4. RESULTS AND DISCUSSION

4.1 Means of uncorrected records

4.1.1 Litter Traits

Means, standard deviations and percentages of variation for litter traits in each separate parity for New Zealand White (NZW) and Californian (CAL) rabbits are presented in **Table 15**. Litter traits changed but with no definite pattern with advance of parity (**Table 15**). Means for litter traits in different parities show that the highest performance was generally recorded by litters of the second and third parities when compared with litters of other parities. NBA, LSW and LWW in both breeds were increased from the first parity to the second parity and decreased thereafter up to 9th parity, while NBD, NDW and AWW were generally decreased from the first parity to the third parity and inreased thereafter. In other words, the performance of the first two parities was the best for LSB, NBA whereas LSW of the second and third parities were the best. However, the number dead either at birth or at weaning was maximum in the first parity and in later ones (i.e. from six parity and laters).

In most parities, the performance of litter traits at birth in NZW was slightly higher than those of CAL breed (**Table 15**). NBA and NDW for both breeds are nearly similar in different parities (**Table 15**). AWW for NZW is lager than that for CAL breed (**Table 15**). The reviewed estimates reported in different Egyptian studies (**El-Maghawry et al., 1988; Askar, 1989; Abdella et al., 1990; El-Desoki, 1991; Sedki, 1991; Yamani et al, 1991; Youssef, 1992; Khalil, 1993b**) indicated that performance of litter traits in NZW rabbits are better than those in CAL. The present and reviewed results were expected and reflecting the superiority of NZW does in their prenatal (in terms of ovulation rate, ova wastage, embryo survival, fetal survival, uterine capacity, intra-uterine environment,... etc) and postnatal (in terms of milk production, maternal behavior, caring ability, ... etc) maternal abilities than CAL does (**Hulot and Matheron, 1980; Lukefahr et al., 1983b; Blasco et al., 1992**). Better performance in NZW does than in CAL was also declared by many other non-Egyptian investigators. In this concern, **Ponce de Leon (1978), Rouvier (1980) and Masoero et al. (1985)** in Europe have been reported that using NZW as a doe breed produced high performance in litter size traits compared to other doe breeds.

Table (15). Actual means and their standard deviations (SD) and percentages of variation (V%) for litter traits of different parities in New Zealand and Californian rabbits.

	California				New Zealand White			
Trait+	No.	Mean	SD	V%	No.	Mean	SD	V%
1st parity								
LSB	338	8.6	2.13	23.4	288	9.2	2.35	22.4
NBA	338	7.1	2.14	29.6	288	7.7	2.15	25.9
NBD	338	1.4	1.77	124.0	288	1.5	1.88	116.6
NDW	347	1.8	1.74	93.7	288	2.4	1.71	65.5
LSW	347	5.3	1.47	27.0	285	5.3	1.44	26.3
LWW	347	2743.9	716.45	25.2	285	2808.4	734.78	25.1
AWW	347	520.8	47.11	9.0	285	530.6	44.98	8.2
2nd parity								
LSB	373	8.5	1.41	15.5	321	8.7	1.70	18.6
NBA	373	8.0	1.52	17.9	321	8.1	1.54	17.9
NBD	373	.5	1.03	201.1	321	.6	1.13	171.3
NDW	373	1.4	1.22	81.3	321	1.7	1.31	73.2
LSW	374	6.6	1.14	17.0	353	6.3	1.17	17.6
LWW	374	3305.3	560.71	16.8	353	3314.6	559.22	16.2
AWW	374	500.5	32.23	6.4	353	521.4	42.86	7.4
3rd parity								
LSB	367	7.9	1.35	16.3	350	7.9	1.62	18.5
NBA	367	7.4	1.30	17.0	323	7.5	1.53	18.7
NBD	367	.5	.91	182.4	350	.4	.95	208.3
NDW	367	1.3	1.22	92.7	350	1.5	1.21	76.0
LSW	365	6.2	1.13	18.1	323	5.9	1.24	19.9
LWW	365	3130.9	541.31	17.3	323	3104.7	609.53	18.7
AWW	365	507.1	34.12	6.5	323	521.9	42.73	8.1
4th parity								
LSB	366	7.8	1.67	20.9	311	7.9	1.71	20.4
NBA	366	7.1	1.62	22.6	311	7.3	1.71	22.8
NBD	366	.6	1.10	169.6	311	.6	1.05	171.8
NDW	366	1.2	1.25	97.0	311	1.6	1.42	86.5
LSW	365	5.8	1.33	22.7	307	5.7	1.32	23.3
LWW	365	2992.4	661.57	6.9	307	3023.5	657.83	21.6
AWW	365	513.2	53.25	10.5	307	528.3	52.46	15.1

Table (15). Cont.

Trait	California				New Zealand White			
	No.	Mean	SD	V%	No.	Mean	SD	V%
5th parity								
LSB	357	7.5	1.52	18.9	304	7.9	1.82	20.6
NBA	358	7.0	1.62	22.0	304	7.3	1.75	22.6
NBD	358	.5	1.11	190.3	304	.5	1.13	198.1
NDW	358	1.2	1.37	109.9	304	1.6	1.26	77.4
LSW	357	5.7	1.39	23.3	303	5.7	1.40	23.7
LWW	357	2942.1	713.29	23.5	303	3006.5	694.30	22.5
AWW	357	515.6	68.85	13.2	303	524.5	39.03	7.0
6th parity								
LSB	326	7.5	1.68	21.2	285	7.9	1.90	22.8
NBA	326	6.8	1.90	26.7	285	7.0	2.09	29.0
NBD	326	.6	1.34	194.0	285	.9	1.66	175.6
NDW	324	1.3	1.50	112.3	277	1.7	1.56	86.3
LSW	324	5.5	1.60	28.4	277	5.4	1.67	30.2
LWW	324	2806.0	776.99	26.9	277	2852.5	832.76	28.5
AWW	324	514.3	47.04	9.0	277	534.6	68.92	12.4
7th parity								
LSB	272	7.5	1.79	23.0	271	7.9	1.76	20.0
NBA	272	6.4	2.17	32.3	271	7.1	1.94	25.9
NBD	272	1.0	1.81	175.0	271	.8	1.59	197.9
NDW	272	1.4	1.61	107.5	271	1.7	1.52	84.7
LSW	267	5.0	1.72	32.9	263	5.5	1.52	27.4
LWW	267	2627.3	845.02	31.3	263	2928.9	774.32	25.8
AWW	267	524.1	46.22	8.5	263	530.9	49.72	9.3
8th parity								
LSB	202	7.0	1.75	23.7	214	7.9	1.66	18.6
NBA	202	5.6	2.23	38.7	451	6.7	2.08	30.8
NBD	202	1.3	1.95	140.0	214	1.2	1.75	160.1
NDW	191	1.1	1.60	137.0	451	1.9	1.89	93.5
LSW	191	4.7	1.89	39.0	214	5.1	1.71	32.6
LWW	191	2431.1	940.52	37.5	214	2720.2	845.16	30.5
AWW	191	521.7	43.96	8.9	214	539.0	54.57	9.1

Table (15). Cont.

	California				New Zealand White			
Trait	No.	Mean	SD	V%	No.	Mean	SD	V%
9th parity**								
LSB					208	7.5	2.01	25.5
NBA					232	6.5	2.15	32.5
NBD					232	1.0	1.52	194.9
NDW					232	2.1	2.00	96.0
LSW					208	4.9	1.74	35.8
LWW					208	2651.3	905.10	34.3
AWW					208	546.4	66.10	11.9

* LSB= litter size at birth, NBA= number born alive, NBD= Number born dead, NDW= number dead at weaning, LSW= litter size at weaning, LWW= litter weight at weaning, AWW= average weaning weight.

