Egyptian Rabbit Science Association

ERSA

Vol. 11(1) 2001
ISSN 1110-6360

Egyptian Journal of Rabbit Science

Published by : Egyptian Rabbit Science Association

Egyptian Journal of Rabbit Science, 11 (1) : 93 -101(2001)

ESTIMATION OF BREEDING VALUES FOR LIFETIME PRODUCTION TRAITS USING ANIMAL MODELS IN NEW ZEALAND WHITE RABBITS RAISED IN HIGH INTENSIVE SYSTEM OF PRODUCTION

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Data on 14210 litters of New Zealand White rabbits produced by 2945 does mothered by 1613 dams and fathered by 842 sires were analysed to characterize animals of this breed genetically for lifetime production traits. Lifetime production traits measured per doe were total number born (TNB), total number born alive (TNBA) and total number weaned (TNW) and length of lifetime production (LT). For animals with and without records, breeding values (PBV) for these traits were predicted using single-trait (SAM) and multi-trait (MAM) Animal Models taking into account the relationship coefficient matrix among animals (A^{-1}). For the list of all animals with records, ***MAM*** *generally recorded higher ranges in estimates of* ***PBV*** *for all traits than those ranges estimated by the* ***SAM****. The ranges in estimates of* ***PBV*** *obtained from the* ***MAM*** *vs* ***SAM*** *were 15.0 vs 8.2 bunnies for TNB, 17.4 vs 9.8 bunnies for* ***TNBA, 16.0*** *vs 11.8 bunnies for TNW and 3.20 vs 2.86 month for* ***LT****. The numbers of sires recorded positive* ***PBV*** *when using the* ***MAM*** *were larger than those sires with positive estimates recorded by the* ***SAM****. The percentages of sires common between the* ***SAM*** *and* ***MAM*** *were relatively moderate and ranged from 19.0 to 52.4% for different traits studied, while the percentages of sires remaining in the same position when using the two models were very low and ranged from 0.0 to 2.4%. Estimates of* ***PBV*** *obtained by the* ***MAM*** *and* ***SAM*** *for animals without records (paternal grand-sires and paternal grand-dams) had the same trend obtained for the animals with records. Also, the percentages of paternal grand-sires or paternal* *grand-dams which were common between the **SAM** and **MAM** were moderate or high and ranged from 15.4 to 69.2%.*

Key words: Rabbit; lifetime production; breeding value; animal model.

Lifetime production of the doe is a function of the length of its productive life and it is an indicator to the doe fertility and prolificacy. Till now, studies available on the evaluation of the lifetime production of doe rabbit were scarce (RINALDO and BOLET, 1988; SZENDRO *et al.*, 1996). This is due to the difficulty to obtain records on this trait as well as the lifetime recording requires also consecutive years contributing to the productive traits of the doe. Although multi-trait mixed-model analyses under a half-sib model has received some attention in some traits in rabbits in recent years, the application of this multi-trait model for lifetime production traits has not been attempted so far. The method of **BLUP** in evaluation of individuals is nowadays utilized.

Under high intensive system of production in the present work (i.e. 8-10 litters per doe per annum), breeding values (**PBV**) for lifetime production traits of New Zealand White animals with and without records were predicted using single-trait (**SAM**) and multi-traits (**MAM**) Animal Models.

MATERIAL AND METHODS

Animals and management :

Data on New Zealand White rabbits (**NZW**) were collected at ZIKA Nucleus Breeding Farm (Schweizerhof Untergroningen) in Germany over 14 consecutive years of intensive production started from 1982. The females were inseminated firstly at a mean age of 121 days (about 4 months) whereas the mean age at kindling was 153 days (about 5 month). The breeding schedule in this rabbitry was allowed to get a maximum number of 10 litters per doe. The does were inseminated artificially within the first few days after kindling. All inseminations were made at random with a restriction of avoiding close relative matings. Does were palpated 18 days post insemination to detect pregnancy. Those, which failed to conceive, were re-inseminated at the next insemination date, which was repeated every 33 days for the same doe group. Does which were not pregnant three times consecutively were eliminated. On the 28th day of gestation, pregnant does were supplied with a thin layer of sanitised wood shaving to provide a comfortable and warm nest for the bunnies. Litters were weaned mostly at the age of about 28 days. All the flock was kept under the same managerial and environmental conditions. Young does were added to the herd as needed to replace those lost by death or by culling.

