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LIFETIME PERFORMANCE TRAITS AND ESTIMATE OF THEIR GENETIC PARAMETERS IN ZARAIBI GOATS

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ABSTRACT

This study included data on 626 Zaraibi does, raised at El-Serw station (Damietta Governorate) of the Ministry of Agriculture and Agrarian Reform during the period 1991-2008. Estimates of least squares means per doe of total number of kids born (TNKB), total number of kids weaned (TNKW), total kilograms born (TKGB), total kilograms weaned (TKGW), total milk yield (TMY), weaning weights (WW) and yearling weights (YW) of kids were 5.82, 5.08, 10.90, 56.21, 887.91,10.7 kg and 23.35kg, respectively. The differences between years of birth were significant on TNKB, TKGB, TMY, WW and YW. Season of birth and type of birth had no significant effect on any of lifetime production traits but had significant effect on WW and YW. The effect of age of dam was not significant on any of studied traits. Partial correlation coefficients between all presented traits in this study are positive and ranged from 0.07 to 0.98. Heritability estimates for TNKB, TKGW, TMY and YW ranged from 0.13 to 0.14, from 0.12 to 0.14, 0.11 to 0.14 and 0.29 to 0.32, respectively, while heritability of WW was estimated as 0.10. Genetic correlations between the studied traits were positive except that between WW and each of TKGW and TMY and ranged from high estimate (0.98) between TMY and each of TNKB and TKGW to low estimate (-0.42) between TMY and WW.

Keywords: *weaning weight, yearling weight, milk production, doe performance, phenotypic and genetic parameters.*

INTRODUCTION

Lifetime performance of the doe is the ultimate indicator of her utility in the herd since it takes account of the stay ability of the doe in the herd and possible trade-offs between performances in consecutive seasons. Lifetime performance is also important in investigating herd economics. Length of lifetime can be seen as a composite trait of production, health and reproduction (Mulder and Jansen, 2001). Dekkers, (1993), Jairath *et al.* (1994) and Boettcher *et al.* (1997) indicated that long lifetime of cattle is considered good indicator for good health and fertility, because it allows the animal to maximize its productive capacity, reduces replacement and treatment costs, means less involuntary culling and increases the scope of voluntary culling.

Very few studies have been made to estimate lifetime performance of the doe and factors affecting it in Egyptian breeds of goats. This investigation was carried out to estimate least squares means and variance-covariance components and genetic parameters for lifetime kid, milk production traits of does from the Egyptian Zaraibi breed.

MATERIAL AND METHODS

Data

The study was carried out on the Zaraibi goat herd kept at El-Serw experimental station located in the North Eastern Delta belonging to Animal Production Research Institute, Ministry of Agriculture and Land Reclamation during the period between 1991 and 2008 except for the does born in the year 2000, due to unknown selection plan of this group of does. A total original of 3441 Zaraibi does were available for the study. Any doe sold for breeding or used for experimental reasons then rejoined the main flock for some seasons or was too young to have the chance to complete six seasons was excluded from the data. Only does which had the chance to complete six years (six kid crops) were considered for the analysis of lifetime performance. These include does that were sold for infertility or which died as a result of diseases. Only 626 does met these criteria and were included in the study.

Management

Natural mating was practiced once a year. Fifty percent of Zaraibi goats were mated in October and the other 50% in June. Does were divided into groups of 25-30 each joined with a fertile buck during the mating season which lasted for 45 days**.** Kids were kept with their dams all the time up to weaning at the age of three months. They were weighed within 24 hours of birth and monthly thereafter until 18 months of age. Does were weighed before mating and at kidding. Animals were housed in semi open pens and fed on Egyptian

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clover (*Trifolium alexandrinum*) from December to May. From June to November they were fed on crop stubbles and green fodder if available, beside a concentrate mixture, clover hay and rice straw. Does were supplemented with half a kilogram concentrate mixture per day for two weeks before the mating season and from the second to the fourth week of pregnancy. Moreover, milking goats were supplemented with one kg of concentrate mixture daily. Does were allowed to drink twice a day. They were first mated at the age of 18 months or when they reach the body weight of 25kg. Aged does and weak growing doe kids were culled from the main flock. The rest of doe kids were selected after first productive season using weight at 1st mating and milk yield at 1st parity as the selection criteria.