** Records of the 9th parity in California rabbits were not avaliable.

Means of litter traits (LSB, NBA, NBD, LSW, LWW, AWW) reported here and those reviewed from literature for NZW and CAL rabbits indicated that rabbits of these two standard breeds raised in other Mediterranean countries are relatively better than those rabbits raised in Egypt. Accordingly, the genetic potentiality of these two standard breeds raised in adverse environment are not completely expressed in Egypt. This is due to NZW and CAL rabbits were raised in Egypt under unsuitable climatic and management conditions. Reduction due to the existence of genotype-environment interaction could be added as another cause in this respect.

4.1.2 Reproductive performance

Means and their standard deviation (SD) and percentages of variation (V%) of doe reproductive performance in separate parities for NZW and CAL rabbits are presented in **Table 16**.

For separate parities, it is clear that different parities have similar NSC, DO and KI (**Table 16**). **El-Desoki (1991)** obtained moderate means of 22.8 and 20.9 days for DO in NZW and CAL raised in Egypt. **Abd El-Raouf (1993)** found that DO for NZW and CAL ranged from 10.4 to 12.7 days. The same author found that KI for both breeds ranged from 51.4 to 52.4 day. Most of the Egyptian studies (i.e. **Khalil and Mansour, 1987, El-Desoki, 1991, Hilmy, 1991; Sedki, 1991; Youssef, 1992)** indicated also that pattern of interval traits (DO&KI) in different parities was inconsistant.

Reproductive intervals for NZW rabbits were relatively lower than those in CAL rabbits (**Table 16**). Periods of DO and KI obtained here indicated also that these intervals are moderate in both breeds raised in adverse environment (DO and KI averaged 16.1 and 31.6 days for NZW and 17.5 and 47.3 days for CAL, respectively). These moderate intervals are one of the encouraging factors to use these exotic breeds in Egypt on a large scale of commercial production. **El-Desoki (1991)** confirmed this concern since he obtained moderate means of DO and KI for NZW and CAL rabbits raised under the Egyptian conditions. The estimates for DO and KI were 22.8 and 52.6 days in NZW and 22.8 and 51.4 days for CAL rabbits, respectively. Also, **Khalil (1993a&b)** reported that the estimates for DO and KI were 17.9 and 48.8 days for Giza White rabbits (GW), 10.4 and 42.2 days for NZW and 12.7 and 43.7 days for CAL rabbits.

Table (16). Actual means and their standard deviations (SD) and percentages of variation (V%) for reproductive performance traits* of different parities in New Zealand White and Californian rabbits.

Trait*	California				New Zealand White			
	No.	Mean	SD	V%	No.	Mean	SD	V%
1st parity								
NSC	373	1.7	.58	32.3	321	1.7	.63	36.4
DO	373	20.9	8.65	40.9	321	19.3	8.97	46.0
KI	373	50.9	7.27	14.2	321	49.3	7.69	15.6
2nd parity								
NSC	367	1.5	.66	43.8	350	1.5	.65	42.6
DO	367	19.8	10.19	52.1	350	16.9	9.95	57.9
KI	367	49.3	7.78	16.1	323	46.6	8.00	17.0
3rd parity								
NSC	366	1.5	.64	39.9	311	1.5	.70	45.1
DO	366	20.2	9.36	45.5	311	17.7	10.27	58.5
KI	366	49.9	7.44	14.7	311	47.4	8.28	17.5
4th parity								
NSC	358	1.6	.72	45.5	304	1.5	.71	45.3
DO	358	20.2	10.41	51.8	304	18.3	10.23	56.8
KI	358	49.6	7.76	16.0	304	48.0	8.42	18.0
5th parity								
NSC	326	1.4	.63	42.7	285	1.5	.68	44.7
DO	326	18.9	9.43	49.1	285	16.8	10.59	60.1
KI	326	48.8	7.57	15.4	285	46.5	8.72	18.0
6th parity								
NSC	272	1.6	.69	41.7	271	1.5	.72	44.3
DO	272	20.6	10.52	49.7	271	17.4	10.94	60.0
KI	272	49.9	7.84	15.3	271	46.9	8.78	18.1
7th parity								
NSC	202	1.5	.66	41.9	214	1.6	.69	42.3
DO	191	18.1	8.89	48.6	214	18.5	10.71	55.7
KI	191	49.1	9.08	18.4	214	48.0	8.54	17.3
8th parity**								
NSC					232	1.6	.69	44.5
DO					232	18.2	10.99	61.7
KI					232	47.7	8.69	18.8

* NSC= number of services per conception, DO= days open, KI= kindling interval.

** Records of the 8th parity in California rabbits were not avaliable

4.2 Variations of uncorrected records

4.2.1 Litter traits

The percentages of phenotypic variation (V%) for uncorrected litter traits in NZW and CAL rabbits are presented in **Table 15.** These estimates were found to be changed, with no clear pattern, as age of litter advanced in both breeds. In general, estimates of V% for LSW were greater than those for LSB in each parity. Similarly, **Lukefahr (1982), Khalil et al. (1987b), Afifi et al. (1992), Hassan (1995), Khalil (1993a) and Abd El-Raouf (1993)** observed higher V% at weaning than at birth for litter traits. Higher percentage of variation in litter size at weaning than at birth may be due to differences in litter losses during the suckling period and to differences in post-natal growth of the litter-mates up to weaning caused by differences in their genotypes and in milk production of their dams during the suckling period (**Khalil, 1994**). High variability of litter traits at birth and at weaning would lead to a greater improvement in these traits through phenotypic selection at weaning than at earlier ages. In the reverse direction, higher variability for NBD than that for NDW may lead to state that a higher improvement in this trait will be gained at earlier ages than at weaning. The estimates of V% given in **Table 15** indicated that phenotypic variation in litter traits was high in the first parity and decreased thereafter until the fourth one which increased forward with advance of parity. **Hulot and Matheron (1980) and Blasco et al. (1992)** attributed the high variation in litter traits at birth to the high variation in ovulation rate, embryo and fetal survival and uterine capacity.

Variations of all uncorrected litter traits in NZW and CAL rabbits were generally moderate or high (**Table 15**). Results of **Lukefahr (1982), Khalil et al. (1987b), El-Maghawry (1990), Lukefahr et al. (1990) and Khalil (1993a)** confirmed this concept. **Khalil et al. (1987a) and Khalil (1994)** attributed this concept on the basis of great variation in growth of bunnies (in terms of variation in milk production) along with preweaning survival where the bunnies up to the age of 12 day (when they open their eyes) remained solely on their dam's milk and thereafter the dam's milk provided the main supply of nutrients for the young until they were weaned. It may be also due to that litters after kindling until weaning become more sensitive to the non-genetic maternal effects (e.g. parity, age of doe, ... etc.) which decrease thereafter with advancing of litter's age.

In each separate parity, esitmates of V% in NZW rabbits ranged from 18.5 to 25.5% for LSB, from 17.9 to 32.5% for NBA, from 65.5 to 96.0% for NDW, from 17.6 to 35.8% for LSW, from 16.2 to 34.3%

for LWW and from 7.0 to 15.1% for AWW **(Table 15)**. For CAL rabbits, the corresponding estimates were from 15.5 to 23.7%, 17.0 to 38.7%, 81.3 to 137.0%, 17.0 to 39.0%, 6.9 to 37.0% and 6.4 to 13.2% **(Table 15)**. Figures for both breeds in each separate parity showed that AWW recorded the lowest variation while NDW recorded the highest variation. LSB, NBA, LSW and LWW recorded moderate variation **(Table 15)**. High or moderate variation obtained here for most litter traits in NZW and CAL rabbits and those high estimates observed by other Egyptian studies for the same traits of the same two breeds and/or other breeds gave an evidence that improvement of litter traits in rabbits through phenotypic selection is quite possible **(Khalil et al., 1987a&b; El-Maghawry, 1990; Hilmy, 1991; Abd El-Raouf, 1993; Khalil, 1993b; Khalil, 1994)**.

4.2.2. Reproductive Performance

Estimates of V% in **Table 16** showed that phmotypic variations of uncorrected interval traits (DO and KI) and NSC were moderate or high in different parities. The estimates ranged from 14.2 to 61.7% in different parities. These estimates indicated that KI exhibited the lowest phenotypic variation while DO and NSC showed the largest variability. Variability trend in different parities of both breeds did not show any consistant trend **(Table 16)**.

