Egyptian Journal of Rabbit Science, 29 (1): 61 - 78(2019)

FACTORS AFFECTING MILK PRODUCTION AND USING APPLICATION SELECTION INDICES TO IMPROVE PRODUCTIVETRAITS OF DOES IN NEW ZEALAND WHITE RABBITS.

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This study was carried out on 765 litters of New Zealand White(NZW)rabbit breed and extended for about 5years to study some factors affecting milk traits. The effect of season of kindling on milk production was higher significantly during most of the weeks of the study and total milk yield. The insignificant effect of parity on milk production and the milk yield during 1st, 3rd week and total milk yield but increased gradually with the advancement of parity from 1st to 3rd parity and decreased for other parities. Increasing the litter size from 3 to 9 was associated with a significant increase for milk production during 1st, 2nd, 3rd, 4th week and total milk yield. Teats number were significant in milk yield during most of weeks and total milk yield of the study. Genetic correlation between litter size at birth and litter weight were positive and high and ranging from 0.48 to 0.66.Genetic correlations between litter size at birth and litter weight at weaning were low while the phenotypic correlations were positive and high and ranging from 0.34 to 0.74.Selection indices for litter and milk traits were constructed incorporating litter size at birth (X_1), litter size at weaning (X_2), litter weight at birth (X_3), litter weight at weaning (X_4) and pre-weaning mortality (X5), milk yield during the 1st, 2nd, 3rd and 4th week (X_1, X_2, X_3, X_4)and total milk yield (X_5) to improvement of productivity of does of New Zealand White rabbits. Relative efficiencies(R_{IH}) in litter traits were high for I_1 (based on five traits) to other indices

Relative efficiency(R_{IH}) in milk traits were high for I_2 (based on four traits) to other indices and recommended for use to maximize response and apply selection on this index. The expected genetic gain changes in litter size at birth was low in all of the indices used and ranging from -0.031 to 0.129 young, in litter size at weaning was low and ranging from 0.065 to 0.100 young, in litter weight at birth was *moderate or high and ranging 3.71 to 9.34 g, in litter weight at weaning was high and ranging 108.99 to 131.65 g and in pre-weaning mortality was ranging 0.282 to 1.30 young. The expected genetic gain changes were high in milk yield during the 1^{st}, 2^{nd}, 3^{rd},4^{th} week and total milk yield and ranging 14.39 to 34.77g, 42.33 to 54.26g, 83.71 to 105.66 g, 10.45 to 32.70 g and 143.60 to 151.76 g.*

***Conclusively,** Milk production was higher in winter months than other seasons. For litter traits recommended for use to maximize response and apply selection on index I_1 (based on five traits).For milk traits recommended for use to maximize response and apply selection on this index, I_2 (based on four traits).*

Key words: Genetic and phenotypic correlation, selection indices.

In general, rabbit does nurse the kits once-a-day for 3-4 minutes. During this time the kits are able to consume their daily feed requirement, which is about equal to 1/6 of their body weight. The milk intake, body weight gain and survival of the kits depend on the milk production and their mother nursing willingness. However, the does are not able to cover the nutrient requirements of the suckling kits, especially on the 3rd week of lactation (Kacsala *et al.,* 2015).The main points in rabbit production is how to achieve optimum growth rate and growth in rabbit is mainly affected by the growth gain during suckling period especially during the first three weeks of life, so for successful rabbit production a great interest must be focused on the newborn bunnies especially during their suckling period, which directly affect later on their growth rate. Lactation can be used as an evaluating factor for the reproductive efficiency of the doe. Rabbits milk yield varies according to physiological, inherited and environmental factors which increases till the 3rdweek, then decreases. The goal of this study is to examine some factors affecting milk production in rabbit is as important as many deaths and growth disturbances in young bunnies may be occurred due to shortage in milk production to help us to solve many problems related to milk yield in rabbit farms such as parity of kindling, season of birth, litter size at birth, teat number and dam body weight.

For the improvement of genetic value of livestock, individuals with the best breeding values have to be chosen as the parents of the next generation. Therefore the application of selection indices may be a good solution to the problem mentioned since profitability is an appropriate parameter to express the importance of the traits in the final evaluation (Gyovai *et al.*, 2012). Therefore, the aims of the selection index method are to maximize the genetic progress towards a stated economic goal and also find an application of selection indices improve of the productivity of rabbits does.

