



## GENETIC IMPROVEMENT OF SOME PRODUCTIVE TRAITS IN ZARAIBI GOATS

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### ABSTRACT

The objective of this study was to evaluate the genetic improvement in Zaraibi goats herd raised on El-serw research station located in the north eastern part of Nile Delta, Egypt. The station belongs to Animal Production Research Institute (APRI). Some body weights at different ages were included in genetic and environmental trends. These weights were 4-month weight (4M), 6-month weight (6M), and 12-month weight (12M). Data and pedigree information were collected from 1988 until 2018. The least square means of body weights at 4M, 6M and 12M were  $12.14 \pm 0.02$ ,  $15.49 \pm 0.02$  and  $24.08 \pm 0.04$  kg, respectively. Year of birth, season, gender of kid, parity of dam and type of birth significantly ( $P < 0.01$ ) affect growth traits. Genetic parameters were estimated using a multi-trait animal model program (MTDFREML). The same previous fixed effects were included in this analysis regarding the animal as random effects. The heritability of the studied body weights tend to increase as age increases. That is inversely matched with the environmental proportion of total variance which was found to be 0.72, 0.66 and 0.62 for M4, M6 and M12, respectively. The heritability value was estimated as 0.28 for 4M.

Genetic trends were obtained as the regression of the predicted breeding values on years of birth and Environmental trends were obtained as the regression of year constants on years of birth.

The annual genetic change trends were positive and significant for 4M, 6M and 12M (0.091, 0.121 and 0.158 kg/year, respectively) and the annual phenotypic change trends were (0.020, 0.045, 0.117 kg/year, respectively). Genetic trends for M12 trait were higher than those for other traits in this

study. Genetic and environment correlations between 4 month body weight and other growth traits were positive. Negative environmental trends indicates poor management system for the flock during studied period. Weight at 12 months of age has the highest heritability in studied body weights and suggested to be selection criteria to improve yearling weight for Zaraibi goat.

**Keywords:** Genetic trend, Growth, Zaraibi, Selection

### INTRODUCTION

Genetic improvement programmers have focused on increasing various economically important traits for higher productivity. Usually in developed countries, goats are considered, as specialty or exotic livestock, whereas in the developing countries, especially those in south-East Asia and Africa goats constitute the major source of meat production (Dhanda et al 2003). Goats are an important source of meat in Egypt and contribute about 5% of all the red meat production (Galal et al 2005). Zaraibi goat considered the main breed dominates under the harsh conditions and food shortage prevailed in the north western coast of Egypt. Genetic trends in production traits are important in that they allow for the evaluation of the efficacy of selection and management schemes. Many studies have examined genetic trend using regression of estimated breeding values on time (Powell et al 1977; Lee et al 1985). Thus, the present study aimed to evaluate the breeding plan and determine the phenotypic trends, and divide it into its genetic and environmental components.



Zaraibi doe (Galal et al 2005)



Zaraibi buck (Galal et al 2005)

## MATERIALS AND METHODS

### Data and herd management

This study was carried out on Zaraibi goats herd kept in El-serw experimental station located in the north eastern part of Nile Delta, Egypt. The station belongs to Animal production Research Institute (APRI), Agriculture Research Center, Ministry of Agriculture.

Data were collected from 1988 to 2018 on 13062 Zaraibi kids progeny of 253 sires and 1447 dams. Measurements were taken on body weight at four month (4M), six month (6M) and twelve month (12M) of age. Kids Weighted within 24 hours after kidding and weighted monthly till 18 months of age. Kids were housed in semi-open and fed on Egyptian clover (*Trifolium alexandrinum*) from December to May. For the rest of the year they fed on rice straw and green fodder, if available, as supplement to concentrate mixture. Does were mated with bucks by natural mating. Bucks were selected from the flock based on body weight at 4 months and at later stage are selected for body weight at 12 month. Mating period lasted for 45 days.

### Statistical analysis

Data were analyzed using the General Linear Model procedures of the Statistical Analysis System (SAS, 2004). The fixed effects considered were gender of kid, type of birth, parity of doe, season of kidding, year of kidding and interaction between (type of birth and parity of dam), (season of birth and parity of dam), (gender and parity of dam), (gender and season of birth), (gender and type of birth), (type of birth and season of birth), (gender and year of birth). The assumed model was:

$$Y_{ijklmn} = \mu + A_i + P_j + S_k + G_l + T_m + (TP)_{mj} + (SP)_{pj} + (GP)_{ij} + (GS)_{lk} + (GT)_{lm} + (TS)_{mk} + (GA)_{li} + e_{ijklmn},$$

Model I

$Y_{ijklmn}$  the growth of the  $n^{\text{th}}$  kids of the  $i^{\text{th}}$  year of birth,  $j^{\text{th}}$  parity of dam,  $k^{\text{th}}$  season of birth,  $l^{\text{th}}$  gender and  $m^{\text{th}}$  type of birth;

