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Effects of Natural Building Ventilation Openings on Rabbit Does in Humid South West Nigeria

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Authors' contributions

Article Information

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ABSTRACT

The research investigated the effects of building ventilation resulting from different combinations of building orientation and opening on some reproductive parameters. The study was 2 x 4 factorial design and carried out at rabbitry section of the Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife, Nigeria between September 2009 and April 2011. Four identical adjoining buildings, each with eight pens with three factors: building orientations, BO (45º, 90º); ventilation openings, VO (20, 40, 60, 80%); seasons (dry, rainy) at 4 replicates each (n = 32 pens) were used. There was a control experiment with n = 4 does, each in a pen. Measured were the weights of the doe before conception, weights during gestation period and weights of does just before weaning. Temperature-humidity indices-THI, of the pens were also calculated. Weight gain by litters was

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significantly affected (*P* = .05) by BO. VO had significant effect (*P* = .05) on litters' percent mortality. At weaning, 80% VO had the highest litters' cumulative weight, 26% (194.375 g), while cumulative weight, 21% (166.5 g) for 60% VO at 45º orientation. Regression analysis showed stronger association between different combinations of various building orientations and openings and the weight gains by the litters during lactation. Temperature and humidity values in rabbits' housing when controlled to the prevailing wet season values between 24ºC-27ºC and at 80% VO in windward direction in the tropics could allow rabbit does to have increased weights.

1. INTRODUCTION

Rearing of rabbits in the tropics may be difficult because of their low temperature needs and in Nigeria, there is no exception especially the fact that majority of the available breeds are heterogenous breeds of non-standards [1]. Wild rabbits, also referred to as hare among the local farmers, could have been crossbred with them and reared for full integration to our tropical climate. Also, their reproductive performance parameters have scanty literatures in the country for farmers to be double sure of what they are investing when they reared rabbits.

Their reproductive parameters are affected by many factors. For instance, [2] says that season affects rabbits' litter size, adding that average litter size varies from two to fourteen depending on the season of birth, however, season of kindling had insignificant effects on the litter size (Ls) at birth [3,4]. The lightest weight was recorded in the summer kindling season while the highest litter weight at the same age was recorded [5]. Moreover, other studies showed that there was no significant difference due to season of kindling on litter weight at 21 days [3,6,7]. Litter's daily body weight gain was found to be lower at 25, 30 and 35ºC than at 15ºC, the decrease was estimated at 43.5% under high temperatures [8].

The conflicting results of various researches in the winter and summer in these temperate countries could seem to be an eye-opener for farmers in the regions toward high yielding rabbits rearing by looking for the best housing conditions for rabbits. In the tropics where Nigeria belongs, environmental influence when interacted with effects of housing type on rabbits still has scanty literatures. Thereby, making rabbits' rearing seemly unpopular like poultry despite their low cholesterol meat content, their ease of rearing and low initial capital with their high propensity to multiply rapidly. It was thereby imperative that rabbits rearing be researched into and especially their welfare under different housing methods. The existing practices in buildings for rabbitry on farms in south west Nigeria are shed with individual rabbit inside a pen of dimensions between the range 0.76-1.00 m; 0.54-0.80 m and 0.54- 0.80 m respectively for length and breadth and height. These pens were seemingly clustered with their feeding and water troughs especially when a doe gave birth to more than two litters. Therefore, this research investigated the effects of building ventilation openings resulting from variations in temperature-humidity index, THI on some parameters like mortality of does and their performance and litters' live weights performance before weaning. The result of the research will among other factors go a long way to increase yield in rabbits' rearing, increase income for peasant rabbits' farmers and provide more protein intake to the people.

2. MATERIALS AND METHODS

The study was carried out at the rabbitry section of the Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife (latitude 07º 28' N and longitude 05º 33' E) in the rain forest zone of Nigeria [9]. Four adjoining identical buildings raised 0.75 m from the ground with dimensions 1.2 m × 4.8 m × 1.2 m (width × length × height, respectively) were constructed. The dimensions were selected based on an earlier experiment [5] where above same dimensions except that length= 9.6 m was used. Each building with eight pens to house a doe each was constructed with consideration of the orientation tested were constructed with wood, wire mesh, galvanised steel gauze as flooring and iron roofing sheets. Floor area per pen was 1.2 m x 0.6 m and 30º roof slope. It had opening on long sides of the building at inlet, windward side and the outlet, leeward side. The leeward side was 20% opened throughout for all the pens for cross ventilation.

