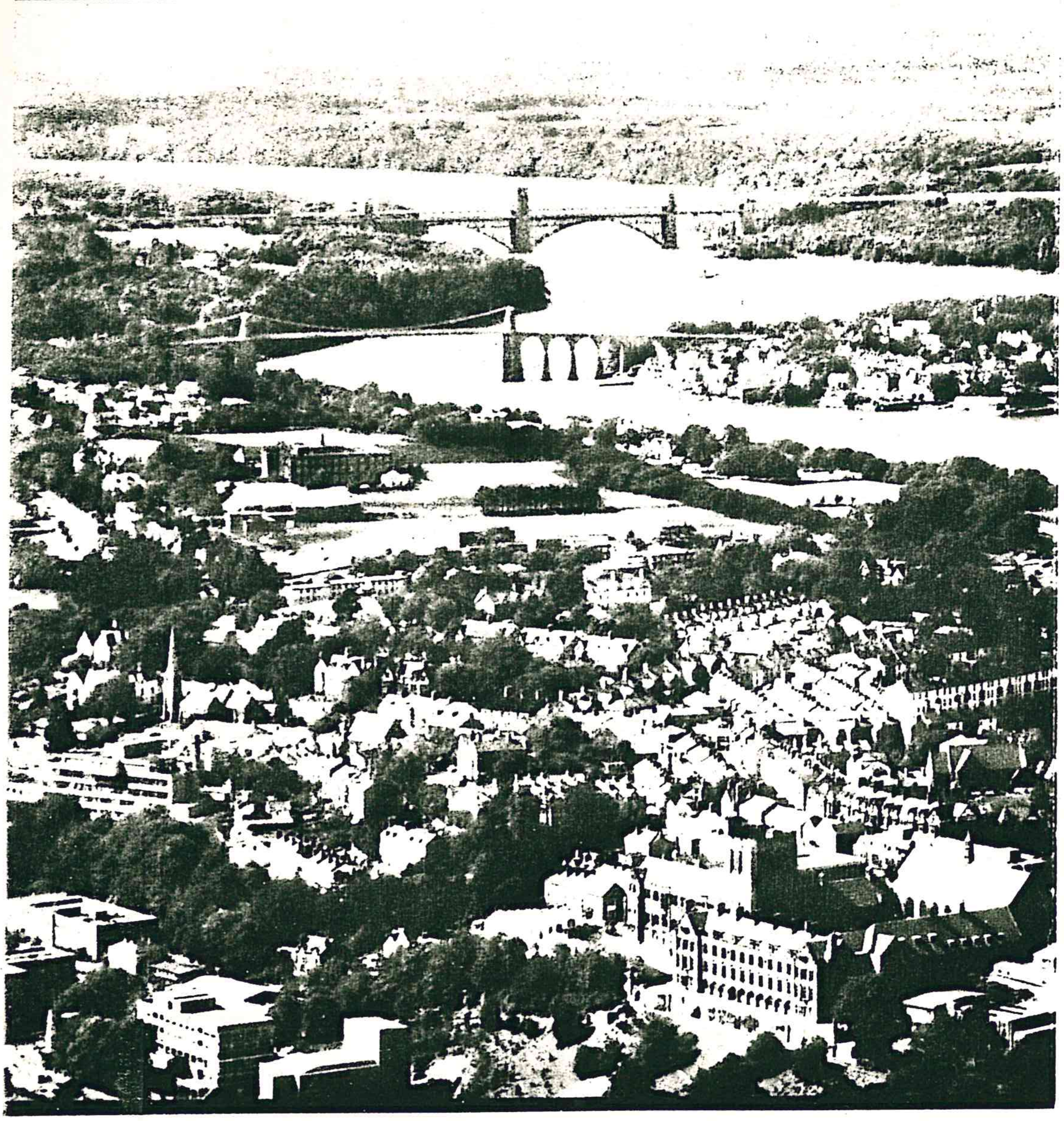
Second Egyptian-British Conference
on
Animal and Poultry Production

August 26th - 28th, 1986
BANGOR, U.K.



University College of North Wales
Bangor

University of Zagazig
Egypt

DOE LITTER PERFORMANCE OF BAUSCAT AND GIZA WHITE RABBITS

M. H. KHALIL AND E. A. AFIFI
Department of Animal Production, Faculty of Agriculture at Moshtohor,
Zagazig University, Banha Branch, Egypt.