MATERIALS AND METHODS

Animals and data:

The data of the present study collected on 765 litters for five consecutive years from the Rabbitry of Faculty of Agriculture at Moshtohor, Benha University, on New Zealand White(NZW) rabbits breed. .Mating, according to the breeding plan, a buck was assigned at random for every 3-4 does for mating with a restriction of avoiding full sib, half sib and parent-offspring mating. The statistical analysis was carried out by weighed least-squares means method in the procedure GLM of statistical software SAS (2003) to obtain least squares and used to compare means by Duncan's multiple range test for milk yield during the 1st, 2nd, 3rd and 4th week (MY1, MY2, MY3 and MY4) and total milk yield (TMY) respectively;.

$$\mathbf{Y_{ijkl} = \mu + S_i + P_j + L_k + T_l + e_{ijkl}.} \quad \textbf{(Model1).}$$

Where:

Y_{ijkl} = the observation on the ijklth milk traits, µ = the overall mean, S_i = the fixed effect of the ith season (i=1,2 and 3), P_j = the fixed effect of the ith parity (l=1,…..5), L_k= the fixed effect of the kth litter size at birth (kth = ≤ 3 …≥ 9), T_l = the fixed effect of the lth teat number (lth = 7,8, 9 and10and e_{ijkl} = the random deviation of all the other effects no specified the model. The model without interaction between different fixed effects to presence of complete confounding between factor in model.

Starting mixed model was obtained applying REML method of VARCOMP procedure of SAS 2003. Data were analyzed using multi-trait animal model of litter and milk traits using MTDFREML programs of Boldman *et al.,*1995, to obtain phenotypic and genetic variances and covariance and heritability to use for calculating selection indices for litter and milk traits given in Table 4&5.Analyses were done according to the general model:

$$\mathbf{y = Xb + Z_1a + Z_2p + e.} \quad \textbf{(Model 2)}$$

Where, y=Vector of observation, X= Incidence matrix of fixed effects; b = vector of fixed effects including season (3 levels) and parity (4 levels); $Z_1$and Z_2= incidence matrices corresponding to random effects of additive (a) and permanent environment (p_e, doe effect), respectively; Heritability were computed as additive direct ($h^2{}_a = \sigma^2{}_a / \sigma^2{}_p$) where $\sigma^2 a$ and $\sigma^2 p$ are the variances due to effects of additive genetic and phenotypic.

Selection Indices:

Different selection indices for litter and milk traits were constructed using MINTAB, (1991). The indices values were calculated as $I = \sum_{i}^{n} (b_i p_i)$where I is selection index, $b_i$is a selection index weighing factor, p_i is a phenotypic measure and n is number of traits. Hazel (1943) proved that maximum r_{HI} is achieved then optimal index weights (b) was calculated for each of the objectives as:

$$b=P^{-1}Ga,$$

Where: $P^{-1}$is the inverse of the phenotypic (co)variance matrix of the traits in the selection index, G is the genetic covariance the economic values for the goal traits. Furthermore the other different properties of the selection index were calculated as following: Standard deviation of the index, $\sigma_I=\sqrt{b'Pb}$, Standard deviation of the aggregate genotype, $\sigma_H = \sqrt{a'Ga}$, Correlation between the index and the aggregate genotype (accuracy) $R_{IH}= \sigma_I / \sigma_H$.

Relative economic value were calculated by Lamont method (1991) the method depending on heritability estimates of the all traits, where, T / h_i^2, where ; T = summation for heritability of different litter and milk traits.

RESULTS AND DISCUSSION

Season effect:

The effect of season of kindling on milk production are presented in Table 1 obtained data declared that milk production was higher significantly ($P \leq 0.01$) during most of the weeks of the study and total milk yield except during the fourth one were the effected was not significant. Milk production was higher in winter months than other seasons.

The significant increase in the milk production during winter months may be attributed to suitability of the environmental conditions to rabbit production, increase in food consumption and abundance of green fodders during winter months. These results agreement with, Ayyat *et al.,*1995, also Ahmed, 1997 reported that the highest milk yield was recorded during winter while the lowest milk yield was produced during Spring. with NZW and California (CAL) rabbits.

Table 1. Least-squares means and standard errors of milk yield (g) traits as affected by season, parity, litter size at birth and teat number for NZW rabbits.