Variation in DO in both breeds was relatively high compared with KI **(Table 16)**. This trend is clear since estimates of V% for DO ranged from 46.0 to 60.7% in NZW and from 40.9 to 57.6% in CAL, while they ranged from 15.6 to 18.8% for KI in NZW and from 14.2 to 18.4% in CAL. The corresponding estimates reported by another Egyptian study **(Khalil, 1993b)** were 138 and 56% for DO and KI in NZW, while they were 122 and 36% for CAL rabbits, respectively. However, high variation in reproductive intervals of doe rabbits in Egypt could be attributed to the variation in management decisions (in terms of post-partum mating system, remating schedule, ... etc.).

4.3 ANOVA and tests of significance

ANOVA and F-ratios estimated by Henderson method and REML along with tests of significance of factors contributing to the variation of different doe traits in NZW and CAL rabbits are shown in **Tables 17&18&19&20&21&22**. In most cases, year-season affected significantly litter traits at birth and at weaning in both breeds, while it showed insignificant effect on DO, KI and NSC in most parities of both breeds.

Table (17). ANOVA and F-ratios (F) for litter traits at birth estimated using **Henderson** method in **Californian** and **New Zealand White** rabbits.

Source of variation	Californian					New Zealand White				
	LSB		NBA		NBD	LSB		NBA		NBD
	d.f.	F	d.f.	F	F	d.f	F	d.f.	F	F
1st parity										
Sire	39	.88		.81	.65	44	1.00		1.26	1.20
Year-season	7	7.67***		3.35**	1.25	11	6.64***		4.18***	1.85*
Remainder d.f	291					232				
Remainder mean sq.		4.07		4.50	3.25		4.34		4.00	3.32
2nd parity										
Sire	39	.80		.92	1.14	44	1.06		1.04	1.75**
Year-season	7	8.91***		6.93***	.81	11	2.90***		3.21***	1.55
Remainder d.f	326					265				
Remainder mean sq.		1.77		2.07	1.05		2.69		2.13	1.14
3rd parity										
Sire	39	.90		.94	.94	44	1.18	44	1.17	.75
Year-season	7	5.47***		3.92***	.80	11	6.75***	11	5.79***	.65
Remainder d.f	320					294		267		
Remainder means sq.		1.71		1.62	.84		2.14		1.99	.94
4th parity										
Sire	39	.71		.52	.70	44	.78		.71	1.13
Year-season	7	5.48***		4.75***	1.23	11	4.50***		3.07***	1.11
Remainder d.f	319					255				
Remainder mean sq.		2.68		2.61	1.26		2.66		2.82	1.10
5th parity										
Sire	39	1.01	39	1.09	1.07	44	.76		.68	.71
Year-season	7	5.41***	7	4.11***	.74	11	6.81***		3.84***	1.84*
Remainder d.f	310		311			248				
Remainder mean sq.		2.06		2.38	1.25		2.70		2.79	1.29
6th parity										
Sire	39	.97		1.19	1.08	44	.49		.98	1.14
Year-season	7	5.53**		2.99**	1.15	11	4.27***		1.49	1.41
Remainder d.f	279					229				
Remainder mean sq.		2.55		3.34	1.79		3.31		4.17	2.67

Table (17). Cont.

Source of variation	Californian LSB d.f.	Californian LSB F	Californian NBA F	Californian NBD F	New Zealand White LSB d.f	New Zealand White LSB F	New Zealand White NBA d.f.	New Zealand White NBA F	New Zealand White NBD d.f.	New Zealand White NBD F
7th parity										
Sire	39	.45	1.12	.72	44	1.09		.78		1.10
Year-season	7	5.93**	3.88***	.50	11	4.71***		3.37***		.85
Remainder d.f	225				215					
Remainder mean sq.		3.02	4.38	3.48		2.56		3.48		2.51
8th parity										
Sire	39	1.37	1.10	1.06	44	1.54*	44	1.06	44	1.07
Year-season	7	1.84	2.01*	.98	11	2.97***	11	1.42	11	1.22
Remainder d.f	155				158		395		158	
Remainder mean sq.		2.82	4.85	3.79		2.19		4.30		2.88
9th parity''										
Sire					44	1.36	44	1.18		.99
Year-season					11	1.59	11	.69		.64
Remainder d.f					152		176			
Remainder mean sq.						3.66		4.58		2.42

*= $P<0.05$, **= $P<0.01$ and ***= $P<0.001$.

' LSB= litter size at birth, NBA= number born alive, NBD= Number born dead.

'' Records of the 9th parity in California rabbits were not avaliable.

Table (18). ANOVA and F-ratios (F) for litter traits at weaning'' estimated using Henderson 3 method in Californian and New Zealand White rabbits.

Source of variation	Californian						New Zealand White				
		LSW	LWW	AWW	NDW			LSW	LWW	AWW	NDW
	d.f.	F	F	F	d.f.	F	d.f.	F	F	F	F
1st parity											
Sire	39	1.23	1.34	1.01	39	1.07	44	1.11	1.08	1.19	1.19
Year-season	7	2.21*	2.42*	1.61	7	1.71	11	2.45**	3.13***	2.43**	3.57***
Remainder d.f	300				300		229				
Remainder means sq.		2.06	478125	2193		2.98		1.97	496588	1879	2.56
2nd parity											
Sire	39	.73	.87	.99		1.28	44	.92	1.06	1.10	1.08
Year-season	7	3.33**	2.32*	1.64		4.75***	11	2.54**	2.22**	6.41***	2.33**
Remainder d.f	327						297				
Remainder mean sq.		1.27	307617	1019		1.38		1.27	289341	1500	1.65
3rd parity											
Sire	39	1.05	.82	1.45*		.75	44	1.07	.96	.68	1.28
Year-season	7	1.31	1.77	1.76		2.05*	11	3.36***	3.89***	2.57**	2.83***
Remainder d.f	318						267				
Remainder mean sq.		1.26	291781	1081		1.49		1.43	337598	1789	1.36
4th parity											
Sire	39	.82	.88	.89		.74	44	.79	1.01	1.28	.50
Year-season	7	2.95**	2.83**	1.01		2.17*	11	1.41	1.28	3.26***	2.66**
Remainder d.f	318						251				
Remainder mean sq.		1.78	428130	2888		1.55		1.82	426733	2467	2.04
5th parity											
Sire	39	1.39	1.16	1.22		.79	44	.72	.75	.98	.71
Year-season	7	1.87	2.20*	1.14		1.39	11	2.86***	2.98***	2.33**	1.72
Remainder d.f	310	1.81					247				
Remainder mean sq.			477350	4599		1.90		1.87	455856	1356	1.61
6th parity											
Sire	39	1.07	1.00	1.00	39	1.04	44	1.13	1.04	1.03	1.15
Year-season	7	2.33*	2.83**	1.55	7	1.37	11	.83	.88	2.44**	1.84
Remainder d.f	277				277		221				
Remainder mean sq.		2.46	569863	2162		2.21		2.69	660671	4363	2.33

Table (18). Cont.

Source of variation	Californian						New Zealand White					
		LSW	LWW	AWW	NDW			LSW	LWW	AWW	NDW	
	d.f.	F	F	F	d.f.	F	d.f.	F	F	F	d.f.	F
7th parity												
Sire	39	1.28	1.18	1.66		1.35	44	.85	.95	.65		.79
Year-season	7	2.24*	2.69**	.38		2.86**	11	1.52	2.48**	1.59		2.305**
Remainder d.f	220											
Remainder mean sq.		2.79	674633	1978		2.57	207	2.32	569338	2457		2.28
8th parity												
Sire	39	1.29	1.33	.63	39	1.01	44	.86	.85	1.54*	44	1.15
Year-season	7	1.50	1.67	1.00	7	1.98	11	1.43	1.44	2.64**	11	1.89*
Remainder d.f	144				144		158				395	
Remainder mean sq.		3.41	831444	2076		2.54		2.80	686451	2388		3.49
9th parity'												
Sire							44	1.00	.99	1.00		.76
Year-season							11	.85	.83	1.78		1.44
Remainder d.f							152					
Remainder means sq.								3.11	829238	4228		4.13

*= P<0.05. **= P<0.01 and ***=P<0.001.