Lifetime production of the doe

The lifetime production was measured in five traits including:

1. Total number of kids born (TNKB)
2. Total number of kids weaned (TNKW)
3. Total kilograms born (TKGB)
4. Total kilograms weaned (TKGW)
5. Total milk yield (TMY)

If the doe did not conceive in any season, her production value was considered as zero. Lifetime production for the doe was calculated by summing up all records of the doe each for NKB, NKW, KGB, KGW and MY after making appropriate adjustments as explained later.

Statistical analysis

Data consisted of two parts; the first included kid data and the second doe data. Data were analyzed in two stages, the first was concerned with analyzing each of kid data to obtain constants for fixed effects, indicated in the statistical model below, to adjust birth weight (BW) and weaning weight (WW) and doe data to obtain constants for fixed, indicated in the statistical model below, to adjust milk yield using Harvey's Mixed Model Least–squares and Maximum Likelihood Computer Program (LSML 87). BW and WW were measured as individual trait on the doe kids. Adjusted BW and WW were summed over the doe to obtain TKGB and TKGW, also, adjusted milk yield was summed to get TMY.

The second stage was concerned with analyzing doe data to estimate the least-squares means using the GLM procedure of the SAS Institute Inc. (1996) and the variance-covariance components and genetic and phenotypic parameters for studied lifetime production traits using Multiple Trait Animal Model program (MTDFREML).

1. Correction for fixed effects in kid weights and doe milk yield

1.1. Correction for fixed effects in kid weights

The following model was fitted to correct for all factors included except for type of birth which was included in the model to obtain estimates of other effects adjusted for it.

The model was:

$$Y_{ijklmn} = \mu + S_i + R_j + A_k + G_l + T_m + (SA)_{ik} + e_{ijklmn} \qquad \textbf{(Model I)}$$

Where,

Y_{ijklmn} is the BW of the nth kid in the ith season of birth, jth year of birth, kth age of dam, lth gender of kid and mth type of birth,

μ is the overall mean,

S_i is an effect due to the ith season of birth, i = 1, 2 for spring and autumn, respectively,

R_j is an effect due to the jth year of birth, j = 1991¸ 1992……… 2008,

A_k is an effect due to the kth age of dam, k=1,2,……..,4 year,

G_l is an effect due to the lth gender of kid, l = 1 and 2 for male and female,

T_m is an effect due to the mth type of birth, m = 1,2,…….,5 for single, twin……..,

$(SA)_{ik}$ is an effect due to interaction of the season of birth and age of dam,

e_{ijklmn} is an effect due to a random error particular to the ijklmnth kid assumed normally and independently distributed with zero mean and variance σ^2_e.

$$Y_{ijklmn} = \mu + S_i + R_j + A_k + G_l + T_m + (ST)_{im} + e_{ijklmn} \qquad \textbf{(Model II)}$$

The definition of terms is as those in model I except Y_{ijklmn} indicates weaning weight and the term of $(ST)_{im}$ (the interaction between season of birth and type of birth) instead of $(SA)_{ik}$ in model I. WW was linearly adjusted to 90 days of age.

1.2. Correction for fixed effects for doe milk yield

Analysis was run to obtain constants for fixed effects to adjust milk yield according to the following model

$$Y_{ijklm} = \mu + P_i + S_j + R_k + L_l + (PS)_{ij} + (PL)_{il} + (SL)_{jl} + e_{ijklm} \qquad \textbf{(Model III)}$$

where,

Y_{ijklm} is the MY of the nth doe in the ith parity, jth season of kidding, kth

year of kidding and l^{th} litter size,

μ is the overall mean,

P_i is an effect due to the i^{th} parity, i = 1,2,……..,6,

S_j is an effect due to the j^{th} season of kidding, j = 1, 2 for spring and autumn, respectively,

R_k is an effect due to the k^{th} year of kidding, k = 1991……..2008,

L_l is an effect due to the l^{th} litter size, l = 1, 2…….. 4 for single, twin……..quaternary,