Fixed effect	**No.**	**MY1**	**MY2**	**MY3**	**MY4**	**TMY**
Overall Mean	765	810 ± 37	962 ± 43	1020 ± 51	465 ± 42	3237 ± 126
Season						
Winter	217	837 ± 24^{a}	1022 ± 29^{a}	1118 ±34^{a}	500 ± 28	3466 ± 83^{a}
Spring	245	790 ± 22^{ab}	951 ± 26^{b}	997 ± 31^{b}	454 ± 25	3188 ± 75^{b}
Autumn	303	788 ± 23^{b}	913 ± 27^{b}	1053 ± 32^{b}	502 ± 27	3224 ± 80^{b}
Sig. test		**Not Sig.**	**	**	**Not Sig.**	**
Parity						
1	269	800 ± 23	973 ± 27	1014 ± 32	501 ± 26	3267 ± 79
2	261	815 ± 21	956 ± 25	1072 ± 29	483 ± 24	3336 ± 72
3	162	844 ± 26	960 ± 31	1103 ± 37	499 ± 30	3408 ± 90
4	73	762 ± 37	958 ± 44	1034 ± 52	459 ± 43	3160 ± 128
Sig. test		**Not Sig.**	**Not Sig.**	**Not Sig.**	**Not Sig.**	**Not Sig.**
Litter size at birth						
≤ 3	38	685 ± 49^{c}	882 ± 58^{c}	910 ± 69^{c}	389 ± 56^{b}	2852 ± 169^{d}
4	60	786 ± 39^{ab}	873 ± 46^{c}	988 ± 55^{bc}	435 ± 45^{ab}	3070 ± 136^{cd}
5	100	777 ± 31^{b}	926 ± 36^{bc}	1052 ± 43^{ab}	483 ± 35^{ab}	3251 ± 106^{c}
6	141	799 ± 28^{a}b	962 ± 32^{bc}	1100 ± 39^{ab}	487 ± 32^{ab}	3346 ± 96^{abc}
7	143	856 ± 27^{ab}	990 ± 32^{ab}	1082 ± 38^{ab}	537 ± 31^{a}	3424 ± 94^{ab}
8	134	863 ±27^{ab}	1030 ± 32^{ab}	1127 ± 38^{a}	551± 31^{a}	3530 ± 93^{ab}
≥9	149	870 ± 27^{a}	1068 ± 32^{a}	1131 ± 38^{a}	517 ± 31^{a}	3578 ± 92^{a}
Sig. test		**	***	**	**	***
Teat number						
7	62	782 ± 39^{b}	951 ± 45	980 ± 54^{b}	429 ± 44^{b}	3111 ± 133^{b}
8	395	803 ± 18^{ab}	926 ± 21	1025 ± 25^{ab}	482 ± 20^{ab}	3207 ± 61^{ab}
9	132	799 ± 27^{ab}	980 ± 32	1107 ± 38^{a}	530 ± 31^{a}	3418 ± 94^{a}
10	176	838 ± 24^{a}	990 ± 28	1111 ± 33^{a}	500 ± 28	3434 ± 82^{a}
Sig. test		**	**Not Sig.**	**	**	**

MY1, MY2, MY3 and MY4 = milk yield during the 1st, 2nd, 3rd and 4th week respectively and TMY = Total milk yield$^{\longrightarrow c}$: Any two means having the same superscript are not significantly different using Duncan's Multiple Range test (P≤ 0.01 or P≤0.001; Duncan 1955).

Soliman, (2008) who found that the decrease in milk production during hot climate may be due to reduce in appetite and food intake. Abd El-monem, (2009)found that milk production was decreased in summer than winter under Egyptian conditions. Mahmoud, (2013) found that The effect of kindling season on milk production was higher significantly (P<0.05) in winter months in both single and double lactation than summer months except during the 3rdweek of single lactation where there was an increase in the milk yield during winter months than that of the summer months but this increase was not significant.

Parity effect:

In generally the insignificant effect of parity on milk production are presented in Table 1. The milk yield during 1st , 3rd week and total milk yield increased gradually with the advancement of parity from 1st to 3rd parity and decreased for other parities. Similar results were also obtained by Iraqi and Youssef, 2006 they reported that effect of parity for most of milk production traits increased with the advancement of parity from the 1st to 3rdparity, then relatively decreased from 3 to 5 parity and increased again to reach the peak at 7th parity. From these results the tendency was compatible with mammary gland advancement and the physiological state of the does (El-Sayiad, 1994).

Litter size at birth effect:

Litter size at birth was important factor determining milk production in rabbit, as increasing the litter size from 3 to 9 was associated with a significant increase ($P \leq 0.01$ or $P \leq 0.001$) in the milk production during 1st, 2nd, 3rd, 4th week and total milk yield (Table 1), the higher milk production in the does with larger litters might be due to the increase in the amount of milk consumed by increasing the number of young which stimulate the mammary gland to increase its production from milk. McNitt and Lukefahr (1990) reported that, as the number of bunnies the litter increased, milk yield increased in a curvilinear manner ($P<0.01$).Mahmoud,(2013) found that the effect of litter size at birth was significant and important factor determining milk production in rabbit, as increasing the litter size from 4 to 6 then to 8 and the higher milk production in the does with larger litters. Kolawole *et al.*,(2013) determined milk yield using the weigh-suckling method and reported an inversely proportional relationship between milk yield and intake as the number of kits increased. Increase in litter size is associated with a decline in quantity of milk share for each kit (Zerrouki *et al.*, 2012; Yuan *et al.*, 2015). In this respect, large sized litters could compromise the nursing ability of does (Vidjannagni *et al.*, 2018).