' =Records of 9th parity in Californian were not avialable.

Table (19). ANOVA and F-ratios (F) for reproductive interval traits[1] estimated using Henderson 3 method in Californian and New Zealand White rabbits.

Source of variation	Californian NSC d.f.	Californian NSC F	Californian DO d.f	Californian DO F	Californian KI F	New Zealand White NSC d.f.	New Zealand White NSC F	New Zealand White DO F	New Zealand White KI d.f.	New Zealand White KI F
1st parity										
Sire	39	1.319		1.279	1.147	44	.766	1.056		.924
Year-season	7	1.572		.479	.479	11	1.299	1.259		1.044
Remainder d.f.	326					265				
Remainder mean sq.		.327		73.272	52.610		.407	78.982		59.279
2nd parity										
Sire	39	.731		.731	.586	44	1.010	.844	44	1.012
Year-season	7	1.988*		1.303	.740	11	1.523	1.610	11	1.080
Remainder d.f.	320					294			267	
Remainder mean sq.		.452		106.662	63.391		.416	96.729		62.747
3rd parity										
Sire	39	1.362		1.250	1.231	44	.829	.973		1.098
Year-season	7	2.100***		1.521	1.038	11	.571	.807		1.127
Remainder d.f.	319					255				
Remainder mean sq.		.394		84.907	53.936		.514	108.019		68.823
4th parity										
Sire	39	.797		.607	.568	44	.786	.870		.728
Year-season	7	1.157		1.593	.716	11	1.024	.644		.732
Remainder d.f.	311					248				
Remainder mean sq.		.531		110.241	63.199		.522	108.072		74.354
5th parity										
Sire	39	1.102		1.083	1.103	44	1.027	1.307		1.272
Year-season	7	1.151		1.455	.652	11	1.683	3.213***		3.024***
Remainder d.f.	279					229				
Remainder mean sq.		.396		86.654	56.812		.463	102.830		70.093
6th parity										
Sire	39	1.303		1.118	1.164	44	.934	1.031		1.026
Year-season	7	1.723		2.334*	2.221*	11	2.666**	2.603**		2.132**
Remainder d.f.	225					215				
Remainder mean sq.		.464		105.807	58.320		.482	109.226		72.567
7th parity										
Sire	39	1.187	39	1.083	1.038	44	1.109	1.240		1.158
Year-season	7	.731	7	.737	.685	11	.824	1.087		.979
Remainder d.f.	155		144			158				
Remainder mean sq.		.423		77.683	81.858		.475	106.295		69.166
8th parity										
Sire						44	.478	.853		.762
Year-season						11	.723	.602		.634
Remainder d.f						176				
Remainder mean sq.							.539	127.511		80.745

*= P<0.05, **= P<0.01 and ***=P<0.001. [1] =Records of 9th parity in Californian were not avialable.

[1][1] NSC= Number of services per conception. DO= Days open, KI= Kindling interval.

Table (20). ANOVA and F-ratios (F) for litter triats at birth estimated using REML method in New Zealand White and Californian rabbits.

Source of Variation	Californian						New Zealand White					
	LSB		NBA		NBD		LSB		NBA		NBD	
	d.f	F	d.f	F	d.f	F	d.f	F	d.f	F	d.f.	F
1^{st} parity												
Year-season									11	4.08***		1.82*
Remainder d.f.									276			
Remainder mean sq.										4.05		3.32
2^{nd} parity												
Year-season					7	0.87	11	3.60***		4.63***		1.58
Remainder d.f					365		343					
Remainder mean sq.						1.05		2.65		2.21		1.16
3^{rd} parity												
Year-season							11	7.35***	11	5.73***		
Remainder d.f							314		311			
Remainder mean sq.								2.11		1.98		
4^{th} parity												
Year-season											11	0.74
Remainder d.f											299	
Remainder mean sq.												1.09
5^{th} parity												
Year-season	7	7.52***	7	6.09***		0.62						
Remainder d.f	349		350									
Remainder mean sq.		2.05		2.38		1.25						
6^{th} parity												
Year-season			7	3.61***		0.96					11	1.45
Remainder d.f			318								273	
Remainder mean sq.				3.32		1.78						2.67
7^{th} parity												
Year-season			7	3.36**			11	5.63***				
Remainder d.f			264				251					
Remainder mean sq.				4.38				2.56				
8^{th} parity												
Year-season	7	1.68		1.27		0.86	11	3.62***	11	1.78*	11	1.91*
Remainder d.f	194						202		207		202	
Remainder mean sq.		2.84		4.84		3.67		2.20		3.82		2.85
9^{th} parity'												
Year-season							11	1.50	11	0.54		
Remainder d.f							196		220			
Remainder mean sq.								3.64		4.45		

*= P<0.05, **= P<0.01 and ***=P<0.001.

' =Records of 9^{th} parity in Californian were not avialable.

' LSB= litter size at birth, NBA= number born alive, NBD= Number born dead.

Table (21). ANOVA and F-ratios (F) for litter triats at weaning estimated using REML method in New Zealand White and Californian rabbits.

Source of variaiton	Californian						New Zealand White							
	LSW		LWW	AWW	NDW		LSW		LWW		AWW		NDW	
	d.f	F	F	F	d.f	F	d.f	F	d.f	F	d.f	F	d.f	F
1st parit														
Year-season	7	2.03*	2.54**	1.52	7	1.46	11	2.36**		2.93***		2.16***	11	3.92***
Remainder d.f	339				339		273						276	
Remainder mean sq.		2.08	480683	2187		3.00		1.96		497166		1919		2.58
2nd parity														
Year-season						4.52***			11	3.31***		7.62***	11	2.42***
Remainder d.f									341				343	
Remainder mean sq.						1.383				290373		1480		1.65
3rd parity														
Year-season	7	1.78		2.15*			11	3.26***					11	3.18***
Remainder d.f	357						311						314	
Remainder mean sq.		1.27		1084				1.42						1.29
4th parity														
Year-season									11	1.35		3.01***		
Remainder d.f									295					
Remainder mean sq.		422600	2508											
5th parity														
Year-season	7	2.79**	3.29**	1.27										
Remainder d.f	349													
Remainder mean sq.		1.80	477200	4588										
6th parity														
Year-season	7	3.11**		2.05*	7	1.71	11	1.58		1.90*		3.07***	11	1.79*
Remainder d.f	316				318		265						273	
Remainder mean sq.		2.47		2147		2.20		2.74		650450		4352		2.33
7th parity														
Year-season	7	1.86	2.28*	.32	7	3.051**								
Remainder d.f	259				264									
Remainder mean sq.		2.78	670693	1972		2.58								
8th parity														
Year-season	7	.96	1.07		7	1.38					11	3.05***	11	1.59
Remainder d.f	183				183						202		207	
Remainder mean sq.		3.42	834325			2.45						2364		2.92
9th parity'														
Year-season							11	0.55				1.61		
Remainder d.f							196							
Remainder mean sq.								3.07				4126		

*= P<0.05, **= P<0.01 and ***=P<0.001.

' =Records of 9th parity in Californian were not avialable.

'' LSW= litter size at weaning, LWW= litter weight at weaning, AWW= average weaning weight, NDW= number dead at weaning

Table (22). ANOVA and F-ratios (F) for reproductive traits estimated using REML method in New Zealan White and Californian rabbits.

