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Original Research

Influence of Some Non-Genetic Factors on Reproductive Performance of Rabbit Line in A University Farm

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Abstract

Rabbit meat, in recent times, is a popular alternative animal protein source that can help Ghana meet its food security needs. The increased production of rabbits as a partial replacement to the production of ruminants could contribute ta o reduction in total methane emissions by livestock. The influence of non-genetic factors on the reproductive performance of 26 does mated by 8 bucks at the University of Cape Coast Teaching and Research Farm were assessed. Data on various reproductive indicators of rabbits were collected over a period of 16 months and analysed using the general linear model procedure of Genstat. The mean litter size at birth (LSB), litter weight at birth (LWB), average kit weight at birth (KWB), mortality, litter size at weaning (LSW), average kit weight at weaning (KWW), percentage survivability (% survival), and gestation length (GL) were 5.39, 268.7 g, 54.18 g, 0.40, 4.28, 646.9 g, 84.8% and 32.2 days, respectively. Season of birth and dam parity had important effect on gestation length but not the other traits. Length of gestation, however, had appreciable influence on both LWW and % survival of kits. The correlations among the reproductive traits range from positive to negative and were mostly important. Negative correlations exist between mortality and all the reproductive indicators. The lack of substantial influence of season of birth on the reproductive indicators of rabbits suggests that breeding of rabbit could be done all year round under intensive system of production.

Keywords: Dam Parity, Gestation Length, Rabbit, Reproductive Traits, Kit,

Introduction

Over the years, swine, cattle, chicken, goats and sheep have been the principal livestock species used for meat in the world. As population increases, it is expected that demand for food will also increase. Similarly, demand for animal-based food and protein will also go up leading to increase in animal farming activities under limited land area, especially in Africa. Ghana has been a heavy importer of meat, especially frozen chicken, to meet the protein demands of her citizens. The heavy importation of meat and meat products into the country results in loss of foreign exchange to the economy. Fortunately, the government of Ghana is rolling out a strategy where livestock especially chicken will be raised in the country for local consumption to reduce the heavy importation of meat into the country. Notwithstanding the government's intervention in boosting poultry production through its flagship programme, 'Rearing for Food and Jobs', the programme alone cannot wholly solve the increased animal protein demands of Ghana. This makes it necessary to shift attention to other non-conventional livestock species that can help to mitigate the heavy demands yet inadequate supply of animal protein products. According to Alu *et al.* (2009), protein deficiency has negative repercussions on the health of individuals.

Recently, rabbit production, which was thought to be non-existent, is increasingly becoming popular in Ghana. The rabbit is an interesting animal and has characteristics which is best suited to help curtail the current and future protein shortages in the country if given the needed attention. The production of this animal could be purposely done as alternate source of animal protein and help reduce the effect of widespread ruminant production in the tropics with its adverse effect on climate change. Rabbit manure is reported to produce the lowest methane compared to ruminants, buffalo and poultry species (Hidayat *et al.* 2021).

The rabbit (*Oryctolagus cuniculus*) is characterized as being very prolific, can be re-mated immediately after kindling, fast-growing, has short gestation length, early maturing, and also utilizes feed efficiently, yet requiring small space for its production.

Output from rabbit farms in Ghana is still very low (Karikari and Asare 2009) because there has not been deliberate and widespread commercialization of this species but rather most backyard rearing. This has resulted in rabbit production lagging behind pig and poultry production (Osei *et al.* 2012). Most rabbit farmers in Ghana use locally adapted breeds for production. These breeds are, however, low in terms of production and meat yield compared to foreign breeds. This has led to few farmers who have enough resources to acquire exotic breeds to improve their production since such breeds are thought to be more productive. Although many farmers seek to import the pure breeds for their production, they are discouraged by the fact that such breeds may not properly acclimatize to the tropical environment, hence not express their full genetic potentials in such environments.

However, there has not been any extensive research to justify whether or not the locally adapted strains of rabbits in Ghana have similar or same genetic potentials as the pure breeds in this tropical condition.

The Department of Animal Science of the University of Cape Coast, has commenced a breed development programme. In this light, locally adapted rabbits have been sourced from various farms across the country and data is being gathered towards breed improvement. Performance test records are being collated to help develop various lines towards improving these rabbits. This initiative, when successful, will go a long way to help farmers acquire locally adapted improved rabbit breeds from the University and also help reduce importation of foreign breeds with their associated cost. The breeding objective of this breeding project is to increase litter size at birth and weaning and also increase growth rate. As production are usually negatively correlated with reproductive traits (Ezzeroug *et al.* 2020), it is important to regularly monitor these reproductive traits so as not to unduly deteriorate them.