From results the increase in milk production by increasing litter size might be due to a greater tactile stimulation of the does teats by their bunnies which enhancing the milk secretion and the higher suckling intensity by the larger litters might also led to higher release of oxytocin resulting in complete evacuation of residual milk from the mammary glands (Hafez,2000).

Teats number effect:

Teats number was important factor affecting milk production in rabbit, with a significant ($P \leq 0.01$) in the milk yield during most of the week and total milk yield of the study, except during 2nd week where the effect was insignificant(Table 1). Szendro, (2008) found that teat numbers are not connected with milk production. It seems that the mammary gland (milk yield) has the same size of does with different teat numbers but kits have more chance to catch a teat during the short nursing time. Despite of similar milk production their chance to suck some milk is higher in case of 10 teats and he is suggested to mark and select female and male newborn rabbits with 10 treats to improve the productivity. Szendro, *et al.*,(2012) found that nursing time duration from 2.5 to 3 min ,during this short period, kits are able to suck an amount of milk equal to 15 to 20% of their body weight. Kits suck very strongly. The moment they feel the teat empty, they release it and try to catch another one. Their chances here depend on teat number and litter size. In a 10-kit litter, two kits are waiting for a teat every second if the doe's teat number is only 8. With 10 teats, all the kits have the opportunity to consume milk.

Genetic correlation:

In general the genetic correlation between litter size at birth and litter weight were significant, positive and high and ranging from 0.48 to 0.66 except between litter size at birth and litter weight at weaning were low in Table 2. Whereas the genetic correlation of litter size or litter weight and pre-weaning mortality were not significant and negative (low or high) ranging 0.09 to -0.78. So genetic correlations are an important measures for the breeder, as it indicates the existence of a relationship between various traits. The correlation coefficient, ranging from –1 to +1, is a measure of this relationship between traits. As long as the coefficient remains within the range –1 to 0, the correlation is negative, which means that an improvement in one trait will result in deterioration of another. These results agreement with Sorhue *et al.,* 2014 reported that positive and significant genetic correlations *(rG)* ($P > 0.05$) was obtained for litter birth weight and litter size born alive (0.94 and 0.67), litter size born alive and weaning weight (0.89 and 0.61), litter birth weight and 21day body weight (0.88 and 0.63) from sire and dam components respectively. Hassan *et al.,* 2015 who reported that all estimates of genetic correlations among litter weights were high and positive. Thus we may build the strategy on selection criteria on these traits.

All possible genetic correlations among milk traits were significant, positive and of moderate to high and ranging 0.14 to 87 in Table 2.Therefore, can be easily understanding for relationship to other traits to make optimum breeding program for milk traits in rabbits. The genetic improvement in milk yield during first week was accompanied by an increase in milk yield during 2nd, 3rd, 4th and total milk yield.

Table 2. Genetic and phenotypic correlation for litter traits

Trait	**Genetic correlation**	**Phenotypic correlation**
LSB & LSW	0.49±0.26**	0.55
LSB & LWB	0.66±0.18**	0.74
LSB & LWW	0.07±0.31**	0.34
LSB & PM	0.40±0.01**	0.17
LSW & LWB	0.48±0.28**	0.51
LSW & LWW	0.52±0.18**	0.71
LSW & PM	-0.78±0.01	-0.79
LWB & LWW	0.35±0.01**	0.39
LWB & PM	0.09±0.01	0.08
LWW & PM	-0.59±0.01	-0.62

LSB = Litter size at birth; LSW = Litter size at weaning; LWB= Litter weight at birth; LWW= Litter weight at weaning and PM = Pre-weaning mortality, $P \leq 0.01$.

Phenotypic correlation:

The phenotypic correlation between litter size at birth and litter weight were positive and high and ranging from 0.34 to 0.74 are presented in Table 2. Whereas the phenotypic correlation litter size or litter weight and pre-weaning mortality were negative (low and high) ranging 0.08 to -0.79.Elamin and Yousif, 2011found that the phenotypic correlations among total born alive, litter size at birth, litter weight at birth and litter size at weaning were positive and significantly high, Such traits are mainly under environmental control and the phenotypic parameters reflect most of the association found among such traits. Sorhue *et al.*, 2014 reported that Phenotypic *(rP)* between the traits studied (litter size at birth, litter size born alive, litter birth weight and litter weight at weaning) were mostly non-significant ($P < 0.05$).

