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CROSSBREEDING EXOTIC AND LOCAL BREEDS OF RABBITS IN CAMEROON: BREED OF SIRE AND BREED OF DAM EFFECTS

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ABSTRACT

Data on 442 offspring from 114 litters produced in a reciprocal crossbreeding programme involving local (LOC), New Zealand White (NZW) and Californian (CAL) rabbits at the Institute for Animal and Veterinary Research (IRZV) Mankon, Bamenda-Cameroon were analysed to ascertain the paternal and maternal breed effects on preweaning litter traits and individual weaning weight using least-squares analysis of covariance. Breed of sire significantly (P<0.05) influenced individual weaning weight (IWW) but not litter birth number (LBN) and litter sizes at birth (LSB), at 21 days (LS21) and at 56 days (LS56), and litter weights and gains from birth to weaning. Progeny of LOC bucks were 166 g above herd average while kits sired by NZW and CAL bucks were below average in IWW. Least-squares constants showed significant (P<0.05) effects of breed of dam on LBN, litter weight at birth (LWB), average daily gain from birth to 21 days (ADG21) and IWW. It would appear that LOC dams had good prolificacy but poor mothering ability while NZW dams showed good prolificacy, mothering ability and growth potentials in their litters. Evidence also showed that CAL dams lacked good prolificacy but had good mothering ability and growth potentials. It was concluded that maternal breed effects appeared to be much more important than sire breed effects in influencing preweaning litter characters of the rabbits.

Key words: Breed, sire, dam, crossbreeding, rabbits.

INTRODUCTION

When heterosis is achieved in a crossbred population, the contribution of the males and females of a particular breed may be of interest. Knowledge of paternal and maternal breed effects, which are direct genetic but non-additive (dominance, epistasis) effects of parental genes on the performance of their offspring, is needed for designing breeding plans with respect to which breed of sire to mate with females of a particular breed or which breed of female to cross with different sire breeds in order to achieve optimum results. A desirable sire breed could pass on to its crossbred progeny genes such as those governing fast growth and high sexual urge, while a desirable dam breed could transfer high prolificacy and good mothering ability to her offspring.

There is a dearth of information on breed of sire and breed of dam effects in heterotic studies conducted on crossbred populations of exotic breeds of rabbits and worse still between exotic and local breeds of rabbits. Nevertheless, Rouvier (1981) in France found Burgundy Fawn and Californian sires, as well as New Zealand White dams the best in a rabbit multibreed comparison of heterotic effects on litter characters. Other studies (Niedzwiadek, 1979; Rouvier, 1980; Lukefahr *et al.*, 1983b) have also established the superiority of NZW does over CAL does in prolificacy. Lukefahr *et al.* (1983a) showed that maternal breed effects appear to be much more important than sire breed effects in influencing litter characters while the study of Partridge *et al.* (1981) on breed differences for maternal and preweaning litter traits has demonstrated the potential role of utilizing existing breed resources to maximize bioeconomic returns to the commercial rabbit

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enterprise. This study was undertaken to investigate the maternal and paternal breed effects on litter characters and individual weaning weight in reciprocal crossbreeding among local, New Zealand White and Californian rabbits.

MATERIALS AND METHODS

Source of data

The rabbit breeding project at the Institute for Animal and Veterinary Research (IRZV) Mankon, Bamenda-Cameroon provided data for the study. The data were collected on 442 offspring from 114 litters obtained from a reciprocal crossbreeding programme involving in all 24 bucks and 67 does of the Local (LOC), New Zealand White (NZW) and Californian (CAL) breeds of rabbits. Two major seasons are recognized in the area: a 5-month dry season (mid-October to mid-March) and a 7-month rainy season (mid-March to mid-October). The ambient temperatures average 21°C but fluctuate a lot during the dry season when a maximum of 31.6° C and minimum of 6.3° C are sometimes recorded. Humidity in general is high and reaches a peak of 87% during the rainy season, with a minimum of 53% during the dry season.