Three factors were considered in the study; season of the year at two levels of dry and rainy

seasons: building orientations (BO) at two levels of 45º and 90º to the directions of the prevailing wind and ventilation openings (VO) at four levels of 20%, 40%, 60% and 80% side openings at the windward side. The directions of the prevailing wind on daily basis obtained from meteorological station on the farm, 250 m away were all SW at all the periods of data collections.

The percent openings were got from product of total height 1.2 m and N as numerator and 5 as denominator, (5 is got from increments, there are 100% and the increment is 20%); where N = 1 for 20% opening---- N = 4 for 80% opening and N = 5 for 100% opening. The BO and VO factors were considered in different seasons of a year. The experimental set up was a 2 x 4 factorial design. Thirty two (n= 32) does of the same age bracket were individually housed in each pen. Each treatment was replicated four times.

Another building completely open from all sides (had only 90º orientation) measuring 22 m x 10 m (length x width) was used as control. It has four long rows stretched (two adjoined and separated from other by walkway) over the span of 18 m with 25 pens, each with dimensions 0.54 m x 0.76 m and height 0.54 m. All were built with galvanized steel for their droppings to fall underneath. To have the same environmental conditions for the buildings, the control building was at the same place within 15m circumferentially. Bucks for servicing these does were kept in the control building each in different pens. They were introduced to the does as appropriate at the same time. The does were mated to produce litters at two parities consecutively per season. At age 5 months, they were stocked and were allowed to integrate with their new homes for a month before mating. Non standard breed or heterogeneous genotypes of rabbits were used. All the rabbits were reared at almost the same age brackets of 1.52±0.04 kg. They had good health and had not yet parturate as ascertained by the veterinary doctor before the commencement of the experiment.

All the does were given the same treatments in terms of feedings and water throughout the period of the experiment. The concentrate feed was made by Guinea Feeds Nig. Ltd usually formulated/prepared for adult rabbits while same roughages were carefully weighed out equally for each of the rabbits once a day to supplement concentrates. Temperatures and relative humidities inside the pens of rabbits were measured twice per day in 10.00 hrs and 14.00

hrs. Temperatures were measured using digital thermometer, (model SW-1189), made by Uniscope Nig Ltd and marketed by Jamot and Co, Osogbo, Nigeria and relative humidities were measured using hygrometer of model M50.60101, No. 023460, made in France. Temperature humidity index of the rabbits were calculated based on [10] THI equation 1 below.

The growth parameters measured for determining growth performance in the gestating rabbits were weights of the doe before conception, weights during gestation period and weight of does during breast feeding. Weights of young rabbits were also measured at weaning age of 5 weeks old. Triple Beam Balance MB with a capacity of 2610 ± 0.1 g was used to measure the weekly weight gain or loss of does.

THI was estimated for the stocked pen using equation by [10],

$$THI = db - \left\{ [0.31 - 0.31 \left[\frac{RH}{100} \right]](db - 14.4) \right\} \quad ...(1)$$

Where

db = dry bulb temperature, ºC and
RH = relative humidity, %

2.1 Statistical Analysis

Data concerning the doe's live weights before, during and after conception were statistically analysed by 2 × 4 factorial design in [11] programme according to the following experimental mixed model:

$$Y_{ij} = \mu + Or_i + Op_j + Or_i. Op_j + e_{ij}$$

where, Y_{ij} = observation on ij^{th} weights of doe due to all factors; μ = overall mean effect; Or_i = the fixed effect of ith orientation (i = 45º, 90º); Op_j = the fixed effect of jth opening (j = 20, 40, 60 and 80%); $Or_i. Op_j$ = interaction effect between the ith orientation and j^{th} opening; and e_{ij} = random error.

3. RESULTS AND DISCUSSION

3.1 Mean Values for Litter Size per Season, Litter Weight and Mortality

3.1.1 Litter size (Ls)

In the dry season, significant effect was observed between the building opening and litter size in

does (Table 1). In the same period, the interactions between the building opening and building orientation did not significantly affect litter size. There were statistical differences among the mean values in both orientations 45° and 90°, in dry season Table 2, and in rainy season, Table 3. Also, there were statistical differences among the mean values in all the openings 20%, 40%, 60% and 80% and the control, 100% in dry season Table 4, and in rainy season, Table 5. During the dry season, the highest mean value for litter size obtained from 60% opening was 2.92 and this was 33.9% increased over the value obtained for 100% opening of 2.18 (Table 4). The litter sizes were generally lesser in the dry season than the rainy season. Other authors [12,2,13] also observed high litter size during winter than summer in the temperate region of the world.