SUMMARY

Data on 849 Bauscat (B) and Giza White (G) litters, collected from October 1975 to September 1983, were used to examine the effects of non-genetic factors on some litter traits and to estimate the repeatability for these traits. Parity, month of kindling and litter size at birth were the non-genetic factors investigated. Traits studied included litter weight at birth and at weaning, preweaning mortality and mean bunny weight at weaning. Fifty-two sires and 210 daughters (paternal half-sisters) were used for the analysis of these traits. Weaning litter weight and mean bunny weight increased ($P < 0.01$ or $P < 0.001$) as parity advanced. No pattern of parity effects on preweaning mortality was observed. There was a general tendency for litter weight and mean bunny weight to be low when kindling took place in the early months of the year of production (October and November) and to increase ($P < 0.001$) as month of kindling advanced and to decrease again with kindling at the end of the year of production during April and May. Preweaning mortality decreased ($P < 0.001$) as month of kindling advanced till March and increased ($P < 0.001$) thereafter during April and May. Litter weight at birth and at weaning increased ($P < 0.01$) with the increase of litter size at birth. Mean bunny weight at weaning increased ($P < 0.01$) as litter size at birth decreased. Birth-litter-size effects on preweaning mortality were very limited ($P > 0.05$). The sire of the doe affected significantly all litter traits studied, with the exception of preweaning mortality in the B breed. Doe litter traits were of low repeatability with the exception of litter weight at weaning in G does (0.32 ± 0.07). Culling of does based on a single production record would not therefore be advised.

INTRODUCTION

Litter size and mean bunny weight are usually regarded as the important elements that contribute to litter weight productivity in rabbits. Also, preweaning litter loss controls the number and total weight of rabbits per litter at weaning and consequently the number of kilograms weaned per doe per year of production. The higher the litter losses the smaller the litter weight per doe at weaning and the lower the income obtained.

Evidence in the literature (Afifi *et al.*, 1976ab; Khalil, 1980; Afifi *et al.*, 1982b; Emara, 1982; Lukefahr *et al.*, 1983ab) reported that parity and month of kindling are the most important non-genetic factors affecting litter traits in rabbits. Therefore, genetic evaluation of doe productivity for repeated traits can be improved by the statistical adjustment of these traits for the significant management and temporary environmental influences. In this respect, most of the studies (Rouvier *et al.*, 1973; Donal, 1973; Suh *et al.*, 1978; Lukefahr *et al.*, 1983ab, Lukefahr *et al.*, 1984; Lahiri, 1984) reported that the estimates of repeatability for litter traits of the doe were generally low to moderate.

The objectives of the present study were: (1) to examine the effects of parity, month of kindling and litter size on the performance of litter traits, (2) to quantify differences in litter traits due to sire of doe and does within sire, and (3) to estimate repeatabilities for doe production traits.

MATERIALS AND METHODS

Data on does of the French Bauscat and Egyptian Giza White breeds were collected from 849 litters born at the Experimental Farm of the Faculty of Agriculture at Moshtohor, Zagazig University, Egypt in the period from October, 1975 to September 1983. Litter traits studied were litter weight at birth and at weaning, preweaning mortality (%) and mean bunny weight at weaning (litter weight at weaning/litter size at weaning). The breeding plan and management of the experimental rabbitry were described by Khalil, Owen and Afifi (1986).

Least-Squares Maximum Likelihood method of analysis (Harvey, 1977) were used to analyse the data. Data were sorted according to the sire-daughter (paternal half-sisters) groups and only sires with at least two daughters were included in the analysis. Therefore, the records of 210 daughters (does) of 52 sires were analysed using the following mixed model:

$$Y_{ijklmn} = \mu + S_i + D_{ij} + A_k + B_l + C_m + e_{ijklmn} \qquad (1)$$

where: Y_{ijlkmn} = The obseervation on the ijklmnth litter;

μ = The overall mean, common element to all observations;

S_i = The random effect of i^{th} sire of doe;

D_{ij} = The random effect of j^{th} doe nested within a random effect of i^{th} sire;

A_k = The fixed effect of k^{th} parity;

B_l = The fixed effect of l^{th} month of kindling;

C_m = The fixed effect of m^{th} litter size at birth,

and e_{ijlkmn} = A random deviation of the n^{th} litter of ij^{th} doe and assumed to be independently randomly distributed $(0,\sigma_e^2)$.

