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Doe productivity indices and sire effects of a heterogeneous rabbit population in South-western Nigeria

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Abstract

Doe productivity indices are important in evaluating rabbit population since it influences the efficiency and profitability of rabbit production for small-holders and commercial rabbit production. Rabbits for this study were obtained from heterogeneous populations reared in south-western Nigeria, and a total of fifty-six adult rabbits (6 months old) comprising of 49 does and 7 sires were randomly allocated into sire families. Reproductive data were taken from each breeding doe and recorded for each sire family. The reproductive data obtained include annual productivity indices for each doe and sire family at birth, weaning and at week 12 post-partum. The total number of kits delivered at each kindling were recorded as the litter size at birth , the numbers weaned/doe/year were derived by multiplying the average litter size at weaning by number of litters/doe/year. The numbers of fryers/doe/year were obtained by multiplying average number weaned/doe by number of litters/doe/year multiplied by post weaning survival. Annual fryer yield (kg)/doe/year were obtained by multiplying total number of fryers/doe/year with live market weight (kg). Kilogram meat/doe/year were derived from the product of annual fryer yield (kg)/doe/year and the dressing percentage (0.55). Descriptive and inferential statistics were computed using SAS® 2004. Results showed that, the long kindling interval (93 to 115 days) between two consecutive litters affected overall numerical doe productivity with a range of 6 to 27, 3 to 21 and 3 to 18 kits per doe/year at kindling, weaning and 12th week of age respectively. Annual fryer yield/doe/year was 20.24 Kg and the projected Kg meat/doe/year was 11.13 Kg. Mortality was highest in the first two weeks of life and continued to occur throughout the period of the study though at varying degrees across sire families. There was significant sire effect ($P<0.05$) in litter size at weaning and kindling- interval in the sire families. It was concluded that, the major factors affecting doe productivity indices in this population were low litter size at birth, long kindling interval and pre-weaning mortality. Thus, future genetic improvement programmes targeted towards productivity for this rabbit population must consider selection for traits which include increased litter size at birth, short kindling interval and low pre-weaning mortality in the maternal lines while litter size at weaning and kindling interval must be considered for the paternal lines.

Key words: Heterogeneous rabbit population, Doe productivity, Sire families).

Introduction

The advantages and potentials of rabbit production over other livestock species have been well documented worldwide (Cheeke 1986; Aduku and Olukosi 1990; Finzi 2000; Laximi *et al.* 2009 and Odeyinka *et al.* 2014). Lebas *et al.* (1997) stated that rabbits are reared differently in specific environments and the productions help to improve family diet of the poor rural families and also the inflow of regular source of income. Their small body size and broad feeding habits also contributed to their productivity success in smallholder farms. The most outstanding quality of rabbit includes prolificacy when compared to other livestock. Heterogeneous rabbit population are neither specialised hybrid nor specific breeds but are products of many years of unplanned crosses among several breeds of rabbits that were imported at different times to sub-Saharan Africa (Lukefahr, 1985). These are majorly kept in backyard systems in urban, *peri*-urban and rural communities in South-western Nigeria (Oseni *et al.* 2008).

Lebas *et al.* (1986) defined rabbit productivity as the number of young produced per doe per unit of time, and this depends on the interval between successive kindling, litter size at birth and survival rate of the kits; and that these factors can be improved by both genetic selection and improved management of the rabbit environment. These authors further stated that under intensive and semi-intensive systems of production in Europe, a doe can produce from 50 to 60 and 45 to 55 rabbit fryers annually respectively. Several authors (Owen 1976; Somade 1985 and Odubote 1988) reported that high ambient temperature, inadequate nutrition and quality of breeds of rabbit are the factors responsible for the depression in growth and reproductive performance of rabbits especially in the humid tropics. Lukefahr and Cheeke (1990) reported a mean of 5.9, 25.2 and 48.6 for live born offspring per litter per doe, total offspring weaned per doe per year and total fryer (Kg) rabbit production per *annum* respectively, and this reflects a lower production than would be expected under more ideal genetic and environmental conditions.

