GROWTH PERFORMANCE OF THE WEST AFRICAN DWARF SHEEP (DJALLONKÉ) AT THE NATIONAL SHEEP BREEDING STATION-EJURA

BY

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This dissertation is submitted to the University of Ghana, Legon in partial fulfilment of the requirements for the award of MA Animal Science Degree

November, 2020

DECLARATION

I hereby certify that this dissertation was written by me as a record of my own study and to the best of my knowledge any help received during the course of this research and all sources of literature used have duly acknowledged. I also solemnly declare that this work has not been and is not being submitted to any other university for the award of any other degree.

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ACKNOWLEDGEMENT

Now to him who is able to do exceedingly abundantly above all that we ask or think according to the power that works in us, to him be glory in the church by Christ Jesus throughout all ages, world without end. Amen (Ephesians 3:20-21).

My first and foremost gratitude goes to the Name above every other name JESUS, thank you Lord for your grace, mercies and unfailing love which has brought me this far (Ebenezer). Ayiyie ne Aseda Nkoaa!!

Secondary, I wish to express my sincere gratitude and appreciation to my parents for their financial support and encouragement in making my studies a success. Thank you and God bless you.

I also express my utmost thanks and gratitude to my helpful supervisors, Prof. F.Y. Obese and Dr. Raphael A. Ayizanga, for their guidance, encouragement and also helping me with data analysis and some literature.

Finally, I am thankful to Mr. Duodoo, the Farm Manager of the National Sheep Breeding Station – Ejura, Mr. Nunoo, the Assistant Farm Manager, Emma, a Technical Officer, for making their records available to me.

May God bless you all for your diverse contributions towards this success.

DEDICATION

I dedicate this work to the Creator of the Universe, thanks for your sufficient grace, goodness, faithfulness, divine provision and protection. I owe all that I am to you.

To my parents Mr. Emmanuel Danso-Mireku and Madam Diana Oforiwaa. I thank you for your support and affection.

To my beloved daughter Emmanuella, thanks for your sacrifice and support. I would never have been able to do it without your endurance.

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LIST OF ACRONYMS

BWT	Birth weight
WWT	Weaning weight
YrWT	Yearling weight
PrWADG	Pre-Weaning Average Daily Weight Gain
PoWADG	Post Weaning Average Daily Weight Gain
WAD	West African Dwarf
GLM	Generalised Linear Models
SAS	Statistical Analysis System
MOFA	Ministry of Food and Agriculture
SNK	Student Newman Keuls
GLSS7	Ghana Living Standard Survey 2017

ABSTRACT

Data on 625 production records collected between 2000 and 2010 on Djallonke sheep at the National Sheep Breeding Station, Ejura in the Ashanti region was used to investigate the effects of non-genetic factors such as season of birth, year of birth, type of birth and sex of lamb on growth parameters such as birth weight, weaning weight, yearling weight, pre-weaning growth rate and post-weaning growth rate. The lambs generally weighed 2.07kg at birth, grew at 64.10 grammes per day to attain an average weaning weight of 9.77kg at 120 days. Thereafter, the lambs gained an average of 29.60g daily to reach a yearling weight of 17.02kg. On the whole, sex of lamb was the only non-genetic factor that did not significantly ($p > 0.05$) affect any of the traits whilst year of birth was the only factor that was found to have significantly ($p < 0.05$) affected all the traits of interest in this study. However, type of birth did not significantly ($p > 0.05$) affect the birth and yearling weight of lambs but significantly ($p < 0.05$) affected pre and post-weaning daily gain together with the weight of the lambs at 120-day weaning weight. Season of birth significantly affected the pre-weaning daily gain and weaning weight but did not affect the lamb birth weight, post weaning daily gain and yearling weight.

CHAPTER ONE

1.0 INTRODUCTION

Agriculture is an important sector in Ghana's economy being the second largest contributor to employment (38.3%) after the service's sector (43.5%), with the industry sector accounting for (18.2%) as indicated in the Ghana Livestock Review Report (2019).