Breeds and animal management

The crossbreeding programme involved the Local (LOC), New Zealand White (NZW) and Californian (CAL) breeds in two-way reciprocal matings. The term reciprocal matings refers to the two variants of (genetically) the same cross which though, on average are genetically alike, differ because the two reciprocal crosses have had a different maternal environment. The reciprocal crosses were: NZW x LOC (main cross), LOC x NZW (reciprocal); CAL x LOC (main cross), LOC x CAL (reciprocal); and NZW x CAL (main cross), CAL x NZW (reciprocal). The maternal influences can be important for the offspring at the time of birth and perhaps, up to the time of weaning. Similarly, the influence of the sire breed can be ascertained from this mating scheme. The animals were bred early in the morning and following a successful mating, pregnancy diagnosis was done by palpation of the lower abdomen 10 days later. Does found empty were re-mated with the corresponding buck. After kindling, litters were evaluated on weekly basis till weaning at 8 weeks when individual weaning weights and sex were recorded. The rabbits were fed a concentrate ration with 18.6% crude protein and 2400 kcal ME/kg body weight given free choice and about 100 g of fresh herbage. Fresh clean water was provided freely.

Characters studied

The traits studied were live birth number (LBN), litter size at birth (LSB), litter size at 21 days (LS21) and at 56 days (LS56), litter weight at birth (LWB), at 21 days (LW21) and at 56 days (LW56), average daily growth rate from birth to 21 days (ADG21), average daily growth rate from 21 to 56 days (ADG56) and individual weaning weight (IWW),
where :

ADG21 = (LW21 - LWB)/[21 x LS21]

ADG56 = (LW56 - LW21)/[(56-21) x LS56]

These traits were recorded for each litter or individual (in the case of IWW) from a cross involving a particular breed of sire and a particular breed of dam.

Statistical analyses

The data were analyzed by least-squares analysis of covariance as described by Harvey (1990). Corrections were made to the data for important environmental effects, namely fixed effect of season of birth of the litter, fixed effect of sex of rabbit (for IWW), and effects of age of doe and weight of doe at kindling through their inclusion in the models as covariates, in order to remove any biases due to these factors. In the initial analysis breed of sire x breed of dam, breed of sire x season of birth and breed of dam x season of birth interactions were included in the models. Since these interaction effects were found to be nonsignificant for most of the traits, they were dropped from the final models. Thus, the two fixed effects models fitted are as follows:

For litter traits:

$$Y_{ijkl} = \mu + A_i + B_j + S_k + b_l(G - \bar{G}) +$$

$$b_2(W-\overline{W}) + e_{ijkl}$$

For individual weaning weight:

$$Y_{ijklm} = \mu + A_i + B_j + S_k + X_l + b_3(G-\overline{G}) + b_4(W-\overline{W}) + e_{ijklm}$$

where:

Y_{ijklm} (Y_{ijkl}) = a single observation on a rabbit (litter)

μ = overall mean

A_i = fixed effect of the i[th] breed of sire (i = 1, 2, 3)

B_j = fixed effect of the j[th] breed of dam (j = 1, 2, 3)

S_k = fixed effect of the k[th] season of birth of the litter (dry vs rainy)

X_l = fixed effect of the l[th] sex of rabbit (male vs female)

G = age of doe at kindling in days

W = weight of doe at kindling in kg

b_1 and b_3 = partial linear regression coefficients of a trait on G

b_2 and b_4 = partial linear regression coefficients of a trait on W

e_{ijklm} (e_{ijkl}) = the random residual effect associated with the variable Y_{ijklm} (Y_{ijkl}) assumed to be identically, independently and normally distributed with zero mean and constant unit variance, i.e. e_{ijklm} (e_{ijkl}) ~ iind (0, σ^2).

Least-squares constants for breed of sire and breed of dam derived from the analysis were used in quantifying the contribution of each parent breed in the performance of different traits.