Table 1. P-values for the effects of building orientation and opening on the performance parameters in litters during different seasons

Parameters	Source	Pr > F	
		Dry season	Rainy season
Weight (kg)	Or.	0.6218	0.0327*
	Op.	0.3492	0.0368*
	Or.* Op.	0.4465	0.0001*
	Season*Or.*Op.	0.304	0.0417
Weight gain, kg/day	Or.	0.0825	0.0775
	Op.	0.0217*	0.047*
	Or.* Op.	0.034*	0.334
	Season*Or.*Op.	0.9811	0.741
Mm	Or.	0.2901	0.1773
	Op.	0.0183*	0.0467*
	Or.* Op.	0.5404	0.1400
	Season*Or.*Op.	0.214	0.4747
Ls.	Or.	0.4133	0.0815
	Op.	0.0467*	0.1995
	Or.* Op.	0.2326	0.0391*
	Season*Or.*Op.	0.0514	0.4007

*- significant at P<0.05 level; Or. – building orientation; Op. – building opening, Or * Op – interaction between building orientation and opening, Ls-litter size Season * Or. * Op.- interaction between seasons, orientation and opening; Mm.- mortality*

In the rainy season, Table 1 showed that there was no significant differences at P<0.05 of the building orientation and ventilation opening on the litter sizes. However, their interactions with season had significant effect on the litter size in doe. Also, interactions among the building orientation and opening significantly affected the doe's number of litter produced. The mean values for the two orientations when compared

showed that 90° had lower mean values for litter size (2.37±0.02 < 3.56±0.02), Table 3. The percentage of litters born in the 45° and 90° orientations were respectively 38.2% and 62.7% more in the rainy season than in the dry season, 90° orientation was high because the THI values in the 90° orientation were less than in the 45° orientation.

Figs. 1 and 2 for dry and rainy seasons respectively show mean weights' gains/losses by litters just before weaning (5-6 weeks) as resulted from different building openings and orientations. The gains and losses in weights of litters could be due to the variations in buildings' internal conditions or animals' physiological traits. The error bars show the standard errors.

The relationship between the THI (represented by independent variable y at 45° or 90° orientations) resulted from different building openings and weight gain (represented by w) by the litters during breast-feeding (at post-natal period) were shown in Tables 6, 7, 8 and 9. The linear expression between the building openings and the weight losses or gains (during the period of n = 35 days) showed that THI was linearly related to weight gains or losses in litters prior weaning. The linear model equations established relationships between the THI resulted from different combinations of various building orientations and openings and the weight gain by the litters and these relationships were stronger as shown by their R^2 values (0.87, 0.86, 0.85) during lactation, Tables 6 and 7.

Table 2. Mean values (±SE) of litters' weights and mortality in dry season at different building orientations

Parameters	Orientations (°)	
	45°	90°
Wt.l	0.126[ab]±0.002	0.133[a]±0.002
Wt.g.l	0.016[ac]±0.001	0.019[a]±0.003
Mm	1.027[a]±0.000	1.027[a]±0.001
Ls	2.45[a]±0.03	2.15[b] ±0.01

Mean values with the same superscript(s) along same row are not statistically different at (p ≤ 0.05); SE – Standard Error; Wt. l – mean weights of litter before weaning, kg; Wt. g. l – mean weight gain in does during breastfeeding in kg, Mm.- mortality of litter before weaning; Ls- litter size at weaning

There were weights' fluctuations as shown by Figs. 1a, b and 2 a, b during both seasons leading to the growth curves not producing the normal classical sigmoid growth curves as expected in growing animals [14,15]. This result

agrees with [8] that weight of litters decrease at temperatures of between 25 and 30ºC. This was as a result of the effect of different rates of ventilation resulting from different openings and orientations of the building that resulted in higher pens' temperatures (30 - 34ºC) observed. The error bars showed the standard errors in percent in Figs. 1 and 2.

