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EFFECT OF INBREEDING ON RABBIT PERFORMANCE IN TRINIDAD

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Abstract

This article looks at the effect of inbreeding of the doe or the litter and the origin of the buck (from within or outside the population) on the litter size (born total) and abortion rate in rabbits. The data was collected from a small experimental rabbitry in Trinidad (West Indies). This paper describes the evolution of inbreeding coefficient of the doe and the litter over time. The inbreeding of the doe adversely affected litter size and abortion rate. A rather unexpected observation was that inbred litters were significantly larger than outbred litters by as much as 0.8 kits. Of the two factors: inbreeding and origin of the bucks, the latter is more important at mild levels (less than 6%) of inbreeding; however, at higher levels of inbreeding its adverse effects assume significance and attempts must be made to bring down inbreeding by opening the herd to outside bucks and by use of group breeding scheme.

Introduction

Literature reports on the effect of inbreeding on rabbit performance are rare. Most experimental herds are of limited size with little migration and this, in general, is limited to the introduction of new breeding stock. In such isolated population, there is always an increase in the level of inbreeding. The resulting inbreeding depression in performance is a function of the genetic properties of the population as well as the trait measured.

The objective of this paper is to study the effect of inbreeding on certain performance traits of rabbits and the extent to which the introduction of new breeding stock is good strategy for reducing the same.

Materials and Methods

The data in this study was collected from an experimental rabbitry which was established in March, 1983 under an old dairy barn (now fully renovated) at the Field Station of The University of the West Indies. Locally adapted rabbits of mixed breeding (including contributions from New Zealand White, Californian, Checkered Giant, etc.) were purchased mostly from pet keepers and a few small rabbitries and represented a wide foundation. The herd was closed by the end of 1983 with ten does and three bucks. Presently, there are 35 breeding does, four bucks and followers.

The does and bucks were housed in individual all-wire cages with built-in nest

boxes. Automatic waterers and feeders were used. Further details on management and breeding of rabbits can be found in a report by Rastogi (1991).
The replacement stock was selected from proven does based on the size of their litters at weaning over the first three kindlings and the inter-kindling period. The male replacements were selected for postweaning growth as well. The bucks were replaced by their sons as early as possible. Nonetheless, significant decline in performance and high doe mortality was observed during early 1985 which was attributed principally to inbreeding depression. The herd was reopened during August 1985 and four bucks were brought in from the sister island of Tobago. Two more bucks were introduced from outside in June 1987 and one in October 1988. In all, 30 bucks were used during 1983-89 period. Since late 1985, a group rotation breeding scheme is in operation in order to keep the level of inbreeding down.

The data was integrated using a software (SYGAP: Système de Gestion et d'Analyse de Population, S. Poulard et al., 1991) which permitted the processing and analysis of pedigree information. The information in the 'Doe Record Card' was divided into two inter-related records, the one containing the pedigree information on the breeding bucks and does and the other containing information regarding the mating (date, litter size and weight, etc.). Based on the pedigree information in the first record, we have calculated the coefficient of inbreeding of each breeding buck and doe and the coefficient of kinship of each couple. These values were then transferred to the second record for statistical analysis. The method of calculating the inbreeding coefficient (F) was based on an exhaustive search of all possible relationship pathways between the buck and the doe so as to consider only those having direct bearing on 'F'.

The study was limited to only two traits, namely litter size (born total) and percent abortion rate. Any successful mating (i.e., doe confirmed pregnant) which did not result in a litter at the end of gestation period constituted an abortion. The abortion rate was calculated for each buck and doe separately.

The analysis of variance (ANOVA) was used to study the effect of following factors on litter size:

- inbreeding of the doe (inbred vs. outbred)
- inbreeding of the litter (inbred vs. outbred)
- origin of the buck (from within or outside the population).

In a general way, we have preferred the comparison between group means rather than use correlations. In the case of inbreeding, there is nothing to prove that its effect on litter size should be linear (see Howard, 1982). The ANOVA approach allowed detection of the effect of inbreeding without being constrained by the linearity of its effect on the trait.

Results

1. Description of the population

1.1 Evolution of 'F' of the does. It is illustrated in Figure 1. The does were grouped according to year of their first mating. The observations in 1989 were too few to be of value.