However, a dependency in the least-squares equations exists when simultaneously using year of kindling, sires and does within sires in the same mixed model of analysis. Accordingly, the data were adjusted for year-of-kindling effects. Estimates of the sire (σ_S^2), does within sire ($\sigma_{D:S}^2$) and within doe (σ_W^2) components of variance for each year-adjusted litter were derived by equating mean squares to their expectations and solving the resulting set of simultaneous equations. Estimates of repeatability or intraclass correlation (t) were computed for each breed as:

$$t = \frac{\sigma_S^2 + \sigma_{D:S}^2}{\sigma_S^2 + \sigma_{D:S}^2 + \sigma_W^2} \qquad (2)$$

where $\sigma_S^2 + \sigma_{D:S}^2$ estimates the sum of genetic and permanent environmental variances among does, and σ_W^2 estimates temporary environmental effects associated with each litter. Approximate standard errors for the repeatability estimates were computed by the LSML 76 program of Harvey (1977). The approximate standard errors for repeatability were computed from procedures described by Swiger et al. (1964).

RESULTS AND DISCUSSION

Estimation of non-genetic effects

Factors affecting litter weight. Litter weight at birth in Bauscat rabbits and at weaning in both breeds were increased significantly ($P < 0.01$ or $P < 0.001$) as parity advanced (Table 1). This trend agrees closely with those observed by Khalil (1980). In this respect, Zusman (1975), Afifi et al. (1976a) in the first year of their study and Afifi et al. (1982a) found that litter weight at birth and/or at weaning increased from the 1st to 2nd parity and decreased in the 3rd. However, changes in the physiological efficiency of the doe (especially those associated with the intra-uterine environment provided during pregnancy as well as milk production and the ability of the doe to suckle its young until weaning) which occur with advance of parity may be considered as factors that played

Table 1. Least-squares means (g) and tests of significance of factors (fixed) affecting litter weight at birth and at weaning in Bauscat and Giza White rabbits.

Indepenent variable	Litter weight at birth						Litter weight at weaning					
	Bauscat (N=502)			Giza White (N=347)			Bauscat (N=425)			Giza White (N=308)		
	No.	Mean	S.E.	No.	Mean	S.E.	No.	Mean	S.E.	No.	Mean	S.E.
Parity		NS			NS			**			***	
1st	90	296	8.9	65	295	9.2	79	1818	120.8	55	1621	151.6
2nd	87	320	8.8	61	301	9.0	79	1821	119.3	52	1716	148.7
3rd	99	320	8.3	67	306	8.5	79	2038	118.8	60	1755	140.9
4th	88	314	8.4	53	319	9.0	73	2179	116.6	52	1948	142.7
5th	65	308	9.4	35	305	10.9	60	2093	125.2	31	2206	171.0
≥ 6th	73	304	10.0	66	305	10.4	55	2380	140.9	58	2502	161.7
Month of kindling		***			***			***			***	
October-November	79	289	9.2	43	272	10.4	67	1416	127.5	40	1592	161.2
December	58	303	10.3	42	295	10.9	52	2142	140.1	39	2072	168.7
January	88	332	9.0	51	320	9.7	78	2369	120.3	49	2059	151.4
February	82	321	9.0	69	318	8.5	73	2453	122.5	63	2408	139.7
March	61	314	10.0	50	315	9.9	55	2272	134.0	46	2297	155.7
April and May	134	304	7.9	92	311	8.1	100	1677	114.2	71	1321	139.6
Litter size at birth		***			***			***			**	
≤ 3	45	157	11.3	19	161	14.3	34	1656	161.5	16	1555	214.1
4	40	250	11.6	36	254	11.4	30	1771	166.4	29	1615	179.3
5	63	275	9.9	72	278	8.9	50	2043	137.7	63	1967	146.7
6	83	321	9.1	53	320	9.7	74	2031	123.2	50	1953	152.8
7	115	350	8.2	68	338	8.8	98	2078	112.1	62	2132	145.1
8	74	387	9.4	53	371	10.1	70	2591	123.3	44	2138	162.7
≥ 9	82	431	9.3	46	414	10.5	69	2215	127.9	44	2347	160.8

NS = not significant, ** = $P < 0.01$, *** = $P < 0.001$.

the role in expressing differences in litter weight between parities. Holdas and Szendro (1982) concluded that milk yield of does increased as parity advanced. Litters of the 1st parity were the lightest either at birth or at weaning when compared with the litters of the other parities (Table 1). Similar results were observed by other Egyptian investigators (Khalil, 1980; Afifi et al., 1982a; Afifi et al. 1982b; Emara, 1982) for litter weight at birth and by Khalil (1980) for litter weight at weaning.