Housing and feeding :

Rabbits were housed in windowed environmentally controlled rabbitry. In the rabbitry, a minimum temperature of 14° C was maintained during the winter (optimum 18° C). The relative humidity was 60% ± 10%. Fresh air circulated in the house using exhaust fans. The breeding animals were kept individually in flat-deck level cages made from galvanised wire. Each cage measured 40 cm width x 60 cm length x 38 cm height and was suspended 1.2 m above the floor level. Each cage was equipped with a feeder, water supply of nipple drinkers and floor plastic plate to protect rabbits against sore hocks. Fibre nesting boxes (38 × 38 × 38 cm) were attached to the cages of the does and they were fixed outside the cages.

Breeding animals fed formulated pelleted ration, in which the minimum rate of crude protein was 16% and the maximum rate of crude fibre was 14%. Mineral and vitamin mixtures were given as supplement in the ration. The animals fed *ad libitum* until 16 weeks of age and thereafter they received a restricted quantity of ration (120 - 130 g per day) until the first mating. The clean fresh water was available to the rabbits all the time. The occurrence of diseases was largely avoided by a high standard of hygiene and careful management, so that the rabbits had never been treated with any kind of medication.

Data structure and traits of lifetime production :

A total of 14210 litters produced by 2945 does mothered by 1613 dams and fathered by 842 sires were analysed. The lifetime production traits measured per doe during her productive life (in all litters produced by the doe) were: total number born (**TNB**), total number born alive (**TNBA**), total number weaned (**TNW**), and length of productive life of the doe (**LT**). In this study, does with at least 4 parities were used. Lifetime production for the doe was calculated by summing all records of the doe for each of the five traits (**TNBA, TNB, TNW, NL** and **LT**), after making appropriate adjustments for the effects of year-season of kindling and parity. The total number of bunnies weaned was 88824. Estimates of heritability for lifetime production traits of the present study were presented previously by Youssef et al (2000).

Prediction of breeding values :

Multi-trait Animal Model program (**PEST**) written by GROENEVELD *et al.* (1990) was used in predicting the breeding values of animals (**PBV**) for lifetime production traits. This computer program considers all the available pedigree information when calculating the inverse of the numerator relationship matrix (FERRAZ and JOHNSON, 1993). The breeding values for lifetime production traits were estimated for all animals (including all animals with records and those without records). In this situation, **BULP** estimates obtained for lifetime production traits are taking into account the relationship coefficient matrix among animals ($\mathbf{A}^{-1}$ matrix). To solve a set of mixed model equations, **IOD-GS** solver (*i.e.* Gauss-Seidel solver with iteration on data described in **PEST** program) was used. The Animal Model in matrix notation used was :

$$Y = X\beta + Z_a \mathbf{u}_a + \mathbf{e}$$

Where: Y= vector of pre-corrected lifetime production trait (data corrected for the effects of year-season of kindling and parity); β = vector of fixed effects of year-season of birth of doe and litter size in which the doe was born; u_a = vector of random effect of animal; X= Design incidence matrix which relates records to fixed effects; Z_a is the incidence matrix relating records to the additive genetic effects; **e**= vector of random error ($I_n\sigma^2 e$). However, U_a estimated from the Animal Model is relevant to the **BLUP** (FERRAZ *et al*, 1992).

RESULTS AND DISCUSSION

Breeding values estimated for animals with records :

For animals with records in the present rabbitry of intensive production, the minimum and the maximum estimates of breeding values (**PBV**) in addition to their ranges (*i.e.* the difference between the maximum and minimum value) for the list of all animals (sires) are presented in Table 1. The ranges in estimates of **PBV** for all traits recorded by the **MAM** were generally higher than those ranges estimated by the **SAM**. The ranges in estimates of **PBV** obtained from **MAM** vs **SAM** were 15.0 vs 8.2 bunny, 17.4 vs 9.8 bunny, 16.0 vs 11.8 bunny and 3.2 vs 2.86 month for **TNB, TNBA, TNW** and **LT**, respectively.