One of the most important components of agriculture in Ghana is the livestock sub-sector. According to the Ghana Livestock Review Report (Oppong-Anane, 2011), local meat production in Ghana constitutes a paltry 30% of the national meat consumption demand. This brings in its wake the need to spend very scarce foreign exchange in importing meat to make up for the demand gap. For example, 241, 872 metric tonnes of frozen meat (amounting to GHC 735, 499,190.99) were imported into the country in 2018 (SRID, 2018). There is therefore the need to increase the productivity of livestock in Ghana.

Among the several options available to make up for the shortfall in local meat production is the improvement in the productivity of small ruminants especially sheep. Their production does not require much land, they are far easier to herd and endure confinement much better than goats, they have fast reproductive rates leading to early returns on investments (Oppong-Anane, 2008).

The common sheep breeds in Ghana are the West African Dwarf sheep (Djallonké), the Sahelian and the crossbred of these two breeds. The Djallonké sheep is the very common breed in Ghana (Baffour-Awuah *et al.,* 2007). It is very hardy, trypanotolerant, tick tolerant and is highly prolific (Koney 2004; Bosso 2006; Bosso *et al.,* 2007).

Using sheep as a model for improving local meat production will fit very well in the Ghanaian situation because sheep production is already an integral part of most farming systems in Ghana. It provides protein and a source of income for farmers (Tuah *et al.,* 1990). However, sheep production in Ghana just as many other local animal species is fraught with a number of challenges including poor feeding, healthcare and housing systems.

According to Baiden and Obese (2010), sheep are traditionally mainly raised on extensive systems by small scale rural farmers where the animals scavenge for food themselves with no or little provision of feed supplementation such as kitchen leftovers and crop residues and also with no proper husbandry and management practices.

The traditional method of raising sheep in Ghana unfortunately has not been able to provide a husbandry system good enough to allow for the animals to express their full genetic potentials particularly in terms of growth and reproduction. Therefore, the traditional method of raising sheep needs to be looked at and some aspects improved in order to increase local mutton production. There are a number of options for improving local sheep production. Baiden and Obese (2010) in their study on the performance of the Djallonké sheep asserted that sheep production can be increased either by increasing

herd size or by increasing productivity per animal. They also indicated that due to the increasing human population and the resultant decrease in farm sizes and grazing land the latter option may seem the best alternative means to increase production.

Increasing local mutton production by increasing the productivity per animal will involve determination of factors that affect productivity in the long term. Peacock (1986) in a two-year study of sheep and goat production systems as part of Kenya's multidisciplinary system study of Masai pastoralism postulated a number of indicators for measuring the productivity of small ruminants and categorised them into indicators relating to reproductive performance, growth performance and flock production indices. Poor growth performance of the Djallonké sheep is one of the most prevailing complaint by most Ghanaian farmers as has also been reported elsewhere (Gbangboche *et al.*, 2006).

Body weight and reproduction are two major components that determine sheep production efficiency and an understanding of environmental factors affecting these traits are important for the formulation of effective improvement programmes to increase productivity (Smith, 1977; Gbangboche *et al.*, 2006).

Presently in Ghana, there is unavailability of affordable animal protein for a greater percentage of the populace. The per capita consumption of animal protein in Ghana is estimated at 16g/person/day compared to the FAO recommended level of 44.4 g/person/day. One way of improving this protein insecurity is to focus much attention on sheep production. Raising of sheep is a very popular enterprise. Also, there exists a niche market for rams especially during cultural festivals in the country. Increasing the

productivity of sheep through improved nutrition and husbandry practices is therefore key in reducing the protein deficit in Ghana. This calls for the evaluation of both genetic and non-genetic parameters that influence productivity of sheep in the breeding stations in Ghana to provide useful information to enhance sheep development.

1.1 OBJECTIVE OF STUDY

This study therefore sought to determine the production system of the sheep kept at the National Sheep Breeding Station at Ejura with the aim of assessing how some non-genetic factors affect growth of the station's sheep. Specifically, the present study investigated the effects of season of birth, year of birth, type of birth and sex of lamb on the birth weight, weaning weight, yearling weight, pre-weaning growth rate and post-weaning growth rate of the Djallonké sheep kept at the National Sheep Breeding Station – Ejura.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 GROWTH TRAITS

Growth performance is one of the key traits of economic importance to any animal producer and is one of the factors to consider in developing any genetic improvement system. Growth traits are influenced by many factors including the breed of the animal, nutrition, health management, season of birth, type of birth, age of the dam and parity of the dam. Understanding of certain parameters used in measuring growth performance such as birth weight, weaning weight, preweaning growth rate, postweaning growth rate and yearling weight is also essential in improving growth performance (Tuah and Baah, 1985; Odoom, 2012).

