Growth and reproductive performance of West African dwarf goats at the Animal Research Institute, Katamanso Station

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ABSTRACT

A study was conducted to evaluate the growth and reproductive performance of the West African Dwarf goat using records kept at the Animal Research Institute, Katamanso Station from 2004 to 2012. The liveweights and growth rates were adjusted for differences in the age of animal at time of weighing. The effect of sex of kid, year of birth, season of birth, parity and type of birth on the growth and reproductive parameters were analysed using the General Linear Model procedure of SAS. The birth weight of kids averaged 1.15 kg with 1.25 kg for males being significantly ($p < 0.05$) higher than 1.12 kg for females. Pre-weaning growth rate averaged 35.78 g/day and was significantly ($p < 0.05$) affected by type of birth. Single born kids (44.73 g/day) had a higher pre-weaning growth rate than the twins (35.59 g/day) and triplets (30.73 g/day). Weaning weight at 120 days averaged 5.44 kg and was not significantly ($p > 0.05$) affected by any of the factors examined in this study except type of birth. Singles weighed heavier than the twins and triplets (6.63 kg versus 5.49 kg and 4.75 kg) respectively. Post weaning daily gain averaged 26.49 g. Year of birth significantly ($p < 0.05$) affected post weaning growth rate. Season of birth, type of birth and sex of kid did not significantly affect the post weaning growth rate. Yearling weight averaged 12.24 kg and was significantly ($p < 0.05$) affected by year and season of birth. The overall kidding interval averaged 247 days and was not affected by year of birth, season of birth and type of birth. However, parity had a significant ($p < 0.05$) effect on kidding interval as primiparous does had a longer interval than multiparous does. The age at first kidding for the does averaged 418 days.

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Introduction

Small ruminants play a major role in the Ghanaian economy because they serve as source of meat and a form of cash savings. Besides, sheep and goats feature prominently in sociocultural activities such as marriages, funerals and also in religious functions (MoFA, 1990). Due to their relatively small size, small ruminants have proved to be of great benefit to farmers with limited access to land for production and refrigerators to keep their meat. Their fast reproductive and fast growth rates and shorter gestation length helps in early return on investment (Oppong-Anane, 2008).

The West African Dwarf (WAD) goat is considered to be confined to 15 countries in West and Central Africa. It has a mature weight of 30 kg and 20 kg for males and females respectively and reaches sexual maturity within 3 – 6 months (National Research Council, 1991). Tuah *et al.,* (1992) reported that the Ghanaian West African Dwarf goat, the commonest breed of goat in Ghana, is known for its prolificacy and trypanotolerance. Its small mature weight of about 15

– 21 kg (Devendra & McLeroy, 1982 cited by Tuah *et al.,* 1992) makes it suitable for slaughter in small communities where there are no cold storage facilities. According to Ademosun (1988), the WAD goat is adapted to the hot and humid environment where it is used as a source of meat. Mack (1983); as cited by Upton (1988) stated that the WAD doe is a veritable engine of production, kidding every eight or nine months on average and bearing an average of one and a half kids per parturition. Thus she produces more than two young every one year from the age of about 18 months under traditional village conditions.

Several researchers have worked on varying aspects of the West African Dwarf goat in Ghana. To cite some examples, Tuah *et al.,* (1992) explored the performance, potentials and limitations of the West African Dwarf goat for meat production in the forest belt of Ghana. In 2004, Turkson *et al*., (2004) worked on the risk factors for kid mortality in WAD goats under intensive management system in Ghana. Baiden (2007) conducted a study on birth weight, birth type and pre-weaning survivability of West African Dwarf goats raised in the Dangme West District of the Greater Accra region of Ghana. In a related and more recent study, Hagan *et al*., (2014) worked on the effects of non-genetic factors on the birth weight, litter size and pre-weaning survivability of West African Dwarf goats in the Accra Plains.