PS_{ij} is an effect due to the interaction of the parity and season of kidding,

PL_{il} is an effect due to the interaction of the parity and litter size,

SL_{jl} is an effect due to the interaction of the season of kidding and litter size and

e_{ijklm} is an effect due to a random error particular to the $ijklm^{th}$ doe assumed normally and independently distributed with zero mean and variance $\sigma^2_{e..}$

2. Estimation of lifetime production traits

2.1. Least-squares means for life time production traits

The following model was applied to estimate TNKB, TNKW, TKGB, TKGW and TMY for the investigated traits:

$$Y_{ijklm} = \mu + R_i + S_j + T_k + A_l + (ST)_{jk} + (SA)_{jl} + e_{ijklm} \qquad \textbf{(Model IV)}$$

Where:

Y_{ijklm}= is the TNKB, TNKW, TKGB, TKGW and TMY and weaning weight (WW) and yearling weight (YW) of the m^{th} doe in the i^{th} year of birth for doe, j^{th} season of birth for doe, k^{th} type of birth of the doe and l^{th} age of dam of doe,

μ = the overall mean,

R_i = is an effect due to the i^{th} year of birth for doe,

S_j = is an effect due to the j^{th} season of birth for doe,

T_k = is an effect due to the k^{th} type of birth of the doe,

A_l = is an effect due to the l^{th} age of dam of doe,

$(ST)_{jk}$ = is an effect due to the interaction of the season of birth of doe and type of birth of doe,

$(SA)_{jl}$ = is an effect due to the interaction of the season of birth of doe and age of dam of doe,

e_{ijklm} is an effect due to a random error particular to the $ijkl^{th}$ doe assumed normally and independently distributed with zero mean and variance $\sigma^2_{e..}$

Partial correlation coefficients were estimated using the same model from the Error SS and CP Matrix / Prob > |r between each pair of WW, YW, TNKB, TNKW, TKGB, TKGW and TMY, using the GLM procedure of the SAS Institute Inc. (1996).

2.2. Estimation of variance-covariance components and genetic parameters of lifetime production traits

Four different combinations of models were used to estimate variance-covariance components and genetic parameters for the doe (WW, TNKB and TMY), (WW, TMY and TKGW), (YW, TNKB and TMY) and (YW, TMY and TKGW), respectively.

The following linear model was fitted to estimate variance-covariance components and genetic parameters for the doe WW, TNKB and TMY (first combination):

$$Y = X\beta + Zu + e, \qquad \textbf{(Model V)}$$

Where,

Y is N*1 matrix of observations of the doe WW, TNKB and TMY,

X is the incidence matrix for fixed effects including year of birth for doe, j^{th} season of birth for doe, k^{th} type of birth of the doe and age of dam of doe,

β is the vector of an overall mean and fixed effects of year of birth, season of birth, type of birth of the doe and age of dam,

Z is the incidence matrix for random effects including animal additive and maternal genetic effects for doe,

u is the vector of random effects of animals additive and maternal genetic effects for doe kid WW or animals additive genetic effects for TNKB and TMY of doe 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 was as follows:

$$\begin{bmatrix} u \\ e \end{bmatrix} = \begin{bmatrix} G & O \\ O & R \end{bmatrix}$$

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Where, Var

G is the additive genetic variance-covariance matrix,

R is the residual variance-covariance matrix.

The same model was used to estimate the variance-covariance components and genetic parameters for the doe WW, TMY and TKGW (second combination).

A model similar to model V, but not including the genetic maternal effect were applied to estimate the variance-covariance components and genetic parameters for the doe YW, TNKB and TMY (third combination) where,

Z is the incidence matrix for random effects,

u is the vector of random effects of animals additive genetic effects for doe kid YW, TNKB and TMY of doe and

G is the additive genetic variance-covariance matrix,

The same model was used another time to estimate the variance-covariance components and genetic parameters for the doe YW, TMY and TKGW (fourth combination),

RESULTS AND DISCUSSION

Weaning, yearling weights and lifetime production traits

Least squares means, standard errors and probability of type I error for WW, YW, TNKB, TNKW, TKGB, TKGW and TMY for different levels of fixed effects are given in table 1.

