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Relationship between parity, dam weight and litter size in West African Dwarf Goats

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ABSTRACT

Goats constitute the largest group of small ruminant livestock in Nigeria, totaling about 73.8 million and also constituting 6.2 percent of the World's goat population. The West African Dwarf goat (WAD) has the ability to thrive and survive under harsh environmental conditions of heat and humidity and it is widely distributed in the rainforest belt of southern Nigeria. They are short-legged and small-bodied animals, weighing between 20 and 36 kg, they are known to have very high rate of fertility and fecundity, their meats. The profitability of goat farming is greatly affected by litter size, which determines the number of animals available for utilization (feed, fur and manure). Therefore, this study aimed to determine the relationship between parity, dam weight and litter size in WAD goats in West Africa. A total of Nineteen (19) apparently healthy West African Dwarf (WAD) Does in their 2nd to 4th parities were used for the study. The animals were weighed 3 times prior to parturition and immediately after birth. The respective weights were recorded in kg. Farm records were also checked for the parity of the animals. Prior to commencement of the experiment, appropriate vaccination against diseases were done. All experimental animals were managed intensively in well-ventilated housing with roof made of corrugated iron sheet and floor being raised about 45cm above ground level. Data collected during this were subjected to analysis of variance using SAS (2003) statistical package. Results showed that there is a prolificacy rate of 142.1% & Average kid born per doe to be 1.42, this means that WAD does are highly prolific. However, litter size was significantly and positively correlated with parity.($p < 0.01$, $r = 0.60$). The results further revealed that parity is an important factor in the evaluation of litter size in goats and multiple births could be achieved with good breeding plan and better management practices. Therefore this study concludes that WAD goats with high body weight and high parity should be selected for breeding purpose.

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***Keywords*:** West African Dwarf goats, litter size, parity, body weight, Nigeria

1. INTRODUCTION

Goat contributes enormously to the food and economic security sector of Nigeria, and is usually known as cash saving and generating animal during emergency (Akintobi et al. 2021). Due to the rapid increasing population of the world's most populous Black Country, Nigeria; the demand for animal and animal protein to meet up with the minimum animal protein requirement per individual per day has skyrocketed tremendously (Ekpo et al. 2022). Studies has shown that the population of Nigeria has been estimated to be about 218.5 million, and it is expected to increase continually (Horsfall et al. 2022). To this end, resulting to the largest group of ruminant livestock in the country is practically unavoidable, as goats are ubiquitous in every region of the country. Goats are hardy with the ability to thrive and survive under harsh environmental conditions of heat and humidity.

During sociocultural activities such as weddings, funerals, apprenticeship graduations, the use of goats and sheep are conspicuous and prominent. They constitute the largest group of small ruminant livestock in Nigeria, totaling about 73.8 million and also constituting 6.2 percent of the World's goat population (Sam et al. 2022).

The Nigerian indigenous goats have been phenotypically classified into three distinct breeds: The Sahel, Red Sokoto, and West African Dwarf goats. The classification is based on their phenotypic traits, origin, function, body size, length or height (Rotimi et al. 2017). The West African Dwarf goat has a wide range of variations in coat colours which ranges from black, white and brown, pied, mixed or mottled (Dursteler, 2019). Their small size has proven to be of great benefit to farmers in Sub Sahara African countries with limited access to land and refrigerators to keep their meat. According to Debele et al. (2011), the goat is the most important of the domestic animals to man in the tropics, as it has variety of functions and in comparison with other ruminants display unique ability to adapt and maintain themselves in harsh environments. Goat meat, which is known as chevon is accepted by the people of all communities in Nigeria irrespective of tribe or religion, unlike pork which is prohibited by some religious groups for its unclean nature (Dursteler, 2019).

Among all breeds of goat, West African dwarf is preferred because it is a non-seasonal breeder, has high prolificacy and usually gives birth to twins and triplets, kidding thrice in two years (Srivastava et al. 1968; Khan et al. 1982; Kaufmann et al. 1984). These characteristics of dwarf goat are in contrast to the breeds and accordingly may exhibit different hormonal mechanism. The reproductive activity is controlled through endocrine secretions, receptors at target organs and feedback mechanisms (Tanaka et al.1992). The West African Dwarf goat (WAD) is widely distributed in the rainforest belt of Southern Nigeria, which includes states like Oyo, Osun, Ekiti, Ogun, Lagos, and Kwara states. They are short-legged and small-bodied animals, weighing between 20 and 36 kg (Briggs et al. 2023). They are known to have very high rate of fertility and fecundity, and their meats are preferred and delicious for preparing plethora of African delicacies (Achoja, 2020).