According to Debele *et al.,* (2011), the goat is the most important of the domestic animals to man in the tropics. Goats have a variety of functions and in comparison with other ruminants display a unique ability to adapt and maintain themselves in harsh environments. The Ghana Livestock Review Report (2011) reported that only 30% of Ghana's meat requirement are met locally. This brings to the fore the urgent need to increase local animal production to feed the ever increasing demand for livestock and livestock products. To achieve this, we need to design appropriate and sustainable animal improvement programmes based on a clear understanding of the status quo, hence this study. The present study, therefore, sought to:

1. Evaluate the growth and reproductive performance of the West African Dwarf goats raised at the Animal Research Institute, Katamanso station.
2. To provide information for development of efficient intervention strategies for the management of the WAD goat for increased productivity.

Materials and methods

The study was carried out at the Katamanso Station of the Animal Research Institute using 71 farm records collected on the West African Dwarf goats for the period spanning 2004 – 2012, however, records for 2008, 2009 and 2010 were not available for this study. The station is located at Katamanso, near Adenta in the Adentan Municipality of the Greater Accra region of Ghana. The main mandate of the Katamanso Station is to conduct research into ways of improving the livestock and poultry in Ghana through the development and transfer of sustainable options to improve livestock and poultry production that will reduce food insecurity, poverty and natural resource degradation (CSIR Webpage, 2018). The area has a bimodal rainfall pattern with the major rainy season occurring from April to July and a minor rainy season from September to November with a dry spell from December to March each year. The annual rainfall of the area ranges between 600mm – 1000mm (Okantah *et al.,* 2005).

The goats were housed in pens but allowed to graze on natural and established pastures. Some pastures made up of grasses/legume mixtures comprising of grass species (*Panicum maximum, Sporobolus pyramidalis and Vertiveria fulvibarbis*) and browse species (*Griffonia simplicifolia, Baphia nitida* and *Milletia thoningii*) (Oddoye *et al.,* 2002) were established. The goats were allowed to graze from 08:30 to 16:00 h daily and given unrestricted access to clean

drinking water. The kids were mostly confined in pens while their dams go out to graze and later come back to feed them until they are weaned naturally at about four months of age. The goats were treated against both ectoparasites (mainly ticks) and endoparasites using appropriate acaricides and anti-helminths respectively fortnightly in the rainy season but once monthly in the dry season. Besides, routine vaccinations were done against *Peste des petits* ruminants (PPR) once a year in May (Hagan *et al.*, 2014). There was no feed supplementation and all sick animals were treated as the need arose. All animals were weighed every month.

Data on growth parameters taken or derived included kid birth weight, kid weaning weight at 4 months, pre-weaning growth rate, yearling weight and post weaning growth rate. The effect of sex of kid, year of birth, parity, season of birth and weaning (major, minor and dry) and type of birth on the growth parameters were analysed. The reproduction parameters of interest in this study included age at first kidding and kidding interval. The effect of season of birth, year of birth, type of birth and parity on the reproduction parameters were also analysed. Due to differences in the age of the goats at the time of weighing for weaning weight and yearling weight, weaning and yearling weight were adjusted as:

$$\text{Adjusted weaning weight} = \left(\frac{\textit{Weaning weight} - \textit{Birth weight}}{\textit{Age (days) at time of weighing}} \; x\ 120 \text{ days}\right) + (\text{Birth weight}).$$

$$\text{Adjusted yearling weight} = \left(\frac{\textit{Yearling weight} - \textit{Weaning weight}}{\textit{Age (days) at time of weighing}} \; x\ 245 \text{ days}\right) + (\text{Weaning weight}).$$

The growth rates were also adjusted for differences in age at weighing.

$$\text{Pre-weaning growth rate was estimated as: } \frac{\textit{(Adjusted weaning weight - Birth weight)}}{\textit{120 days}} \text{ x 1000g/kg}$$

$$\text{and post-weaning growth rate estimated as: } \frac{\textit{(Adjusted yearling weight - Weaning weight)}}{\textit{245 days}} \text{ x 1000g/kg}$$

These parameters were then analysed using the General Linear Model (GLM) {Type III} procedure of the Statistical Analysis System and significant means separated by the PDIFF procedure of SAS (SAS, 2002).