The aim of this study therefore was to evaluate the reproductive performance of the locally adapted rabbit lines that are being developed as affected by some non-genetic factors such as season of birth, dam parity and gestation length.

Materials and Methods

Study Area

This study was carried out at the A.G. Carson Technology Area of the Teaching and Research Farm of the School of Agriculture, University of Cape Coast, Ghana. The region is characterized by a bimodal precipitation pattern with an average total yearly rainfall of 920 mm. The average temperature of the environment is around 23˚C. The relative humidity is about 85% in the evening and reduces steadily to 70% during the midday, between May and September.

Experimental Animals and Management

The rabbits were housed in wooden cages with wire meshes. The building where the rabbits were raised had natural ventilation. The cages were fitted with nipple drinkers to avoid water contamination and wastage. Animals were fed with formulated diet of 16% crude protein and 2400 kcal Metabolizable Energy which was fed *ad libitum*. Periodically, animals were given forages as supplement to improve fibre in their diet. All animals were tags for identification. Routine medication was administered for preventive and curative purposes.

The reproductive phase consisted of 8 bucks and 26 does. Females were sent to the buck's cage for mating and observed to ascertain that mating has been successful. The females were observed for pregnancy and non-pregnant does were re-mated until conception has been achieved. Does that do not conceive after three successive matings were culled. Prior to kindling i.e. 25 days after successful mating, nest boxes were provided to the pregnant does. On the day of kindling, boxes were inspected to remove and record mortalities at birth. The young ones were inspected daily to remove dead ones. Kits fed on dams' milk until 21 days of age. At day 21, both doe and its young kits were fed together since the milk of the doe is insufficient to provide the nutrition the young kits needed. The kits were left to be with the doe for up to six weeks and then weaned. The litter size at weaning and litter weight at weaning were recorded.

Data Collection and Trait Definition

The data collection on reproductive performances of rabbits persisted for a period of 16 months between January, 2020 and April, 2021. A total of twenty-six (26) does and eight (8) bucks were involved in the study. The data was collected within four (4) doe parities across the three seasons in the study area; dry (December - March), major rain (April - July) and minor rain (September - November) seasons. The reproductive parameters of the does that were measured included:

Litter size at birth (LSB) – the number of kits kindled at parturition.
Litter weight at birth (LWB) – weight of all the kits kindled at parturition.
Kit weight at birth (KWB) – average weight of kit being LWB divided by LSB.
Litter size at weaning (LSW) –the number of kits weaned at day 42.
Kit weight at weaning (KWW) – by dividing the LWW by LSW.
Mortality at birth –the number of kits that died within 24 hours after kindling.
Percent survival to weaning was estimated by dividing the LSW by LSB and multiplying by 100%.
Beside the reproductive parameters records, season of birth, dam parity and gestation length were also recorded.

Data Analysis

Data were analysed using the general linear model procedure of GenStat statistical software (Edition 12.1) to investigate the influence of season of birth, dam parity and gestation length on the reproductive traits measured. Differences observed between means were separated at 5% level of significance. Below is the model for the analyses of reproductive traits measured:

$Y_{ijkl} = \mu + S_i + P_j + G_k + e_{ijkl}$
Y_{ijkl} = individual observations of each body trait;
μ = overall mean;
S_i = fixed effect of i^{th} season of birth (i = major rain, minor rain or dry season);
P_j = fixed effect of the j^{th} dam parity (Parity 1, 2, 3 or 4);
G_k = fixed effect of the k^{th} gestation length (30, 31, 32, 33 or 34 days);
e_{ijkl} = random error associated with each record ~ $N(0, \sigma^2_e)$ where σ^2_e is residual variance.

Differences between means of a fixed effect were separated at 5% probability level using Least Square Difference (LSD).

Results and Discussion

The mean LSB, LWB, KWB, mortality, LSW, KWW, % survival and GL for the data collected are presented in Table 1. The mean LSB of 5.39 ± 0.22 observed in this study is with the range of 4.23 and 6.75 reported by Fadare and Fatoba (2018) for four rabbit breeds in the humid tropics. The mean KBW and LBW in the present study were higher that the 42.9 g (KBW) and 230.4 g (LBW) reported by Odubote and Akinokun (1991). The mean GL of 32.1 days was similar to the mean of 31.6 by Odubote and Akinokun (1991) and 31.9 day by Fadare and Fatoba (2018).