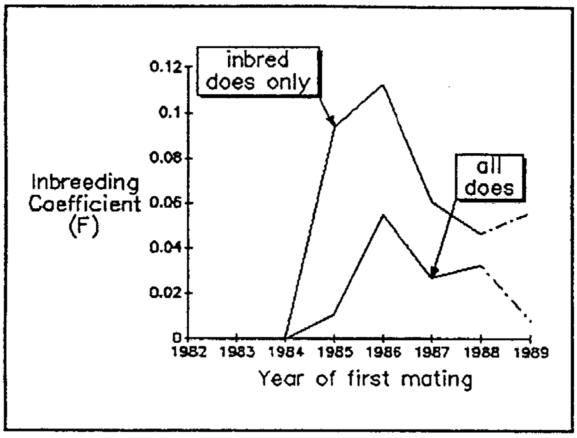

Figure 1. Evolution of inbreeding coefficient of the does

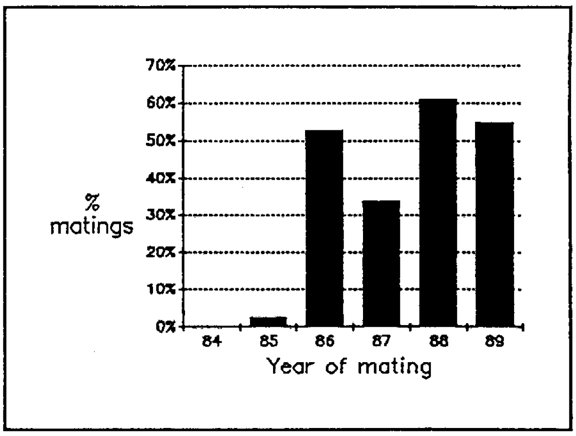

Figure 2. Percentage of matings involving an inbred doe

The average coefficient of inbreeding of all the does increased from zero in 1984 to a peak of just about 5.5% in 1986 and then declined to less than 3% in 1987. If we consider only the inbred does, the average level of 'F' increased to a peak of just about 11% in 1986.

The selected females were in reproduction from 7 to 20 months of their life. Figure 2 illustrates the evolution of the percentage of matings involving an inbred doe. Thus, the low value in 1987 (33%) is due to small number of inbred females born in 1986 and first mated in 1987. On the other hand, in 1986, 1988 and 1989, more than 50% matings involved an inbred doe.

1.2 Evolution of 'F' of the litter. It is illustrated in Figure 3. The peak value of 'F' for all litters (7%) was reached in 1985 and declined thereafter due to the introduction of outside bucks. Considering inbred litters only, the maximum

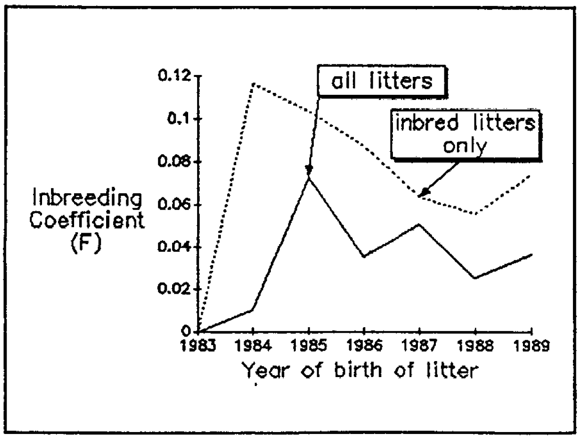

Figure 3. Evolution of inbreeding coefficient of litters

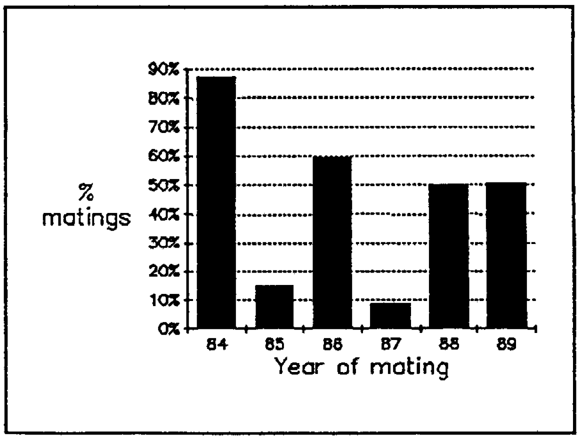

Figure 4. Percent matings with outside bucks

'F' (12%) was reached in 1984 and then declined steadily.