Source of variation[1]	Californian					New Zealand White					
	NSC		DO		KI	NSC		DO		KI	
	d.f	F	d.f	F	F	d.f	F	d.f	F	d.f	F
1st parity											
Year-season	7	1.73		0.54	0.51			11	1.36		
Remainder d.f	365							343			
Remainder mean sq.		0.33		73.5	52.5				83.0		
2nd parity											
Year-season						11	1.60			11	1.53
Remainder d.f						314				311	
Remainder mean sq.							0.42				62.2
3rd parity											
Year-season	7	1.81		1.25	1.14					11	0.59
Remainder d.f	358									299	
Remainder mean sq.		0.39		85.3	54.1						68.6
5th parity											
Year-season	7	1.28		1.74	0.79	11	1.18		2.21**		2.18**
Remainder d.f	318					273					
Remainder mean sq.		0.39		86.0	56.6		0.46		103.8		70.7
6th parity											
Year-season	7	1.03		2.13*	2.18*			11	3.19***		2.41**
Remainder d.f	264							259			
Remainder mean sq.		0.47		106.2	58.6				107.7		72.8
7th parity											
Year-season	7	0.86	7	1.02	0.98	11	1.03		1.49		1.37
Remainder d.f	194		183			202					
Remainder mean sq.		0.43		77.9	82.1		0.48		107.8		69.6

*= P<0.05, **= P<0.01 and ***=P<0.001.

[1] K values for 4th and 8th parities were not available and consequently equations had not iteration solution.

[11] NSC= Number of services per conception, DO= Days open, KI= Kindling interval.

Least-squares means for litter traits (LSB, NBA, NBD, LSW, LWW, NDW and AWW) and reporoductive performance traits (NSC, DO and KI) in different year-season subclasses are presented in **Appendices 1&2&3&4&5&6**.

4. 4 Variance components

For both breeds, differences in most doe traits due to sire effect were inconsistent and not significant (**Tables 17&18&19**). In Egypt, some investigators reported non-significant sire effect on litter traits in rabbits (**Khalil et al., 1987b; Afifi et al., 1989; Farghaly et al., 1993**), while others reported significant effect (**Khalil et al., 1987a; Khalil and Afifi, 1991; Khalil, 1993a; Farghaly et al., 1993**). **Afifi et al. (1992)** with NZW and CAL rabbits found that sire affected significantly LSW in NZW ($P<0.05$), while it had no significant effect on all other doe traits (LSB, LS21, LWB, LW21 and LWW). **Khalil (1993a)** with Giza White (GW) rabbits reported insignificant sire effect for all traits studied (LSB, LSW, LWB and LWW) except PM ($P<0.001$).

Ronningen (1972) reported that the knowledge of variance components and the size of heritability is of great importance in the descision of which selection methods should be used. **Khalil et al. (1986)** reported that the apparent differences in sire variance components and heritabilities for litter traits in rabbits were probably due to: (i) the method of estimation, (ii) the genetic make-up of the breeds in the herd, (iii) the availabe number of observations used in the estimation, and (iv) the correction for the non-genetic factors which were made on each set of data.

4.4.1 Mehtods of estimation and variance components

The variance components estimated using Henderson's method and Restircted Maximum Likelihood (**REML**) along with percentages of variation (V%) attributed to the sire and remainder for litter traits, number of services per conception and reproductive intervals in NZW and CAL rabbits are shown in **Tables 23&24&25&26.**

In different parities, percentages of variatiion due to sire estimated here using **Henderson** method were low or somewhat moderate (**Tables 23&25**). The estimates for CAL rabbits ranged from 0.1 to 7.1% for LSB, 1.1 to 2.4% for NBA, 0.8 to 1.5% for NBD, 0.3 to 5.0% for NDW, 0.6 to 6.0% for LSW, 1.8 to 6.7% for LWW, 0.01 to 9.3% for AWW, 0.2 to 3.9% for NSC, 1.1 to 3.4% for DO and 0.8 to 3.4% for KI. The corresponding estimates in NZW ranged from 0.8 to 10.9% for LSB, 0.6 to 4.0% for

Table (23). Estimates (σ^2) and percentages (V%) of variance components due to sire (σ^2_s) and remainder (σ^2_e) and sire heritabilities (h^2) estimated using Henderson 3 method for litter traits in different parities for New Zealand White and Californian rabbits

Trait	Californian						New Zealand White					
	Sire		Remainder		h^2	SE	Sire		Remainder		h^2	SE
	σ^2_s	V_s%	σ^2_e	V_e%			σ^2_s	V_s%	σ^2_e	V_e%		
1st parity												
LSB	a		4.07	100.0	a		a		4.34	100.0	a	
NBA	a		4.50	100.0	a		.1680	4.0	4.00	96.0	.161	.176
NBD	a		3.25	100.0	a		.1120	3.3	3.32	96.7	.131	.172
NDW	.0240	0.8	2.98	99.2	.032	.120	.0820	3.1	2.56	96.9	.124	.171
LSW	.0573	2.7	2.06	97.3	.108	.133	.0362	1.8	1.97	98.2	.072	.165
LWW	19458.1	3.9	478125.7	96.1	.156	.141	6974.4	1.4	496588.3	98.6	.055	.163
AWW	2.9	0.1	2193.5	99.9	.005	.115	60.6	3.1	1879.1	96.9	.125	.173
2nd parity												
LSB	a		1.77	100.0	a		.0217	0.8	2.6888	99.2	.032	.140
NBA	a		2.07	100.0	a		.0139	0.6	2.1326	99.3	.026	.139
NBD	.0158	1.5	1.05	98.5	.059	.116	.1267	10.0	1.1396	90.0	.400	.191
NDW	.0425	3.0	1.38	97.0	.120	.127	.0191	11.2	1.6484	88.8	.046	.142
LSW	a		1.28	100.0	a		a		1.2658	100.0	a	
LWW	a		307617.4	100.0	a		2225.7	0.8	289341.1	99.2	.031	.126
AWW	a		1019.6	100.0	a		19.6	1.3	1500.7	98.7	.052	.130
3rd parity												
LSB	a		1.71	100.0	a		.0516	2.4	2.1428	97.6	.094	.137
NBA	a		1.62	100.0	a		.0487	2.4	1.9876	97.6	.096	.149
NBD	a		.84	100.0	a		a		.9412	100.0	a	
NDW	a		1.5	100.0	a		.0515	2.4	1.3644	97.3	.146	.145
LSW	.0070	0.6	1.3	99.5	.022	.112	.0150	1.0	1.4266	99.0	.042	.140
LWW	a		291781.5	100.0	a		a		337598.2	100.0	a	
AWW	55.5	4.9	1082.0	95.1	.195	.142	a		1789.5	100.0	a	
4th parity												
LSB	a		2.6750	100.0	a		a		2.6610	100.0	a	
NBA	a		2.6105	100.0	a		a		2.8197	100.0	a	
NBD	a		1.2574	100.0	a		.0214	1.91	1.1018	98.0	.076	.151
NDW	a		1.5539	100.0	a		a		2.0429	100.0	a	
LSW	a		1.7760	100.0	a		a		1.8155	100.0	a	
LWW	a		428130.4	100.0	a		704.6	0.16	426733.4	99.8	.007	.143
AWW	a		2888.4	100.0	a		105.52	4.10	2467.9	95.9	.164	.166

Table (24). Estimates (σ^2) and percentages (V%) of sire and error variance components and sire heritabilities ($\pm$SE) estimated using REML method for litter traits in different parities for New Zealand White and Californian rabbits.