Table 1: Minimum, maximum and ranges of breeding values for animals with records estimated by single-trait and multi-traits Animal Models for lifetime production traits in New Zealand White rabbits

Trait[+]	Single-trait			Multi-traits		
	Minimum	Maximum	Range	Minimum	Maximum	Range
TNB	-4.20	4.00	8.20	-4.40	10.60	15.00
TNBA	-5.20	4.60	9.80	-12.60	4.80	17.40
TNW	-6.00	5.80	11.80	-9.00	7.00	16.00
LT	-1.40	1.46	2.86	-1.40	1.80	3.20

[+] **TNB** = total number born, **TNBA** = total number born alive, **TNW** = total number weaned and **LT** = length of lifetime production.

The numbers of animals with records (and their percentages) having positive breeding values (Table 2) indicate that estimates recorded by the **MAM** were higher in **PBV** than those estimates recorded by the **SAM** for **TNBA** and **TNW**. In this respect, MRODE (1996) reported that selection bias could be the result of using **SAM**, which does not include the information of relatives upon which selection was practiced. He added that **MAM** is the optimum methodology to evaluate animals using all traits, because it accounts for the relationships among them.

Table 2: Numbers (and percentages) of sires with positive estimates of breeding value (animals with records) recorded by single-trait and multi-traits Animal Models for lifetime production traits in New Zealand White rabbits

Trait [+]	Single-trait Animal Model		Multi-traits Animal Model	
	No. of sires	% of sires	No. of sires	% of sires
TNB	382	45.7	348	41.3
TNBA	391	46.5	475	56.5
TNW	395	47.0	430	51.1
LT	379	47.2	389	47.3

[+] Traits as defined in Table 1.

For the list of the top 5% of sires with records used in the present study, the percentages of sires common (in the same position) between the **SAM** and **MAM** procedures for **TNB**, **TNBA**, **TNW** and **LT** were 7.1, 19.0, 28.6 and 52.4%, respectively. Moderate estimates for **TNBA** and **TNW** and high estimate for **LT** indicate that the same top 5% of sires with records observed in the **SAM** were also found in the **MAM**. On the other hand, the percentages of sires remaining in the same position (*i.e.* don't change their ranks) were very low and ranged from 0.0 to 2.4%. This means that when considering all the sires' list in evaluation (with their records available), the **SAM** procedure will be completely different in estimating breeding values of sires comparable to the **MAM**. These great differences may be due to that covariance components among lifetime production traits were included in solving the iterative equations of **MAM**.

Breeding values estimated for animals without records:

The minimum and maximum estimates of breeding values and their ranges recorded by the **MAM** and **SAM** for animals without records (i.e. paternal grand-sires and paternal grand-dams) indicate that these estimates had the same trend obtained for sires with records (Table 3). The ranges in

Table 3: Minimum, maximum and ranges of estimates of breeding value for paternal grand-sires and grand-dams (animals without records) obtained by single- and multi-traits animal models for lifetime production traits in New Zealand White rabbits

Trait +	Paternal grand-sires			Paternal grand-dams		
	Minimum	Maximum	Range	Minimum	Maximum	Range
Single-trait Animal Model:						
TNB	-1.40	1.80	3.20	-2.20	2.20	4.40
TNBA	-1.40	2.00	3.40	-2.80	2.40	5.20
TNW	-1.60	2.60	4.20	-3.60	3.60	7.20
LT	-0.38	0.52	0.90	-0.88	0.86	1.74
Multi-traits Animal Model:						
TNB	-3.20	6.00	9.20	-3.40	4.60	8.00
TNBA	-6.60	3.40	10.00	-5.20	4.20	9.60
TNW	-3.60	3.60	6.00	-4.60	4.00	8.60
LT	-0.58	0.90	1.58	-0.80	1.00	1.80

+ Traits as defined in Table 1.