3.1.2 Does' mortality

There was significant difference (P= 0.018) between the building opening and mortality in doe in both seasons, Table 1. The mean values were all statistically different from one another in the same period, Tables 2, 3, 4 and 5. The 60% opening had 4.2% more than 100% opening while 80% opening had 3.4% more mortality recorded than the 100%. In the rainy season, mortality percent was not significantly affected by the building orientations and openings and their interactions. The mean values for the two orientations when compared showed that 90º had lower values for all the reproductive parameters (does' weight gain/loss, litter size, litter weight, mortality) considered in the rainy season, Table 3. A doe was recorded dead in 45º orientation and at 40% opening, upon post mortem analysis of doe's death by veterinary doctor, the cause of the death was unknown,

thereby attributing the cause to the animal's environment which lies in its housing conditions.

3.1.3 Litter weights

There was no significant difference (P = 0.45) between building orientation, openings, their interactions and the weight of the litters (Table 1) in dry season, whereas, the weight gain by the litters (at pre-weaning period) was significantly affected (P =.034) by the building opening and the interactions of the building opening and the orientation, (Table 1). The mean values of litter weight per season showed statistical differences between openings and orientations, they also showed that 45º orientation had lower weight value of 0.126 kg and weight gain value of 0.016 kg day^{-1} (Tables 2, 3) and 90º orientation had more weight value of 0.019 kg day^{-1}. Opening 80% had highest litter weight (0.149 kg) in rainy season while 40% opening recorded lightest weight of litter (0.117 kg) in the dry season. The highest weight 0.022±0.002 kg, Table 5, was recorded in the rain in 20% opening while lowest weight 0.018±0.000kg, Table 4 was recorded in the dry season at 40% opening at the same age. Thus there were differences in mean litter weight due to season of kindling, this was also observed by [6] under Egyptian conditions, which is sub-tropic.

Table 3. Mean values (±SE) of litters' weights and mortality in rainy season at different building orientations

Parameters	Orientations (º)	
	45º	90º
Wt.l	0.166[b]±0.006	0.179[a]±0.006
Wt.g.l	0.019[b]±0.001	0.020[a]±0.001
Mm	1.017[b]±0.005	1.019[a]±0.005
Ls	3.56[a]±0.02	2.37[a]±0.02

Mean values with the same superscript(s) along same row are not statistically different at (p ≤ 0.05);
SE – Standard Error; Wt. l – mean weights of litter before weaning, kg; Wt. g. l – mean weight gain in does during breastfeeding in kg, Mm.- mortality of litter before weaning; Ls- litter size at weaning

Table 4. Mean values (±SE) of litters' weights and mortality in dry season at different building openings

| Parameters	Openings (%)				
	20	40	60	80	100
Wt.l	0.136[ab]±0.001	0.117[d]±0.002	0.127[ac]±0.003	0.140[a]±0.004	0.131[c]±0.002
Wt.g.l	0.021[a]±0.000	0.018[c]±0.000	0.018[bc]±0.003	0.017[c]±0.002	0.020[a]±0.002
Mm	1.025[b]±0.002	1.024[ab]±0.001	1.026[ab]±0.001	1.027[a]±0.000	1.023[ac]±0.000
Ls	2.10[ac]±0.02	1.83[d]±0.01	2.92[a]±0.02	2.29[b]±0.00	2.18[c]±0.03

Mean values with the same superscript(s) along same row are not statistically different at (p ≤ 0.05);
SE – Standard Error; Wt. l – mean weights of litter before weaning, kg; Wt. g. l – mean weight gain in does during breastfeeding in kg, Mm.- mortality of litter before weaning; Ls- litter size at weaning

Table 5. Mean values (±SE) of litters' weights and mortality in rainy season at different building openings

| Parameters	Openings (%)				
	20	**40**	**60**	**80**	**100**
Wt.l	0.180^{ab}±0.001	0.168^{ac}±0.002	0.195^{a}±0.002	0.149^{abc}±0.008	0.166^{bc}±0.002
Wt.g.l	0.022^{a}±0.002	0.021^{ab}±0.002	0.018^{bc}±0.002	0.018^{bc}±0.002	0.019^{ac}±0.000
Mm	1.020^{c}±0.001	1.023^{d}±0.002	1.025^{a}±0.002	1.022^{ab}±0.004	1.023^{ab}±0.003
Ls	2.14^{abc}±0.01	3.13^{b}±0.01	3.00^{bc}±0.02	3.44^{ab}±0.04	2.11^{d}±0.02
Wt.l	0.180^{ab}±0.001	0.168^{ac}±0.002	0.195^{a}±0.002	0.149^{abc}±0.008	0.166^{bc}±0.002

