also in our study.

Sire transmitting ability:

The minimum, maximum and range of sire transmitting abilities for growth traits using 10 lambs or more for each ram are presented in Table 5. It could be noticed that there are large differences between the bottom and the top sires in ETA's values. The present results given in Table 5 show large genetic differences among sires for different studied traits, which accordingly reflect the high potentiality for rapid genetic progress in growth traits through selection of rams within the Rahmani sheep flocks. Concerning percentage of number of rams that had negative BLUP estimates for different studied traits (Table 5), about 47.6 to 54.0% of the rams had negative values. Selecting rams with high values than average of the flock in studied growth traits which had positive BLUP estimates, for intensive use in breeding purposes may lead to rapid genetic improvement in these traits. In the same time, by mating ewes to rams selected from the top ranking performance tested rams for growth traits, this procedure would help minimize the impact of selection errors due to the low accuracy on individual animal records.

Table 5: Minimum, maximum and range for sire transmitting ability for growth traits in Egyptian Rahmani lambs.

Trait	BLUP estimates			Negative estimates %
	Min.	Max.	Range	
Birth weight (kg)	-0.439	0.308	0.744	52.4
Weight at 3-months of age (kg)	-1.684	2.735	4.419	54.0
Weight at 6-months of age (kg)	-2.742	3.542	6.284	47.6
ADG from birth to 3 months (g)	-18.82	29.93	48.75	54.0
ADG from birth to 6 months (g)	-13.76	19.65	33.41	47.6
ADG from 3 – 6 months (g)	-15.46	31.57	47.03	52.4

Spearman rank correlation coefficients among the ETA's for studied traits are given in Table 6. The highest rank correlations among ETA's of sires were found between BT6 and ADG0-6 (1.00), BT3 and ADG0-3 (0.999), between ADG0-3 and ADG0-6 (0.836) and between BT3 and BT6 (0.829). Positive correlated response should be expected in other correlated traits due to the generally large and positive rank correlations On the other hand, rank correlation coefficients between BWT and each of BT6, ADG0-6 and ADG3-6 were negative and low (-0.096, -0.096 and -0.360, respectively) indicating that selection of rams for one trait will improve the other traits.

Table 6: Spearman rank correlation coefficients among sire transmitting abilities (ETA's) for live body weights and averages daily gain.

Trait	BWT	BT3	BT6	ADG0-3	ADG0-6
BT3	0.120				
BT6	-0.096	0.829			
ADG0-3	0.120	0.999	0.835		
ADG0-6	-0.096	0.830	1.00	0.836	
ADG3-6	-0.360	0.311	0.736	0.319	0.762

CONCLUSION

From the results of this study' it is concluded that: 1) the traits can be improved by selection with no serious antagonisms among traits studied, 2) heritabilities were large enough that selection would be effective for improving any of the studied growth traits and 3) Genetic improvement through the selection of rams for rapid pre- and post-weaning average daily gain may be a key resource producers need to meet the challenges in lamb production systems.

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تقدير المعايير الوراثية وتقييم الطلائق لصفات النمو فى الحملان الرحمانى المصرية

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استخدمت فى هذه الدراسة سجلات الأوزان لعدد ٢٤١٧ حمل رحمانى أبناء لعــدد ١١٤ طلوقــة خلال الفترة من عام ١٩٨٩ إلى ١٩٩٩. بلغ متوسط عدد الحملان لكل أب ١٩ر٠١ . استخدمت طريقــة تحليل الحد الأدنى للمربعات بنموذج احصائى احتوى على تأثير الأب (كمتغير عشوائى) وتأثير كل من سـنة الميلاد وموسم الميلاد وجنس الحمل ونوع الولادة (مفرد أو توأم) والتفاعل بيـن الجنـس ونـوع الـولادة (كمتغيرات ثابتة) على ستة صفات نمو هى: وزن الحمل عند الميلاد، ٣ ، ٦ شهور من العمر ومعدل النمـو اليومى من الميلاد حتى عمر ٣ شهور ، من الميلاد حتى عمر ٦ شهور ، من عمر ٣ – ٦ شهور. كما تـم إضافة وزن الحمل عند الميلاد الى نموذج التحليل الاحصائى (كمعامل انحدار خطى وقـوس خطـى) عنـد تحليل جميع الصفات في ماعدا وزن الحمل عند الميلاد. ويمكن تلخيص النتائج المتحصل عليها فيما يلى:

١. بلغت متوسطات الحد الأدنى للمربعات للصفات الستة سالفة الذكر كما يلى: ٩٧ر٢، ١٦,٦، ٤ر٢٤ كجم، ١٥١، ١١٩، ٨٦ جم/يوم على التوالى.