Results and discussion

Birth Weight

Table 1 shows the effect of year of birth, season of birth, type of birth and sex of kid on birth weight, weaning weight, pre-weaning growth rate, yearling weight and post weaning growth rate. The present study recorded a low overall mean birth weight of 1.15 kg since Addae *et al.,* (2000) in their study on the behavioural interactions between WAD nanny goats and kids categorised a birth weight as low if it is $\leq$ 1.20 kg or high if $>$ 1.20 kg. Theoretically, all mamma-lian species have an optimum birth weight in which uncomplicated natural parturi-tion occurs and neonatal survival is maximised and this is surrounded by a range of adequacy where birth weight deviates from this optimum but neonates survive to reproductive age (Gardner *et al*., 2007). Turkson *et al*., (2004) observed in their study on the risk factors for kid mortality in WAD goats that kids that died before weaning were significantly

lighter in weight at birth than those that survived. Gardner *et al.,* (2007) confirmed this observation when they stated that low birth weight is associated with increased neonatal mortality whilst too high birth weight is associated with dystocia and sometimes, maternal death.

The birth weight recorded in this study is similar to 1.17 kg reported by Baffour – Awuah *et al.,* (2008) for the same breed of goat at the National Goat Breeding Station, Kintampo between 1997 and 2001 but records from the station over the period 1995 to 2007 the same breed of goat revealed a higher birth weight of 1.31 kg (Ayizanga *et al*., 2013). The difference in birth weight may be due to differences in the nutritional status of the doe during pregnancy, age or parity of doe as well as management practices during the reference periods. The present study found that males were significantly ($p < 0.05$) heavier than females (1.25 kg versus 1.12 kg) at birth. This is highly anticipated and similar to the observations made by Fall *et al.,* (1982), Ayizanga *et al.,* (2013) and Hagan *et al*., (2014). The greater rate of skeletal growth of male foetuses than females account for the heavier birth weight of males (Malik *et al.,* 1970; Robinson *et al.,* 1977).

Generally, kids born as singles weighed 1.27 kg at birth with 1.22 kg for twins and 1.06 kg for triplets, but these weights were not significantly ($p > 0.05$) different. This is similar to reports by Ayizanga *et al.,* (2013) but work done by Hagan *et al.,* (2014) on the WAD goats in the Accra Plains reported that type of birth had a significant effect on birth weight. According to Tuah *et al.,* (1992), birth weight is inversely proportional to litter size due to the competition between foetuses for available uterine space and nutrients.

Kids born in the minor rainy season weighed 1.21 kg at birth. Weight of 1.18 kg and 1.17 kg were recorded for those born in the dry season and major rainy season respectively but these weights were not significantly ($p > 0.05$) different. This indicates that the does and their kids were adequately fed throughout the year.

Pre-weaning Growth Rate

Pre-weaning growth rate averaged 35.78 g/day in this study. This is higher than 27.60 g/day reported by Ayizanga *et al.,* (2013) for the same breed of goats at Kintampo. It is generally recognised that the early post-natal growth phase in goats is a very critical stage because the kid is exposed to environmental stress which tends to limit its growth (Das *et al.*, 1996). According to Baffour-Awuah *et al.,* (2007) pre-weaning lamb growth rate is a trait of great economic importance in sheep production. Sex of kid did not constitute a significant source of variation for pre-weaning growth rate as males recorded 37.21 g/day pre-weaning growth rate whilst the females managed to attain 36.81 g/day in this study.

TABLE 1

Least squares mean ± standard error for birth weight (Bwt), pre-weaning growth rate (PrADG), weaning weight (Wwt), post-weaning growth rate (PstADG) and yearling weight (YrWt) of WAD goats