The effect of year of birth of doe on TNKB, TKGB, TMY, WW and YW was significant but non significant on TNKW and TKGW (table 1). Although the effect of year was not significant on some traits, there were wide variations observed in means of all lifetime production traits through different years.

Season of birth and type of birth of does had no significant effect on studied traits except WW and YW of the does, indicating no difference between summer and autumn and between different types of birth for their performance throughout their lifetime. However, does born in a triplet kidding gave higher estimates of all lifetime production traits (kids and milk) than those born single, twin or quaternary.

None of studied traits was affected by age of dam of doe. Nevertheless, the estimates decreased for does born of aged dams.

Correlation coefficients

Partial phenotypic correlation coefficients between studied traits are presented in table 2**.** Estimates of Partial correlation coefficients between concerned traits were positive and significant and ranged from 0.07 to 0.98. Only, partial correlation coefficient between WW and TMY was not significant. Table 2 shows that the lifetime kid production traits are strongly correlated with each other, while the partial correlation coefficients between TMY and lifetime kid production traits were moderate. Estimates of correlation between all lifetime production traits and WW were low, while they were little higher with YW, which indicate that YW can indirectly be used in improving life time production traits.

Genetic parameters for weaning and yearling weights and lifetime production traits

Estimation of variance components. Genetic, environmental and phenotypic variance-covariance estimates for different traits are presented in table 3. The estimates of genetic and environmental variances for WW and YW increased with increasing age of kids. Mousa (1989) found the same trend in his study on lambs and reported that the rate of increasing the log genetic variance with degree of maturity appeared to be roughly linear in all measurements. The genetic and environmental variances for TMY were higher than those of TNKB and TKGW. According to the previous results, the genetic covariance for TNKB with TMY was lower than that for TKGW with TMY.

The genetic covariance for WW and both of TNKB and TKGW were lower than that for YW and each of TNKB and TKGW, also genetic covariance for WW with TMY was lower than that for YW with TMY. The genetic maternal variances of WW differ from model to another.

Generally, estimates of variance components for a trait by using MTDFREML depends on the traits included in the model.

Heritability. Heritability estimates (h^2) of WW, YW and studied lifetime production traits from four different combinations of models are presented in Table 4. Heritability estimates (h^2) of WW were 0.10 and they did not change with the models used. While heritability estimates of YW were 0.29 and 0.32, respectively in the used models. The heritability estimate of weight at 90 days on Zaraibi goats reported by Bata (1989)(0.11) was close to that reported in the present study , while it was estimated as 0.28 in study on the same herd by Mekkawy

(2000) using random regression. Roy et al. (1997) reported a heritability estimate of weight at 90 days on Jamnapari goats as 0.30. The heritability estimate of YW (weight at 365 days) in the present study (0.29, 32) was lower than those reported by Mekkawy (2000)

for Zaraibi goats (0.54) and Singh (1997) for Black Bengal goats (0.55), while it was much higher than it reported by Bata (1989) for Zaraibi goats (0.0).

The estimate of heritability for the same trait differed from one model to another, according to the other traits included in the model. The genetic and environmental covariance estimated among the traits are affected the different variances which are accounted in estimation of heritability for the studied traits.

Generally, the estimated heritability of WW and YW in the present study indicated that mass selection for weaning or yearling weight in Zaraibi does could not be effective. However heritability estimate for weaning and yearling weight cannot be representative of the breed in general. They represent only females that went into the breeding flock and had the chance to stay for six seasons.

Genetic correlations. Genetic correlations among WW, YW, TNKB, TKGW and TMY estimated from four combinations of models are presented in table 4. Estimates of genetic correlations between concerned traits in four models are positive with the exception of that between WW and each of TMY and TKGW.

Negative genetic correlation at the present study differed from that reported in sheep by Osman et al. (1994). They estimated the genetic correlation between WW and TKGW as 0.30. However, Osman *et.al.* (1994) obtained a similar estimate to that reported between YW and TKGW (0.23 vs. 0.25), while Shelton and Menzies (1968) calculated that as 0.13.