1.3 Percent matings with outside bucks. It is shown in Figure 4. The results of introductions of outside bucks in 1985, 1987 and 1988 are reflected in relatively high percent matings with these males in 1986, 1988 and 1989, respectively. This is further reflected in low level of litter inbreeding in these latter years (cf. Fig. 3). In the same way, in 1984, about 85% of total matings involved unrelated foundation males and females and thus, their kinship coefficient is nil. This explains low average inbreeding coefficient for all litters born in 1984 (cf. Fig. 3).

2. Effect of inbreeding and origin of the bucks

2.1 Effect on the abortion rate

2.1.1 Effect of doe inbreeding on the abortion rate. Table 1 shows the difference in abortion rate of inbred and outbred does. The does were grouped according to the year of their first mating. During 1986-88, when there were enough number of does to allow comparison, one observed that the abortion rate was clearly higher among inbred does. This difference was found to be highly significant and reached a peak in 1987 (30.18 vs 6.88).

Table 1. Doe inbreeding and abortion rate.

Year	Doe inbred		Doe outbred	
	No.	% abortion	No.	% abortion
84	0	-	15	0.00
85	2	0.00	15	14.63
86	17	19.10	18	14.33
87	11	30.18	14	6.88
88	14	25.20	6	2.08
89	1	25.00	6	23.61

2.1.2 Effect of origin of bucks on the abortion rate. It is illustrated in table 2. The bucks were grouped according to the year of first service. Small number of bucks each year made it difficult to draw any valid conclusions and statistical analysis did not indicate any significant effect of origin of bucks. Nonetheless, there appeared to be a slight trend of higher abortion rate when bucks were introduced from outside.

Table 2. Origin of bucks and abortion rate

Year	Bucks from outside		Bucks from within pop.	
	No.	% abortion	No.	% abortion
84	5	1.43	0	-
85	2	8.93	6	0.00
86	3	24.76	5	17.99
87	1	11.11	4	12.90
88	2	13.38	4	10.15
89	1	15.38	3	12.22

2.2 Effect on the litter size.

2.2.1 Effect of doe inbreeding on litter size. It is presented in table 3. The aborted litters were excluded. Outbred does produced larger litters than inbred does except in 1989. Statistical analysis confirmed the differences to be highly significant.

Table 3. Doe inbreeding and litter size

Year	Doe inbred		Doe outbred	
	No.	litter size	No.	litter size
84	0	-	80	5.09
85	2	4.50	76	5.01
86	61	4.69	55	5.42
87	40	4.95	85	5.62
88	59	5.14	41	5.27
89	34	5.06	26	4.96

2.2.2 Effect of litter inbreeding on litter size. It is presented in table 4. Litters were grouped according to the year of birth. An interesting observation was that, except in 1984, the litter size was always higher for inbred litters than for outbreds. The difference was of the order of 0.8 in 1987-89. Statistical analysis found the differences to be highly significant.

Table 4. Litter inbreeding and litter size

Year	Litter inbred		Litter outbred	
	No.	litter size	No.	litter size
84	7	4.71	73	5.12
85	56	5.07	22	4.82
86	48	5.38	68	4.79
87	99	5.56	26	4.85
88	45	5.67	55	4.80
89	28	5.43	32	4.66

2.2.3 Effect of origin of bucks on litter size. It is presented in Table 5. Aborted litters have been excluded. The litter size was always superior for bucks selected from within the population except in 1984 when the foundation bucks were still in service. The differences were found to be highly significant and had a tendency to increase as selection progressed from one year to another. Thus, the difference increased from 0.6 in 1986 to 1.0 in 1988 but dropped to 0.8 in 1989.

Table 5. Origin of bucks and litter size

Year	Bucks from within pop.		Bucks from outside	
	No.	Litter size	No.	Litter size
84	9	4.78	71	5.13
85	63	5.03	15	4.87
86	48	5.38	68	4.79
87	114	5.51	11	4.36
88	50	5.70	50	4.68
89	28	5.43	32	4.66

Discussion

The patterns of evolution of 'F' of does (cf. Fig. 1) and litters (cf. Fig. 3) were quite similar. This observation could allow us to conclude that the selection practised was neutral in its overall effect on the inbreeding level of the population.