Factor	*n*	*Bwt (kg)*	*PrADG (g/day)*	*Wwt (kg)*	*PstADG (g/day)*	*YrWt(kg)*
Overall	71	1.15 ± 0.03	35.78 ± 1.13	5.44 ± 0.14	26.49 ± 1.08	12.24 ± 0.31
Sex						
Male	28	1.25a ± 0.07	37.21a ± 2.63	5.71a ± 0.32	27.81a ± 2.50	12.78a ± 0.55
Female	43	1.12b ± 0.06	36.82a ± 2.18	5.54a ± 0.27	29.05a ± 2.06	12.97a ± 0.66
Type of birth						
Single	14	1.27a ± 0.08	44.73a ± 3.01	6.63a ± 0.37	30.26a ± 2.84	14.32a ± 0.76
Twin	48	1.22a ± 0.05	35.59b ± 2.06	5.49b ± 0.25	29.82a ± 1.95	13.03b ± 0.52
Triplet	9	1.06a ± 0.09	30.73b ± 3.40	4.74b ± 0.42	25.82a ± 3.22	11.27b ± 0.86
Year						
2004	20	1.09a ± 0.06	39.08a ± 2.18	5.78a ± 0.27	26.69b ± 2.06	12.83ab ± 0.55
2005	18	1.16a ± 0.06	34.24a ± 2.32	5.27a ± 0.28	27.00b ± 2.19	12.05ab ± 0.58
2006	20	1.07a ± 0.06	34.33a ± 2.37	5.19a ± 0.29	20.86b ± 2.24	10.70b ± 0.60
2007	9	1.21a ± 0.09	34.24a ± 3.38	5.32a ± 0.41	21.89b ± 3.20	10.80ab ± 0.85
2011	3	1.38a ± 0.14	34.78a ± 5.30	5.55a ± 0.65	38.10ab ± 5.01	14.84a ± 1.33
2012	1	1.19a ± 0.24	45.40a ± 9.10	6.63a ± 1.11	37.26a ± 8.61	16.03a ± 2.29
Season						
Dry	26	1.18a ± 0.07	39.78a ± 2.52	5.95a ± 0.31	27.43a ± 2.39	12.77a ± 0.63
Major	26	1.16a ± 0.07	35.53a ± 2.59	5.42a ± 0.32	30.62a ± 2.45	13.20a ± 0.65
Minor	19	1.21a ± 0.08	35.73a ± 2.91	5.50a ± 0.36	27.86a ± 2.75	12.65a ± 0.73

Means within a factor with different superscripts are significantly ($p < 0.05$) different; n = number of records used.

Type of birth had a significant ($p < 0.05$) effect on pre-weaning growth rate. Single born kids recorded a pre-weaning daily gain of 44.73 g and this was 9.14g higher than twins and 14.00 g higher than triplets. This conforms to work done by Tuah *et al.,* (1992) who observed a pre-weaning average daily gain of 39.60 g, 33.10 g, 31.60 g and 29.00 g for singles, twins, triplets and quadruplets respectively in their study on the performance, potentials and limitations of the WAD goat for meat production in the forest belt of Ghana. Khombe (1985) also obtained a mean pre-weaning growth rate of 12.60 g/day for singles and 12.10 g/day for twins for crossbred goats on range grazing in Zimbabwe. Das *et al.,* (1996) in their study on the phenotypic and genetic parameters of growth traits of Blended goats in Tanzania reported a higher ($p < 0.05$) least squares mean pre-weaning average daily gain of 87 g for singles than 67 g for twins. The differences observed may be due to differences in husbandry systems, breed effects and differences in the general maternal environment.

Weaning Weight

The age at weaning and hence weaning weight varies with the management system under which animals are kept. Studies have indicated that in goats, weaning can take place from 35 days after birth or any time the kid attains a 250% increase in its weight at birth (Fehr, 1975). In this study, weaning weight at 120 days averaged 5.44 kg and this compares favourably to 4.62 kg reported for WAD goats at Kintampo by Ayizanga *et al.,* (2013) at same age. Sex of kid did not constitute a significant source of variation in weaning weight in this study. However, Turkson *et al.,* (2004) reported a mean weaning weight of 4.32 kg for males and this was significantly ($p < 0.05$) higher than the 4.06kg recorded for females at a weaning age of 90 days in WAD goats. In a related study, Baffour-Awuah *et al.,* (2007) reported that ram lambs weighed higher (9.10 kg) at weaning than ewe lambs (8.80 kg) in Djallonké sheep at Ejura at 90 days old. Das *et al*., (1996) also reported a similar effect of sex on weaning weight in the Blended goat of Tanzania. It has also been postulated that the weaning weight of a mammal reflects more of the dam's mothering ability and the maternal environment rather than the offspring's own genetic merit (Ayizanga *et al.,* 2013). In this study, single born kids weighed heavier than twins and triplets (6.63 kg, 5.491 kg and 4.75 kg respectively) at weaning. This is due to their higher birth weights and faster pre-weaning growth rates, an observation also reported by Tuah *et al.,* (1992). Weaning weight was however not significantly affected by year and season of birth. The values obtained were 5.95 kg, 5.42 kg and 5.50 kg for dry, major and minor rainy seasons respectively. This suggests that grazing materials and/or feed supplementation was equally available throughout the year.