Table 4: Numbers of animals (and percentages) with positive estimates of breeding value for paternal grand-sires and grand-dams (animals without records) recorded by single-trait and multi-traits Animal Models for lifetime production traits in New Zealand White rabbits

Trait+	Single-trait Animal Model		Multi-traits Animal Model	
	No. of animals	% of animals	No. of animals	% of animals
Paternal grand-sires:				
TNB	119	46.5	115	44.9
TNBA	120	46.9	138	53.9
TNW	121	47.3	139	54.3
LT	123	48.0	140	54.0
Paternal grand-dams:				
TNB	162	44.6	165	45.2
TNBA	179	49.3	204	55.9
TNW	172	47.4	171	38.6
LT	168	46.3	173	44.7

+ Traits as defined in Table 1.

estimates of breeding value for lifetime production traits for paternal grand-sires recorded by **MAM** vs **SAM** were 9.2 vs 3.2 bunny, 10.0 vs 3.4 bunny, 6.0 vs 4.2 bunny and 1.58 vs 0.9 month for traits of **TNB, TNBA, TNW** and **LT**, respectively. The respective ranges in breeding value for paternal grand-dams recorded by **MAM** vs **SAM** were 8.0 vs 4.4 bunny, 9.6 vs 5.2 bunny, 8.6 vs 7.2 bunny and 1.8 vs 1.74 month. These high ranges in breeding value for most lifetime production traits may lead to state that evaluation of sires based on records of their parents (paternal grand-sires or paternal grand-dams) may help in improvement of lifetime production traits in rabbits.

The number of paternal grand-sires and paternal grand-dams (and their percentages) with positive breeding values (Table 4) indicate that estimates recorded by the **MAM** were mostly higher in breeding values than those obtained by the **SAM**.

For most lifetime production traits (namely **TNBA, TNW** and **LT**), the percentages of paternal grand-sires or grand-dams which are common between **SAM** and **MAM** were moderate or high and ranged from 15.4 to 69.2% (Table 5), *i.e.* the top 5% of paternal grand-sires or paternal grand-dams recorded by the **SAM** were the same as found in the **MAM**. For **TNB**, the top 5% of breeding values for the paternal grand-sires estimated by the **SAM** were not commonly as those estimated by the **MAM.** But, the top 5% of paternal grand-dams recorded a common estimate of 19.4% for both methods used in evaluation, *i.e.* both Animal Models used gave the same number of the top 5% of paternal grand-dams for this trait. Contrary to what mentioned before for animals without records, the percentages of paternal grandsires (**PGSR%**) and paternal granddams (**PGDR%**) remaining in the same position (*i.e.* don't change their ranks) were low and ranged from 0.0 to 7.7% (Table 5). Consequently, the **SAM** gave ranks completely differed from ranks obtained by the **MAM**. This is because covariance structure among traits was considered in the **MAM**.

Table 5: Percentages of paternal grand-sires (PGSC%) and paternal grand-dams (PGDC%) common and remaining (PGSR% and PGDR%) in the same position recorded by single-trait vs multi-traits Animal Model for the top 5% of animals without records

Trait[+]	Paternal grand-sires		Paternal grand-dams	
	PGSC%	PGSR%	PGSC%	PGSR%
TNB	0.0	0.0	19.4	0.0
TNBA	23.1	0.0	27.0	0.0
TNW	69.2	7.7	15.4	0.0
LT	52.4	7.7	36.6	0.0

[+] Traits as defined in Table 1.

Acknowledgments: The authors are gratefully acknowledging the ZIKA Nucleus Breeding Farm (Schweizefhof untergroningen) in Germany for supplying the data.