The least-squares means given in Table 1 showed a general tendency for litter weight at birth to be low in the beginning of the year of production (October and November) and to increase ($P < 0.001$) as month of kindling advanced (reaching its peak in March) and to decrease ($P < 0.001$) slightly at the end of year of production during April and May. The same pattern was observed for the effect of month of kindling on litter weight at weaning, but the peak was recorded by litters born during February. This trend was nearly reported by other Egyptian investigators (Afifi et al., 1976a; Khalil, 1980; Emara, 1982). However, this trend was explained by Afifi et al. (1976a) on the basis of the amount and nutritive value of the available greens and of temperature during these months.

The average weight of the litter at birth and at weaning increased ($P < 0.01$ or $P < 0.001$) with the increase of litter size at birth (Table 1). The levels of significance for the effects of litter size at birth and month of kindling on litter weight indicate that both factors were the most important factors influencing litter weight at birth. Similar results have been reported by Afifi et al. (1976a) and Emara (1982).

Factors affecting preweaning mortality. Preweaning mortality percentages were subjected to arc-sin transformation before being analysed in order to approximate normal distribution. The least-squares means were retransformed to the original scale before being illustrated in Table 2.

Preweaning mortality was slightly changed with the advance of parity and that no definite trend could be established (Table 2). Most of the studies reviewed (Rouvier et al., 1973; Khalil, 1980) showed a general trend indicating that preweaning mortality rate decreased as parity sequence advanced till a definite parity, then increased again in the later subsequent parities. Here, it has been suggested that rabbits' mothering and rearing performance improves with experience. Contradictory to the previous reviewed trend, Afifi et al. (1982a) and Emara (1982) reported

Table 2. Least-squares means and tests of significance of factors (fixed) affecting preweaning mortality and mean bunny weight at weaning in Bauscat and Giza White rabbits

Independent variable	Preweaning mortality				Mean bunny weight at weaning					
	Bauscat		Giza White		Bauscat			Giza White		
	No.	Mean	No.	Mean	No.	Mean	S.E.	No.	Mean	S.E.
Parity		***		***		NS			NS	
1st	90	19.1	65	23.5	79	401	19.2	55	373	21.8
2nd	87	19.3	61	24.5	79	445	18.8	52	420	21.2
3rd	99	31.6	67	27.6	79	455	18.7	60	459	19.7
4th	88	32.4	54	15.5	73	484	18.2	52	442	20.1
5th	65	27.5	35	27.3	60	493	20.1	31	520	25.5
≥ 6th	73	31.1	66	16.5	55	538	23.4	58	532	23.7
Month of kindling		***		***		***			***	
October-November	79	36.5	44	34.0	67	401	20.6	40	414	23.6
December	58	18.8	42	13.2	52	475	23.2	39	480	25.1
January	88	19.2	51	13.8	78	528	19.0	49	481	21.8
February	82	20.0	69	13.2	73	506	19.5	63	523	19.5
March	61	21.6	50	12.0	55	495	21.9	46	459	22.6
April and May	134	46.7	92	56.4	100	410	17.7	71	389	19.4
Litter size at birth		***		***		NS			NS	
≤ 3	45	19.2	19	9.3	34	667	27.5	16	601	33.4
4	40	36.5	36	17.5	30	501	28.5	29	525	27.0
5	63	20.9	72	26.0	50	476	22.7	63	469	20.8
6	83	26.4	53	18.8	74	437	19.6	50	415	22.0
7	115	28.2	68	30.0	98	425	17.2	62	423	20.5
8	74	17.0	53	34.9	68	389	19.7	44	387	23.9
≥ 9	82	39.9	47	23.3	71	390	20.3	44	384	23.6

NS = not significant, *** = $P < 0.001$.

that the percent of litter losses during the suckling period increased from the 1st to the subsequent parities. Results given in Table 2 presented evidence indicating that parity effects had negligible or no significant influence on preweaning litter mortality. Similar findings were reported by other Egyptian investigators (Khalil, 1980; Emara, 1982).