RESULTS AND DISCUSSION

Breed of sire

Least-squares constants for breed of sire for reproduction traits are shown in Table 1. Least-squares means were 6.37 for LBN, 6.51 for LSB, 5.40 for LS21 and 5.06 for LS56. There were no significant differences (P>0.05) between breeds of sire in these traits. However, LOC bucks tended to have litters with the poorest performance in early preweaning characters (LBN, LSB and LS21). Litters from NZW sires were intermediate in birth traits (LBN and LSB). At 21 and 56 days litters sired by NZW bucks were the most numerous although the differences among breeds were not significant (P>0.05). There was also a tendency for CAL sires to excel in LBN and LSB.

Breed of sire effect was nonsignificant (P>0.05) for litter traits involving weights and gains but differed (P<0.05) for IWW (Table 2). Litters from LOC bucks had the highest IWW (166 g above herd average), indicating the good growth potential inherent in sires of the breed. NZW and CAL sires were below average in influencing IWW.

Previous results with respect to number weaned (Rouvier, 1973) and weaning weights (Carregal, 1980) agree with the present findings in demonstrating minor differences attributable to NZW vs CAL sires. The ranking of NZW and CAL sires on their influence on weaning weight from the present study agrees with the report of Rouvier (1980). The present results also agree with Lukefahr *et al.* (1983a) who reported small differences for all traits studied except percentage early survival of litters, in a New Zealand White-Californian sire breed contrast. In particular, none of the sire breeds was outstanding in influencing reproductive (prolificacy) characteristics.

Table 1. Least-squares constants[1] for breed of sire[2] for reproduction traits[3]

	No. obs.	LBN	LSB	LS21	No. obs.	LS56
Total/overall mean	114	6.37	6.51	5.40	104	5.06
LOC	48	-0.47	-0.51	-0.49	47	-0.09
NZW	44	-0.25	0.10	0.43	37	0.52
CAL	22	0.72	0.41	0.06	20	-0.43

[1] There were no significant differences between breeds of sire (P>0.05).
[2] LOC = Local, NZW = New Zealand White, CAL = Californian.
[3] LBN = Live birth number, LSB = Litter size at birth, LS21 (LS56) = Litter size at 21 days (56 days).

Table 2. Least-squares constants for breed of sire[1] for production traits[2]

	No. obs.	LWB (kg)	LW21 (kg)	No. obs.	LW56 (kg)	No. obs.	ADG21 (g/d)	No. obs.	ADG56 (g/d)	No. obs.	IWW (g)
Overall mean	114	0.354	1.210	97	3.839	112	7.9	94	15.8	442	755
LOC	48	-0.061	-0.085	44	0.270	47	2.5	43	-1.7	213	166^a
NZW	44	0.027	0.169	33	0.443	44	1.7	33	-1.8	147	-4^b
CAL	22	0.034	-0.084	20	-0.713	21	-4.2	18	3.5	82	-162^c

[a,b,c] Constants within columns with different superscripts are significantly (P<0.05) different.
[1] Refer to Table 1.
[2] LWB = Litter weight at birth, LW21 (LW56) = Litter weight at 21 days (at 56 days), ADG21 = Average daily growth rate from birth to 21 days, ADG56 = Average growth rate from 21 to 56 days, IWW = Individual weaning weight.

Table 3. Least-squares constants for breed of dam[1] for reproduction traits[2]

	No. obs.	LBN	LSB	LS21	No. obs.	LS56
Total/overall mean	114	6.37	6.51	5.40	104	5.06
LOC	45	1.49^a	1.42	0.61	44	0.29
NZW	43	0.04^b	0.10	0.05	38	-0.51
CAL	26	-1.53^c	-1.52	-0.66	22	0.22

[a,b,c] Constants within columns with different superscripts are significantly (P<0.05) different.
[1] LOC = Local, NZW = New Zealand White, CAL = Californian.
[2] LBN = Live birth number, LSB = Litter size at birth, LS21 (LS56) = Litter size at 21 days (56 days).