Post-weaning Growth Rate

The post-weaning growth rate averaged 26.49 g/day in the present study and this is higher than 17.62 g/day reported by Ayizanga *et al.,* (2013) for the same breed of goats at Kintampo. Except for year of birth which significantly affected the post-weaning growth rate, all the other sources of variation of interest in the present study did not significantly affect post-weaning average daily gain. Ayizanga *et al.,* (2013) also reported growth rate values of 16.86 g/day, 16.85 g/day and 14.33 g/day for singles, twins and triplets respectively and these were not significantly ($p < 0.05$) different. The year 2011 and 2012 had a significantly ($p < 0.05$) higher mean post-weaning growth rate (38.10 g/day and 37.26 g/day respectively) than 2006 (20.86 g/day). This may be due to a high quantity and quality pasture available as a result of the pastures that were established in 2010 at the station. However, the post-weaning growth rate recorded for 2004 (26.69 g/day), 2005 (27.00 g/day) and 2007 (21.89 g/day) did not differ significantly ($p > 0.05$) from each other.

Yearling Weight

The yearling weight averaged 12.24 kg with a range of 6kg – 17.04kg. In a related study, Ayizanga *et al.,* (2013) reported a lower mean yearling weight of 8.78 kg with a range of 3.50 kg – 13.50 kg for the same breed of goats at Kintampo. This is an indication that the yearling weight of the WAD goat can be improved. There was a significant effect of type of birth and year of birth on yearling weight but the other sources of variation did not significantly affect yearling weight. The yearling weight of 12.78 kg for males was not significantly ($p > 0.05$) different from 12.97 kg for females. Turkson *et al.,* (2004) however reported a mean yearling weight of 8.07 kg for females which was significantly ($p < 0.05$) higher than 7.91 kg obtained for male WAD goats.

The mean yearling weight of 14.32 kg recorded for singles was significantly ($p < 0.05$) heavier than 13.03 kg and 11.27 kg recorded for twins and triplets respectively. There was, however, no significant ($p > 0.05$) difference in the yearling weight for twins and triplets. This is highly anticipated because single born kids have exclusive access to their dam's milk which gave such kids an advantage over the twins and triplets. This culminated in significantly faster pre-weaning growth rate for the singles and hence heavier liveweight at one year of age.

Age at First Kidding

Table 2 shows the effect of year of birth, season of birth, type of birth and parity on age at first kidding and kidding interval of the WAD goats in this study. The overall average age at first kidding was found to be 417.57 days and this is within the range of 360 – 540 days reported by Payne and Wilson (1999) for goats in the tropics. This is, however, an improvement over the 543.18 days reported by Tuah *et al.,* (1992) in their study on the performance, potentials and limitations of the West African Dwarf goat for meat production in the forest belt of Ghana probably due to improved feed supplementa-tion, better housing and improved healthcare and/or improved record keeping.

TABLE 2

Least squares mean ± standard error for age at first kidding and kidding interval of WAD goats