Mean values with the same superscript(s) along same row are not statistically different at (p ≤ 0.05);
SE – Standard Error; Wt. l – mean weights of litter before weaning, kg; Wt. g. l – mean weight gain in does during breastfeeding in kg, Mm.- mortality of litter before weaning; Ls- litter size at weaning

a).
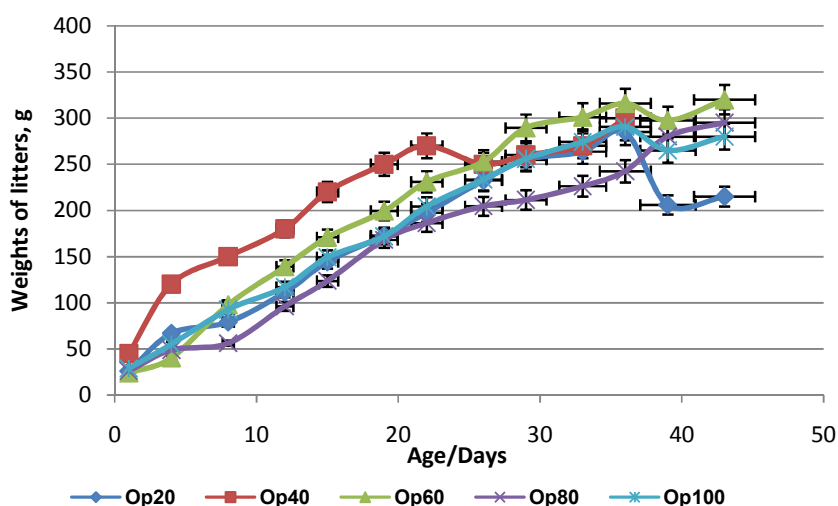
Op20= opening 20%; Op40=opening 40%; Op60=opening 60%; Op80=opening 80% and Op100=opening 100%
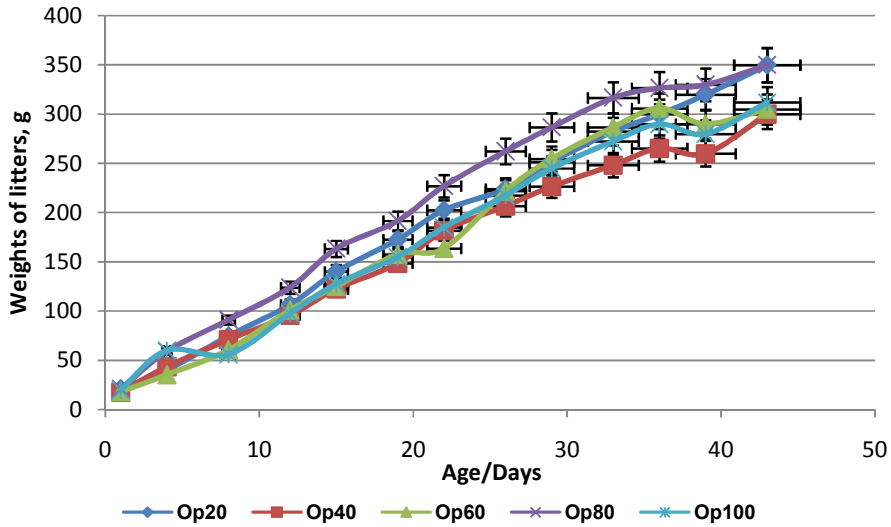
b).
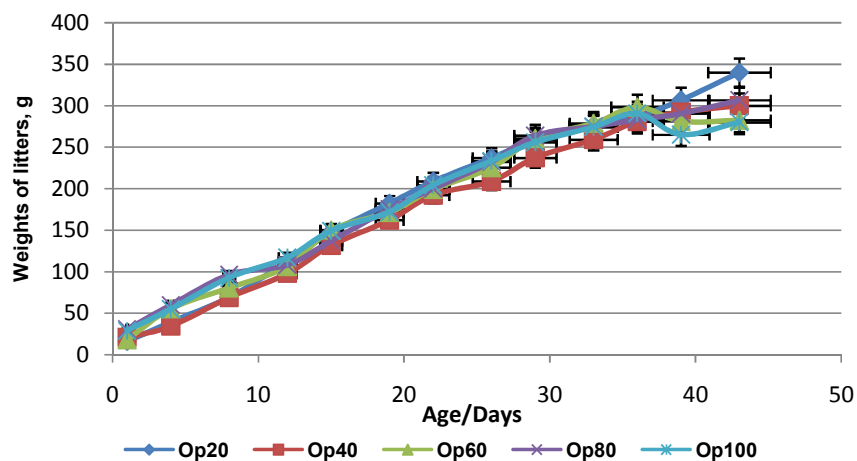
Op20= opening 20%; Op40=opening 40%; Op60=opening 60%; Op80=opening 80% and Op100=opening 100%

Fig. 1. Mean growth curves of litters before weaning during dry season
(a). 45º (b). 90º orientation

a).