$\mu$  is the overall mean;

$A_i$  is the effect of  $i^{\text{th}}$  year of birth,  $i = 1984, 1985 \dots 2018$ ;

$P_j$  is the effect of  $j^{\text{th}}$  parity of dam,  $j=1, 2, \dots \geq 5$ ;

$S_k$  is the effect of  $k^{\text{th}}$  season of birth,  $k=1$  for January, February, March, April and May,  $k=2$  for August, September, October, November and December, respectively;

$G_l$  is the effect of  $l^{\text{th}}$  gender, 1 and 2 for male and female, respectively;

$T_m$  the effect of  $m^{\text{th}}$  type of birth,  $m=1, 2$  and 3 for single, twice and triplet or more;

$e_{ijklmn}$  random residual associated with the  $n^{\text{th}}$  individual assumed normally distributed with  $(0, \sigma^2_e)$ .

Genetic parameters for the studied traits were also estimated. Multiple traits animal model (MTDFREML) proposed by **Boldman et al (1993)** was used to estimate the heritability, genetic and phenotypic parameters. The same previous fixed effects were included in this analysis in addition to the animal as random effects. The following linear model was used:

$$Y = X\beta + Z_a a + e,$$

where,

$Y$  = is N vector of observations of 4M, 6M and 12M;  
 $X$  = is the incidence matrix for fixed effects including year of birth, parity of dam, season of birth, gender and type of birth;

$\beta$  = is the vector including the overall mean and the fixed effects;

$Z_a$  = is the incidence matrix for random effects;

$a$  = is the vector of direct genetic effect of animal assuming.

$V(a) = \sigma^2_a$ , considering the relationship among all animals;

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

The animal predicted breeding values (EBVs) were predicted from the previous analysis.

Genetic trends were obtained as the regression of the predicted breeding values on years of birth and environmental trends were obtained as the regression of year constants on years of birth.

## RESULTS AND DISCUSSION

### Growth traits

Least square means and standard error (SE) of different growth traits are shown in **Table (2)**. The average of 4M, 6M and 12M months of weight were  $12.14 \pm 0.02$ ,  $15.49 \pm 0.02$  and  $24.08 \pm 0.04$  kg, respectively. The growth traits were significant ( $P < 0.01$ ).

**Mekkawy (2000)** reported that the weights of Zaraibi kids are 11.64 kg at 4 months, 14.17kg at 6 months and 22.73 at 12 month. 6M averaged  $15.49 \pm 0.02$  Kg, agreement with **Aboul-naga et al (2012)** and **Hamed (2010)** estimates. **Table (2)** reveal that males had significantly heavier body weights compared with females for all studied body weights, it agrees with **Hamed (2010)** result.

**Table 1.** Analysis of variance for body weights at 120 days, 4M; 180 days, 6M and 360 days, 12M in Zaraibi goats

S.O.V	4M			6M			12M		
	D.f.	M.S.	pr	D.f.	M.S.	pr	D.F.	M.S.	pr
Gender	1	3045.62	0.01	1	3775.97	0.01	1	4568.01	0.01
Type of birth (TB)	2	2491.01	0.01	2	1545.95	0.01	2	377.59	0.01
Season (S)	1	319.41	0.01	1	642.18	0.01	1	618.95	0.01
Year of birth	30	677.80	0.01	30	1121.60	0.01	30	761.87	0.01
Parity (P)	4	140.82	0.01	4	146.72	0.01	4	80.71	0.01
TB*P	8	14.29	0.01	8	22.55	0.01	8	8.85	0.52
S*P	4	44.81	0.01	4	38.86	0.01	4	52.70	0.01
G*P	4	9.89	0.15	4	8.25	0.36	4	23.47	0.05
G*S	1	9.25	0.21	1	13.59	0.18	1	23.33	0.12
G*TB	2	14.98	0.08	2	20.27	0.07	2	3.89	0.67
TB*S	2	16.04	0.06	2	13.00	0.18	2	8.96	0.40
G*year	30	24.43	0.01	30	64.21	0.01	30	108.17	0.01
<b>Residual</b>	<b>10847</b>	<b>5.95</b>		<b>9623</b>	<b>7.66</b>		<b>4854</b>	<b>10.011</b>	
<b>Cv %</b>		<b>20</b>			<b>17.9</b>			<b>13.17</b>	
<b>R<sup>2</sup></b>		<b>0.34</b>			<b>0.39</b>			<b>0.48</b>	

CV = coefficient of variation, R<sup>2</sup> = coefficient of determination and pr = probability of type I error.