The profitability of goat farming is greatly affected by litter size, which determines the number of animals available for utilization (feed, fur and manure). Therefore, the improvement and increment of the reproductive traits in goats cannot be overemphasized (Ciptadi et al. 2019).

Kidding frequency and litter size are important components of an efficient kid production system. Litter size or number of kids in the litter as defined by Alexandre et al. (1999) as the total number of born kids per kidding and per goat.

The average litter size and prolificacy increased with age (Kaufmann et al. 1984; Adebambo et al. 1994). Birth weight, litter size and pre-weaning survivability are some other important traits that can affect the profitability of the goat enterprise. These traits are affected by a number of environmental factors. Odubote (1996) reported significant effect of parity and year of birth on litter size of WAD goats. Being polyestrous, the WAD goats produce kids and come into milk at any time of the year. Milk production tends to be of secondary importance as they are known of meat type. Litter size or number of kids in the litter is defined as the total number of born kids per kidding and per goat (Alexandre et al. 1999). According to Fitzhugh and Bradford, (1983) litter size is dependent on breed of goat and several other factors which include age of doe, season of birth or conception, feeding and management system.

The litter size at birth is an important trait for selection of goats to produce the next generation and increase of meat and milk production. It seems to be the most useful selection criterion for genetic improvement of meat production (Cobo et al. 2021). Although selection for litter size has been successful, the rate of improvement has not been large, partly because the trait is only observable in females of reproductive age that do conceive and maintain their pregnancy. Litter size in goat is influenced by numerous factors. Amoah and Gelaye, (1990) established that it is under significant influence of goat age and parity, whereas Awemu et al. (1999) stated parity, year and season are important factors as well. Song et al. (2006) stated that reproductive efficiency of goats is determined by age of goats at first kidding, kidding interval, type of birth, litter size and mass of kids at birth and weaning. However, adequate knowledge about the relationship of parity and litter size will help in determining the parity level when a doe's prolific ability reaches its peak. Moreover, this information is very important in culling and or selection program (Ithurbide, 2022).

The increasing litter size depends on several factors, of which ovulation rate is particularly important (Ghiasi, 2021). The number of mature oocytes released in a reproductive cycle is determined by a complex interplay between endocrine signaling, the pituitary gland, the ovary, paracrine and possibly endocrine signaling within ovarian follicles, and adjacent somatic cells (Recchia et al., 2021)

Reproductive traits are of great interest to goat breeders as prolific breeds can increase productivity, and provide a good profit (Simões et al., 2021). One of such traits is litter size (number of kids per birth cycle), which measures the fertility of an animal (Nowier et al., 2023). Reproductive traits such as litter size are sex-limited traits with heritability values between zero and one, low (0-0.19), moderate (0.2-0.39) and high (0.40-1.0), as described by Briggs et al., (2023). Low to moderate heritability ranging from 0.08 to 0.37 was observed in different goat breeds (Meza-Herrera et al., 2019). Litter size in a goat is influenced by the season of parturition (Margatho et al., 2019). Phenotypic value for litter size in goats has been shown to be highly dependent on genetic and non-genetic factors such as the age of a particular dam, nutrition, breed, season, body weight and parity (Assan, 2020).

The body weight of a goat is important for a number of reasons, related to breeding (selection) feeding and health care. However this fundamental knowledge is often unavailable to those working with goats in the small scale-farming sector, due to unavailability of scales. Furthermore increasing prolificacy per each animal is the factor which breeders try to reach consequently they tend to raise animals with higher body weight. It is essential to raise goat that are genetically able to produce more meat that would result in increasing income of meat. (Ambhore et al. 2003; Fouri et al. 2002; Riva et al. 2003; Vashan et al. 1998). In order to evaluate genetic potential of goat to produce more meat, it is necessary to collect records from carcass and body weight; however it would be possible when animals are slaughtered (Waldron, 2003)

Therefore, the present study is aimed at investigating the relationship between parity, dam weight and litter size in West African dwarf goats.