Op20= opening 20%; Op40=opening 40%; Op60=opening 60%; Op80=opening 80% and Op100=opening 100%

b).

Op20= opening 20%; Op40=opening 40%; Op60=opening 60%; Op80=opening 80% and Op100=opening 100%
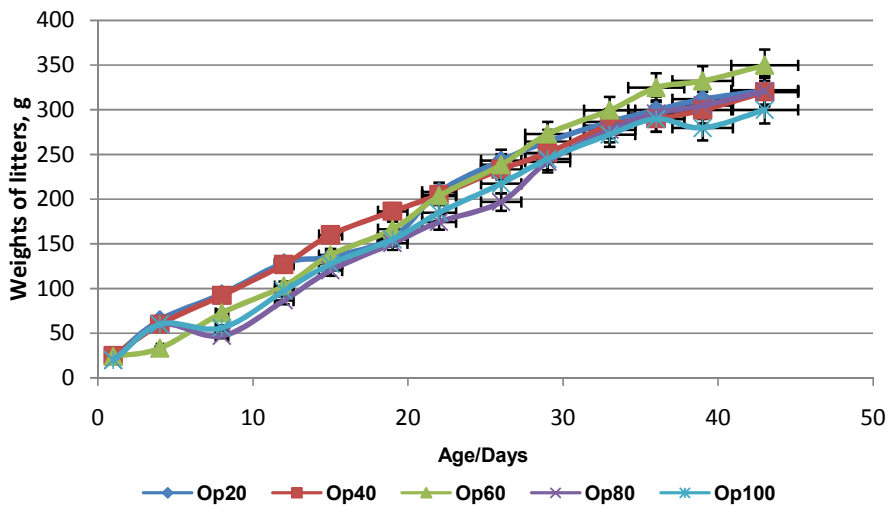
**Fig. 2. Mean growth curves of litters before weaning during rainy season
(a). 45º (b). 90º orientation**

The mean values of the weight gains in the rainy season, Tables 3, 5 were statistically different as they were higher than their counterpart values in the dry season Tables 2, 4. This could be because of the lower THI values in the pens in the rainy season that made the rabbits to stay within their range of thermo-comfort level and then increase in size [16]. These results agree with [17,10] that body weights increase or decrease with the season of rearing. The weight gains were not uniform, because of high THI values of 27.22±0.402, 27.21±0.271 respectively in the pens 20 and 40% in the 45º orientation and lower THI values of 23.9±0.074, 23.99±0.074 in the 60% opening pen. It could also be due to a failure of the physiological mechanisms to maintain thermal balance of the animals due to variations in the THI with the surroundings [16,10].

3.1.4 Litters' weight at birth and weight changes

The average litters' weights at birth per pen were within the range of 21.32 g and 23.83 g in the dry and rainy seasons. Tables 10 and 11 revealed their cumulative weights in both dry and rainy seasons at 45º and 90º orientations respectively at their 5 weeks old weaning period. These values are very low as the case may be at both seasons. The reason may be physiological or could be due metabolic problems or the housing systems experimented. The 80% opening had the highest growth performance with highest cumulative weight value of litters of 194.375 g, 60% opening of cumulative weight value of 166.5 g at 45º orientation at weaning during dry season. The average weights of litters per day were 22.59 g day^{-1} and 40.21 g day^{-1} (highest) respectively for March to May and June to September during the peak of rainy season. The 60% opening had the highest cumulative weight value of litters of 241.875 g in the 45º orientation (Table 10) followed by 80% opening of cumulative weight value of 230.65 g in the 90º orientation during the rainy season at weaning at 35 days. The highest cumulative weight of litter at weaning was for opening 60% at 45º orientation in rainy season of value 241.875 g followed by 230.625 g for opening 80% in the 90º orientation in the rainy season. This means that the low temperature and high humidity recorded in the rainy season (between April and October) increased live weight in the litter by 45.67% in the 60% opening than in dry season. The 100% opening added an increase of 43.95% of carcass to the litter at both orientations in rainy season than in dry season, 80% opening was 32.95% more in rain than in dry season.