2.2 LAMB BIRTH WEIGHT (BW)

One of the most important determinants of the survival and growth of the newborn mammal is its birth weight. Lamb birth weight is the weight of the newborn taken within six hours of lambing. According to Salah *et al.* (1989), lamb birth weight is an important parameter in meat producing animals because it is strongly correlated with viability of the newly born, its growth rate and matured size. A study by Rastogi and Yousef (1979), confirmed that the vitality and growth potential of the lamb is determined by its birth weight. Gardner *et al.* (2007) also reported that low birth weight is associated with increased neonatal mortality. Generally, within acceptable ranges, lambs born heavier tend to have better performance later in life than those with the lighter birth weight. Birth weight of a lamb is affected by factors such as nutritional

status of the dam, season of lambling, parity of dam and sex of lambs (Robinson *et al.*, 1999).

Gardner *et al.* (2007) reported that prenatal factors accounting for the variation on birth weight is of primary importance with regards to immediate (neonatal) and long- term health and viability of the offspring. Nutrition of the pregnant ewe especially in the last trimester is a principal environmental factor influencing lamb birth weight (Hammond et *al*., 1983; Robinson *et al*., 1999). Supplying dams with extra food during the second half of pregnancy causes increased growth rate of the prenatal lamb and also increase in development of the udder so that more milk is secreted after parturition resulting in much quicker growth of lambs after birth. For example, ewes fed well during the second half of pregnancy had twin lambs which were heavier (30kg) at 13 weeks compared with those not fed well which lambs of lighter (8kg) weight (Hammond *et al.*, 1983). Seasonal changes affect feed availability to dams and consequently influence birth weight of lambs (Inyangala *et al.*, 1992; Das *et al.*, 1996). Lambs born in the wet season were reported to be heavier than those delivered in the dry season (Buvanendran *et al.*, 1992). The seasonal effect has been attributed to the quantity and quality of forage available to the ewe during pregnancy (Adu and Olaloku, 1979). There is high voluntary feed intake by the dam during the rainy season when the quality and quantity of feed is usually high leading to better provision of nutrients from the mother to lambs thus increasing lamb birth weight. Djallonké lambs born in the rainy season were reported to be heavier than their counterparts born in the dry season (Tuah and Baah, 1985; Agbolosu *et al.*, 2005).

Another factor that is known to affect birth weight is the sex of the lamb. Male lambs tend to be heavier at birth than female lambs (Fall *et al.*, 1982, Adeyinka *et al.*, 2006; Baffour -Awuah *et al.*, 2007; Senou *et al.*, 2009; Ampong *et al.*, 2019). Baffour-Awuah *et al.* (2007) reported that mean birth weight of male Djallonké lambs was higher than that of their female counterparts (1.90kg versus 1.81kg) at the Ejura Sheep Breeding Station. Also, Ampong *et al.* (2019) observed that male Djallonké lambs (1.80kg) were heavier at birth than female lambs (1.7kg) at the Livestock and Poultry Research Centre of the University of Ghana, Legon. According to Malik *et al*. (1970), the rate of skeletal growth in-utero is greater in male than in female fetuses' and this may account for the difference in the birth weight in sheep. Some studies have reported of no significant effect of sex of lamb effect on its birth weight (Khombe, 1985; Agbolosu , 2005). For example, in the year 2003, Agbolosu worked on the Djallonké sheep at the Ejura Breeding Station and reported that male lambs weighed 2.10kg at birth and this was not significantly different from the 2.02kg that was obtained for female lambs.

Type of birth is a factor that can influence the birth weight of lambs. Payne (1990) reported that lambs born as single tend to be heavier than those born as twins. This was attributed to competition between foetuses for available uterine space and nutrition. Studies by various authors with the Djallonké have reported higher birth weight of single born lambs than twin born lambs or triplets (Agbolosu *et al.*, 2005; Baffour Awuah *et al.*, 2007; Ampong *et al.*, 2019; Patterson, 2020).