(Pr > .05) is not significant, (pr ≤ .05) is significant, (pr ≤ 0.01) is highly significant

**Table 2.** Least square means (LSM) and their standard errors (SE), for weights at 4-month (4M), 6-month weight (6M) and 12-month weight (12M)

Items	4M, Kg		6M, Kg		12M, Kg	
	NO	LSM±SE	NO	LSM±SE	NO	LSM±SE
<b>Over all mean</b>	10937	12.14±0.02	9713	15.49±0.02	4944	24.08±0.04
<b>Season of birth;</b>						
<b>Season1</b>	6724	12.64 <sup>a</sup> ±0.05	3861	15.99 <sup>a</sup> ±0.06	1883	24.40 <sup>b</sup> ±0.11
<b>Season2</b>	4213	12.06 <sup>b</sup> ±0.06	5852	15.10 <sup>a</sup> ±0.07	3061	25.84 <sup>a</sup> ±0.15
<b>Gender;</b>						
<b>Male</b>	5764	13.18 <sup>a</sup> ±0.05	4958	16.54 <sup>a</sup> ±0.06	1728	27.03 <sup>a</sup> ±0.15
<b>Female</b>	5173	11.52 <sup>b</sup> ±0.05	4755	14.55 <sup>b</sup> ±0.06	3216	23.21 <sup>b</sup> ±0.11
<b>Type of birth;</b>						
<b>Single</b>	796	13.75 <sup>a</sup> ±0.11	677	16.68 <sup>a</sup> ±0.13	251	26.03 <sup>b</sup> ±0.28
<b>Twin</b>	6271	12.29 <sup>b</sup> ±0.03	5580	15.53 <sup>b</sup> ±0.04	2721	25.08 <sup>ab</sup> ±0.08
<b>≥ Triplet</b>	3870	11.01 <sup>c</sup> ±0.04	3456	14.43 <sup>c</sup> ±0.05	1972	24.25 <sup>a</sup> ±0.08
<b>Parity;</b>						
<b>1</b>	3352	11.77 <sup>c</sup> ±0.05	2932	14.91 <sup>c</sup> ±0.07	1343	24.44 <sup>c</sup> ±0.13
<b>2</b>	2748	12.38 <sup>b</sup> ±0.06	2430	15.67 <sup>b</sup> ±0.08	1224	25.47 <sup>b</sup> ±0.15
<b>3</b>	2076	12.37 <sup>b</sup> ±0.09	1893	15.65 <sup>b</sup> ±0.11	1017	25.28 <sup>b</sup> ±0.20
<b>4</b>	1309	12.62 <sup>a</sup> ±0.11	1172	15.78 <sup>a</sup> ±0.14	632	25.13 <sup>a</sup> ±0.29
<b>≥5</b>	1452	12.61 <sup>a</sup> ±0.11	1286	15.72 <sup>a</sup> ±0.13	728	25.28 <sup>b</sup> ±0.25

### Genetic parameters

**Table (3)** shows heritability estimates of studied traits. It appeared that heritability of body weights tend to increase as age increased. That is inversely matched with the environmental proportion of total variance which was found to be 0.72, 0.66 and 0.62 for 4M, 6M and 12M respectively. Heritability estimates for weight at 4, 6 and 12 months of age are in **Table (3)**. The heritability value was calculated as 0.28 for 4M which was lower than those reported for the same herd by **Mekkawy (2000; 0.384)**, Comparable result  $0.28 \pm 0.0028$  was obtained from a study of Rahmani at 4 months (**Shaht et al 2004**). The present analyses suggested that after weaning, maternal permanent environmental effects were an important source of variation. **Hamed et al (2009)** found that the heritability estimate for the 6 months of age was 0.12 in Zaraibi goat, which is lower than the present findings, **Leo et al (2010)** estimated heritability for weight at 6 month ( $0.21 \pm 0.03$ ), which is also lower than the present study. In contrast, **Hassan et al (2013)** found that the heritability for the 6 months of age was 0.45 for exotic goat which is higher than the estimate of the present study, heritability estimates for 6 month ranges (.21-.28) of **El-Awady et al (2019)** in the same breed. **Mekkawy (2000)** found that the heritability estimate for 12 mo. of age was 0.538, which is higher than the present findings. The difference in heritability estimates could be due to the different methods used for the estimation and population sampled.