All possible the phenotypic correlations among milk traits were positive and of moderate to high and ranging 0.31 to 83 in Table 3.

Selection Indices:

Phenotypic and genetic variances and covariance and heritability to use for calculating selection indices for litter and milk traits given in Tables 4 and 5.

Several selection indices for litter and milk traits were constructed incorporating litter size at birth (X_1), litter size at weaning (X_2), litter weight at birth (X_3), litter weight at weaning (X_4) and pre-weaning mortality (X_5), milk yield during the 1st, 2nd, 3rd and 4th week (X_1, X_2, X_3, X_4) and total milk yield (X_5) of NZW rabbits, respectively are presented in Tables 6, 7, 8 and 9.

Table 3. Genetic and phenotypic correlation for milk traits.

Trait	**Genetic correlation**	**Phenotypic correlation**
MY_1& MY_2	0.78±0.14**	0.51
MY_1& MY_3	0.24±0.17**	0.46
MY_1& MY_4	0.14±0.33**	0.31
MY_1&TMY	0.64±0.10**	0.74
MY_2& MY_3	0.61±0.11**	0.56
MY_2& MY_4	0.17±0.28**	0.31
MY_2&TMY	0.83±0.06**	0.78
MY_3& MY_4	0.76±0.20**	0.38
MY_3&TMY	0.87±0.06**	0.83
MY_4&TMY	0.65±0.18**	0.55

MY_1; MY_2; MY_3; MY_4 = Milk yield during the 1st, 2nd, 3rd and 4th week TMY =Total milk yield, $P \leq 0.01$.

Table 4. Phenotypic and genetic variances (on diagonal), covariance (above diagonal) and heritability of litter traits of NZW rabbits.

Varieties	**LSB**	**LSW**	**LWB**	**LWW**	**PM**	**h^2_a**
Phenotypic						
LSB	2.9926					0.08±0.04
LSW	1.8541	3.7263				0.09±0.01
LWB	159.94	120.64	1563.52			0.07±0.03
LWW	713.63	1134.01	57432.90	1383218.70		0.09±0.01
PM	2.16	17.99	1163.57	10910.84	349.90	0.03±0.01
Genetic						
LSB	0.2426					
LSW	0.1141	0.2463				
LWB	11.16	8.46	1164.72			
LWW	12.96	87.63	4215.60	124697.70		
PM	0.6437	0.8207	56.44	583.99	10.94	

Litter size at birth (LSB); Litter size at weaning (LSW); Litter weight at birth (LWB); Litter weight at weaning (LWW) and Pre-weaning mortality ratio (PM)was calculated as a percentage of dead young at weaning to the total litter size born.

Table 5. Phenotypic and genetic variances (on diagonal) , covariance (above diagonal) and heritability of milk traits of NZW rabbits.

Varieties	**MY1**	**MY2**	**MY3**	**MY4**	**TMY**	**h^2_a**
Phenotypic						
MY1	89455.55					0.11±0.05
MY2	53525.92	124126.9				0.15±0.04
MY3	56829.66	81773.42	174227.87			0.25±0.05
MY4	31352.92	36924.84	54554.80	116827.09		0.06±0.04
TMY	227716.87	285460.0	351923.96	195130.61	1080643.21	0.14±0.01
Genetic						
MY1	9537.89					
MY2	10502.43	18853.84				
MY3	4970.52	17647.96	44624.82			
MY4	1159.81	1963.46	14256.33	7798.1		
TMY	33747.67	45710.18	56711.95	20938.31	160134.6	

MY1, MY2, MY3 and MY4 = Milk yield during the 1st, 2nd, 3rd and 4th week, respectively and TMY = Total milk yield.

All possible combinations, the values of b (b= Partial regression coefficient) for each of a total of 11 indices were large differences, even, in some of the indices were low, moderate and high and were negative and positive in other indices for litter and milk traits in Tables 6 and 8. These results were indicated the values b's depending on phenotypic, genetic variances and covariance, heritability and relative economic value. High values of b's might be attributed to positive genetic correlations between different traits and its high relative economic value and low values of b's might be refer to low heritability. Khalil, 1986 found that the large differences in index weights for litter size at weaning in index I_1 v. I_3 and I_4 v. I_6, and he suggested the reason is that litter size at birth has been measured in indices I_1 and I_4 not in I_3 or I_6 and it contributes substantially to total genetic gain in aggregate genotype of I_1 and I_4.

Relative efficiency(R_{IH}) in litter traits (Table 6) were high for I_1(based on five traits) to other indices and recommended for use to maximize response and apply selection on this index.