Table 6. Regression analysis between THI and weight gain/loss by litters during lactation at 45º orientation in dry season

Openings (%)	Linear model		Quadratic model	
	Regression equation	R^2	Regression equation	R^2
20	y = -0.007 w + 0.038	0.69	y = -0.0028 w^2 + 0.027 w - 0.035	0.85
40	y = -0.007 w + 0.0405	0.25	y = -0.0019 w^2 + 0.017 w - 0.001	0.41
60	y = -0.001 w + 0.0062	0.55	y = -0.0094 w^2 + 0.004 w - 0.005	0.87
80	y = -0.011 w + 0.079	0.58	y = -0.0023 w^2 + 0.017 w + 0.018	0.78
100	y = -0.0009 w - 0.0005	0.01	y = -0.0028 w^2 - 0.033 w + 0.073	0.29

w = weight gain/loss by litters; y = THI

Table 7. Regression analysis between THI and weight gain/loss by litters during lactation at 90º orientation in dry season

Openings (%)	Linear model		Quadratic model	
	Regression equation	R^2	Regression equation	R^2
20	y = -0.007 w + 0.050	0.48	y = -0.0004 w^2 - 0.012 w + 0.062	0.49
40	y = -0.004 w + 0.035	0.49	y = -0.0008 w^2 + 0.006 w + 0.013	0.85
60	y = -0.002 w + 0.0202	0.22	y = -0.0009 w^2 - 0.013w + 0.0439	0.86
80	y = -0.007 w + 0.0452	0.39	y = -0.0007 w^2+0.001w+ 0.0268	0.82
100	y = -0.0009 w - 0.0005	0.01	y = -0.0028 w^2 - 0.033 w + 0.073	0.29

w = weight gain/loss by litters; y = THI

Table 8. Regression analysis between THI and weight gain/loss by litters during lactation at 45º orientation in rainy season

Openings (%)	Linear model		Quadratic model	
	Regression equation	R^2	Regression equation	R^2
20	y = -0.003 w - 0.019	0.012	y = -0.0027 w^2 + 0.030 w - 0.090	0.09
40	y = -0.001 w + 0.015	0.003	y = -0.0001 w^2 - 0.003 w + 0.019	0.001
60	y = -0.011 w + 0.085	0.022	y = -0.0016 w^2 - 0.031 w + 0.127	0.52
80	y = -0.011 w + 0.1037	0.19	y = -0.0037 w^2 - 0.056 w + 0.201	0.65
100	y = -0.0073 w + 0.006	0.107	y = -0.0033 w^2 - 0.047 w + 0.146	0.28

w = weight gain/loss by litters; y = THI

Table 9. Regression analysis between THI and weight gain/loss by litters during lactation at 90° orientation in rainy season

Openings (%)	Linear model		Quadratic model	
	Regression equation	R^2	Regression equation	R^2
20	$y = -0.008\ w + 0.0716$	0.095	$y = -0.0016\ w^2 - 0.027\ w + 0.114$	0.13
40	$y = -0.006\ w + 0.043$	0.28	$y = -0.0014\ w^2 + 0.011\ w + 0.007$	0.41
60	$y = -0.015\ w + 0.0767$	0.075	$y = -0.0066\ w^2 - 0.094\ w + 0.249$	0.69
80	$y = -0.004\ w + 0.0244$	0.055	$y = -0.0006w^2 + 0.0003w + 0.0091$	0.60
100	$y = -0.0073\ w + 0.060$	0.107	$y = -0.0033\ w^2 - 0.047\ w + 0.146$	0.28

w = weight gain/loss by litters; y = THI

Table 10. Cumulative weights of litter just before weaning in dry and rainy seasons at 45° orientation

Openings (%)	Cumulative weights (g)	
	Dry season	Rainy season
20	128.125	180
40	135.125	165.625
60	166.5	241.875
80	194.375	154.25
100	-	-

Control building with 100% had no 45° orientation and therefore no cumulative weights of litter

Table 11. Cumulative weights of litters just before weaning in dry and rainy seasons at 90° orientation

Openings (%)	Cumulative weights (g)	
	Dry season	Rainy season
20	178.25	152.25
40	112.5	218.75
60	164.65	178.75
80	173.5	230.625
100	155	223.125

4. CONCLUSION

Rearing of rabbits requires adequate ambient THI that can be provided via environmental modifications through building design for proper orientation and ventilation openings that will provide best environment to increase productivities in rabbits. This may be provided by using 90° building orientation and 80% building opening.