**Table 3.** Heritability estimates (on diagonal), environmental (above diagonal) and genetic correlations (below diagonal) for body weights at 120 days, 4M; 180 days; 6M and 360 days, 12M in Zaraibi goats

Trait	W120	W180	W360
W120	<b>0.28</b>	0.83	0.61
W180	0.89	<b>0.34</b>	0.68
W360	0.76	0.92	<b>0.38</b>
Additive genetic variance	1.81	3.03	4.79
Environmental variance	4.60	5.90	7.93

The estimates of genetic trend (Kg/year) for investigated traits are reported in **Table (4)**. The annual genetic changes for 4M, 6M and 12M between 1988 and 2018 generally showed an increase over time for the studied traits. The annual genetic trends were positive and significant ( $p < 0.01$ ) for all growth traits. Estimates of annual genetic changes for 4M, 6M and 12M were 0.091, 0.121 and 0.158 (kg/year), respectively. The annual genetic change for 4M (0.091 kg/year) in the present study was higher than those of 15.51g/year reported by **Latfi and Razmkabir (2019)** in Markhoz goat at weaning weight (kids were weaned until ~ 4 months of age). The annual genetic change estimate for 6M in the current study (0.121kg/year) was greater than those reported by **Hamed (2010)** in the same herd (0.118 kg/year). Also, estimate of genetic trend for 12M in the present study was higher than the estimates of 156 g/year reported by **Mokhtari & Rashidi (2010)**, and lower than the estimates of 448 g/ year reported by **El-Wakil and Manal Elsayed (2013)** and the estimates of 1.02 kg per generation by **Mansour et al (1977)** in Barki sheep. In general, selection for growth traits were effective.

**Table 4.** Estimates of annual genetic changes (Kg/year) and their standard errors for kid's traits of Zaraibi goat

Trait	4M	6M	12M
Genetic changes	0.091 ± 0.007	0.121 ± 0.001	0.158 ± 0.001
Phenotypic changes	0.020 ± 0.003	0.045 ± 0.004	0.117 ± 0.007

All the estimate are significant ( $p < 0.01$ )

The genetic trends among the years of birth of Zaraibi goat for 4, 6 and 12-month body weight are presented in **Figs. (1, 2 and 3)**. **Fig. (3)** shows that genetic trends for WM12 trait was higher than those for other traits in this study. It agrees with **Hamed (2010)**. Environmental trends are presented in **Figs. (4, 5 and 6)** for weight at 120, 180 and 360 days of age, respectively. Negative values in environmental trends indicate poor environmental care of animal the herd and absence of environmental improvement during studied period.