CONCLUSION

Including weaning weight in selection program for lifetime production is not recommended because of negative genetic correlation between WW and lifetime production traits. Using yearling weight as selection criterion can be considered to indirectly improve lifetime production traits.

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Table 1. Least squares means, standard error (± SE) and probability of type I error (P) for TNKB, TNKW, TKGB, TKGW, TMY,WW and YW

Factor	No	TNKB[1]	TNKW[2]	TKGB[3]	TKGW[4]	TMY[5]	WW[6]	YW[7]
		Mean±SE P	Mean±SE P	Mean±SE P	Mean±SE P	Mean±SE P	Mean±SE P	Mean±SE P
μ		5.82 ± 0.42	5.08 ± 0.39	10.90 ± 0.86	56.21 ± 4.30	887.91 ± 82.25	10.70 ± 0.17	23.35 ± 0.37
:Year		0.03^{*}	0.1	0.00^{**}	0.11	0.01^{*}	0.00^{**}	0.00^{**}
1989	40	7.1 ± 0.7^{a}	6.1 ± 0.7^{a}	13.9 ± 1.5^{ab}	73.1 ± 7.4^{a}	1184.0 ± 141.6^{a}	10.8 ± 0.3^{cd}	18.9 ± 0.6^{e}
1990	38	5.5 ± 0.8^{ab}	4.8 ± 0.7^{ab}	9.9 ± 1.5^{bcd}	54.4 ± 7.6^{ab}	1067.6 ± 145.7^{ab}	9.5 ± 0.3^{ef}	22.1 ± 0.7^{cd}
1991	73	6.5 ± 0.6^{ab}	5.4 ± 0.5^{ab}	12.1 ± 1.2^{abc}	57.9 ± 5.9^{ab}	976.9 ± 111.7^{ab}	11.4 ± 0.2^{ab}	22.6 ± 0.5^{cd}
1992	32	5.7 ± 0.8^{ab}	5.2 ± 0.7^{ab}	11.2 ± 1.5^{abcd}	56.3 ± 7.6^{ab}	732.5 ± 145.4^{b}	11.2 ± 0.3^{bc}	22.5 ± 0.7^{d}
1993	75	6.8 ± 0.5^{a}	5.7 ± 0.5^{ab}	13.5 ± 1.1^{a}	60.4 ± 5.2^{ab}	1124.1 ± 100.1^{a}	10.4 ± 0.2^{cd}	22.2 ± 0.5^{cd}
1994	59	5.9 ± 0.6^{ab}	5.1 ± 0.5^{ab}	12.6 ± 1.1^{abc}	55.5 ± 5.7^{ab}	869.7 ± 108.4^{ab}	9.5 ± 0.2^{f}	22.2 ± 0.5^{cd}
1995	54	6.8 ± 0.6^{a}	5.8 ± 0.5^{ab}	14.0 ± 1.2^{a}	61.9 ± 5.8^{ab}	924.3 ± 110.9^{ab}	10.1 ± 0.2^{de}	21.9 ± 0.5^{d}
1996	69	6.2 ± 0.5^{ab}	5.4 ± 0.5^{ab}	11.9 ± 1.1^{abc}	59.6 ± 5.2^{ab}	880.3 ± 100.0^{ab}	11.4 ± 0.2^{ab}	25.1 ± 0.5^{b}
1997	33	5.6 ± 0.7^{ab}	4.9 ± 0.6^{ab}	9.8 ± 1.4^{bcd}	56.1 ± 7.0^{ab}	944.3 ± 134.4^{ab}	11.1 ± 0.3^{bc}	25.5 ± 0.6^{b}
1998	67	5.4 ± 0.5^{ab}	4.8 ± 0.5^{ab}	8.8 ± 1.0^{cd}	53.4 ± 5.1^{ab}	858.8 ± 98.1^{ab}	10.8 ± 0.2^{bc}	25.2 ± 0.4^{b}