Factor	*Age at first kidding (days)*		*Kidding interval (days)*	
Overall	417.57 ± 6.67	(140)	246.90 ± 12.97	(67)
Year of birth				
2004	383.96^{c} ± 10.23	(55)	259.95^{a} ± 24.60	(45)
2005	490.98^{a} ± 13.80	(25)	268.01^{a} ± 51.80	(8)
2006	458.92^{a} ± 10.99	(40)	284.70^{a} ± 35.28	(10)
2007	444.54^{b} ± 14.91	(20)	216.95^{b} ± 35.28	(4)
Season of birth				
Dry season	456.79^{a} ± 10.72	(50)	234.20^{a} ± 28.8	(21)
Major rains	449.35^{a} ± 10.79	(50)	271.76^{a} ± 29.56	(24)
Minor rains	427.67^{a} ± 11.68	(40)	266.23^{a} ± 32.87	(22)
Type of birth				
Singles	419.99^{b} ± 10.40	(40)	246.65^{a} ± 30.15	(21)
Twins	419.45^{b} ± 7.91	(80)	269.35^{a} ± 26.19	(40)
Triplets	494.37^{a} ± 15.59	(20)	256.20^{a} ± 49.28	(6)
Parity				
1	462.62^{a} ± 25.56	(6)	456.95^{a} ± 64.83	(6)
2	436.52^{a} ± 13.53	(22)	211.28^{b} ± 29.52	(22)
3	442.12^{a} ± 11.82	(28)	262.38^{b} ± 34.93	(15)
4	442.12^{a} ± 11.82	(28)	183.92^{b} ± 39.32	(12)
5	442.12^{a} ± 11.82	(28)	201.63^{b} ± 46.93	(7)
6	442.12^{a} ± 11.82	(28)	228.25^{b} ± 52.20	(5)

Means within a factor with different superscripts are significantly ($p < 0.05$) different; Number in brackets indicates the number of observations used in the computation.

Mengistie *et al*., (2013) in their study on the reproductive performance of central highland goats under traditional management in Sekota District in Ethiopia, reported a similar value of 407.9 days as age at first kidding. Season of birth and parity did not constitute a significant source of variation for age at first kidding but kids born as triplets took significantly longer time (494.37 days) to kid compared to 419.99 days for singly born kids and 419.45 days for twins. The age at first kidding for singles was, however, not significantly different from that for twins. This means that triplets give birth on average 75 days after their cohorts born as singles or twins have kidded. This is highly expected because triplets need more time to develop condition before being mated.

Kidding Interval

Kidding interval is a measure of how soon nannies become pregnant again and produce kids after kidding (Steele, 1996) and serves as one of the indicators of reproductive efficiency in a flock. The overall kidding interval was found to average 246.90 days in the present study. This is seven days shy of the desired kidding interval of 240 days in areas where all year round breeding is practised (Steele, 1996) and, therefore, the kidding interval at the station is within acceptable range. In a similar study earlier, Tuah *et al.,* (1992) reported a mean kidding interval of 284.26 days for the same WAD goats in the forest belt of Ghana. This indicates a reduction of about 37 days probably due to improved husbandry practices (feeding, housing and healthcare) and/or improved record keeping. In another study, an overall mean kidding interval of 307.9 days was reported in the central highland goats of Ethiopia (Mengistie *et al*., 2013). Kidding interval varies between breeds as Indian and Malaysian goats kid in 90 – 120 day intervals whereas crossbred Anglo-Nubian does kid in 204 day intervals (Devendra, 1990). It has also been reported that meat type goat breeds have shorter kidding interval than milk type goats (Devendra, 1990). Differences in management practices leading to improved nutritional status of dams in 2007 may account for the shorter kidding interval observed compared to the other years. Season of birth and type of birth did not constitute a significant source of variation for kidding interval in this study. Kids born as singles recorded numerically the shortest kidding interval of 247 days while twins and triplet recorded 269 days and 256 days respectively. It stands to reason that does nursing fewer kids did not lose too much of their body condition and therefore took relatively shorter times to replenish body reserves and this shortened the post-partum anoestrous period. Parity of doe influenced kidding interval with primiparous does having the longest kidding interval of 456.95 days. This could be attributed to the fact that primiparous does are still growing and might have competed with their foetuses for available nutrients for growth and maintenance during pregnancy and this could adversely affect foetal growth and development during gestation, thus extending the kidding interval.

Conclusions and recommendations

The West African Dwarf goats at the Animal Research Institute – Katamanso Station recorded a low birth weight but with improved pre-weaning growth rate, weaning weight and yearling weight when compared to the performance of the same breed of goat at the National Goat Breeding Station at Kintampo. On their reproductive performance, the goats kidded for the first time at about 14 months old with a kidding interval of about eight months. To further improve the growth and reproductive performance of the WAD goat, we recommend the need to focus on improving the husbandry practices, especially nutrition of the animals through feed supplementation.

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