Currently, there is dearth of information on productivity of heterogeneous rabbit population. Thus, the objectives of this study were to determine the productivity indices and sire effects on some reproductive performance at birth, weaning and 12 weeks for individual does and sire families of a heterogeneous rabbit population.

Materials and Methods

Location

This study was conducted at the Rabbit Unit of the Obafemi Awolowo University Teaching and Research Farm, Ile-Ife, Nigeria, located at latitude , 7^0 28^1 N and longitude 4^0 34^1 E. (Wikipedia.org.) Ile-Ife ecologically typifies the hot and humid tropical forest zone.

Animal, housing and reproductive management

Rabbits for this study were obtained from composite populations reared in Ibadan, Osogbo and Ile-Ife in Southwestern Nigeria. The heterogeneous rabbit stocks are products of non-specific crosses of New Zealand White, California, Chinchilla and Flemish Giant breeds. The animals were over six months of age, with weights ranging between 1.5 to 2.8 kg. A total of fifty-six animals comprising of 49 does and 7 sires were used for this study. Seven sire families were formed and the 49 does were randomly allocated into these sire families with the use of Tables of Random Numbers (Steel and Torrie 1980). Does were mated within each family and traits related to doe productivity were recorded.

Before the commencement of the experiment, all the animals were injected with ivomec® to treat both internal and external parasites at a recommended dosage of 0.2 ml per animal. Pens were thoroughly cleaned and disinfected with izal® and drained engine oil was applied periodically around the pen to keep away soldier ants that constitute a perennial problem around the experimental site. Animals were housed in cages made of wood and chicken wire mesh with each cell measuring 76 × 62 × 42 cm and raised with wooden stands measuring 90 cm high from concrete floor. The rabbitary house was covered with chicken wire mesh at three of the sides and store for feed at the other end while the roofing material was the asbestos sheets.

Two clay pots for feed and water were placed in each hutch. Does were identified by ear tattoo on their left ears using a tattooing set and bucks were identified by means of cage numbers. Matings were routinely done in the morning before the weather got hot usually between 08.00 and 09.00 hrs. Females were usually taken to the males for mating in the bucks' cages. Gravidity test was carried out on each doe at 12^{th} to 14^{th} day after mating by abdominal palpation**.** Does that were not gravid were re-mated immediately. For all gravid does, kindling boxes were placed in their cages on 25^{th} day of their gestation period and daily checking of nest boxes were done to ascertain the date of kindling.

Duration of the study

The study commenced in November 2008 and ended in October 2009. The commencement of the study coincided with dry season when temperature was high and forages were scarce and this resulted in reduced number of successful matings at the initial stage.

Feeds and feeding

Water was given to the animals *ad-libitum* daily. Concentrate feed (chicken growers mash) was made available according to the animal's physiological status (120, 100 and 80 g/head for lactating, gravid and growers respectively). Proximate composition of the experimental diet was as follows: Dry matter =90.95 %, Ash =8.14 %, Crude fiber =5.9 %, Ether extract = 7.8 % and Crude protein = 24.3 %. Forages served included *Centrosema pubescens***,** vines of *Ipomea batatas and Gliricidia sepium.*

Data collection

Reproductive and survival data were obtained from the breeding does offspring respectively from each sire family. Data obtained include number of kits born per doe, average number of kits per doe per parity, total number weaned and average weaned per parity and total number of fryers at 12 weeks Others are average number of fryers per parity, percentage survival from birth to weaning, percentage survival from birth to 12 weeks and survival from weaning to 12 weeks. Kindling interval was recorded as the period (in days) between two successive kindlings.

Data analysis

Descriptive and inferential statistics were computed using SAS® 2004.The data obtained were subjected to analysis of variance using General linear model procedure of SAS. Duncan's New Multiple Range Test was used to separate the means. Annual productivity indices for each doe and sire family at birth, weaning and at week-12 post–partum were estimated using the following variables:

(a) Number weaned/doe/year = Average litter size at weaning × number of litters/doe/year

(b) Number of fryers/doe/year = Average number weaned/doe × Number of litters/doe/year × post weaning survival.