Preweaning mortality decreased ($P < 0.001$) as month of kindling advanced until March and increased ($P < 0.001$) thereafter during April and May (Table 2). The lower litter losses during December to March, as compared with the other months of the year of production, may be due to the higher availability and better nutritive value of green fodder, in addition to the milder weather (especially the atmospheric temperature) which prevails during December, January, February and March months. It is also shown that the lowest litter losses occurred for litters born during December, while the highest losses per litter occurred during April and May. Findings of Ragab and Wanis (1960) and Nossier (1970) proved that the lowest mortality rate up to weaning was for rabbits born during January and February. Lower litter losses were recorded by Khalil (1980) during November and December and by Emara (1982) during March and April. However, the levels of significance for the factors studied indicate that month of kindling was the only factor with a meaningful effect on preweaning mortality. For the breeds studied here and for other breed groups of rabbits, results obtained by some Egyptian studies (Ragab & Wanis, 1960; Khalil, 1980; Emara, 1982) showed the same effect of month of kindling on preweaning mortality. Extensive studies in other countries (Rouvier et al., 1973; Lukefahr et al. 1983c) have demonstrated that month- or season-of-birth effect has an influence on preweaning mortality rate. Khalil (1980) stated that differences among results of different investigators for the effect of month of kindling on mortality percent may be due to differences in the breed groups used, location, management, feeding systems and climatic conditions.

Preweaning litter mortality differed as the size of the litter changed, but the differences were not significant (Table 2). Most of the Egyptian studies (Ragab & Wanis, 1960; Khalil, 1980; Emara, 1982) showed a general trend indicating that mortality percent between birth and weaning increased with the increase of litter size at birth. The increase of preweaning mortality with the increase of litter size at birth seems to be a normal trend. This is because the increase in litter size at birth is associated with a decrease in the average individual weight in the litter at birth (Afifi et al., 1973) and with a lower share of the dams milk during the short period of suckling (2.7 to 4.5 minutes/day) where competition for teats is greater (teat number in the doe ranges from 8 to 10) and consequently the small rabbits become weak, unfit and more susceptible to death.

Factors affecting mean bunny weight at weaning. The mean bunny weight at weaning increased ($P < 0.01$ or $P < 0.001$) as parity sequence advanced till the 6th (Table 2). However, comparing this trend with that observed previously for litter weight at weaning (Table 1) confirms the direct and positive association between litter weight and individual bunny weight measured at weaning. This trend is thought to be due to the improvement in the care and ability of the doe to suckle her young with advance of parity sequence. The highest mean bunny weight at weaning was shown by litters in the 6th parity and the lowest weight was recorded by those of 1st parity (Table 2). Reversed results were observed by Afifi et al. (1982b). Possibly, the present findings are expected because does in their 1st parity have just reached sexual maturity and consequently their ability to suckle her young during the suckling period were at lowest level.

As observed for litter weight, mean bunny weight at weaning increased significantly but at a decreasing rate, as month of kindling advanced (Table 2). The levels of significance for the non-genetic effects included in the model of the statistical analysis, indicates that month of kindling was the most important factor influencing ($P < 0.01$) mean bunny weight at weaning. Lukefahr (1982) observed that month of service had effects ($P < 0.01$) on average bunny weight at weaning at 4 weeks of age.

The average individual bunny weight at weaning decreased ($P < 0.001$) with the increase of litter size at birth (Table 2). The same trend was reported by Afifi et al. (1973). Coupling these findings with the corresponding findings obtained for litter weight at birth and at weaning (Table 1), it could be concluded that larger litter size at birth is related to heavier litter weight at birth and at weaning but with lighter average weaning weight per bunny in the litter.

Estimation of random components of variance

Reference to sires in this study means sire of the doe that produced the litter. The sire of doe affected all the preweaning litter traits, with the exception of preweaning mortality in Bauscat breed (Table 3). However, significant sire effect on most of the litter traits indicate that sire-of-doe effects must be seriously considered when undertaking studies on litter traits in rabbits. Accordingly, improvement in litter traits of rabbits could be made by selection of sires of does based on their own performances for litter traits.

Differences in litter traits due to doe effect were not significant with the exception of litter weight at birth ($P < 0.001$) in Bauscat breed and litter weight at weaning ($P < 0.001$) in Giza White (Table 3). It may be possible that the system of feeding and management practices might have masked the full expression of doe differences as well as a negative covariance may have existed between litters in adjacent years because of imbalances in body reserves of the doe from one year to another. Another explanation could be that does of the present study were not kindled or reared in the same size or weight of litter. This confirmed that the dam effects result in a negative maternal environmental influence on the daughter's litter size and litter weight which may be vary from one doe to another.