Sodiq et al. (2003) reported that the reproduction rate of Kacang and Peranakan Etawah does tended to increase with advance in parity up to the 4th parity and slightly decrease thereafter. Das (1993) working on meat goats in Malya, Tanzania reported that prolificacy tends to increase from first parity and decrease in the sixth parity. Wilson and Light (1986) and Awemu et al. (1994) reported that litter size increased with parity with the largest litter at the fifth parity on goat and sheep in Central Mali and on Red Sakoto goat in Nigeria, respectively. These observations indicate that the parity level in which doe's prolific ability reaches its peak is between the 4th and 5th parity, thus culling of does from the herd can starts beyond the 5th parity. It may be economically unwise to culled does at the early parities (except for ill-health) when the full genetic potential of their reproductive rate has not yet been fully expressed.

Nowier, (2022) reported that the prolificacy of does tended to increase with advanced parity. Although incidence of quadruplets was rare (0.8) in this breed it was however observed that the incidence occurred mostly on doe of advanced parity. The increase in litter size with advance parity may be associated with the physiological maturity of the doe. Rodríguez-Hernández et al., (2022) reported that lower prolificacy of primiporous does may be associated with an under developed state of the reproductive features required for successive litter bearing compared with those of multiparous does that have reached physiological maturity.

2. MATERIAL AND METHODS

2. 1. Location of experimental Site

The study was carried out at a constructed pen of the Directorate of University farms (DUFARMS) of the Federal University of Agriculture, Abeokuta, Ogun State, Nigeria located next to Ogun-Osun River Basin Development Authority (OORBDA), along Osiele-Abeokuta road, off Abeokuta-Ibadan road in the north Eastern end of the city at Alabata. The study area lie approximately on latitude 7°13′ 49″N and longitude 3°26′ 12″E (Figure 1). It lies within the humid lowland rain forest region with two distinctive seasons. The wet season extends from March to October while the dry season extends from November to February. The mean annual rainfall is 1113.1 mm. The rainfall has a characteristic bimodal distribution with peaks in July and September and breaks in August.

Generally, the rainfall could be heavy and erosive sometimes accompanied by lightning and thunderstorm at the beginning and the end of rainy season. The mean monthly temperature varies from 22.9 °C in August to 36.32 °C in March. The relative humidity is high ranging from 75.52% in February to 88.15% in July (Aiboni, 2001; Akintade, 2017).

The vegetation of the area comprises of low land forest but become secondary rainforests or forest re-growth because of the increase in land use and exposure. The vegetation has the characteristics of tropical rain forest such as high forest and growth of massive trees and twinning shrubs. The forest is covered with litters of fallen trees by both human and natural activities. The Federal University of Agriculture, Abeokuta, Ogun State, overlies the pre-Cambrian metamorphic rocks of the basement complex (Jones, 1964), with biotitic hornblende gneisses, quartzite and quartz schist. Physical structures and facility available include, academic core, unity building, lecture theatre rooms, institutes, strict nature reserve, farm centre etc. as well as existing rivers/streams which included rivers Oshinko, Ole/Alakata, Arakanga, Pala, Pap/Olu and Tigba/Ajigbayin.