REFERENCES

FERRAZ, J. B., JOHNSON, R. K. (1993): Animal Model estimation of genetic parameters and response to selection for litter size and weight, growth, and backfat in closed seedstock populations of large White and Landrace swine. *Journal Anim. Science. 71 (4) : 850-858.*

FERRAZ, J. B. S., JOHNSON, R. K., VAN VLECK, L. D. (1992): Estimation of genetic trends and genetic parameters for reproductive and growth traits of rabbits raised in subtropics with Animal Model. *Journal. Applied. Rabbit Research., 15: 131-142.*

GROENEVELD, E., KOVAC, M., WANG, T. (1990): PEST, A general purpose BLUP package for multivariate prediction and estimation. *Proceedings of the 4th World Congress on Genetics Applied to Livestock Production, 1990, Edinburgh, 488-491, University of Illinois, USA (Mimeograph).*

MRODE, R. A. (1996): Linear models for the prediction of animal breeding values. *CAB International, Biddles Ltd, Guildford, UK.*

RINALDO D., BOLET G. (1988): Effect of selection for litter size at weaning on productive life of female rabbits. *4th World Rabbit Congress, Budapest, April 1988, Vol. 2, 269 - 274.*

SZENDRO, ZS., BIRO-NEMETH, E., RADNAI I., MILISITS, G. ZIMANYI, A. (1996): Connection between reproductive performance and productive lifetime of rabbit doe. *6th World Rabbit Congress, Toulouse, France, July 1996, Vol. 2:123 - 126.*

Youssef, M.K., Khalil, M.H., Afifi, E.A. Afifi, El-Raffa, A.M. and Zahed, S.M. (2000): Heritability and non-genetic factors for lifetime production traits in New Zealand White rabbits raised in intensive system of production. *7th World Rabbit Congress,* 3-7 July 2000, Volume A, Valencia, Spain.

تقدير القيمة التربوية لصفات فترة الحياة الإنتاجية باستخدام نموذج الحيوان فى ارانب النيوزيلندي الأبيض تحت نظام الإنتاج المكثف

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أجريت هذه الدراسة على عدد ١٤٢١٠ خلفة (بطن) أنتجتها ٢٩٤٥ أنثى نيوزيلندي ابيض من عدد ١٦١٣ أم و٨٤٢ أب. وذلك لدراسة صفات الحياة الإنتاجية لكل أنثى وهى العدد الكلى للأرانب المولودة – العدد الكلى للأرانب المولودة حية – العدد الكلى للأرانب المفطومة (عند عمر ٤ أسابيع) وطول فترة الحياة الإنتاجية. وذلك للحيوانات آلتي لها سجلات والتي ليس لها سجلات (أباء الذكور وأمهات الذكور). حيث تم تقدير القيم التربوية لهذه الصفات باستخدام نموذج الحيوان وحيد الصفة وكذلك نموذج الحيوان متعدد الصفات مع الأخذ في الاعتبار مصفوفة القرابة بين الحيوانات.

وقد أوضحت النتائج أن القيم التربوية بالنسبة للحيوانات آلتي لها سجلات والمقدرة بواسطة نموذج الحيوان متعدد الصفات لها مدى أعلى من تلك المقدرة بواسطة نموذج الحيوان وحيد الصفة.

كذلك كان عدد الأباء التي سجلت قيم تربوية موجبة باستخدام نموذج الحيوان متعدد الصفات اكبر من المقدرة باستخدام نموذج الحيوان وحيد الصفة وكانت النسبة المئوية لعدد للذكور التي اشتركت فى نسبة أعلى ٣٠ في كلا طريقتي التحليل متوسطة تقريبا وتتراوح بين ١٩ إلى ٥٢,٤ للصفات المختلفة بينما النسب المئوية للذكور التي احتفظت بنفس ترتيبها في الطريقتين منخفضة جدا ويتراوح نسبتها بين صفر و٢,٤ .

لوحظ أن القيم التربوية المتحصل عليها بواسطة نموذج الحيوان متعدد الصفات ونموذج الحيوان وحيد الصفة بالنسبة للحيوانات التي ليس لها سجلات كان لها نفس الاتجاه الذي لوحظ بالنسبة للحيوانات التي لها سجلات.

كانت النسبة المئوية للحدود (أباء الذكور وأمهات الذكور) المشتركة في كلا طريقتي التحليل متوسطة ومرتفعة وتراوحت بين ١٥,٤ ألي ٦٩,٢ .