The estimates of the sire, doe within sire and within doe components of variance for the different litter traits are shown in Table 3. The percent of the variance attributable to the sire component for all litter traits of Giza White breed are larger than those corresponding variances in Bauscat, i.e. indicating the presence of moderate or high additive genetic variance in Giza White. Therefore, the great variability due to sires shows the possibility for the rabbit breeders in Egypt to improve litter traits of this breed through selection. As for the sire, variation percent due to doe effects on litter traits of Giza White rabbits were larger than those corresponding percentages in Bauscat. This indicates a higher variance of maternal and milking abilities from birth to weaning in the Gize White than in the Bauscat.

The smaller percentages of variation in this study due to doe effect than the sire effect, reflects a larger environmental component of variance associated with the doe during kindling and raising a litter to weaning. Genetic and environmental differences in pre- and post-natal maternal influences can be added as another cause in this respect. Results of some investigators (Rouvier et al., 1973; Garcia et al., 1982ab) showed that in litter traits of rabbits, the dam contributes strongly to the phenotypic

Table 3. Variance component estimates (σ^2) and percentages of variation (V%) due to random effects for litter traits in Bauscat and Giza White rabbits.

	Variance components								
	Sire			Doe/sire			Error		
Litter traits	D.F.	σ^2_S	V%	D.F.	$\sigma^2_{D:S}$	V%	D.F.	σ^2_W	V%
Bauscat									
Litter weight at birth	24	130.04	3.6*	99	371.76	10.2***	356	3151.13	86.2
Litter weight at weaning	23	20299.61	4.4**	92	a	0.0	293	439013.46	95.6
Preweaning mortality (%)	24	a	0.0	99	a	0.0	356	854.89	100.0
Mean bunny weight at weaning	23	612.03	4.7**	92	a	0.0	293	12312.02	95.3
Giza White									
Litter weight at birth	26	296.59	9.5**	59	144.35	4.6	245	2680.81	85.9
Litter weight at weaning	24	128149.90	20.0***	56	79714.40	12.5**	211	431924.55	67.5
Preweaning mortality (%)	26	48.27	7.5*	59	18.20	2.8	245	579.51	89.7
Mean bunny weight at weaning	24	2229.50	14.1***	56	a	0.0	205	13594.34	85.9

[a] Negative estimate of sire or doe components of variance set to zero

value of her product not because of her gene transmission but due to her maternal environmental effects on them. The absence of positive doe variance components for some litter traits and the small values observed for other suggests unreliable estimates of variance for these traits (Table 3). This may be due to small numbers of sires or non-randomness in the distribution of the small numbers of does (daughters) within sire groups. However, the negative or low estimate of variance due to doe effects may suggest that selecting does from dams with better litter traits would not assure genetic response unless corrections were made for maternal environment.

Repeatability estimates

Repeatability estimates for litter traits are given for Bauscat and Giza White in Table 4. Repeatability estimates for most of the litter traits were in general agreement beween the two breeds in this study with the exception of litter weight at weaning, which were 0.04 ± 0.039 and 0.32 ± 0.071 for Bauscat and Giza White rabbits, respectively.

Table 4. Repeatability estimates (t) of litter traits in Bauscat and Giza White rabbits.

Litter traits	Bauscat			Giza White		
	No.	t	S.E.	No.	t	S.E.
Litter weight at birth	496	0.14	0.045	347	0.14	0.054
Litter weight at weaning	425	0.04	0.039	302	0.32	0.071
Preweaning mortality	496	a		347	0.10	0.050
Mean bunny weight at weaning	425	0.05	0.040	302	0.14	0.059

[a] Negative estimate of sire and doe components of variance set to zero.

Repeatability estimates for litter weight at birth and at weaning in both Bauscat and Giza White (Table 4) agree closely with the corresponding estimates of 0.09 ± 0.13 and 0.22 ± 0.14 reported by Lukehfahr et al. (1984). Estimates of Giza White together with the corresponding estimates obtained by Lukefahr et al. (1984) and Lahiri (1984) indicate that repeatabilties for litter weight at weaning were higher than the corresponding estimates at birth. This is because litter weight at birth was highly influenced by litter size at birth (Table 1) and since litter size is of low repeatability (Khalil, 1986), low repeatability estimates for litter weight at birth were to be expected. However, Rouvier et al.