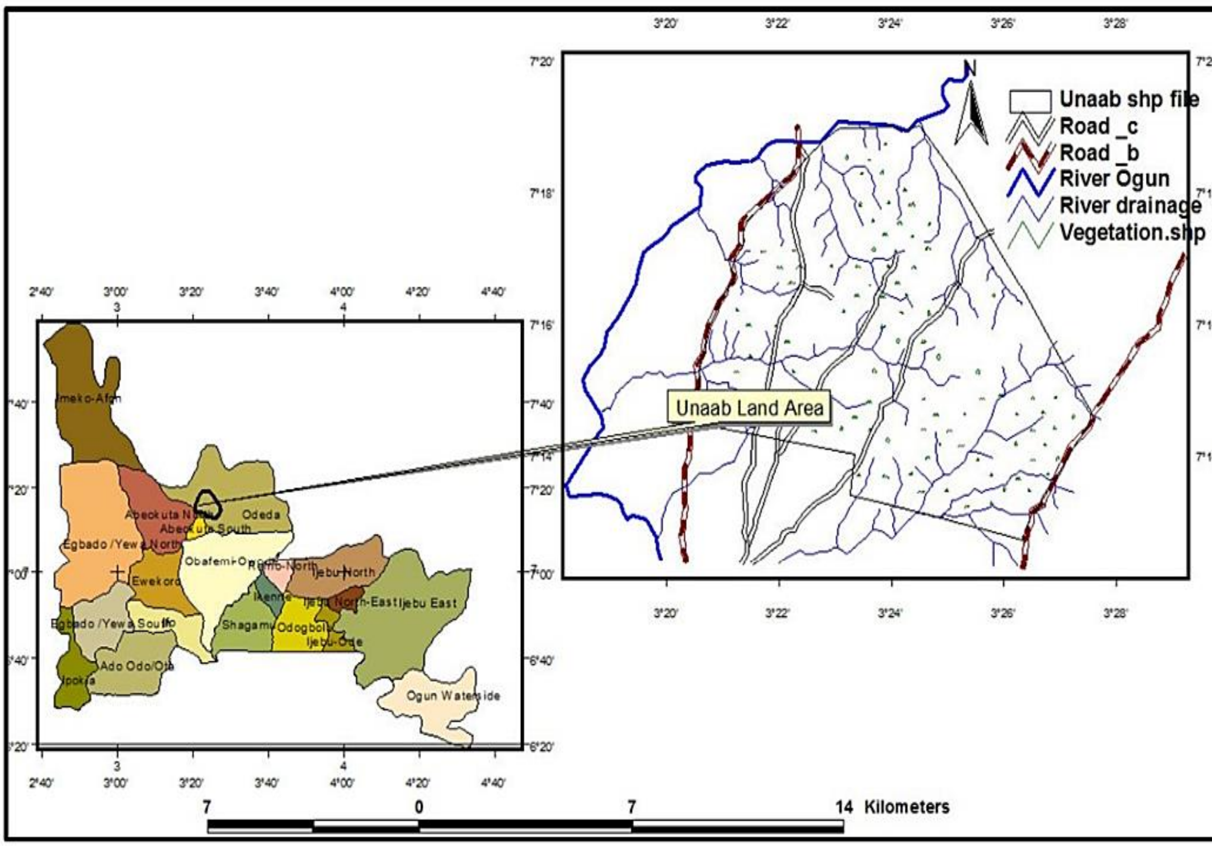

Figure 1. Map of Ogun state showing the study area (Ufoegbune & Fabiyi 2016)

2. 2. Experimental Animals and Management

A total of 19 healthy West African Dwarf (WAD) does in their second to fourth parities were used for this study. For identification purpose, individual animals were ear tagged. Prior to the commencement of the experiment, appropriate vaccination against diseases were done. Moreover, in the course of the experiment, medication were administered when the need arises. All experimental animals were managed intensively in a well-ventilated housing with roof made of corrugated iron sheet and floor being raised about 45cm above ground level.

2. 3. Feeding and Feed Composition

The experimental animals were fed twice daily with concentrate and grass. Feeding consist of 50% forages and 50% concentrate. Does were fed 6% of their body weight. Clean and cool water was given *ad libitum.* Forage consist of guinea grass (*Panicum maximum)* and elephant grass (*Pennisetum purpureum*). The composition of the experimental diet to be given to the animals is presented in Table 1.

Table 1. Feeding Composition of Concentrate for the Experimental Animals.

Ingredients	Percentage
Maize	20
Wheat offal	40
Palm kernel cake	30
Bone meal	2
Groundnut cake	7
Common salt	1
Total	100

Calculated Analysis

Metabolizable energy (kcal/kg)	2272.1
Crude protein	17.35
Crude fiber	7.75
Ether Extract	4.42
Calcium	0.859
Available phosphorus	0.5

2. 4. Breeding and Pregnancy Detection

All does were serviced by two bucks in the herd. Does were allowed to express estrus naturally and subsequently introduced to a buck. All does were observed for return to estrus 3weeks after first mating. Pregnancy was assumed to be established when does do not return to estrus. Animals that shows signs of heat were inseminated again (Lopez-Sebastián et al., 2014).

2. 5. Data collection

Litter size of individual WAD doe were recorded immediately after parturition, birth type consisted of single, twins and triplet. Parity was based on the number of times the does had kidded (1, 2, 3, 4, 5 and 6. Furthermore, body weights of does were taken bimonthly during gestation and weekly after parturition until the end of the experiment. Dam weights were measured using a spring balance. The dam was put in a sack and hanged on the hanging scale then readings were taken and recorded individually in kilograms. All information obtained was used to examine the relationship between parity, dam weight and litter size in West African Dwarf goats.

2. 6. Experimental design and statistical analysis

A completely randomized design was used for this study. Data collected was subjected to analysis of variance using SAS (2003) statistical package. Significant least squares means was separated using Duncan Multiple Range Test (Bewick et al., 2004) within the same statistical package.