Agbolosu *et al*. (2005) reported that singles born lambs at the Ejura Sheep Breeding Station were significantly ($p < 0.001$) heavier than twin lambs. The least square mean reported were 2.10kg and 1.93kg for singles and twins respectively.

The birth weight of lambs tends to increase with increasing age of dam (Oppong-Anane, 1971; Tuah and Baah, 1985). Oppong-Anane (1971) in a study with Djallonké sheep recorded mean lamb birth weight of 2.1kg for primiparous ewes. The same study recorded a mean lamb birth weight of 2.2kg and 2.4kg for ewes that were two years and three years old respectively. Also, Tuah and Baah (1985) recorded the mean birth weight Djallonké sheep aged one, two, three, four, five, six and seven years to be 1.43kg, 1.71kg, 1.68kg, 1.79kg, 1.94kg, 1.90kg and 2.0kg respectively. Lamb birth weight increases with age of ewes due to the fact that the size of the ewe as well as its uterus increases with age and also the placenta becomes fully developed and can thus, send across relatively more nutrients to the developing foetus (Tuah and Baah, 1985). Also, younger ewes are still growing and therefore utilise nutrients for their own maintenance and development which tends to affect the birth weight of their lambs, while old age ewes are considered fully grown channel and use more of their nutrients for productivity resulting in heavier lamb production.

Another factor that has effect on birth weight is the breed of the sheep. The mean birth weight of blackbelly and black head Persian lambs were observed to be 2.8kg and 3.0kg respectively by Rastogi and Yousef (1979). A study by Tibbo (2006) on Ethiopian Horro and Menz breeds recorded birth weight of 2.40kg and 2.06 respectively. In Ghana, the Djallonké sheep have been reported to have mean birth weight range from 1.3kg to 2.4kg (Awuah, 2009). On the other hand, mean birth weight for Nugua Blackhead sheep in Ghana ranges from 2.3kg to 2.6kg (Awuah, 2009).

2.3 WEANING WEIGHT

The growth rate of lambs and the number of lambs weaned per ewe constitute important production traits of interest to farmers. Weaning weight of lambs may reflect more of the dams mothering ability or the maternal environment than the offspring's own genetic makeup. Weaning weight and age at weaning will vary depending on the management system under which the animals are kept.

The weaning weight of sheep may be influenced by factors including breed, sex, type of birth and seasonal variation during different years (Akhtar *et al.,* 2006). In sheep, breed was found to affect weaning weight. For example, Tibbo, 2006, observed that Horro lambs to be heavier at weaning compared with Menz lambs (9.48kg versus 8.64kg).

The effect of type of birth on weaning weight have been reported in both tropical and temperate sheep and goats (Moore, 2000). Djallonke sheep weaned at 120 days shows significant difference in weaning weight between single and twins' lambs (Fall *et al*, 1982). They reported twins weight of 7.56kg as against 9.85kg for singles at weaning.

Baffour-Awuah *et al.* (2007), in a related study, reported the significant effect of type of birth on weaning weight in Djallonké sheep. They obtained mean weaning weight of 9.10kg and 7.30kg for single lambs and twins lambs respectively. Furthermore, a study by Bahreini *et al.* (2007), with Kermani sheep in Iran showed that lambs born as singles had higher weaning weight 22.42kg ± 0.10 than those born as twins (20.27kg ± 0.86). These results indicate the tendency of single lambs to be heavier at birth than twins and triplets. After birth, single born lambs have advantage over twins and triplets as the

twins and triplets have to compete for the dam's milk, while the single lamb has access to sufficient milk for growing up to weaning.

According to Baffour -Awuah *et al*. (2007), sex of lamb had significant effect on lamb weaning weight in Djallonké sheep at the Sheep Breeding Station at Ejura. They reported a mean weaning weight of 9.10kg and 8.80kg for ram lambs and ewe lambs at 90 days respectively.

Season of birth is known to influence lamb weaning weight. According to Baffour-Awuah *et al*. (2007), lambs delivered in the major rainy season had higher weaning weights than their counterparts born in the minor rainy season (8.70kg) in the Djallonké sheep.