Table 1: Mean ± standard error (SE) of the variables studied in the rabbits

Variable	N	Mean ± SE
Litter size at birth, LSB	528	5.39 ± 0.22
Litter weight at birth, LWB	528	268.7 ± 11.9
Kit weight at birth, KWB	528	54.2 ± 1.51
Mortality	104	0.40 ± 0.12
Litter size at weaning, LSW	449	4.28 ± 0.23
Kit weight at weaning, KWW	449	646.9 ± 24.0
Percentage survival, % survival	449	84.8 ± 2.93
Gestation length, GL	104	32.1 ± 0.09

[1] *N – Number of observations*

The influence of season of birth was not important (p>0.05) on the LSB of rabbits (Table 2). Numerically, the LSB was highest in the minor rain season, while it was lowest in the major rain season. The results of this experiment are in consonance with the report by Rajapandi et al. (2015) who also obtained unimportant effect of season of birth on LSB. The current result also confirmed earlier results by several authors (Cherfaoui et al. 2013; Fayeye and Ayorinde 2010; Ghosh et al. 2008; Lazzaroni et al. 2012; Pasupathi et al. 2014). The unimportant effect of season on LSB could be partly attributed to the fact that rabbits are intensively kept animals hence not severely influenced by season. However, contradictory outcome was reported by Kumar et al. (2013) who realized an important effect of season on LSB. The influence of season of birth on LSB have also been reported by several authors (Zotte and Paci 2013; Szendrő et al. 2012; Villalobos et al. 2010). The mean LSB was highest in the minor rain season (5.8±1.8) than the dry (5.4±1.7) and major rainy (5.2±2.2) seasons. This agrees with the findings of Kumar et al. (2013) who reported that LSB was higher in spring than summer and winter. Zotte and Paci (2013), however, reported that LSB was greater in the major rain season than in summer for rabbits managed under organic production system. In addition, Rajapandi et al. (2015) also reported that the mean LSB was greater in the major rain season than in the dry season in broiler rabbits reared in sub-temperate climate in India. The non-substantial effect of the season of birth on litter traits shows that rabbit production can be done all year round without seasonal effects on litter related reproductive traits. It is however important to note that in the major rainy season, LSB is relatively low which could be attributed to the fact that pregnant does do not shed many ovaries for fertilization and hence the low LSB.

Table 2: Means ± standard deviation for the effects of season of birth and dam parity on reproductive performance indicators of rabbits

Season of birth	**Traits**							
	LSB	**LWB**	**KWB**	**Mortality**	**LSW**	**KWW**	**% Survival**	**GL (days)**
Major rain	5.2 ± 2.2	267.3±112.0	56.1 ± 10.3	0.4 ± 0.9	3.9 ± 2.0	644.7±240.3	82.9 ± 27.8	31.9±0.8^{b}
Minor rain	5.8 ± 1.8	303.5±124.0	56.7 ± 18.6	0.7 ± 1.3	4.9 ± 2.3	671.7±210.6	88.3 ± 25.2	31.9 ± 0.9^{b}
Dry	5.4 ± 1.7	247.3±85.4	49.3 ±13.8	0.3 ± 1.3	4.4 ± 2.0	633.4±189.6	85.5 ± 26.1	32.7 ± 0.5^{a}
Dam arity								
1	5.1 ± 2.1	233.4±104.6	50.5 ± 14.5	0.5 ± 1.3	4.0 ± 2.1	590.8±185.3	84.1 ± 25.8	32.4 ± 0.7^{b}
2	5.5 ± 2.3	281.1±114.1	57.0 ± 10.4	0.4 ± 0.3	4.1 ± 2.1	677.6±260.0	80.9 ± 30.1	31.6 ± 0.8^{c}
3	5.9 ± 1.8	306.8±121.0	55.4 ± 16.6	0.6 ± 1.3	4.8 ± 2.4	642.3±254.0	86.4 ± 31.0	31.9 ± 0.9^{bc}
4	5.1 ± 1.5	263.5±69.6	55.0 ± 12.1	0.1 ± 0.3	4.4 ± 1.3	704.8±133.2	90.0 ± 15.2	32.9 ± 0.4^{a}