(c) Annual fryer yield (kg)/doe/year = total number of fryers/doe/year × live market weight (kg).

(d) Kg meat/doe/year = Annual fryer yield (kg)/doe/year × dressing percentage (0.55). The statistical model used in the analysis is:

$$y_{ij} = \mu + \alpha_i + e_{ij} \quad \text{...........................} \quad (1)$$

where: y_{ij} = observation of the j^{th} record from the i^{th} sire family;

μ = population mean;

α_i = effect of the i^{th} sire (1, 2, …….7) ;

e_{ij} = random error associated with sires which are normally and independently distributed with zero mean and variance (σ^2).

Results and Discussion

Table 1 shows the total number of kits ranging from 6 to19 and a mean of 14.10± 0.47 for three parities at birth and corresponding values at weaning and at 12^{th} week were 4 to15 with a mean of 9.38 ± 0.45 and 4 to 14 with a mean of 8.42 ± 0.37 respectively. The number of kits weaned under this study was lower to 29-32 weaned in the report of Zerrouki *et al*. (2005) using the Algerian local rabbit breeds. Survival rate from birth till weaning was between 26.70 and 100 % with a mean of 67 (33% mortality) in the seven sire families while survival between birth and 12 weeks ranged between 26.70 and 100 % and a mean of 61.The survival rate between weaning and 12 weeks ranged between 50 and 100 % with a mean value of 92 as shown in Table 1. Zerrouki *et al.* (2008) reported 15 % mortality from birth to weaning in Algerian white rabbit which is lower than 33% recorded in this study. The 33 % mortality is this report is within the range reported by Abu *et al*. (2008). They reported high peri- and post-natal overall mortalities of between 30 to 40 % from birth to marketing and noted that mortality rate is highest among young rabbits in Nigeria. Fayeye and Ayorinde (2008) suggested that incidences of high mortality calls for improved nutrition and other management practices like the use of prophylactic drugs, longer nursing period, gradual change from milk to mash feeds and the use of therapeutics like antibiotics and coccidiostat in addition to the exploitation of crossbred livability. The 100% value in the maximum column (Table1) for percentage survival from birth to weaning, birth to 12^{th} week and weaning to 12^{th} week indicated that some does did not lose any of their kits from birth through 12^{th} week of age. The wide range of 26.7 and 100 % might be due to genotypes and environmental (nutrition, health and housing) effects.

Figure 1 shows a sharp increase in mortality between weeks one and two of the litters and then the curves followed a declining trend till week 12. The high mortality in the first two weeks of life in this study is in agreement with the report of Rashwan and Marai (2000). They noted that nearly most of the pre-weaning mortality occurs in the first two weeks of life. Annual fryer yield/doe/year was 20.2 Kg (10.1(fryers at 12wks /doe/year)) multiplied by projected average weight at maturity of 2000 g). The Kg meat/doe/year was 11.13 Kg (Annual fryer yield × dressing % of rabbit (55%). This is lower to the report of Lukefahr and Cheeke (1990). The authors reported 48.6 kg for annual production of rabbit meat. The number weaned/doe/year (11.30±0.62) is lower than 25.2 reported by Lukefahr and Cheeke (1990). This might be as a result of longer weaning period (42 days) that was used in this experiment when compared with other studies (Zerrouki *et al*. 2008) that weaned between 30 to 35 days. PI for fryers at 12wks /doe/year was 10.1±0.51 which was very close to the PI at weaning (11.30±0.62) although low, showed that there was less mortality between weaning and 12th week of age. Owen (1976) observed that there is lowered productivity of rabbits raised under intensive system in tropical countries due to reduced management quality per animal.

Table 2 shows that there was significant sire effect ($P < 0.05$) in litter size at weaning and kindling interval between sire families. Sire 20 family had the longest average kindling interval (115 ± 7.74 days) and consequently had the lowest LSB (4.14 ± 0.50), LSW (2.38 ± 0.33) and LS12 (2.28 ± 0.28). However Sire 25 family, had the least kindling interval (93.00 ± 3.8) but this did not translate to highest LSB (5.14± 0.34), LSW (3.43 ± 0.45) and LS12 (3.09 ± 0.44) compared with the corresponding variable values of 5.28 ± 0.25, 3.89 ± 0.32 and 3.34 ± 0.30 respectively recorded for sire family 38 that had an average kindling interval of 99.08 ± 2.16.