Baffour-Awuah *et al. (*2007), reported that year of birth is significant source of variation in weaning weight in the Djallonké sheep with mean weaning weight of 10.60kg in 1999 and 8.30kg in 1998.

2.4 PRE-WEANING GROWTH RATE

Growth is the rate of increase in body size per unit time and can be expressed as average daily gain in unit of gramme or kilogram per day. Baiden and Duncan (2009), reported that pre-weaning growth rate is a major production trait of interest of farmers which determines how quickly a farmer gets returns on his/her investment. Pre-weaning lamb's growth rate is one of the traits of greatest economic importance in sheep production (Baffour-Awuah *et al.*, 2007).

Pre-weaning average daily gain (pre-weaning growth rate) in sheep is influenced by factors including nutrient supply by the mother, parity of dam, genetic composition and season of birth and sex of lamb. Pre-weaning growth depends on milk production of the dam as well as her mothering ability. Milk production of the ewe is needed to supply newly born lambs with antibodies that supports a good immune system and nutrients to encourage fast healthy growth early in life. Campbell and Lasley (1975), reported that pre-weaning growth rate may be affected by the maternal environment to which the young are exposed before and after birth. They also reported that in mammals the inherited growth impulse possessed by the young may be temporarily overshadowed by the amount of milk supplied by the dam. Milk production increases with parity, older cows tend to be better milkers.

It has been reported by Mavrogens (1996) that pre-weaning mean of 235g/day for lambs born to ewes in the first parity compared with the lambs born in the second parity ewe is 261g/day. Senou *et al.* (2009), reported that ewes with adequate nutrition are able to provide adequate milk for their lambs to grow. They obtained a pre-weaning growth rate of Djallonké sheep in Benin to be 64.87g/day. Patterson (2020) obtained higher pre-weaning growth rate for Djallonké lambs born in the wet season (81.09 g/day) than those delivered in the dry season (78.56g/day).

Sex was not a significant source of variation on pre-weaning growth rate of Djallonké sheep (Baffour- Awuah *et al.*, 2007; Ampong *et al.*, 2019). On the contrary Khombe (1985) reported that preweaning growth rate of males was faster than females in sheep crossbred and goat in Zimbabwe. The authors obtained 12.90g/day and 11.00g/day for pre-weaning growth rate for males and females respectively.

2.5 POST-WEANING GROWTH RATE

According to Holloway *et al.* (2002) post-natal lamb growth rate is the effect of its genotype interaction with the environment. Maternal influences reduce after weaning, thereafter the lamb's growth depends on the interaction between its genetic make-up and the environment.

Agbolosu *et al.* (2005) reported that season of birth and year of birth and type of birth significantly affected post-weaning growth rate of Djallonké lambs. On the contrary, Odoom (2012) did not observe any significant effect of the above factors on the post-weaning growth rate. Senou *et al.* (2009), reported that post-weaning growth rate was comparatively smaller than pre-weaning growth rate. They reported values of 64.8g/day and 50.17g/day respectively for Djallonké sheep in Benin.

2.6 YEARLING WEIGHT

Yearling weight is the cumulative growth effect of all growth traits of mammals at one year. Yearling weight is influenced by factors such as sex of kid, type of birth, year of birth, season of birth, breed of kid and management system of the animal. According to Agbolosu (2003) reported season of birth has significant effect on yearling weight of Djallonke sheep. He reported a best yearling weight of 22.49kg ± 0.73 in late rainy season and 19.27kg ± 0.054 in the dry season, however there was no significant difference in values obtained in the early rainy season and dry season. Salah *et al.*, (1989) in another study reported yearling weight is not significant source of variation in Aordi goats in Saudi Arabia.

Agbolosu (2003), reported that the effect of sex on yearling weight is significant as yearling weight of ram 21.62kg was heavier than 19.66kg for ewes, however Turkson 2004 reported yearling weight of 7.91kg for male kid which was significantly lower than 8.07kg for female in WAD goats.