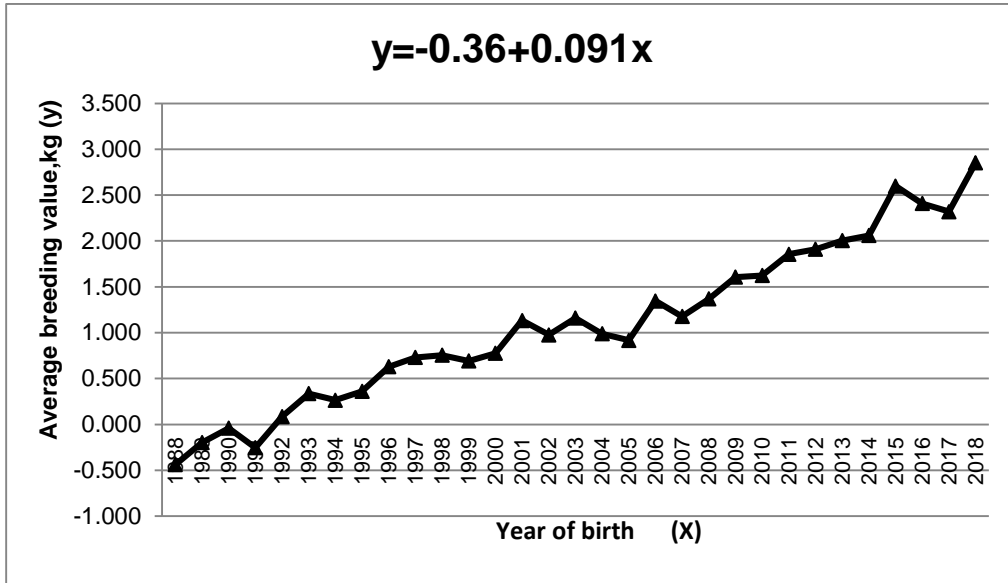


Fig. 1. Genetic trend for 4M (Kg) in Zaraibi kids

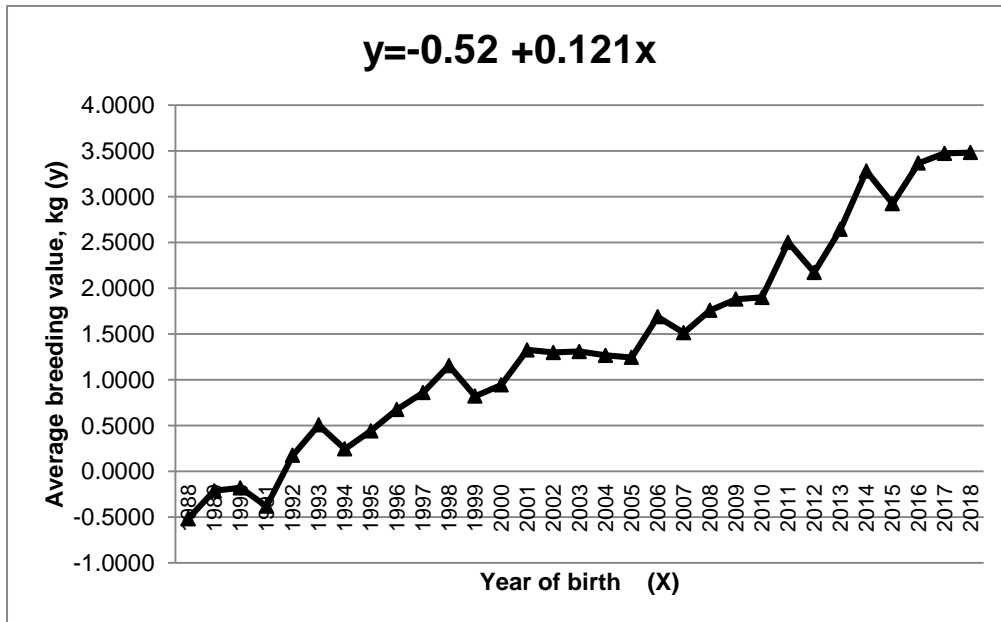


Fig. 2. Genetic trend for 6M (Kg) in Zaraibi kids

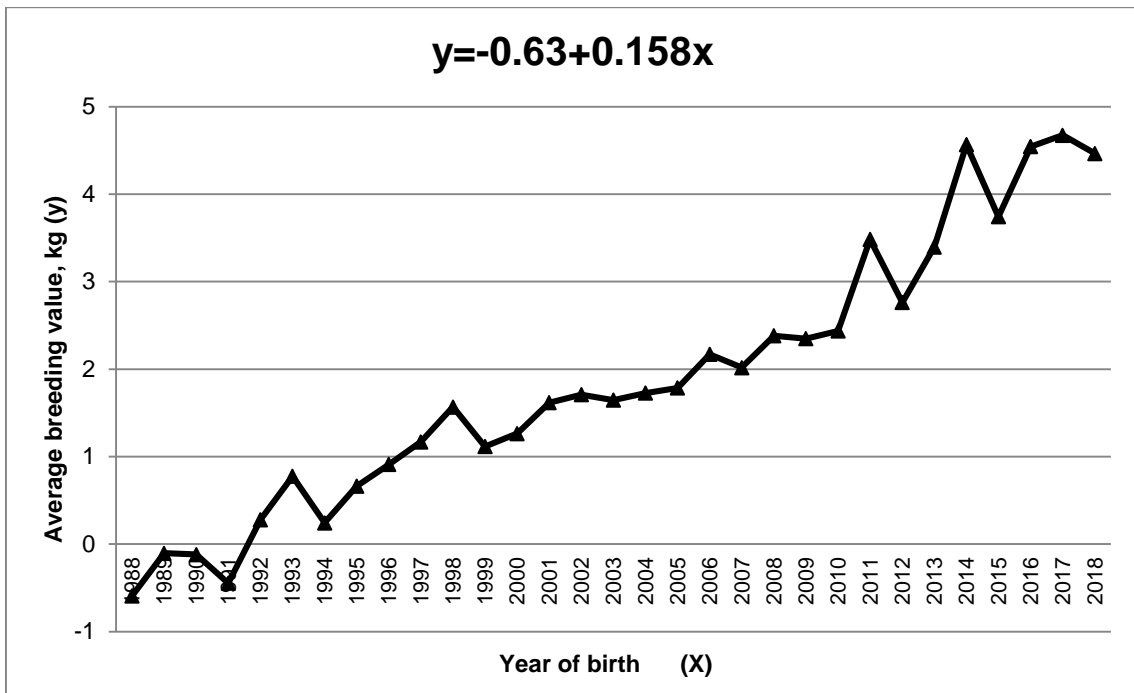


Fig. 3. Genetic trend for 12M (Kg) in Zaraibi kids

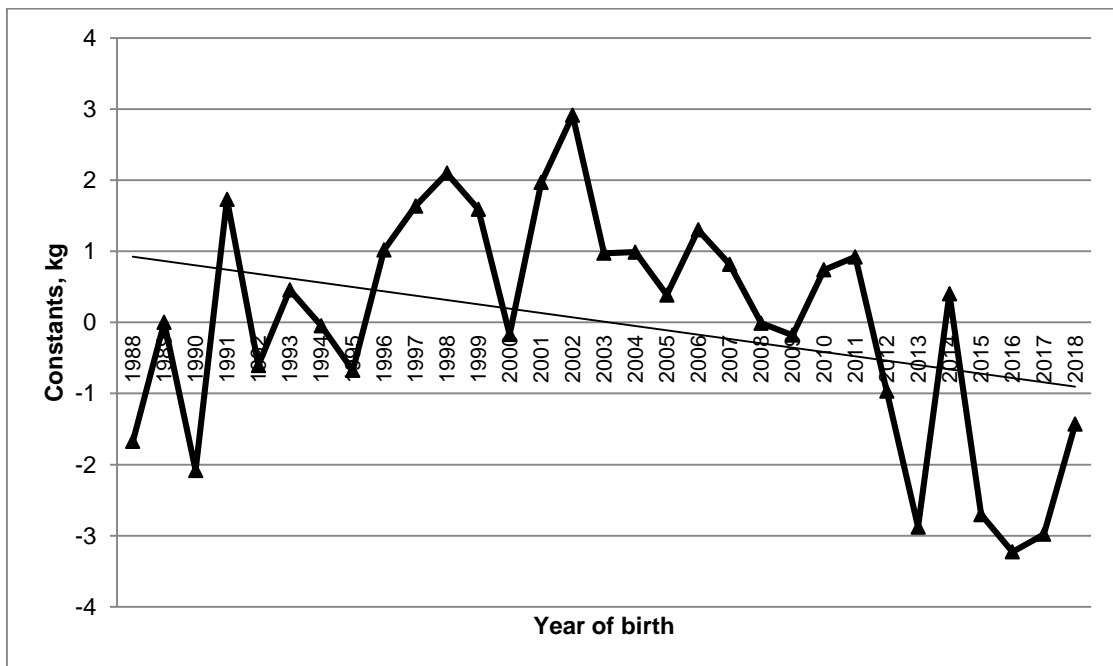


Fig. 4. Environmental trend for 4M (Kg) in Zaraibi kids

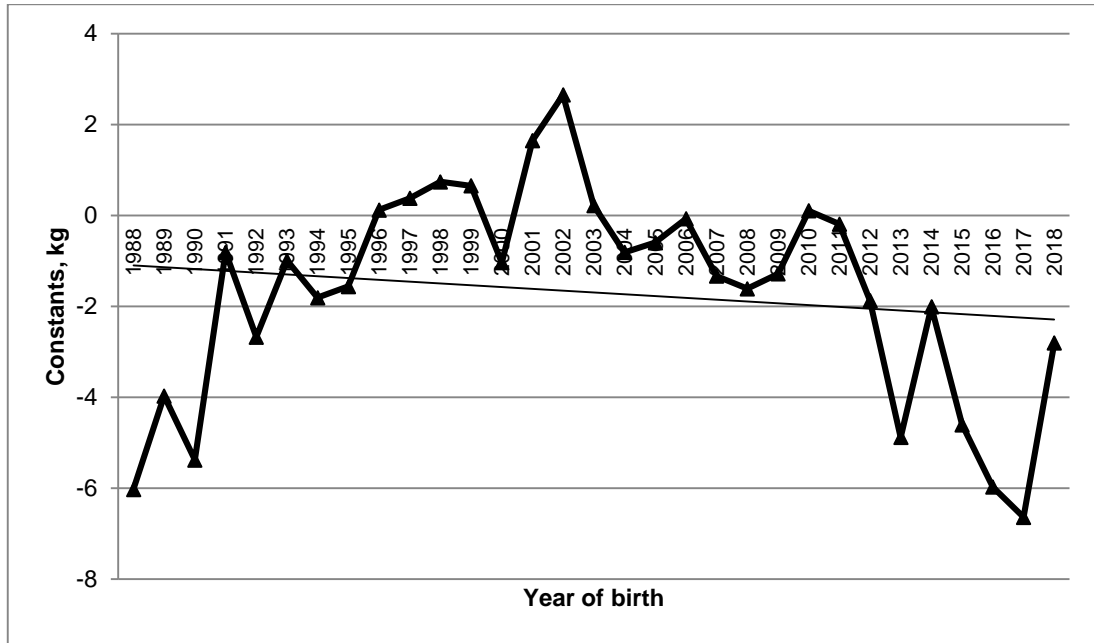


Fig. 5. Environmental trend for 6M (Kg) in Zaraibi kids

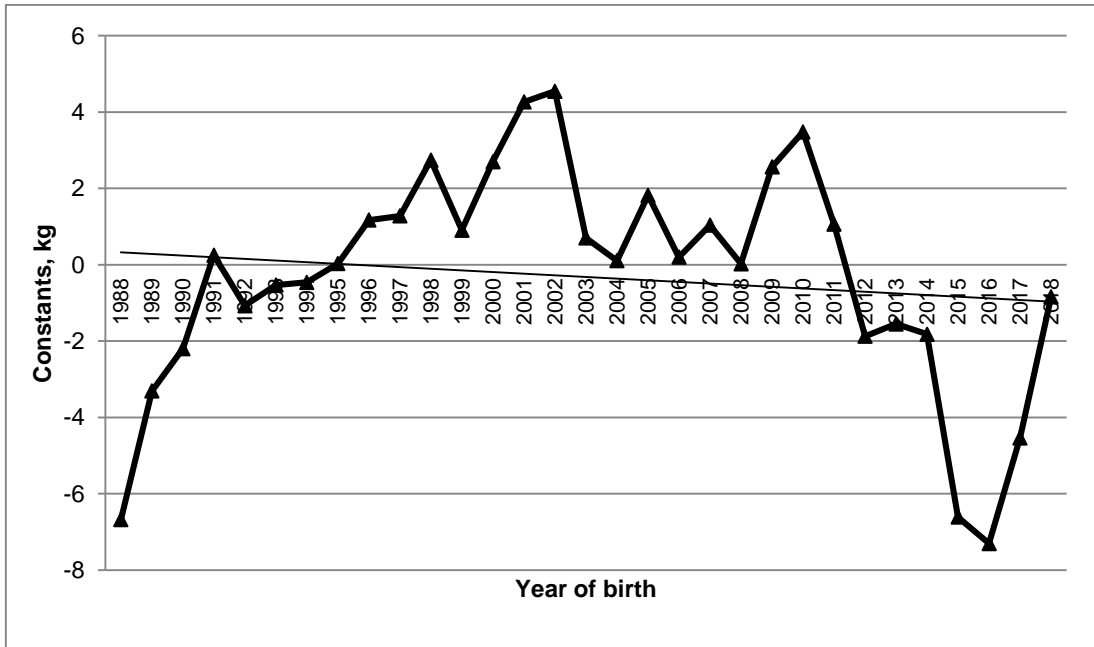


Fig. 6. Environmental trend for 12M (Kg) in Zaraibi kids



### CONCLUSIONS

Genetic trend for 12M trait was higher than those for other traits in this study. Negative values of environmental trend indicate poor of care for the herd during studied period. Weight at 12 months of age has the highest heritability in this study, so it is preferable to be the selection criteria to improve Body weights of Zaraibi goats. Breeders must be concerned with improving environmental conditions to benefit from the potential genetic of the animals.

### REFERENCES

- Abul-Naga A.M., Hamed A., Shaat I. and Mabrouk M.M.S. 2012. Genetic improvement of Egyptian Nubian goats as sub-tropical dairy prolific breed. *Small Rum. Res.* **102**,125-130
- Boldman K.G., Kriese L.A., Van Vleck L.D. and Kachman S.D. 1993. A manual for use of MTDFREML, a set of Programs to Obtain Estimates of Variances and Covariance (Draft). US. Department of Agriculture, Agriculture Research Service, 120 p.