Inbreeding of the does has been shown to have adverse effect on litter size and abortion rate by some other researchers also. Chai (1969) reported an adverse effect of inbreeding on rabbit performance, particularly prolificacy (a decrease of 0.7 kits born alive for an increase of 10% in 'F'). Poujardieu and Toure (1980) reported that an increase of 10% in doe inbreeding resulted in a decrease of 0.17 kits born, 0.13 kits born alive and 0.37 kits at weaning. Howard (1982) reported that the effect of inbreeding of doe on her reproduction was variable from one generation of selection to the next. However, Miros et al. (1987) reported that litter size, preweaning survival and kit growth did not differ significantly between outbred matings and four types of inbred matings ('F'=12.5 or 25%). Nunes and Polastre (1988) similarly reported from Brazil that mild inbreeding (4.79 and 1% for progeny and dams, respectively) had no significant effect on litter size or the percentage of still births.

Our results concerning the important positive effect of litter inbreeding on litter size are interesting and may be considered unexpected. There can be several explanations for this observation. (1) Firstly, the inbred litters would have been sired by bucks selected from within the population. This also means that outbred litters were sired by unselected bucks purchased from outside and this may have resulted in smaller litter size. (2) Secondly, the level of inbreeding was rather low (less than 9% except in 1984 and 1985). Actually, in 1984, because of higher level of litter inbreeding ('F' = 12%, cf. Fig. 3) these litters were smaller compared to outbred litters. But from literature reports, it is not clear wether 'F' of the litter increases or decreases litter size. For example, Howard (1982) computed partial regression coefficients between litter size and 'F' of the litter in a closed rabbit herd in which selection was practised for several generations. He found significant positive as well as negative relationships. In pigs, Gerasch (1986) reported that litters with 11.6% or more than 30% 'F' were significantly smaller than outbred litters whereas litters with 12.5% 'F' showed no significant difference.

Our results indicated that doe inbreeding had an adverse effect on litter size as well as abortion rate. One strategy to keep the doe inbreeding down would be to open the herd to outside bucks. The choice of herds to purchase bucks is critical in that these herds must be equal or superior in performance to one's own herd. The outside bucks in this study were purchased from small operators who did not practice any systematic form of selection and this may account for smaller litters following their introduction into our herd.

By comparing the size of litters born to inbred does mated to selected bucks from within the herd with those born to outbred does mated to outside bucks, it should be possible to determine as to which of the two factors, inbreeding of the doe or origin of the buck, has more influence on the litter size. This comparison is shown in Table 6 below.

Table 6. Comparison between size of litters from inbred does mated to selected bucks from within the population and those from outbred does mated to outside bucks.

Year	Doe inbred & buck from population		Doe outbred & buck from outside	
	No.	Litter size	No.	Litter size
84	0	-	71	5.13
85	1	5.00	14	4.93
86	13	4.15	20	4.70
87	35	5.06	6	4.50
88	30	5.50	21	4.57
89	18	5.61	16	4.88

Except in 1986, the litter size is higher for inbred does mated to selected bucks from within the herd. The does in reproduction in 1986 have maximum inbreeding (F=11%, cf. Fig. 1), the effect of which is reflected in maximum decline (0.73 kits) in their litter size (cf. Table 3). It would then appear that the adverse effect of introducing outside bucks is more important than the favourable effect due to a decrease in the inbreeding coefficient of the doe. However, a perusal of Figure 1 and the litter size for 1986 in Table 6 would indicate that should the doe inbreeding rise above a certain level, say 6%, it is preferable to introduce outside bucks even at the risk of their poor performance.

Conclusions

The inbreeding reduces reproductive performance of a population as does the introduction of unselected new bucks into a closed herd under systematic selection. Of these two factors: inbreeding and origin of the bucks, the latter is more important at mild levels of inbreeding (euql or less than 6%) and one should select replacement bucks from within the herd; however, the effects of inbreeding become more important as it rises above certain level and attempts should be made to reduce inbreeding level by opening the herd to outside bucks purchased from superior herds.

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