Agbolosu *et al*. (2003) in a study of djallonke sheep at Ejura, reported that season of birth and year of birth are two sources of variation significant for yearling weight. He reported best yearling weight of 22.10 kg in 1998 and the worst yearling weight of 19.14 kg in 1996 respectively.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 STUDY AREA

The study was conducted at the National Sheep Breeding Station, Ejura in the Ashanti region using data collected between the years 2000 and 2010. Ejura is the capital of the Ejura Sekyedumase Municipal Assembly of the Ashanti region. The district is located within longitudes 1.5W and 1.39W and latitudes 7'9N and 7'36N. Ejura lies in the semi deciduous rain forest and Guinea savanna transitional zone with a bimodal type of rainfall pattern. The area has a mean annual rainfall of about 1200mm – 1500mm. The major rainy season of the area spans from April to August. September to November constitute the period of minor rains with a dry season occurring between December to March. The mean monthly temperatures range from 21^0C – 30^0C with January – April being the warmest months whereas July – August is the coolest of the year (www. Ejurasekyeredumasi.ghanadistrict.gov.gh).

3.2 ANIMAL MANAGEMENT

At the National Sheep Breeding Station, animals were tagged using plastic ear tags bearing unique identification numbers. They were housed in pens with concrete floors for protection against inclement weather. The Djallonké sheep kept on the station are allowed to graze daily from 9:30am to 5:30pm on cultivated pastures during the wet and dry season. The established pastures were made up of *Panicum minimum*, *Centrosaema spp*, *Lucaena spp* and *Stylosanthes spp*. They were also given supplementary feeds including maize stover, wheat bran, rice bran, cottonseed,

groundnut haulms and maize husks especially during the dry season. They also have free access to water and salt lick ad libitum.

The animals are routinely checked daily for signs of ill health and duly treated when the need arises. The sheep were also regularly vaccinated against Peste Des Petits Ruminants (PPR) disease around March every year. Endoparasites are also treated by deworming the animals every fortnight during the major rains and once a month in the dry season with Albendazole® or Leva Cloza®. In order to control ectoparasites, dipping is done twice every month in the wet season and once a month in the dry season with Amitrax® 20%, an Acaricide.

Controlled mating is done twice in a year, between February/March and October/November. The lambs are weaned four months after lambing and the dam crossed again two months after weaning the lambs. Weaned lambs are separated from their dams and grouped by sexes into other pens. At the Ejura Sheep Station, mating of gimmers were delayed until they are 8 – 12 months old. The lambs are weighed within six hours of lambing for their birth weight and subsequently weighed monthly, at weaning (four months) and then yearly.

3.3 DATA COLLECTION

Breeding records of the Djallonké sheep on station, were used, the records covered the period from 2000 to 2010, not including years 2004 and 2006. Growth traits such as birth weight, weaning weight at four months, yearling weight, pre-weaning growth rate and post weaning average daily gain up to the 12th month) were studied. The effect of season of birth (dry and wet), type of birth (single or twins), year of birth (2000 – 2003, 2005 – 2010), sex of lamb (male or female) on these parameters were determined.

Pre-weaning average daily gain (PRWADG) was calculated as:

$$\frac{\text{WWT}-\text{BWT}}{Age\ at\ weaning\ (120\ days)}\ \text{X}\ 1000\text{kg}$$

Post –weaning average daily gain (PSTADG) to yearling was calculated as:

$$\frac{\text{MWT12}-\text{WWT}}{Duration\ of\ weaning\ to\ one\ year\ (245\ days)}\ \text{X}\ 1000\text{kg}$$

Where:

BWT = Birth weight

WWT = Weaning weight

MWT12 = Yearling weight

3.4 DATA HANDLING AND DATA CODING

Data was checked for possible outliers and all data points found to be more than 3 were regarded as outliers and therefore removed from data set. This was done for only yearly weight. Birth weight and weaning weight data was found to be normally distributed. The nature of the data kept at the station did not allow for adjustments of the liveweights due to differences in the age of the animals at the time of weighing. This is because the exact date of weighing for the liveweights were not indicated in the record books at the station. In addition, parity of dam is a known non-genetic factor which affects the parameters measured in this study, however it was not possible to include parity in the model because it was difficult to trace one ewe beyond its primiparous lambing. This is due to the fact that some animals lost their ear tags and were replaced without recourse to their original identification numbers.