ACKNOWLEDGEMENTS

CONSENT

All authors declare that 'written informed consent was obtained from the patient (or other approved parties) for publication of this case report and accompanying images.

ETHICAL APPROVAL

All authors hereby declare that "Principles of laboratory animal care" (NIH publication No. 85-23, revised 1985) were followed, as well as specific national laws where applicable. All experiments have been examined and approved by the appropriate ethics committee.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Lamidi WA. Effects of building ventilation on the reproductive performance of female rabbits in humid tropics. Ph.D Thesis, Department of Agricultural Engineering, Faculty of Technology, Obafemi Awolowo University, Ile-Ife, Nigeria; 2011.

2. Marai IFM, Ayyat MS, Gabr HA, Abd El-Monem UM. Effects of summer heat stress and its amelioration on productive performance on production performance of New Zealand White adult female and male rabbits under Egyptian conditions. 6th World Rabbits Congress, Toulousse, France. 1996;2:197-208.

3. Hassan NS, El-Tawil EA, Karima AS, Gad HAM. Performance of NZW Does as affected by different Environmental Factors. Opt. Med. 1994;8:271-278.

4. Hammed AE. Studies on rabbit production effect of some factors affecting reproductive performance of rabbits in a

commercial rabbitry. M.Sc. Thesis, Faculty of Agriculture, Mansoura University, Mansoura, Egypt; 1994.

5. Marai IFM, Habeeb AAM, Gad AE. Rabbit's productive, reproductive and psychological traits as affected by heat stress: A review. Livestock Production Science. 2002;78:71-90.

6. Nasr AS. Milk yield and some associated traits affected by season of kindling, Parity and Kindling intervals in NZW doe rabbits under Egyptian conditions. Egyptian J of Rabbit Science. 1994;4(2):149-159.

7. Nasr AS. Effect of summer heat stress on adult NZW rabbit performance, in Egypt. In: Proceedings of the International Conference on Animal Production and Health in Semi-Arid Areas El-Arish North Sinai, Egypt. 1998;385-393.

8. Boiti C, Chiericato GM, Filotto N, Conali C. Effect of High Environmental Temperature on Plasma testostrone, Cortisol, T3 and T4 levels in the growing rabbit'. J of Applied Rabbit Resources. 1992;15:447-455.

9. Osun State Diary. Osun State Government Diary for 2014, Published by Government of the State of Osun, Nigeria; 2014.

10. Marai IFM, Ayyat MS, Abd El-Monem UM. Growth Performance and Reproductive Traits at first parity of NZW female Rabbits as affected by Heat Stress and its Alleviation, under Egyptian conditions. J of Tropical Animal Health and Prod. 2001;33 (6):451-462.

11. SAS. Statistical Analysis Software. Guide for Personal Computers. Release by SAS Institute Inc. Cary, North Carolina, USA; 2008.

12. McNitt JI, Moody Jr. GL. Effects of month, breed and parity on doe Productivity in Southern Louisiana. J of Applied Rabbit Res. 1990;13:169-175.

13. Bassuny SA. Performance of Doe Rabbits and their Weanings as affected by Heat Stress and their Alleviation by Nutritional Means under Egyptian conditions. J of World Rabbit Science. 1999;9:73-86.

14. Edey TN. Growth: Principles and patterns. In: a course manual in Tropical sheep and goat production (Editor: T. N. Edey). Australian Vice Chancellors' Committee. 1983;83-91

15. Ogebe PO, Ogunmodede BK, McDowell LR. Growth and reproductive characteristics of Nigerian Southern goat raised by varying management patterns. Livestock Research for Rural Development. 1995;7(1):18-21.

16. Bruce JM. Livestock Housing-Criteria for defining the building system. CIGR Handbook in Agricultural Engineering, Animal Production and Aquacultural Engineering, Ed: CIGR-The Int'l Commission of Agricultural Engineering, Pub by ASAE- American Society of Agricultural Engineering, Niles Rd, MI, USA; 1987.

17. Shehata AS, Sarhan MA, Gendy KM. Digestability, thyroid function and growth Performance of NZW Rabbits as affected by season of the year and age. Egyptian J of Rabbit Science. 1998;8(2):141-156.

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