٢. كان لكل من الأب وسنة الميلاد وجنس الحمل تأثيرات عالية المعنوية (على مسـتوى ٠٠١ر٠) علـى جميع الصفات المدروسة. كما أظهر موسم الميلاد تأثيرا عالى المعنوية (على مستوى ٠٠١ر٠) علـى كل من الوزن عند عمر ٣ شهور ومعدل النمو اليومى من الميلاد حتى عمر ٣ شهور و٣ – ٦ شـهور من العمر. كان لنوع الولادة تأثيرا عالى المعنوية (على مسـتوى ٠٠١ر٠) علـى جميـع الصفـات المدروسة فيما عدا معدل النمو اليومى من ٣ – ٦ شهور من العمر. بينما لم يكن للتفاعل بيـن جنـس الحمل ونوع الولادة أى تأثير معنوى على جميع الصفات عدا الوزن عند عمر ٣ شهور ومعدل النمـو اليومى من الميلاد حتى عمر ٣ شهور. كان معامل الانحدار الخطى للصفـات المدروسـة علـى وزن الحمل عند الميلاد موجبا ومعنويا. بينما كان معاملات الانحدار القوس خطية غير معنوية فيمـا عـدا انحدار كل من معدل النمو اليومى من الميلاد حتى ٦ شهور ومن ٣ – ٦ شهور من العمر علـى وزن الحمل عند الميلاد كان سالبا ومعنويا.

٣. بلغت قيم المكافئ الوراثى ٣٢٥ر٠، ٣٦٣ر٠، ٤١٨ر٠، ٣٨٣ر٠، ٤٤٧ر٠، ٤٧٨ر٠ للصفات الستة على التوالى. كانت معظم معاملات الارتباط الوراثى والمظهرى والبيئى بين الصفات المدروسة عاليـة وموجبة (٧١٢ر٠ الى ٩٩٢ر٠) فيما عدا تلك بين وزن الميلاد والصفات الأخرى كـانت الارتباطـات ضعيفة جدا الى معتدلة وسالبة وراثيا مع جميع صفات معدلات النمو (تراوحت بيـن ٠٠٨ر٠ إلـى – ٢٤٢ر٠) وكذلك بين معدل النمو اليومى من عمر ٣–٦ شهور وكل من معدل النمو من الميلاد حتـى ٣ شهور وزن ٣ شهور كانت الارتباطات منخفضة وموجبة (١٢٢ر٠ الى ١٨٨ر٠).

٤. قدرت قيم المقدرة العبورية للطلائق كانحراف عن المتوسط العام للصفة بطريقة أفضل تقديـر خطـى غير متحيز للكباش التي توفر لها عشرة حملان فأكثر (٦٣ كبش) وقد تراوحت قيم المقدرة العبورية مـا بين –٤٣٩ر٠ الى +٣٠٨ر٠، –٦٨٤ر١ الى +٧٣٥ر٢، –٧٤٢ر٢ إلى +٥٤٢ر٣ كجم –٨٢ر١٨ إلى +٩٣ر٢٩، –٧٦ر١٣ إلى +٦٥ر١٩، –٤٦ر١٥ الى +٥٧ر٣١ جم/يوم على التوالى. كما بلغت نسبة الكباش التى تحمل قيم عبورية سالبة بالنسبة للعدد الكلى للكباش ٦ر٤٧ إلى ٥٤ر٠% لجميع الصفـات. كانت قيم معامل ارتباط الرتب لبيرسون بين قيم المقدرة العبورية للطلائـق لجميـع الصفـات عاليـة وموجبة (٣١١ر٠ الى ٠ر١) فيما عدا الارتباطات بين وزن الميلاد وكل من وزن ٣ شـهور ومعـدل النمو اليومى من الميلاد حتى ٣ شهور كانت منخفضة (١٢٠ر٠، ١٢٠ر. على التوالى) وكذلـك بيـن وزن الميلاد وكل من وزن ٦ شهور ومعدل النمو اليومى من الميلاد حتى ٦ شـهور و٣ – ٦ شـهور كانت معاملات الارتباط سالبة (– ٠٩٦ر٠ الى – ٣٦٠ر٠).

يستخلص من هذه الدراسة:١– يمكن عن طريق الانتخاب تحسين صفات النمو المدروسة دون أن يكون هناك تضاد فيما بينها ٢– ارتفاع قيم المكافى الوراثى يساهم فى رفع كفاءة التحسـين الوراثـى المتحصـل عليـه بالانتخاب للصفات المدروسة ٣– الانتخاب بين الكباش المختبرة لصفات معدل النمو العالى قبل وبعد الفطـام يمكن أن يساعد المربين بدرجة فعالة فى رفع الكفاءة الإنتاجية لنظم إنتاج الحملان.