- Dhanda S.J., Taylor G.D., Murray J.P., Pegg B.R. and Sand J. 2003. Goat meat production: Present Status and Future Possibilities. *Asian-Australasian J. Animal Sci.*, **16**, 1842-1852.
- El-Awady H.G., El-Moghazy M.M., Abu El-Naser I.A.M. and El-Raghi A.A. 2019. Direct and Maternal Genetic Trend Estimates for Growth Traits of Zaraibi Goats in Egypt Using Multivariate Animal Models. *Int. J. of Modern Biology and Medicine*, **10(1)**, 1-19.
- Galal S., Ferial Abdel Rasoul, Anous M.R. and Shaat I. 2005. Small Ruminant Breeds in Egypt. In Iniguez, Luis. (Ed.) 2005. Characterization of Small Ruminant Breeds in West Asia and North Africa. *Inter. Center for Agric. Res. In the Dry Areas (ICARDA), Aleppo, Syria*, **2**, 146-193.
- Hamed A. 2010. Genetic studies on Zaraibi goat. Ph.D. Thesis, Fac. of Agric., Al-Azhar Univ., Egypt, pp. 123-130.
- Hamed A., Mabrouk M.M., Shaat I. and Bata S. 2009. Estimation of genetic parameters and some non-genetic factors for litter size at birth and weaning and milk yield traits in Zaraibi goats. *Egypt. J. Sheep and Goats Sci.*, **4**, 55-64.
- Hassan M.R., Sultana S., Iqbal A. and Talukder M.A. 2013. Estimation of heritability, breeding values and genetic trends for growth traits of exotic goat. *Int. J. Nat Sci.*, **3**, 7-11.
- Latifi M. and Razmkabir M. 2019. Short communication: Estimation of genetic trends for body weight traits in Markhoz goat at different ages. *Span. J. Agric. Res.*, **17**, 2171-2192.