3.5 STATISTICAL ANALYSIS

The data was analysed using the Generalised Linear Model (GLM) type III procedures of the Statistical Analysis Systems (SAS, 2002), Differences among treatment means were separated using Student Newman Keuls Test (SNK).

$Y_{ijklm} = \mu + T_i + S_j + N_K + Y_l + E_{ijklm}$

Where:

Y_{ijklm} is the response variable (birth weight, weaning weight, yearling weight, pre-weaning average daily gain and post weaning average daily gain)

μ is the overall mean

T_i is the effect of the i^{th} type of birth

S_j is the effect of the j^{th} sex of lamb

N_K is the effect of the k^{th} season of birth

Y_m is the effect of the m^{th} year of birth

E_{ijklm} is the random error term, assumed = NID (o, O e)

CHAPTER FOUR

4.0 RESULTS

Table 1 shows the effect of type of birth, year of birth, sex of lamb, season of birth on birth weight, weaning weight, yearling weight, pre-weaning average daily gain and post –weaning average daily gain in the Djallonké sheep.

The appendices at page 38 – 40 shows the analysis of variance for evaluation of factors affecting birth weight, weaning weight, pre-weaning average daily gain, yearly weight and post weaning average daily gain in Djallonke sheep at Ejura Breeding Station.

4.1 BIRTH WEIGHT

The overall mean birth weight was 2.07kg. Sex of lamb did not have a significant ($p > 0.05$) effect on the birth weight of the lambs. Male and female lambs recorded birth weights of 2.00kg and 2.01kg respectively. Type of birth did not affect ($p > 0.05$) birth weight. The weight of lambs born as singles and twins were 2.09kg and 1.92kg respectively. Also, lambs delivered in the wet season (2.00kg) had similar ($p > 0.05$) weight as those delivered in the dry season (2.01kg).

Year of birth however, influenced the birth weight of the lambs. Lambs delivered between the years 2005 and 2010 had higher ($p < 0.05$) birth weights than those delivered between the years 2002 and 2003. Birth weight generally increased with year of birth except for the years 2002 and 2003. The highest birth weight was recorded in the year 2010 (2.25kg) while the lowest were recorded in the years 2003 (1.82kg) and 2002 (1.82kg).

4.2 WEANING WEIGHT

The overall average weaning weight at four months (120 days) was 9.77kg. Male lambs (9.50kg) had similar ($p > 0.05$) weaning weight as their female (9.03kg) counterparts. However, type of birth influenced ($p < 0.05$) weaning weight. Lambs born as singles were heavier than those born as twins (9.48kg versus 8.70kg) at weaning. Also, the weaning weight of lambs delivered during the period of major rains was higher ($p < 0.05$) compared with their counterparts delivered in the dry season (9.57kg versus 8.97kg).

Weaning wights of lambs born in the years 2003, 2005, 2008 and 2010 were higher ($p < 0.05$) than their counterparts born in the years 2000 and 2002.

4.3. PRE-WEANING AVERAGE DAILY WEIGHT GAIN

The overall pre-weaning average daily weight gain was 64.10g/day. Sex of lamb did not affect ($p > 0.05$) pre-weaning average daily weight gain. Male and female lambs recorded 62.50g/day and 58.57g/day respectively.

Single born lambs had higher ($p < 0.05$) pre-weaning average daily weight gain than twin born lambs (64.56kg versus 56.51kg). Also, the pre-weaning average daily weight gain of lambs born in the wet season (63.09kg) was higher ($p < 0.05$) than those born in the dry season (57.98kg).

Year of birth affected ($p < 0.05$) pre-weaning average daily weight gain. The average daily weight gain of lambs born in the years 2003, 2005 and 2008 were higher ($p < 0.05$) than those born in the years 2000 and 2002. There was a general increase in average pre-weaning daily weight gain from the years 2000 to 2005, followed by declines to year 2010.

4.4. YEARLING WEIGHT

The overall average yearling weight was 17.02kg. The yearling weight of lambs born in the years 2003, 2005 and 2007 were higher ($p < 0.05$) than those born in the years 2009 and 2010. Also, lambs born in 2000, 2001, 2002, 2008 and 2009 were higher ($p < 0.05$) than those born in 2010. There was a general increase in lamb yearling weight from 2000 to 2005. This was followed by declines to 2010. Sex of lamb, type of birth and season of birth did not affect ($p > 0.05$) yearling weight.