	$\mathbf{R_{IH}}$
$I_1 = 14.07\ X1+17.99\ X2+4.88\ X3+0.500\ X4+18.50\ X5$	0.3687

The high efficiency of index may be attributed to high phenotypic and genetic variances of those traits. Khalil, 1986 found that the chief measure of the utility of an index is its correlation with aggregate genotype, r_{IH}, where the genetic response to selection is proportional to this correlation, with corresponding r_{IH}, the first index (I_1),which incorporated five varieties(litter size at weaning, mean bunny weight at weaning, pre-weaning mortality, litter size at birth and litter weight at birth) and the forth index (I_4),which incorporated four varieties out five have r_{IH}, values of 0.31 and 0.48in Bauscat and Giza White were the most accurate while I_2, I_5, I_7 and I8 were the lowest.

Relative efficiency(R_{IH}) in milk traits (Table 6) were high for I_2 (based on four traits) to other indices and recommended for use to maximize response and apply selection on this index.

R_{IH}

I_2 = -0.109 X1+0.366 X2+1.71 X3+0.141 X4 0.4483

The expected genetic gain, (ΔG) in each trait for litter traits are presented in Table 7. The expected genetic gain changes in litter size at birth was low in all of the indices used and ranging from -0.031 to 0.129 young, in litter size at weaning was low and ranging from 0.065 to 0.100 young, in litter weight at birth was moderate or high and ranging 3.71 to 9.34 g, in litter weight at weaning was high and ranging from 108.99 to 131.65 g and in pre-weaning mortality was ranging from 0.282 to 1.30 young. From these pervious results could be genetic improvement for doe productivity of New Zealand White rabbits achieved through selection for litter weight at birth and litter weight at weaning. Khalil, 1986 found that the expected genetic gain, (ΔG)in any trait achieved by selection differential of one standard deviation in the index is the product of the genetic standard deviation for the trait and correlation between the index and the genetic value for such trait, However, the magnitude of the expected genetic change in litter size at weaning was slight in all of the indices used, due to the low heritability values for this trait, all ranging from 0.05 to 0.06 young for the Bauscat and 0.09 to 0.10 young for the Giza White. Similarly, the estimate of expected genetic change in mean bunny weight at weaning was low in Bauscat rabbits for the same reason. On the other hand, the expected genetic change in mean bunny weight at weaning of Giza White rabbits was high from using the different indices, all ranging from 20.4 to 26 g per bunny. Accordingly, it could be stated that considerable genetic improvement for doe productivity of Giza White rabbits might be achieved through selection for mean bunny weight at weaning.

Table 6. Selection indices , weighting factors (values of b) in each trait and relative efficiency (R_{IH}) in litter traits and pre-weaning mortality of NZW rabbits.

Index no.	**Values of b**	**R_{IH}**
I1	$-14.07_{X1}+17.99_{X2}+4.88_{X3}+0.500_{X4}+18.50_{X5}$	0.3687
I2	$13.89_{X1}+14.60_{X2}+1.32_{X3}+0.390_{X4}$	0.3248
I3	-2.76 X1+1.22 X2+0.350 X3-0.007 X5	0.2691
I4	$-19.33_{X1}+15.93_{X2}+0.356_{X4}-7.62_{X5}$	0.3248
I5	$-6.95_{X1}+14.19_{X2}+0.277_{X4}$	0.3113
I6	$0.787_{X1}+0.138_{X2}+0.317_{X5}$	0.2410
I7	$-1.37_{X1}-0.128_{X2}+0.253_{X3}$	0.2733
I8	$0.086_{X1}+0.047_{X2}$	0.2655
I9	$0.089_{X1}+0.01_{X3}$	0.2740
I10	$15.58_{X1}+0.194_{X4}$	0.3247
I11	$0.819_{X1}+0.112_{X5}$	0.2102

X_1 = Litter size at birth; X_2 = Litter size at weaning; X_3= Litter weight at birth; X_4 = Litter weight at weaning and X_5 = Pre- weaning mortality.

Table 7. Expected genetic gain, g (ΔG) in each trait in litter traits and pre-weaning mortality of NZW rabbits.

Index no.	**ΔG_{X1}**	**ΔG_{X2}**	**ΔG_{X3}**	**ΔG_{X4}**	**ΔG_{X5}**
I1	0.072	0.089	5.09	131.65	0.194
I2	0.024	0.070	3.71	111.96	-
I3	0.084	0.096	9.34	-	0.274
I4	0.047	0.073	-	114.54	0.282
I5	-0.031	0.065	-	108.99	-
I6	0.077	0.068	-	-	1.30
I7	0.083	0.065	9.34	-	-
I8	0.123	0.100	-	-	-
I9	0.129	-	8.14	-	-
I10	0.072	-	-	113.69	-
I11	0.103	-	-	-	0.672

X_1 = Litter size at birth; X_2 = Litter size at weaning; X_3= Litter weight at birth; X_4 = Litter weight at weaning and X_5 = Pre-weaning mortality.