1999	45	4.8 ± 0.7^{bc}	4.0 ± 0.6^{bc}	8.1 ± 1.4^{de}	46.1 ± 6.9^{bc}	828.7 ± 132.6^{ab}	10.9 ± 0.3^{bc}	23.3 ± 0.6^{c}
2001	41	5.6 ± 0.8^{ab}	5.5 ± 0.7^{ab}	9.6 ± 1.5^{bcd}	60.0 ± 7.6^{ab}	736.5 ± 145.8^{ab}	11.7 ± 0.3^{a}	27.5 ± 0.7^{a}
Season of birth:		0.36	0.43	0.32	0.52	0.95	0.00^{**}	0.00^{**}
1	446	6.1 ± 0.3^{a}	5.3 ± 0.3^{a}	11.5 ± 0.6^{a}	58.2 ± 3.2^{a}	891.8 ± 60.8^{a}	10.3 ± 0.1^{a}	21.9 ± 0.3^{a}
2	180	5.5 ± 0.5^{a}	4.9 ± 0.5^{a}	10.3 ± 1.18^{a}	54.2 ± 5.4^{a}	884.0 ± 103.8^{a}	11.1 ± 0.2^{b}	24.8 ± 0.5^{b}
Type of birth:		0.54	0.8	0.33	0.79	0.37	0.00^{**}	0.00^{**}
1	46	5.4 ± 0.8^{a}	4.8 ± 0.7^{a}	10.1 ± 1.6^{a}	53.6 ± 8.1^{a}	863.5 ± 154.0^{a}	12.3 ± 0.3^{a}	24.6 ± 0.7^{a}
2	342	5.8 ± 0.3^{a}	5.2 ± 0.3^{a}	10.9 ± 0.6^{a}	56.8 ± 3.2^{a}	893.2 ± 60.1^{a}	10.8 ± 0.1^{b}	23.8 ± 0.3^{a}
3	187	6.3 ± 0.4^{a}	5.4 ± 0.3^{a}	12.1 ± 0.7^{a}	59.8 ± 3.6^{a}	995.4 ± 68.5^{a}	10.1 ± 0.1^{b}	22.9 ± 0.3^{a}
4	51	5.8 ± 0.6^{a}	5.0 ± 0.6^{a}	10.6 ± 1.2^{a}	54.6 ± 6.2^{a}	799.5 ± 118.0^{a}	9.7 ± 0.3^{c}	22.1 ± 0.5^{b}
Dam age		0.74	0.7	0.9	0.57	0.82	0.07	0.15
2	181	5.6 ± 0.4^{a}	4.9 ± 0.5^{a}	10.4 ± 0.8^{a}	54.2 ± 3.9^{a}	898.8 ± 75.3^{a}	10.4 ± 0.2^{cb}	22.7 ± 0.3^{bc}
3	136	5.7 ± 0.4^{a}	5.0 ± 0.4^{a}	10.5 ± 0.9^{a}	55.5 ± 4.4^{a}	882.8 ± 83.5^{a}	10.4 ± 0.2^{c}	23.2 ± 0.4^{bc}
4	120	6.1 ± 0.4^{a}	5.5 ± 0.4^{a}	11.6 ± 0.9^{a}	61.6 ± 4.3^{a}	941.7 ± 82.5^{a}	10.6 ± 0.2^{abc}	23.1 ± 0.4^{bc}
5	78	6.1 ± 0.5^{a}	5.3 ± 0.4^{a}	11.3 ± 0.1^{a}	59.4 ± 4.9^{a}	994.0 ± 94.1^{a}	10.1 ± 0.2^{a}	24.2 ± 0.4^{ab}
6	41	6.0 ± 0.8^{a}	5.0 ± 0.7^{a}	11.0 ± 1.6^{a}	54.1 ± 7.8^{a}	869.3 ± 149.2^{a}	11.2 ± 0.3^{ab}	23.2 ± 0.7^{c}
≥7	70	4.9 ± 0.9^{a}	4.3 ± 0.9^{a}	10.1 ± 1.9^{a}	45.4 ± 9.5^{a}	695.2 ± 180.7^{a}	10.7 ± 0.4^{c}	23.8 ± 0.8^{abc}

TNKB, TNKW, TKGB, TKGW, TMY, WW and YW were not significantly affected by Season * type of birth**,** age of dam ***** season.