- Lee K.L., Freeman A.E. and Johnson L.P. 1985. Estimation of genetic change in registered Holstein cattle population. *J. Dairy Sci.* **68**, 2629-2638.
- Leo L.L.P., Gopal R.G., Chopra A. and Arora A.L. 2010. Estimates of (co) variance components and genetic parameters for growth traits of Avikalin sheep. *Tropical Animal Health and Production*, **42(6)**, 1093-1101.
- Mansour H., Galal S., Hassan G.M. and Ghanem Y. 1977. Estimation of genetic trends in traits of a flock of Barki sheep. *Egypt. J. Genet. Cytol.* **6**, 223-228.
- Mekkawy W.A. 2000. Estimation of genetic parameters for growth performance of Zaraibi goats. M.Sc. Thesis, Fac. of Agric., Ain Shams Univ., Cairo, Egypt, pp. 21- 49.
- Mokhtari M.S. and Rashidi A. 2010. Genetic trends estimation for body weights of Kermani sheep at different ages using multivariate animal models. *Small Rumin Res.* **88**, 23-26.
- Powell R.L., Norman H.D. and Dickinson F.N. 1977. Trends in breeding value and production. *J. Dairy Sci.*, **60**, 1316-1326.
- Salwa I. El-Wakil, and Manal Elsayed 2013. Genetic, phenotypic and environmental trends towards improving body weight in BARKI sheep. *Egypt. J. Sheep and Goats Sci.*, **8**, 11-20.
- SAS 2004. Statistical Analysis System. SAS Users Guide: Statistics. SAS Institute Inc. Editors, Cary, NC.
- Shaat I., Galal S. and Mansour H. 2004. Genetic trends for lamb weights in flocks of Egyptian Rahmani and Ossimi sheep. *Small Ruminant Research*, **51(1)**, 23-28.