[1] *LSB = Litter size at birth; LWB = Litter weight at birth; KWB = Average kit weight at birth; LSW = Litter size at weaning; KWW = Average kit weight at weaning; GL = Gestation length;*

[2] *Means within a sub-column with different superscripts are significantly different at p<0.05*

Table 3: Means ± standard deviation for the effect of gestation length on reproductive performance indicators of rabbits

	Traits						
GL (days)	**LSB**	**LWB (g)**	**KWB (g)**	**Mortality**	**LSW**	**KWW (g)**	**%Survival**
30	8.0 ± 0.0	384.0±22.6	48.0 ± 2.8	0.0 ± 0.0	3.5 ± 4.9	317.5±449.0^{b}	43.8 ± 61.9^{b}
31	5.0 ± 2.5	271.1±127.7	58.2 ± 10.8	0.1 ± 0.4	3.7 ± 2.03	632.6±300.2^{a}	77.9 ± 34.7^{a}
32	5.8 ± 1.6	276.5±121.0	51.0 ± 15.6	0.7 ± 4.5	4.5 ± 2.1	608.3±197.1^{a}	82.5 ± 27.4^{a}
33	5.0 ± 2.0	254.4 ± 79.0	55.3 ± 11.8	0.2 ± 0.6	4.5 ± 1.8	718.7±137.2^{a}	93.3 ± 12.2^{a}
34	4.0 ± 0.0	199.5±57.3	69.8 ± 13.8	1.0 ± 1.4	3.0 ± 1.4	753.0±329.5^{a}	100.0±0.00^{a}

[1]LSB = Litter size at birth; LWB = Litter weight at birth; KWB = Average kit weight at birth; LSW = Litter size at weaning; KWW – Kit weight at weaning

[2]Means within the same sub-column with different superscripts are significantly different at p<0.05

Table 4: Pearson correlations among some reproductive traits of rabbits

	MOR	**LSB**	**LWB**	**KWB**	**LSW**	**KWW**
LSB	0.052					
LWB	-0.435*	0.780*				
KWB	-0.433*	-0.422*	0.114			
LSW	-0.342*	0.651*	0.702*	-0.108		
KWW	-0.240*	-0.378*	-0.122	0.565*	0.136	
% Survival	-0.313*	-0.174	0.034	0.377*	0.530*	0.743*

*[1]LSB - Litter size at birth; LWB - Litter weight at birth; KWB - Kit weight at birth; KWW - Kit weight at weaning; MOR – Mortality; *Correlation is significant at p<0.05*

Season of birth had no effect (p>0.05) on the LWB of rabbits. The results of this research revealed that LWB was highest in the minor rainy season (303.5 g), followed by the major rainy season (267.3 g) and least during the dry season (247.3 g). The effect of season on KWB was also not important (p>0.05). The KWB was least (49.32 g) in the dry season whereas the rainy seasons recorded higher weights (56.71 g and 56.14 g), respectively for the minor and major seasons. Szendrő et al (2019) argued that the negative effect of warmer months on kit birth weight could have resulted from the decreased feed consumption by pregnant does, leading to reduced milk production (Abdel-Monem et al. 2008; El-Deghadi 2019; Soliman 2008) and consequently reducing the weight of the litters kindled. Jiménez et al. (2017) who studied birth weight at thermo-neutral and higher temperature had indicated that birth weight reduced by 8% in the higher temperature. Cherfaoui et al. (2013) and Rajapandi et al. (2015) have both reported non-important influence of season of birth on the birth weight and litter weight of rabbits which is consistent with the current study. A contradictory result has, however, been reported by Tůma et al. (2010), Kumar et al. (2013), and Zotte and Paci (2013) on the seasonal effect on LWB and KWB.

Zotte and Paci (2013) reported a lighter weight for kits kindled in the rainy season compared to kits kindled during hotter months. The results of this study revealed higher LSB, LWB and KWB in the minor rain season than in the dry season (5.824, 303.5, 56.71 vs 5.360, 247.3, 49.32). This finding has been supported by Sivakumar et al. (2013) but different from results of Apori et al. (2014).