Table 1: **Overall annual doe productivity indices of litter size at birth, weaning and at 12 weeks across sire families**

Variable	n	Mean ±SE	Min.	Max.
Total no. of kits at birth (3p)	663	14.10±0.47	6 .00	19.00
Average. no. of kits/doe/parity	221	4.70±0.15	2.00	6.00
Total number weaned (3p)	441	9.38±0.45	4.00	15.00
Average weaned/parity	147	3.12±0.15	1.00	5.00
Total no. of fryers at 12wks (3p)	396	8.42±0.37	4.00	14.00
Average no. of fryers/parity	132	2.80±0.12	1.00	4.00
% Survival (birth to weaning)	-	66.70±2.47	26.70	100.00
% Survival (birth to12wk)	-	60.60±2.40	26.70	100.00
% Survival(weaning to12wk	-	91.60±1.73	50.00	100.00
PI for (kits/doe/year)	-	16.90±0.70	6.00	27.00
PI for (weaners/doe/year)	-	11.30±0.62	3.43	21.30
PI for (fryers at 12^{th} wk /doe/year)	-	10.10±0.51	3.43	18.50

SE =Standard error, 3p= three parities, PI = productivity indices, no.=number

Kindling interval in this study was prolonged, with a range of 93 to 115 days and a mean of 102.3±2.21 days, compared to the report of Odubote and Akinokun (1991) that recorded 79 days, and Ohiosimuan *et al.* (1996) with a report of 118.76 days. It must be noted that some of the does were mated repeatedly for up to five times (i.e. fertility = 20% or less) before they conceived. Cheeke (1986) noted that major limitation to rabbit production in the tropics is that rabbits are susceptible to heat stress at temperatures above 30^0c. Moreover, Lebas *et al.*, (1986) suggested that adequate nutrition in quantity and in quality should be provided for rabbits under intensive and semi-intensive reproduction systems. If not, the does will accept the male but will abort and this will consequently lead to lengthening of the kindling intervals.

Other variables (litter size at birth and at 12^{th} week, percentage survival from birth to weaning, birth to 12^{th} week and weaning to 12th week) were not significantly different ($P > 0.05$) across sire families. This indicates that, there was no sire effect in these traits of this population under this study.

Table 2: Effect of sire on litter sizes at birth, weaning, 12-week, survival and kindling interval of the seven families

Sire ID	Sire 20	25	28	31	32	38	51
Variable	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE
Litter size at birth (LSB)	4.14 ± 0.50	5.14± 0.34	4.19 ± 0.45	4.95 ± 0.29	4.83 ± 0.47	5.28 ± 0.25	4.48 ± 0.45
Litter size at weaning (LSW)	2.38 ± 0.33^{b}	3.43 ± 0.45^{ab}	2.95 ± 0.33^{ab}	3.05 ± 0.39^{ab}	3.22 ± 0.48^{ab}	3.89 ± 0.32^{a}	3.09 ± 0.44^{ab}
Litter Size at 12wk (LS_{12})	2.28 ± 0.28	3.09 ± 0.44	2.81± 0.27	2.62 ± 0.29	3.00 ± 0.36	3.34 ± 0.30	2.62 ± 0.35
Survival at weaning (SW)	0.59 ± 0.06	0.65 ± 0.06	0.71 ± 0.05	0.61 ± 0.05	0.69 ± 0.10	0.73 ± 0.05	0.69 ± 0.08
Kindling interval (KI) in days	$115 .86 \pm 7.74^{a}$	93.00 ± 3.87^{b}	100.64 ± 5.14^{ab}	97.00 ± 3.57^{b}	105.00 ± 5.91^{ab}	99.08 ± 2.16^{ab}	105.29 ± 7.42^{ab}
% survival (birth-weaning	59.00 ± 5.96	65.05 ± 5.69	71.29 ± 5.42	60.87 ± 5.69	68.95 ± 10.48	73.65 ± 4.59	69.70 ± 7.05
% survival (birth-12wks)	56.92 ± 5.21	58.23 ± 5.71	68.25 ± 4.56	53.19 ± 5.05	65.44 ± 10.39	63.55 ± 5.54	60.29 ± 8.15
% survival (Weaning-12wks)	97.11 ± 1.88	90.21 ± 5.05	96.32 ± 2.52	89.47 ± 6.95	95.56 ± 4.45	86.39 ± 5.04	86.06 ± 4.21