## التحسين الوراثي لبعض الصفات الإنتاجية في المعز الزرايبي

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### الموجز

كانت قيم المكافئ الوراثي لصفة الوزن عند 4 شهور 0.28.

الإنتاجات الوراثية تم تقديرها من قيمة إنحدار القيم التربوية المنتبأ بها على سنة الولادة، كما تم حساب الإنتاجات البيئية لانحدار ثوابت سنة الميلاد على سنة الميلاد.

أوضحت النتائج أن اتجاهات التغيرات الوراثية كانت موجبة ومعنوية للوزن عند 4 شهور، 6 شهور و 12 شهر (0.091 , 0.121 and 0.158 kg/year) على التوالي. وكانت الاتجاهات للتغيرات المظهرية كما يلي (0.02 , 0.045 and 0.117 kg/year). الاتجاهات الوراثية للوزن عند 12 شهر كانت أعلى من الصفات الأخرى في هذه الدراسة. أوضحت الدراسة أن الارتباط الوراثي والبيئي بين وزن الجسم عند 4 شهور والأوزان الأخرى موجباً. القيم السالبة في الاتجاهات البيئية المدروسة يوضح ضعف نظم رعاية القطيع وغياب التحسين البيئي في القطيع خلال مدة الدراسة. أوضحت الدراسة أن الوزن عند 12 شهر له أعلى مكافئ وراثي في هذه الدراسة. يوصي البحث أن إستخدم هذه الصفة في عمليات الانتخاب لتحسين وزن جسم المعز الزرايبي عند عمر سنة، وأهمية التحسين البيئي حتى يمكن الاستفادة من الحيوانات المميزة وراثياً.

**الكلمات المفتاحية:** الإتجاه الوراثي، النمو، معز الزرايبي، الانتخاب

الهدف من هذه الدراسة تقييم التحسين الوراثي في قطيع المعز الزرايبي المرابي في محطة بحوث السرو الخاصة بمعهد بحوث الإنتاج الحيواني (APRI).

تم استخدام بعض أوزان الجسم في أعمار مختلفة في حساب الاتجاهات الوراثية والبيئية، كانت هذه الأوزان كما يلي: الوزن عند 4 شهور (4M)، الوزن عند 6 شهور (6M) والوزن عند 12 شهر (12M).

تم تجميع البيانات ومعلومات النسب من سنة 1988 وحتى سنة 2018، كانت تقديرات متوسطات المربعات الصغرى لأوزان الجسم كما يلي:  $12.14 \pm 0.02$  للوزن عند 4 شهور،  $15.49 \pm 0.02$  للوزن عند 6 شهور و  $24.08 \pm 0.04$  للوزن عند 12 شهر.

تم دراسة تأثير كل من سنة الولادة، نوع المولود، موسم الولادة ونوع الولادة على صفات النمو وكانت كلها معنوية ( $P < 0.01$ ). قدرت المعالم الوراثية باستخدام برنامج الحيوان للصفات المتعددة (MTDFREML)، شامله العوامل الثابتة السابق ذكرها في التحليل السابق مع اعتبار كل من تأثير الحيوان كتأثيرات عشوائية.

أوضحت النتائج أن المكافئ الوراثي للصفات المدروسة يزيد كلما زاد العمر، وأتضح من النتائج أن نسبة التباين البيئي للتباين الكلي كانت: 0.72، 0.66، 0.62 للصفات الثلاثة ( $W_4, W_6, W_{12}$ ) على الترتيب،