The statistical model for this study will be of the form:

$$Y_{ij} = \mu + A_i + \Sigma_{ij}$$

where; Y_{ij} = Trait of Interest,
μ = Population mean,
A_i = Effect of i^{th} Age of the doe, i = 1, 2, 3, 4… and
$\sum_{ij}$ = Random residue

3. RESULTS

Table 2 shows the percentage of West African dwarf goat with different litter size group and its prolificacy. The litter size proportion for single and twins were 57.9% and 42.1% respectively. The birth of 27 kids was recorded from 19 does given an average of 1.42 kids/doe and the prolificacy rate of 142.1% was recorded.

Table 2. WAD goats with different litter size group and prolificacy.

Parameters	Litter size		Total kids born	Average kid born/doe	Prolificacy (%)
	Single	Twins			
No. of animals	11	8	27	1.42	142.1
% of animals	57.9	42.1			

Table 3 shows the Pearson correlation between body weight, parity and litter size. There is a positive correlation between body weight and parity (0.520) i.e. as parity increase in WAD goats, body weight also increase. There is also a positive correlation between parity and litter size (0.602), this signifies that as parity increase in WAD goats, litter size also increase. Therefore parity was significant with $p<0.001$.***

Table 3. Pearson correlation between body weight, parity, and litter size.

	Body Weight	Parity	Litter size
Body weight	1.000		

Parity	0.520**	1.000	
Litter size	0.173	0.602***	1.000

4. DISCUSSION

Table 2 shows the percentage of West African Dwarf goat with different litter size group and its prolificacy. The average kid born /doe is 1.42 and its prolificacy is 142.1%. The average litter size being 1.42 in this study is quite comparable with some world prolific goat breeds example. American Alpine, Saanen and Toggenburg with an average litter size of 1.9, 1.7, and 1.6 respectively (Amoah et al. 1996; Rouatbi et al., 2022). Prolificacy of 142.1% also compares well with other goats' breed of the world, this shows that WAD goats are highly prolific (Wachida et al., 2018). Table 3 reveals the correlation between parity and litter size. Litter size in this study showed a tendency to increase with parity because there is a positive correlation between parity and litter size. This is in consistent with Akpa et al. (2011). Litter size in this study showed a tendency to increase from first parity to fifth parity and a reduction in the sixth parity. It was observed that does giving birth to quadruplets continue to remain in the herd for a long time, this suggest that the farmers in the study area are conscious of retaining does that had high potential for multiple births in order to increase their herd size. Although the farmers started culling the does after the 2nd parity, majority of the does were culled after the 4th parity. This is probably due to the fact that after the 4th parity the performance of the doe decreased, hence it may not be economical to keep these does beyond the 4th parity. The positive relationship of parity and litter size implies that prolificacy of this goat increased with parity. This is consistent with the report of some researchers (Amoah and Gelaye 1990; Das 1993; Wilson and Light 1986; Awemu et al. 1994, 1999; Mtenga et al. 1994; Husain et al. 1996; Margatho, 2019; Singh et al. 2021; Briggs et al. 2023)

Therefore the increase in litter size with increasing parity in this study could be related to physiological maturity and management of the doe (McGregor, 2016). In accordance to Gatew (2014), these observations indicate that the parity level in which doe's prolific ability reaches its peak is between the 4th and 5th parity, thus culling of does from the herd can starts beyond the 5th parity. Parity is directly proportional to body weight. The number of litter size observed in West African Dwarf goats in this current study indicates that the breed is prolific and has a high kidding rate (Bitrus et al., 2023). This suggest that to improve the prolificacy rate of this does, selection of does to be parents of next generation should be made on those of advanced parity when their genetic potential must have been fully expressed.(de Lima et al., 2020).

The annual reproductive rates of WAD goats are composite parameters, which do not appear to be utilized as much as it should be (Wilson, 1989). The total number of young per breeding female per year has been calculated as the size of the litter and the number of days in a year divided by the kidding interval that is (litter size x365 / kidding interval).

5. CONCLUSION

Based on the findings of this study, WAD goats are highly prolific when compare to other breeds, thereby making it an economical and ideal choice for livestock farming. Moreover, parity and body weight; which are two important factors in genetic evaluation of litter size in goats, are directly proportional to each other. This signified that their body weight increases as their parity does. Hence, WAD goats with high body weight and high parity should be selected for breeding purpose. Therefore this study suggested that to improve the prolificacy rate of West African Dwarf does, selection of does to be parents of next generation should be made on does of advanced parity when their genetic potential must have been fully expressed.

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