Means in the same row with different superscripts are significantly different ($P < 0.05$).
ID - Identification, SE-Standard error, LS_{12}- litter size at 12 weeks

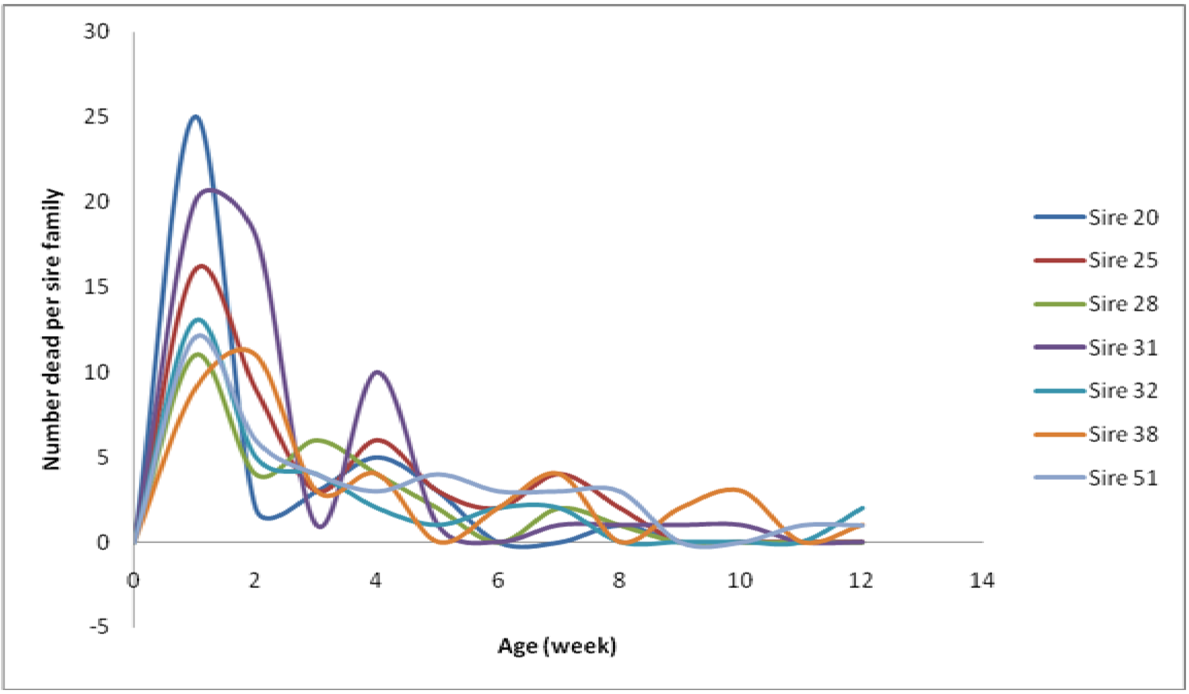

Figure 1: Mortality trend per sire family

Conclusion

It was concluded that, doe productivity indices of this rabbit population is low compared to the biological potential of rabbits in their home environment and also reports in the literature especially for pure bred and definite crossbred stocks. There was sire effect in litter size at weaning and kindling interval between sire families. The major factors affecting doe productivity indices in this rabbit population are the low litter size at birth, long kindling interval and high pre-weaning mortality. Thus, this study suggests that, future genetic improvement programmes targeted towards productivity for this rabbit population must consider selection for increased litter size at birth, short kindling interval and low pre-weaning mortality in the maternal lines while litter size at weaning and kindling interval must be considered for the paternal lines.

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