[1]: Total number of kids born, [2] : Total number of kids weaned, [3] : Total kilograms born, [4] : Total kilograms weaned, [5] : Total milk yield, [6] : weaning weight and [7]: yearling weight

* = P<0.05 ** = P<0.01

Means with different superscripts are significantly different (P<0.05).

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Table 2. Partial correlation coefficients / Prob > r between TNKB, TNKW, TKGB, TKGW, TMY, WW and YW

	TNKB[1]	TNKW[2]	TKGB[3]	TKGW[4]	TMY[5]	WW[6]	YW[7]
TNKB							
TNKW	0.96 0.00						
TKGB	0.97 0.00	0.94 0.00					
TKGW	0.94 0.01	0.98 0.00	0.92 0.00				
TMY	0.77 0.00	0.74 0.00	0.75 0.00	0.77 0.01			
WW	0.1 0.01	0.1 0.02	0.12 0.00	0.11 0.00	0.07 0.1		
YW	0.14 0.00	0.14 0.00	0.15 0.00	0.15 0.00	0.18 0.00	0.45 0.00	

[1]: Total number of kids born, [2] : Total number of kids weaned, [3] : Total kilograms born, [4] : Total kilograms weaned, [5] : Total milk yield, [6] : weaning weight and [7] : yearling weight

Table 4. Heritability estimates (h^2) (on the diagonal) and genetic correlations (r_g) (lower the diagonal) in Zaraibi does estimated from different models.

Traits	Model Combination								
	First				Second				
	WW	TNKB	TMY	Maternal for WW		WW	TMY	TKGW	Maternal for WW
WW	0.10				WW	0.10			
TNKB	0.08	0.13			TMY	-0.42	0.11		
TMY	0.00	0.96	0.14		TKGW	-0.25	0.92	0.14	
Maternal for WW	0.00	0.00	0.28	0.06	Maternal for WW	-0.28	0.19	-0.21	0.11
	Third				Fourth				
	YW	TNKB	TMY			YW	TMY	TKGW	
YW	0.29				YW	0.32			
TNKB	0.14	0.14			TMY	0.40	0.11		
TMY	0.20	0.98	0.13		TKGW	0.23	0.98	0.12	

Table 3. Genetic, environmental and phenotypic variances (on the diagonal) and covariance (off the diagonal) structures for Different models used in statistical analysis in Zaraibi

Model	Traits	Variance components									
		Genetic variance-covariance				Environmental variance-covariance			Phenotypic variance covariance		
First combination		WW	TNKB	TMY	Maternal effect for WW	WW	TNKB	TMY	WW	TNKB	TMY
	WW	0.214				1.814			2.159		
	TNKB	0.047	1.687			0.508	11.143		0.555	12.830	
	TMY	0.000	29673.1	56927.6		06020.3	149107.0	356546.4	07219.6	178780.1	413474.0
	Maternal effect for WW	0.000	0.000	02398.6	0.130						
Second combination		WW	TMY	TKGW	Maternal effect for WW	WW	TMY	TKGW	WW	TMY	TKGW
	WW	0.209				1.778			2.154		
	TMY	-04422.6	53495.5			09923.5	434694.6		06547.1	488190.1	
	TKGW	-1.600	294271.9	192.39964		7.632	1679958.4	1166.314	5.328	1974230.3	1358.714
	Maternal effect for WW	-0.061	02092.4	-1.40732	0.227						
Third combination		YW	TNKB	TMY		YW	TNKB	TMY	YW	TNKB	TMY
	YW	2.948				7.078			10.02565		
	TNKB	0.329	1.862			1.238	11.44430		1.568	13.306	
	TMY	08702.6	34508.1	64186.0		30018.1	163005.4	427872.1	38720.7	197513.5	492058.1
Fourth combination		YW	TMY	TKGW		YW	TMY	TKGW	YW	TMY	TKGW
	YW	3.178				6.891			10.6840		
	TMY	17039.4	56009.1			23425.7	434224.2		40465.1	490233.4	
	TKGW	5.376	299144.7	165.052		12.971	1683285.8	1196.220	18.346	1982430.6	1361.272

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