	Californian						New Zealand White					
	Sire		Remainder		h^2	SE	Sire		Remainder		h^2	SE
Trait''	σ^2_s'	V_s%	σ^2_e	V_e%			σ^2_s	V_s%	σ^2_e	V_e%		
1st parity												
LSB	a		a				a		a			
NBA	a		a				0.12070	2.9	4.05	97.1	0.116	0.048
NBD	a		a				0.10690	3.1	3.32	96.9	0.124	0.052
NDW	0.00682	0.2	2.99	99.8	0.009	0.004	0.06653	2.5	2.58	97.5	0.100	0.042
LSW	0.04024	1.9	2.08	98.1	0.076	0.034	0.03787	1.9	1.96	98.1	0.075	0.032
LWW	16939	3.4	480684	96.6	0.136	0.060	6387	1.3	497169	98.7	0.050	0.021
AWW	b		2223	100.0			19.2	1.0	1919	99.0	0.039	0.016
2nd parity												
LSB	a		a				b		2.75	100.0		
NBA	a		a				b		2.32	100.0		
NBD	0.01943	1.8	1.05	98.2	0.072	0.032	0.07133	5.8	1.16	94.2	0.232	0.096
NDW	0.03999	2.8	1.38	97.2	0.112	0.050	b		1.73	100.0		
LSW	a		a				a		a			
LWW	a		a				1157	0.4	290376	99.6	0.016	0.006
AWW	a		a				39.8	2.6	1481	97.4	0.104	0.044
3rd parity												
LSB	a		a				0.06859	3.2	2.11	96.8	0.126	0.052
NBA	a		a				0.05488	2.7	1.98	97.3	0.108	0.045
NBD	a		a				a		a			
NDW	a		a				0.02522	1.9	1.29	98.1	0.076	0.032
LSW	0.00095	0.1	1.27	99.9			0.02257	1.6	1.42	98.4	0.062	0.026
LWW	a		a				a		a			
AWW	53.4	4.7	1084.7	95.3	0.188	0.083	a		a			
4th parity												
LSB	a		a				a		a			
NBA	a		a				a		a			
NBD	a		a				0.03118	2.8	1.09	97.2	0.111	0.046
NDW	a		a				a		a			
LSW	a		a				a		a			
LWW	a		a				4954	1.2	422604	98.8	0.046	0.019
AWW	a		a				b		2598.8	100.0		

Table (24). Cont.

Trait	Californian						New Zealand White					
	Sire		Remainder		h^2	SE	Sire		Error		h^2	SE
	σ^2_s	$V_s\%$	σ^2_e	$V_e\%$			σ^2_s	$V_s\%$	σ^2_e	$V_e\%$		
5^{th} parity												
LSB	b		2.06	100.0			a		a			
NBA	0.02881	1.2	2.38	98.8	0.048	0.021	a		a			
NBD	0.00615	0.5	1.25	99.5	0.019	0.008	a		a			
NDW	a		a				a		a			
LSW	0.08444	4.5	1.80	95.5	0.179	0.079	a		a			
LWW	8971	1.9	477204	98.1	0.074	0.033	a		a			
AWW	129.4	2.7	4588	97.3	0.109	0.049	a		a			
6^{th} parity												
LSB	a		a				a		a			
NBA	0.09934	2.9	3.32	97.1	0.116	0.051	a		a			
NBD	0.02857	1.6	1.78	98.4	0.063	0.028	0.06289	2.3	2.67	97.7	0.092	0.038
NDW	0.02124	1.0	2.20	99.0	0.038	0.017	0.05548	2.3	2.33	97.7	0.093	0.039
LSW	0.00695	0.3	2.47	99.7	0.011	0.005	0.00862	0.3	2.73	99.7	0.012	0.005
LWW	a		a				b		665714	100.0		
AWW	15.6	0.7	2148	99.3	0.028	0.013	30.91	0.7	4352.8	99.3	0.028	0.012
7^{th} parity												
LSB	a		a				b		2.66	100.0		
NBA	0.08000	1.8	4.38	98.2	0.072	0.032	a		a			
NBD	a		a				a		a			
NDW	0.13384	4.9	2.58	95.1	0.197	0.087	a		a			
LSW	0.12214	4.2	2.78	95.8	0.168	0.074	a		a			
LWW	22363	3.2	670695	96.8	0.129	0.057	a		a			
AWW	208.9	9.6	1972.7	90.4	0.382	0.165	a		a			
8^{th} parity												
LSB	0.19496	6.4	2.83	93.6	0.257	0.113	0.25573	10.4	2.20	89.6	0.416	0.169
NBA	0.11536	2.3	4.84	97.7	0.093	0.041	0.02933	0.8	3.82	99.2	0.030	0.012
NBD	0.17034	4.4	3.67	95.6	0.177	0.078	0.07932	2.7	2.85	97.3	0.108	0.045
NDW	0.08576	3.4	2.45	96.6	0.134	0.060	0.15364	5.0	2.92	95.0	0.200	0.083
LSW	0.21173	5.8	3.42	94.2	0.233	0.102	a		a			
LWW	58046	6.5	834327	93.5	0.260	0.114	a		a			
AWW	a		a				313.1	11.7	2364.6	88.3	0.467	0.189

Table (24). Cont.

	Californian						New Zealand White					
	Sire		Remainder		h^2	SE	Sire		Remainder		h^2	SE
Trait	σ^2_s	V_s%	σ^2_e	V_e%			σ^2_s	V_s%	σ^2_e	V_e%		
9th parity'												
LSB							0.32834	8.3	3.64	91.7	0.331	0.135
NBA							0.29083	6.1	4.45	93.9	0.245	0.101
NBD							a		a			
NDW							a		a			
LSW							0.04744	1.5	3.07	98.5	0.060	0.025
LWW							a		a			
AWW							107.3	2.5	4126.3	97.5	0.101	0.042

' Records of 9th parity in Californaian rabbits were not avaliable.

a= Traits having negative variance component in Henderson's method was not included in estimation of variance components by REML procedure.

b= Traits having negative sire variance components set to zero.

'' LSB= litter size at birth, NBA= number born alive, NBD= Number born dead, NDW= number dead at weaning, LSW= litter size at weaning, LWW= litter weight at weaning, AWW= average weaning weight.

Table (25). Estimates (σ^2) and percentages (V%) of variance components due to sire (σ^2_s) and remainder (σ^2_e) and sire heritabilities (h^2) estimated using Henderson 3 method for litter traits in different parities for New Zealand White and Californian rabbits

	Californian						New Zealand White					
	Sire		Remainder		h^2	SE	Sire		Remainder		h^2	SE
Trait	σ^2_s	V_s%	σ^2_e	V_e%			σ^2_s	V_s%	σ^2_e	V_e%		
1st Parity												
NSC	.0115	3.4	.33	96.6	.137	.130	a		.4067	100.0	a	
DO	2.2672	3.0	73.27	97.0	.120	.127	.6528	0.8	78.98	99.2	.033	.140
KI	.8579	1.6	52.61	98.4	.064	.117	a		59.28	100.0	a	
2nd Parity												
NSC	a		.45	100.0	a		.0005	0.1	.4159	99.9	.005	.123
DO	a		106.66	100.0	a		a		96.73	100.0	a	
KI	a		63.39	100.0	a		.1058	0.2	62.75	99.8	.007	.135
3rd Parity												
NSC	.0161	3.9	.3939	96.1	.158	.136	a		.5142	100.0	a	
DO	2.4134	2.8	84.91	97.2	.111	.128	a		108.0	100.0	a	
KI	1.4169	2.6	53.94	97.4	.102	.126	1.0252	1.47	68.8	98.5	.059	.149
4th Parity												
NSC	a		.5305	100.0	a		a		.5218	100.0	a	
DO	a		110.2	100.0	a		a		108.07	100.0	a	
KI	a		63.20	100.0	a		a		74.35	100.0	a	
5th Parity												
NSC	.0051	1.27	.3962	98.7	.051	.131	.0020	0.4	.4633	99.6	.018	.157
DO	.9157	1.05	86.65	98.9	.042	.130	5.27	4.9	102.83	95.1	.195	.182
KI	.7439	1.29	56.81	98.7	.052	.131	3.18	4.3	70.09	95.7	.174	.179
6th Parity												
NSC	.0215	0.2	.4638	99.8	.177	.177	a		.4824	100.0	a	
DO	1.90	1.8	105.80	98.2	.071	.161	.59	0.5	109.23	99.5	.022	.166
KI	1.46	2.4	58.32	97.6	.098	.165	.33	0.5	72.57	99.5	.018	.166
7th Parity												
NSC	.0165	3.7	.4232	96.3	.151	.231	.0116	2.4	.4751	97.6	.096	.228
DO	1.4311	1.8	77.68	98.2	.072	.234	5.75	5.1	106.30	94.9	.205	.241
KI	.6932	0.8	81.86	99.2	.034	.229	2.46	3.4	69.17	96.6	.137	.233
8th Parity'												
NSC							a		.5387	100.0	a	
DO							a		127.51	100.0	a	
KI							a		80.74	100.0	a	

' Records of the 8th parity in Californian rabbits were not avaliable.