Season of birth had no influence (p>0.05) on LSW and KWW. However, numerically higher mean LSW and KWW were recorded in the minor rainy season (4.941 kits and 671.7 g, respectively) than the dry and major rainy seasons. Several authors have also reported no effect (p<0.05) of season of birth on LSW and KWW of rabbits (Pasupathi et al. 2014); Ghosh et al. 2008; Rajapandi et al. 2015; Cherfaoui et al. 2013). However, Sivakumar et al. (2013) and Kumar et al. (2013) have reported important effect of season of birth on the KWW of rabbits. Similarly, this study showed no effect (p>0.05) of season of birth on percent survivability. Numerically higher percentage survivability was recorded in the minor rain season followed by the dry season and then the major rain season. The relatively low percentage survivability of kits in the major rainy season could be attributed to cold temperature during such periods which could result in incidences of pneumonia in rabbit kits (Bhatt et al. 2002). Abdel-Azeem et al. (2007) have attributed high mortality of kits in the dry season to reduced metabolic activity of kits. Cherfaoui et al. (2013) and Tůma et al. (2010) have also reported higher mortality in the major rain season than the other seasons. The unimportant effect of season of birth on kits survivability to weaning have been corroborated by other authors (Mazouzi-Hadid et al. 2014; Fayeye and Ayorinde 2010).

The effect of season of birth on GL was important ($p<0.05$) (Table 2). Relatively longer GL was observed in the dry season (32.7 days) than in the rainy seasons (31.9 days and 31.9 days). The reports of Kumar et al. (2013), Apori et al. (2014) and Askar and Ismail (2012) that season of birth influenced ($p<0.05$) gestation length of pregnant does corroborate the findings in this study. Gestation length was found to be shorter in the rainy season than in the dry season (Apori et al. 2014; Sivakumar et al. 2013), which agree with the present study. However, reports from other literature showed that the season of birth did not influence gestation length (Fayeye and Ayorinde 2010; Kumar et al. 2006; Tůma et al. 2010).

Dam parity had no effect ($p>0.05$) on the LSB (Table 2). Several authors have also reported no effect of dam parity on LSB in rabbits (Kumar et al. 2013; Lazzaroni et al. 2012; Rajapandi et al. 2015; Sivakumar et al. 2013; Tůma et al. 2010). Mean litter size at birth generally increased with increase in dam parity although there was a reduction in the fourth parity. Similarly, LWB was not affected by the season of kindling. The highest LWB was recorded in the third parity which could be attributed to the high litter size at such parity. Pollesel et al. (2020), Amao (2020), and Ayo-Ajasa et al. (2015) have however reported that dam parity had influence ($p<0.05$) on both LSB and LSW of rabbits. Fouda and Ismail (2018) and Apori et al. (2014) have also reported effect of dam parity on LWB. The average kit weight at birth was higher in the second parity (56.95 g) than in the third parity (55.36 g) which could be attributed to lower LSB in the second parity. Although both first and fourth parities had relatively low LSB, the kit weight at the second (56.95 g) and third (55.36 g) parities were higher those of the first (50.50 g) and fourth parity (54.97 g) parities. This could partly be attributed to the good maternal care of the does and management. The unimportant effect ($p>0.05$) of parity on LSW and KWW agree with results of Kumar et al. (2013), Rajapandi et al. (2015) and Sivakumar et al. (2013). However, other authors have reported important effect of dam parity on LSW and KWW in rabbits (Fouda and Ismail 2018; Amao 2020; Apori et al. 2014; Ayo-Ajasa et al. 2015; Lazzaroni et al. 2012; Rajapandi et al. 2015; Sivakumar et al. 2013). The LSW was highest (4.842 kits) in the third parity and this could be due to the higher LSB recorded at this parity. The LSW was also higher in the fourth parity (4.400 kits) than in the second (4.045 kits) and first (4.00 kits) parities. The higher LSW in the fourth parity could be attributed to the relatively lower kit mortality (0.066) and higher survivability (89.968%) – which could have been as a result of good mothering ability of experienced does. The LSW was slightly higher in the second parity (4.045) than in the first (4.00), as a result of a lower LSB and relatively higher kit mortality in the first parity. The fourth parity recorded the highest mean KWW (704.8 g) and this could have been as a result of the smaller LSB, lower kit mortality at birth, and a higher survivability from birth to weaning. In the first parity, KWW was expected to be greater since smaller number of kits were weaned, however, the least KWW was recorded. It could be said that the does were young and inexperienced in the first parity, and hence lacked good mothering abilities resulting in the lower LSW and KWW. The lower KWW (642.3 g) recorded for the third parity was a result of the higher LSW. Some authors (Kumar et al. 2013; Sivakumar et al. 2013) reported that the lowest LSW was recorded in the first kindling which is in consonance with the findings of this study. Important effect of dam parity on the gestation length of rabbits was observed in this study. The GL was longest in the fourth parity (32.9 days), followed by the first parity (32.4 days). In the second parity, the period from conception to birth was relatively shorter (31.6 days) compared to all the other parities. The finding of Amao (2020), and Sivakumar et al. (2013) who presented an important influence of the dam parity on the GL is in line with the results of the present study. However, other findings have reported a non-significant ($p>0.05$) effect of parity on the GL (Apori et al. 2014; Askar and Ismail 2012; Salem and Gomaa 2014; Tůma et al. 2010). According to Askar and Ismail (2012), and Tůma et al. (2010), as dam parity increases, GL also advances which contradicts the findings of this study.