(1973) reported repeatability estimates for litter weight at 21 and 56 days of age to be 0.126 and 0.117 for New Zealand White and 0.237 and 0.211 for Fauve de Bourgogne rabbits, respectively. Also Lukefahr et al. (1983b) reported repeatabilties of 0.33 ± 0.07 and 0.07 ± 0.08 for litter weight at birth and at weaning, respectively.

Repeatability estimate for mortality to weaning in Giza White rabbits is within the range of estimates reported in the literature. Rouvier et al. (1973) reported repeatability estimates for mortality rate from birth to 21 or 56 days of age to be 0.158 and 0.197 for New Zealand White and 0.145 and 0.105 for Fauve de Bourgogne rabbits, respectively. Concerning survival rate of the litter to weaning, repeatability estimates of 0.22 ± 0.08 and 0.18 ± 0.14 were reported by Lukefahr et al. (1983a) and Lukefahr et al. (1984), respectively.

Repeatability estimates for mean bunny weight at weaning in both Bauscat and Giza White are lower than the corresponding estimate of 0.41 ± 0.13 reported by Lukefahr et al. (1984). Also, Rouvier et al. (1973) reported repeatability estimates for individual bunny weight at 21 and 56 days of age to be 0.191 and 0.183 for New Zealand White and 0.208 and 0.379 for Fauve de Bourgogne rabbits, respectively. However, the low estimates of repeatability in both breeds of the present study may be due to mean bunny weight at weaning was greatly affected (P < 0.001) by litter size either at birth or at weaning (Khalil, 1986), and since litter size at the two ages is of low repeatability, low repeatability estimates for mean bunny weight at weaning were to be predicted. Low or slightly moderate estimates ranging from 0.12 ± 0.14 to 0.39 ± 0.19 were also reported by Garcia et al. (1982ab) for New Zealand White and Californian rabbits in the 4 successive years of their study (1977-1980).

In conclusion, the results indicate that doe litter traits were of low repeatability with the exception of litter weight at weaning in Giza White rabbits, i.e. more litters are to be considered before selecting an animal for these traits. Therefore, culling of does based on a single production record would not be advised and consequently assessment of several records are required before selecting does for litter traits. It is recommended to commercial rabbit producers in Egypt and other countries that doe culling could be feasibly practised on litter interval to increase litter productivity per year (Donal, 1973; Lukefahr et al., 1984), on litter weight at 21 days (peak of lactation, Lukefahr et al., 1983b) to improve overall herd milking level, and on mean bunny weight at weaning to attain high growth potential of the young (Lukefahr, 1982). Moreover, number of bunnies weaned per litter should be a practical trait on which to base culling strategies of does of similar genetic background, to improve mean mean herd productivity (Donal, 1973; Lukefahr et al., 1983a). Our data does not suggest, in general, that culling of does for litter traits based on a single production record, as commonly practised in commercial rabbitry operations, would be efficient from a genetic standpoint.

REFERENCES

AFIFI,E.A., EL-TAWIL,E.A., GALAL,E.S.E. & EL-KHISHIN,S.S. (1973). Some aspects of production in three breeds of rabbits and their crosses. I. Average individual weight per litter at birth. Annales of Agricultural Science, Faculty of Agriculture, Ain-Shams University, Egypt. Vol. 18, No.2.

AFIFI,E.A., GALAL,E.S.E., EL-TAWIL,E.A. & EL-KHISHIN,S.S. (1976a). Litter weight in three breeds of rabbits and their crosses. Egyptian Journal of Animal Production 16(2), 99-108.

AFIFI,E.A., GALAL,E.S.E., EL-TAWIL,E.A. & EL-KHISHIN,S.S. (1976b). Litter size at birth and at weaning in three breeds of rabbits and their crosses. Egyptian Journal of Animal Production 16(2), 109-119.

AFIFI,E.A., ABDELLA,M.M.M., EL-SARAFY,A.M. & EL-SAYAAD,G.A. (1982a). Litter traits as affected by feeding urea, breed group and other non-genetic factors. 7th International Congress for Statistics, Computer Science, Social and Demographic Research. March 1982, Ain-Shams University, Cairo, Egypt.

AFIFI,E.A., GALAL,E.S.E. & KADRY,A.E.H. (1982b). The effect of breed and some environmental factors on litter traits in rabbits. 7th International Congress for Statistics, Computer Science, Social and Demographic Research. March 1982, Ain-Shams University, Cairo, Egypt.