'' NSC= Number of services per conception, DO= Days open, KI = Kindling interval.

Table (26). Estimates (σ^2) and percentages (V%) of sire and error variance components, and sire heritability (±SE) estimated using REML method for number of services per conception and reproductive intervals in New Zealand White and Californian rabbits.

	Californian						New Zealand White					
	Sire		Remainder				Sire		Remainder			
Trait[++]	σ^2_s[+]	V_s%	σ^2_e	V_e%	h_s^2	SE	σ^2_s	V_s%	σ^2_e	V_e%	h_s^2	SE
1st parity												
NSC	0.01338	4.0	0.32	96.0	0.158	0.070	a		a			
DO	2.04056	2.7	73.5	97.3	0.108	0.048	b		83.45	100.0		
KI	0.95283	1.8	52.5	98.2	0.071	0.032	a		a			
2rd parity												
NSC	a		a				0.00185	0.4	0.42	99.6	0.017	0.007
DO	a		a				a		a			
KI	a		a				0.69620	1.1	62.18	98.9	0.044	0.018
3th parity												
NSC	0.01705	4.2	0.39	95.8	0.166	0.073	a		a			
DO	2.04180	2.3	85.27	97.7	0.093	0.041	a		a			
KI	1.28853	2.3	54.06	97.7	0.093	0.041	1.20455	1.7	68.65	98.3	0.068	0.029
5th parity												
NSC	0.00704	1.8	0.39	98.2	0.070	0.031	0.00077	0.2	0.46	99.8	0.006	0.002
DO	1.56924	1.8	86.0	98.2	0.071	0.032	4.26301	4.0	103.8	96.0	0.158	0.066
KI	0.99905	1.7	56.6	98.3	0.069	0.031	2.25104	3.1	70.7	96.9	0.123	0.051
6th parity												
NSC	0.01575	3.3	0.47	96.7	0.130	0.057	a		a			
DO	1.42579	1.3	106.3	98.7	0.052	0.023	b		109.8	100.0		
KI	1.16592	2.0	58.6	98.0	0.078	0.035	0.10320	0.1	72.8	99.9	0.005	0.002
7th parity												
NSC	0.01487	3.4	0.43	96.6	0.135	0.060	0.00711	1.5	0.48	98.5	0.058	0.024
DO	1.13134	1.4	77.98	98.6	0.057	0.025	4.23618	3.8	107.81	96.2	0.151	0.063
KI	0.46848	0.6	82.07	99.4	0.022	0.010	1.84017	2.6	69.65	97.4	0.102	0.043

[+] K values for 4th and 8th parities were not available and consequently equations had not iteration solution.

a= Traits having negative variance component in Henderson's method was not included in estimation of variance components by REML procedure.

b= Traits having negative sire variance components set to zero.

[++] NSC= Number of services per conception, DO= Days open, KI = Kindling interval.

NBA, 1.4 to 10.0% for NBD, 1.6 to 11.2% for NDW, 0.04 to 2.2% for LSW, 0.2 to 1.4% for LWW, 0.4 to 10.9% for AWW, 0.1 to 2.4% for NSC, 0.5 to 5.1% for DO and 0.2 to 4.3% for KI. In Egypt, most estimates of sire varince components were detected using Henderson method. In NZW, the reviewed estimates of sire variance component were 1.9% for LSB, 2.7% for LSW, 2.4% for LWB and 0.9 for LWW, while they were 2.9, 1.8 and 2.2% for LSB, LSW and LWB in CAL, respectively **(Afifi et al., 1989; Afifi et al., 1992).**

As for Henderson method, low or relatively moderate estimates of sire variance component were obtained using **REML** for litter traits and reporductive intervals in different parities **(Tables 24&26).** The estimates for CAL rabbits ranged from 6.4% for LSB, 1.2 to 2.9% for NBA, 0.5 to 4.4% for NBD, 0.2 to 4.9% for NDW, 0.01 to 5.8% for LSW, 1.9 to 6.5% for LWW, 0.7 to 9.6% for AWW, 1.8 to 4.2% for NSC, 0.2 to 2.3% for DO and 0.6 to 3.1% for KI. The corresponding estimates in NZW ranged from3.2 to 10.4% for LSB, 0.8 to 6.1% for NBA, 2.3 to 5.8% for NBD, 1.9 to 5.0% for NDW, 0.3 to 1.9% to LSW, 0.4 to 1.3% for LWW and 0.7 to 11.7% for AWW, 0.2 to 1.5% for NSC, 3.8 to 4.0% for DO and 0.1 to 3.1% for KI. In Egypt, scarce estimates of variance attributed to sire components were found. The reviewed estimates almost were negative in NZW **(Hassan et al, 1994). El-Raffa (1994)** with NZW found that estimates of sire component of variance were 2.5, 1.7 and 2.1% for LSB, NBA and LSW.

Reviewed percentages of variation estimated by **Henderson** or **REML** methods show that the contribution of sire was generally low or moderate and ranged from 1.3 to 6.1% for LSB, 1.8 to 6.6% for LSW, 1.5 to 10.0% for LWB and 0.9 to 20.0% for LWW **(Khalil et al, 1987a; Khalil and Afifi, 1991; Afifi et al., 1992; Khalil et al., 1993a).** Such low or moderate percentages of variation in litter traits may be due to that system of feeding and management practices might have masked the full expression of non-genetic paternal differences of sire.

For litter traits in NZW and CAL rabbits, estimates of sire component of variance obtained using **REML** method are generally smaller than those obtained using **Henderson** method **(Tables 23&24),** i.e. error variances for **REML** method were larger than those for **Henderson** method. **Teepker and Swalve (1988), Cameron (1988), Raheja (1992) and Xu et al, (1994)** reported that the sire variance components obtained using **Henderson** method were smaller than those estimated using **REML** procedure.

For NSC, DO and KI in both breeds of the present study, sire component of variance estimated using REML or Henderson methods showed that no definite trend could be plotted along the parity **(Tables 25&26)**. **Khalil (1993a)** came to the same conclusion for the same two breeds of rabbits.

4.4.2 Genetic make-up of the breeds and variance components

For litter traits of both breeds, most estimates of sire component of variance (V%) obtained usnig Henderson or REML methods were lower than 12% **(Tables 23&24)**, reflecting the large environmental components of variance associated with the sire **(Khalil et al., 1987a)**. For each separate parity, percentages of variance (V%) attributed to sire effect for litter traits of NZW rabbits were generally larger than those estimates obtained for CAL rabbits **(Tables 23&24)**. A reverse trend was observed for reproductive intervals (e.g. DO and KI) where CAL rabbits recoreded the highest estimates of sire component of variance **(Tables 25&26)**. High variation in paternity of lactation of NZW rabbits may be responsible for such high estimates of V% for litter traits in this breed, while stress of lactation in such breed may be the cause of low V% due to sire for reproductive intervals. Since CAL rabbits orginated from NZW rabbits and an intensive selection programme was practiced in the establishment of CAL, therefore, a reduction in V% due to sire could be attained for litter traits in this breed. The reviewed estimates of variance components due to sire for litter traits and reproductive intervals are quite variable between NZW and CAL raised in Egypt **(Afifi et al, 1989; Afifi et al, 1992; Khalil, 1993a; Farghaly et al, 1994)**.

4.5. Heritabilities

Sire heritabilities estimated using **Henderson** and **REML** methods for litter traits, number of services per conception and reproductive intervals in NZW and CAL rabbits are given in **Tables 23&24&25&26**. However, sire heritabilities in the present study were similar to those obtained by some Egyptian investigators **(Khalil et al., 1987a, Afifi et al., 1992, Khalil, 1993b; Farghaly et al., 1994)**. Other non-Egyptian studies on different breeds showed low sire heritabilities for litter traits in rabbits **(Garcia et al., 1980, Randi and Scossiroli, 1980,Lahiri and Mahajan, 1982, Panella et al., 1992, Ferraz et al., 1992; Baselga et al., 1992a)**.