The number of pregnancies that reach viable gestational age, when the foetus can survive outside the uterus, and thus the number of parturitions of a female animal, is referred to as parity. The parity effect on the litter parameters was not important. Nevertheless, the results in this study revealed that LSB increased as parity advanced up to the third and declined afterwards. For improved LSB, farmers should not breed does beyond the third parity as performance could reduce as the doe ages.

The GL had a no influence ($p>0.05$) on the LSB, LWB, average kit weight, mortality and LSW (Table 3). The longest GL (34 days) recorded the least LSB (4.00 kits) whereas the highest LSB (8.00 kits) was recorded in the shortest GL (30 days). The non-significant differences seen in the LWB, KWB, mortality and LSW could be a reflection of the fluctuations in the LSB. The GL had a significant effect ($p<0.05$) on %survival. As the GL lengthens, %survival improved. Egena et al. (2014) reported that weight of kit born within the shortest GL is lower than later ones, which supports the report of this study.

The relationships among the reproductive traits are presented in Table 4. There was a weak relationship (0.052) between the mortality at birth and the LSB. However, mortality correlated negatively and important ($p<0.05$) with LWB (-0.435), average kit weight (-0.433), LSW (-0.342), KWW (-0.240), and % survival (-0.313). The negative correlation between mortality and KWW and KWB observed in this study corroborates the report of Fadare and Fatoba (2018) that mortality had negative relationship with KWW and the KWB. The LSB correlated positively ($p<0.05$) with LWB and LSW (0.78 and 0.651), which is in consonance with the report published by other authors (Behiry et al. 2021; Egena et al. 2012; El-Deghadi 2019; Moustafa et al. 2014). In addition, our findings agree with Fadare and Fatoba (2018) results which indicated positive correlation existed between the LSB and the LWB (0.878). However, LSB correlated negatively with the KWB (-0.422) at birth, which corroborates the report of Fadare and Fatoba (2018) who also found that higher litter sizes resulted in lower kit (individual) weight at birth.

The LWB had positive relationship with LSW (0.702). LWB also correlated lowly with the KWB (0.114) and % survival at weaning (0.034). Some authors reported a positive connection between kit weight and litter weight at birth which agrees with the results of this study, however, Fadare and Fatoba (2018), Iraqi et al. (2007) and Topczewska et al. (2013) reported a strong relationship opposing the weak relationship observed in this study. Litter weight at birth, however, had a negative relationship with the KWW (-0.122). The kit weight at birth had a positive association with KWW (0.565) and % survival (0.377) at weaning, KWB however had a negative relationship with the LSW (-0.108). This report agrees with Fadare and Fatoba (2018) who reported a moderate (0.513) relationship between the kit weight at birth and weaning weight. The LSW had a low correlation with KWW (0.136), and had a positive relationship with % survival (0.530). The relationship existing between the KWW and % survival was important ($p<0.05$) and positive (0.743), agreeing with other research who found that heavier kits had superior chances of survival than weaker once (Elmaghraby and Elkholya 2010; Martínez-Paredes et al. 2018; Reyes-Meza et al. 2011; Zerrouki et al. 2012) This could be attributed to the weaker kits' inability to compete for the does milk and low mobility resulting in chilling (Muciño et al. 2009).

Conclusions

The season of birth, and dam parity did not significantly influence the litter traits studied. The season of birth, however, had an effect on how long it took a doe from conception to parturition. In addition, the parity of the doe influenced significantly the gestation length of the doe. How long it took a doe to kindle did not necessarily influence the litter size. With these findings, it could be said that rabbit production can be done all year round. However, doe productivity declined after the third parity.

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Conflict of Interests

There is no conflict of interest.

Publisher Disclaimer

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