DONAL,R. (1973). Repeatability of performance and culling criteria for rabbits on commercial farms. In Journées de Recherches Avicoles et Cunicoles, December 1973, Paris, France.

EMARA,M.E.A. (1982). Effect of crossbreeding on some productive traits in rabbits. Ph. D. Thesis, Faculty of Agriculture, Moshtohor, Zagazig University, Egypt.

GARCIA,F., BASELGA,M., BLASCO,A. & DELTORO,J. (1982a). Genetic analysis of some productive traits in meat rabbits. I. Numeric traits. 2nd World Congress On Genetics Applied to Livestock Production, October 1982, Madrid, Spain.

GARCIA,F., BASELGA,M., BLASCO,A. & DELTORO,J. (1982b). Genetic analysis of some productive traits in meat rabbits. II. Ponderal traits. 2nd World Congress On Genetics Applied to Livestock Production, October 1982, Madrid, Spain.

HARVEY,W.E. (1977). User's guide for LSML76, Mixed Model Least-Squares and Maximum Likelihood Computer Program, Mimeo., Ohio State University, U.S.A.

HOLDAS,S. & SZENDRO,Z. (1982). Milk production of rabbits. Allattenyésztés és Takarmányozás 1(2), 179-184. (Hungarian Agric. Rev., 32:95).

KHALIL,M.H.E. (1980). Genetic and environmental studies on some productive traits in rabbits. M. Sci. Thesis, Faculty of Agricultural Science, Moshtohor, Zagazig University, Egypt.

KHALIL,M.H.E. (1986). Estimation of genetic and phenotypic parameters for some productive traits in rabbits. Ph. D. Thesis, Faculty of Agriculture, Moshtohor, Zagazig University, Egypt.

KHALIL,M.H., OWEN,J.B. & AFIFI,E.A. (1986). A genetic analysis of litter traits in Bauscat and Giza White rabbits. Animal Production. (Submitted for publication).

LAHIRI,S.S. (1984). Possibility of early selection in New Zealand White rabbits. Livestock Adviser 10(12), 11-12.

LUKEFAHR,S., HOHENBOKEN,W.D., CHEEKE,P.R. & PATTON,N.M. (1983a). Doe reproduction and preweaning litter performance of straightbred and crossbred rabbits. Journal of Animal Science 57(5), 1090-1099.

LUKEFAHR,S., HOHENBOKEN,W.D., CHEEKE,P.R. & PATTON,N.M. (1983b). Characterization of straightbred and crossbred rabbits for milk production and associative traits. Journal of Animal Science 57(5), 1100-1107.

LUKEFAHR,S., HOHENBOKEN,W.D., CHEEKE,P.R. & PATTON,N.M. (1983c). Breed, heterotic and diet effects on postweaning litter growth and mortality in rabbits. Journal of Animal Science 57(5), 1108-1116.

LUKEFAHR,S., HOHENBOKEN,W.D., CHEEKE,P.R. & PATTON,N.M. (1984). Genetic effects on maternal performance and litter pre-weaning and post-weaning traits in rabbits. Animal Production 38, 297-300.

RAGAB,M.T. & WANIS,A.A. (1960). Mortality rate in the Baladi rabbit. Bulletin No. 222, Faculty of Agriculture, Cairo University, Egypt.

ROUVIER,R., POUJARDIEU,B. & VRILLON,J.L. (1973). Statistical analysis of the breeding performance of female rabbits: Environmental factors, correlations and repeatabilities. Annales de Génétique et de Sélection Animale 5(1), 83-107.

SCHLOLAUT,W. (1982). The nutrition of the rabbit. Roche, Animal Nutrition Department, Switzerland.

SUH,G.S., KIM,H.S., LEE,K.S., & PARK,Y.I. (1978). Repeatabilities and environmental factors affecting litter size at birth and at weaning and gestation length in rabbits. Research Reports of the Office of Rural Development, Livestock 20, 39-43, Korea.

SWIGER,L.A., HARVEY,W.R., EVERSON,D.O. & GREGORY,K.E. (1964). The variance of intraclass correlation involving groups with one observation. Biometrics 20, 818-826.

ZUSMAN,N.S. (1975). The effect of repeated mating on conception rate and litter size. Animal Breeding Abstracts 44, 2924.