The discrepancy between most estimates obtained in this study and the corresponding estimates reported in the literature may be attributed to the different breeds of rabbits reared under particular environmental conditions during definite periods of time. Statistically, the wide range can be attributed to the use of small data sets with poor structure and to a variety of statistical methods used.

4.5.1 Method of estimation and heritabilities

Sire heritabilities estimated using **Henderson** method for litter traits and reproductive intervals in NZW and CAL rabbits were low or relatively moderate **(Tables 23&25).** These heritabilities for different parities ranged from 0.004 to 0.284 for LSB, 0.043 to 0.095 for NBA, 0.031 to 0.059 for NBD, 0.018 to 0.120 for NDW, 0.022 to 0.24 for LSW, 0.072 to 0.269 for LWW, 0.001 to 0.372 for AWW, 0.051 to 0.177 for NSC, 0.042 to 0.120 for DO and 0.034 to 0.135 for KI in CAL rabbits,
while they ranged from 0.032 to 0.437 for LSB, 0.023 to 0.161 for NBA, 0.058 to 0.40 for NBD, 0.046 to 0.146 for NDW, 0.002 to 0.087 for LSW, 0.007 to 0.055 for LWW, 0.003 to 0.435 for AWW, 0.005 to 0.096 for NSC, 0.022 to 0.205 for DO and 0.007 to 0.174 for KI in NZW rabbits. The reviewed h^2 estimated using Henderson method for litter traits in NZW raised in Egypt were also low. These estimates in NZW were 0.08, 0.13, 0.10, and 0.05 for LSB, LSW, LWB and LWW, respectively **(Afifi et al., 1992; Farghaly et al., 1994)**, whereas the corresponding estimates in CAL rabbits were 0.11, 0.07, 0.09 and 0.28 for LSB, LSW, LWB and LWW **(Afifi et al., 1992).**

As in Henderson method, sire heritabilities estimated using REML for litter traits and reproductinve intervals in NZW and CAL rabbits were low or relatively moderate **(Tables 24&26).** These estimates in different parities ranged from 0.0 to 0.022 for LSB, 0.048 to 0.257 for NBA, 0.019 to 0.093 for NBD, 0.009 to 0.197 for NDW, 0.011 to 0.179 for LSW, 0.074 to 0.233 for LWW, 0.013 to 0.26 for AWW, 0.070 to 0.166 for NSC, 0.052 to 0.108 for DO and 0.022 to 0.093 for KI in CAL rabbits, while they ranged from 0.126 to 0.416 for LSB, 0.030 to 0.245 for NBA, 0.092 to 0.232 for NBD, 0.076 to 0.20 for NDW, 0.060 to 0.075 for LSW, 0.016 to 0.050 for LWW, 0.028 to 0.467 for AWW, 0.006 to 0.058 for NSC, 0.151 to .158 for DO and 0.005 to 0.123 for KI in NZW rabbits. The corresponding reviewed estimates obtained using **REML** for NZW and CAL rabbits raised in Egypt were scarce. The available estimates reported by **El-Raffa (1994)** were 0.10, 0.69 and 0.084 for LSB, NBA and LSW in NZW rabbits. In Mediterranean countres, the corresponding estimates in NZW and CAL were 0.054 for LSB and 0.074 for LSW **(Baselga et al.,** 1992a). In USA, sire heritabilities for NZW and CAL rabbits were low or relatively moderate and ranged from 0.054 to 0.212 for LSB, 0.063 to 0.299 for NBA, 0.0 to 0.138 for LSW, 0.043 to 0.071 for LWB, 0.0 to 0.21 for LWW and 0.002 to 0.023 for preweaning mortality rate **(Ferraz et al., 1991&1992)**.

Reviewed negative and low heritability estimates and those obtained here using **Henderson** or **REML** may be due to the large maternal variation that could mask any additive genetic variance due to increasing non-additive genetic effect **(Garcia et al., 1982a)**. In general, estimates of heritability for litter traits computed by **REML** are lower than those estimates obtained by **Henderson** method. Comparing reviewed heritabilities estimated using **Henderson** method for litter traits in rabbits **(Garcia et al., 1980; Randi and Scossiroli, 1980; Khalil et al, 1987a; Affi et al, 1992; Farghaly et al., 1994)** with those heritabilities estimated using REML method **(Baselga et al., 1992a; Ferraz et al., 1991&1992; El-Raffa, 1994; Hassan, 1995)**, it is clear that estimates of **REML** method are somewhat lower than those estimates obtained by **Henderson** method. In this respect and for rabbits, methods like **MIVQUE** or **REML** have been recommended **(Baselga et al., 1992a; Ferraz et al., 1992; El-Raffa, 1994; Hassan, 1995)**. In species other than rabbits, **Chauhan (1991)** reported that heritability estimated using **Henderson,** estimate for milk yield in cattle decreased from 0.41 to 0.24 estimated using **REML** procedure. Also, **Gama et al. (1991)** obtained unexpected higher heritability estimates from **Henderson** method than those estimated by REML procedure. The same authors explained these discrepancies to the difference in the two data set that were used in the two methods. **Raheja (1992)** found that the heritabilities estimated using **Henderson** method were overestimated by about 15-20% than those calculated using REML. Simulation studies (e.g. **Rothschiled et al., 1979; Meyer and Thompson, 1984; Sorensen and Kennedy, 1984)** have shown that customary methods like **Henderson** method, lead to biased estimates when selected data are used. In contrast to above mentioned trend, **Cameron (1988)** with sheep, **See et al. (1993)** with swine, **Swalve et al. (1992)** with dairy cattle reported that heritabilities estimated using **Henderson** method were slightly smaller than those estimated by REML procedure.

The extremely small differences (0.02) between heritability estimated using **Henderson** method and **REML** were also observed in other studies **(Colleau et al., 1989; Schutz et al., 1990; Ahlborn and Dempfle, 1992)**. The explanation may be due to that a comparatively balanced design and an efficient data structrue from progeny testing sires in contracted herds were used. These systematic matings generated a homogenous number of daughters per sire and a sufficient number of sires providing connections between cells. **Reverter et al. (1994)** noted that **REML** procedure produces the same estimators as **ANOVA** methods with balanced data (**Corbeil and Searle, 1976; Anderson et al., 1984**).

4.5.2 Available number of records and heritabilities

Small or negative estimates of most sire heritabilities obtained here and large standard errors of positive estimates could be attributed: (1) to the small sample size per generation (**Narayan et al., 1985**), (2) to the small number of progeny per sire (**El-Maghawry, 1990**), (3) to the non-randomness in the distribution of daughters within sire groups (**Khalil, 1989**), and (4) to the sampling error (**Thompson and Moor, 1963**).

4.5.3 Genetic make-up of breeds and heritabilities

Although all estimates of heritability are generally low, estimates for all litter traits in NZW rabbits are higher than those corresponding estimates in CAL rabbits, while the reverse was observed for reproductive interavals (**Table 25**). This reverse notation is clear since heritability estimates ranged from 0.05 to 0.177 for NSC, 0.009 to 0.108 for DO, 0.022 to 0.125 for KI in CAL rabbits, while they ranged from 0.006 to 0.058 for NSC, 0.151 to 0.158 for DO and 0.005 to 0.123 for KI in NZW rabbits. In Egypt , a flactuated trend for reviewed h^2 estimated using Henderson method was observed. In this respect, **Afifi et al. (1992) and Farghaly et al. (1994)** found that h^2 estimated for LSB and LWW were greater in CAL (0.11 and 0.28) than that in NZW (0.08 and 0.05), while the reverse trend was observed for LSW (0.07 vs 0.13) and LWB (0.09 vs 0.10).