Table 8. Selection indices , weighting factors (values of b) in each trait and relative efficiency(R_{IH}) in milk yield and total milk yield of NZW rabbits.

.Index no.	Values of b	RIH
I1	-0.073 X1+1.71 X2+3.37 X3+0.284 X4-0.115 X5	0.4221
I2	-0.109 X1+0.366 X2+1.71 X3+0.141 X4	0.4483
I3	0.288 X1+2.05 X2+1.87 X3-0.073 X5	0.4118
I4	-0.742 X1+0.410 X2-0.321 X4+0.938 X5	0.3784
I5	0.279 X1+0.480 X2+0.182 X4	0.3274
I6	0.080 X1+1.05 X2+0.294 X5	0.3860
I7	0.220 X1+0.706 X2+0.593 X3	0.4216
I8	0.240 X1+0.359 X2	0.3943
I9	0.186 X1+0.396 X3	0.3997
I10	0.151 X1+0.155 X4	0.2605
I11	-0.117 X1+0.324 X5	0.3667

X_1; X_2; X_3; X_4 = Milk yield during the 1st, 2nd, 3rd and 4th week X_5 = TMY.

The expected genetic gain, (ΔG) in each trait for milk traits are presented in Table 9. The expected genetic gain changes were high in milk yield during the 1st, 2nd, 3rd,4th week and total milk yield and ranging 14.39 to 34.77g, 42.33 to 54.26g, 83.71 to 105.66 g, 10.45 to 32.70 g and 143.60 to 151.76 g.

Table 9. Expected genetic gain, g (ΔG) in each trait in milk yield and total milk yield of NZW rabbits.

Index no.	ΔG_{X1}	ΔG_{X2}	ΔG_{X3}	ΔG_{X4}	ΔG_{X5}
I1	18.22	49.70	102.40	29.45	146.98
I2	14.39	45.42	105.66	32.70	-
I3	24.40	54.66	88.53	-	149.32
I4	21.63	47.69	-	19.41	151.76
I5	31.43	49.01	-	10.45	?
I6	28.76	42.33			143.60
I7	26.24	54.26	83.71		
I8	34.77	53.30	-		
I9	19.23	-	93.05		
I10	20.81			16.70	
I11	21.32				146.62

X_1; X_2; X_3; X_4 = milk yield during the 1st, 2nd, 3rd and 4th week X_5 = TMY.

From these results could be genetic improvement for doe productivity of New Zealand White rabbits achieved through selection for milk yield during the 1st week, lead to improvement for milk production during 2nd, 3rd,4th week and total milk yield.

CONCLUSION:

Results can be concluded in the following practical things which may be helpful as guides to for rabbit breeders; Milk production was higher in winter months than other seasons. In generally the insignificant effect of parity on milk production. The higher milk production in the does with larger litters might be due to the increase in the amount of milk consumed by increasing the number of young which stimulate the mammary gland to increase its production from milk. Select female and male new born rabbits with 10 treats to improve the productivity. Genetic correlation are helpful as guides to selection. For example, by offer encouragement to the rabbit breeder to select for litter size and litter weight traits at earlier ages. The genetic improvement in milk yield during first week was accompanied by an increase in milk yield during 2nd, 3rd, 4th and total milk yield. For litter traits recommended for use to maximize response and apply selection on index I_1 (based on five traits). For milk traits recommended for use to maximize response and apply selection on this index, I_2 (based on four traits).

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العوامل المؤثرة على أنتاج اللبن وتطبيق أدلة الانتخاب لتحسين الصفات الإنتاجية للأمهات في أرانب النيوزيلندي الأبيض.