Table 4. Least-squares constants for breed of dam[1] for production traits[2]

	No. obs.	LWB (kg)	LW21 (kg)	No. obs.	LW56 (kg)	No. obs.	ADG21 (g/d)	No. obs.	ADG56 (g/d)	No. obs.	IWW (g)
Overall mean	114	0.354	1.210	97	3.839	112	7.9	94	15.8	442	755
LOC	45	0.057^a	0.009	41	-0.201	44	-4.5^c	40	3.3	227	-138^b
NZW	43	0.039^a	-0.011	34	0.016	42	0.2^b	32	2.3	135	68^a
CAL	26	-0.096^b	0.002	22	0.185	26	4.3^a	22	-5.6	80	70^a

[a,b,c] Constants within columns with different superscripts are significantly (P<0.05) different.
[1] Refer to Table 3.
[2] LWB = Litter weight at birth, LW21 (LW56) = Litter weight at 21 days (at 56 days), ADG21 = Average daily growth rate from birth to 21 days, ADG56 = Average growth rate from 21 to 56 days, IWW = Individual weaning weight.

Breed of dam

LOC dams kindled litters with the highest live birth number (LBN), 1.49 above average (Table 3). Although the least- squares constants were also highest for LOC dams in LSB, LS21 and LS56, differences between breeds of dam were not significant (P>0.05). Least-squares constants for breed of dam for production traits (Table 4) show significant effects (P<0.05) of the breeds on LWB, ADG21 and IWW. While LOC dams were the best in LWB (least-squares constant 57 g), reflecting their highest performance in LBN, their litters were the poorest in ADG21 (least-squares constant -4.5 g/d) and IWW (least-squares constant -138 g). Dams of Californian breed excelled in ADG21 (4.3 g/d above the mean) and had IWW similar to that of NZW does (70 g vs 68 g above the mean). However, they were the worst (-96 g below average) in LWB. The breeds of dam did not significantly (P>0.05) influence the other production traits.

It is noteworthy that NZW dams were intermediate in performance of the dam breeds in all traits studied (both reproduction and production) including those in which significant differences did not exist, with the exception of LS56 and LW21. It would appear that LOC dams had good prolificacy but poor mothering ability as reflected in IWW of their kits. NZW dams showed good prolificacy, mothering ability and growth potentials in their litters. Although the dam breeds did not differ in LW21, the observed differences in ADG21 may be considered a reflection of milk yield in the dams (Lukefahr *et al*., 1981). It could be deduced from the results that CAL dams lacked good prolificacy but had good mothering ability and growth potentials.

The superiority of NZW does over CAL does in prolificacy has been established (Niedzwiadek, 1979; Rouvier, 1980; Lukefahr *et al*., 1983b). In agreement with the present study, Garcia *et al.* (1980) and Ledur *et al.* (1994) have shown that kits of CAL dams have higher growth potentials than those of NZW dams. Nevertheless, the ranking of NZW does as poorer milk producers compared with CAL does (judged by ADG21) contradicts Lukefahr *et al.* (1983b) who reported a highly significant superiority of 0.91 kg of milk in NZW dams over CAL dams in the early preweaning stage. A possible explanation of the present result is that CAL does adapt better, and therefore show better mothering ability than NZW does in the tropics (Ledur *et al.*,1994). The existence of reciprocal differences between LOC x NZW and NZW x LOC litters in LBN, LSB, LS56 and IWW and between NZW x CAL and CAL x NZW litters in LBN, LSB and IWW (Ngo Ndjon, 1997) would suggest differences in prolificacy, mothering ability and growth potentials between LOC vs NZW dams and NZW vs CAL dams.

On the whole, breed of sire influenced only IWW whereas breed of dam effect was manifested in LBN, LWB, ADG21 and IWW. These findings are consistent with Lukefahr *et al.*(1983a) who noted that maternal breed effects appeared to be much more important than sire breed effects in influencing preweaning litter characters of rabbits.

Conclusion

The greatest cross advantages are expected in the mating CAL x LOC for prolificacy and mothering ability and LOC x CAL for growth potentials to weaning. These results suggest that where the three breeds LOC, NZW and CAL are available for crossbreeding in Cameroon, the mating LOC x CAL will produce the best results in the traits considered.

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