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أجريت الدراسة على ٧٦٥ بطن من سلالات أرانب النيوزيلندي الأبيض لدراسة بعض العوامل التي تؤثر على أنتاج اللبن حيث كان تأثير الموسم معنوي على أنتاج اللبن بشكل ملحوظ خلال معظم أسابيع الدراسة ما عدا الأسبوع الرابع. كان تأثير البطن غير معنوي على أنتاج اللبن خلال الأسبوع الأول والثالث ومجموع اللبن الكلى ولكن ازداد أنتاج اللبن خلال الأسبوع الأول والثالث ثم انخفض في باقي البطون. كان تأثير عدد الخلفه في البطن عاملا مهما لتحديد أنتاج اللبن في الأرانب حيث ارتبط زيادة عدد خلفة البطن من ٣ إلى ٩ بزيادة معنوية فى أنتاج اللبن خلال الأسبوع الأول والثاني والثالث والرابع ومجموع اللبن الكلى.كان تأثير عدد الحلمات معنويا على انتاج اللبن معظم الأسابيع ومجموع اللبن الكلى. كان الارتباط الوراثي بين عدد الخلفات ووزنها موجبا وعاليا وتتراوح قيمته بين ٠,٤٨ إلى ٠,٦٦ . الارتباط بين عدد خلفة البطن ووزنها عند الفطام كانت منخفضة. كان الارتباط المظهري بين حجم البطن والوزن ايجابيا وعاليا ويتراوح بين ٠,٣٤ إلى ٠,٧٤ . وبتطبيق أدلة الانتخاب لتحسين إنتاجية أمهات النيوزيلندي وتم تكوين الدليل بالنسبة لصفات الخلفه حيث (X_1) تمثل عدد الخلفه عند الميلاد و (X_2) عدد الخلفه عند الفطام و (X_3) وزن الخلفة عند الميلاد و (X_4) وزن الخلفة عند الفطام و (PM) معدل النفوق قبل الفطام. وتم تكوين الدليل بالنسبة لصفات اللبن $(X_1, X_2, X_3$ and $X_4)$ أنتاج اللبن خلال الأسبوع الأول والثاني والثالث والرابع و $(X_٥)$ مجموع اللبن الكلى. بالنسبة لصفات الخلفه كانت الكفاءة بالنسبة للدليل الأول عالية ويوصى بها للمربى باستخدامه لتحسين إنتاجية الأم. بالنسبة لصفات اللبن وكانت الكفاءة بالنسبة للدليل الثاني عالية ويوصى بها للمربى باستخدامه لتحسين إنتاجية الأم. كانت قيم التحسين الوراثي المتوقع لعدد الخلفه عند الميلاد منخفض بالنسبة لكل الأدلة ويتراوح بين ٠,٣١ إلى ٠,١٢٩ جم وأيضا منخفض للعدد عند الفطام ويتراوح بين ٠,٦٥ إلى ٠,١٠٠ جم. وكان معتدل أو مرتفع لوزن الخلفه عند الميلاد ويتراوح بين ٣,٧١ إلى ٩,٣٤ جم . وكان مرتفعا لوزن الفطام ويتراوح بين ١٠٨,٩٩ إلى ١٣١ جم ومن هذه النتائج يمكن التحسين الوراثي لإنتاجية أمهات النيوزيلندي من خلال الانتخاب للوزن عند الميلاد والفطام. كانت قيم التحسين الوراثي المتوقع عالية لإنتاج اللبن خلال الأسبوع الأول والثاني والثالث والرابع ومجموع اللبن الكلى حيث كانت تتراوح على الترتيب

١٤,٣٩ إلى ٣٤,٧٧ جم و ٤٢,٣٣ إلى ٥٤,٢٦ جم و ٨٣,٧١ إلى ١٠٥,٦٦ جم و ١٠,٤٥ إلى ٤٢,٧٠ جم و ١٤٣,٦٠ إلى ١٥١,٧٦ جم. ومن هذه النتائج يمكن التحسين الوراثي لإنتاجية أمهات النيوزيلندي من خلال الانتخاب لإنتاج اللبن خلال الأسبوع الأول يؤدى إلى تحسين أنتاج اللبن خلال باقي الأسابيع ومجموع اللبن الكلى.

التوصية :يمكن التوصية بأشياء قد تكون مفيدة وكدليل لمربى الأرانب. وهى أنتاج اللبن في الشتاء اعلي عن باقي الأشهر. كان تأثير البطن على أنتاج اللبن غير معنوي. زيادة أنتاج اللبن مع زيادة عدد الخلفه الذي يحفز الغدة اللبنية لزيادة أنتاجها من اللبن ويجب انتخاب الأرانب الذكور والإناث من أمهات لها ١٠ حلمات لتحسين الإنتاجية. الصفات ذات الارتباط الوراثي الأيجابى القوى فان الانتخاب لهذه الصفة سيؤدى إلى التحسين في الصفات الأخرى. أما الارتباط السلبي لأحد الصفات يمكن أن يؤدى إلى التحسين إذا كان هناك رغبة في تقليل الصفة الأخرى.الارتباط الوراثي يكون مفيد بالنسبة للمربى وكدليل للانتخاب المبكر لوزن الخلفه عند الميلاد والفطام. تحسين أنتاج اللبن خلال الأسبوع الأول يؤدى إلى زيادة لإنتاج اللبن خلال الأسبوع الأول والثاني والثالث والرابع ومجموع اللبن الكلى.