4.5. POST WEANING AVERAGE DAILY WEIGHT GAIN.

The overall mean of post weaning average weight gain was 29.60g/day. Lambs born as twins had higher ($p < 0.05$) post-weaning average daily weight gain than those born as singles (37.19 versus 28.77g/day). Lambs born in the year 2002 had the highest post - weaning average daily weight gain (38.21g/day) while those born in the year 2010 recorded the least (21.8g/day).

Male and female lambs had similar ($p > 0.05$) post-weaning average daily weight gain. Also, lambs born in the dry season had similar ($p > 0.05$) post-weaning average daily weight gain as those born in the wet season.

Table 1: Effect of non-genetic factors on growth parameters of West African Dwarf Sheep

Factor	BWt (kg)	PreADG (g/day)	WWt (kg)	PstADG (g/day)	YrWt (kg)
Overall	2.07 (625)	64.1 (625)	9.77 (625)	29.60 (581)	17.02 (581)
Sex of lamb					
Male	2.00^{a} (304)	62.50^{a} (304)	9.50^{a} (304)	31.06^{a} (277)	17.05^{a} (277)
Female	2.01^{a} (321)	58.57^{a} (321)	9.03^{a} (321)	34.90^{a} (304)	17.47^{a} (304)
Type of birth					
Singles	2.09^{a} (588)	64.56^{a} (588)	9.84^{a} (588)	28.77^{b} (549)	16.87^{a} (549)
Twins	1.92^{a} (37)	56.51^{b} (37)	8.70^{b} (37)	37.19^{a} (32)	17.65^{a} (32)
Season of birth					
Wet	2.00^{a} (169)	63.09^{a} (169)	9.57^{a} (169)	32.05^{a} (160)	17.29^{a} (160)
Dry	2.01^{a} (456)	57.98^{b} (456)	8.97^{b} (456)	33.92^{a} (421)	17.23^{a} (421)
Year of birth					
2000	1.93^{cd} (21)	54.33^{c} (21)	8.45^{c} (21)	37.96^{ab} (21)	17.63^{ab} (21)
2001	1.96^{cbd} (49)	54.67^{bc} (49)	8.52^{bc} (49)	37.68^{ab} (49)	17.68^{ab} (49)
2002	1.82^{d} (92)	53.27 ^{c} (92)	8.22^{c} (92)	38.21^{a} (92)	17.47^{ab} (92)
2003	1.82^{d} (55)	65.71^{a} (55)	9.70^{ab} (55)	34.43^{ab} (55)	18.06^{a} (55)
2005	1.99^{bc} (135)	68.69^{a} (135)	10.23^{a} (135)	32.37^{ab} (135)	18.07^{a} (135)
2007	2.14^{b} (58)	62.5^{abc} (58)	9.64^{abc} (58)	34.37^{ab} (58)	17.89^{a} (58)
2008	2.06$^{b\ c}$ (94)	63.11^{ab} (94)	9.64^{ab} (94)	31.77^{ab} (94)	17.49^{ab} (94)
2009	2.08^{bc} (69)	60.03^{abc} (69)	9.28^{abc} (69)	28.23^{b} (69)	16.11^{b} (69)
2010	2.25^{a} (52)	62.46^{abc} (52)	9.74^{ab} (52)	21.83^{c} (52)	14.92^{c} (52)

BWt = Birth weight: WWt = Weaning weight: PreADG = Pre-weaning average daily gain: YrWt =Yearling weight: PstADG =Post weaning average daily gain: N=number of records.

Means within the same column with each factor with different superscript are significantly different ($p < 0.05$). Number in brackets represents the number of observations in each case

CHAPTER FIVE

5.0 DISCUSSION

5.1 BIRTH WEIGHT

The overall mean birth weight of the Djallonké lamb in this study was 2.07kg. This was similar to the value of 2.3kg observed for the Djallonke (Awuah, 2009). It was higher than the values ranging from 1.72kg to 1.85kg obtained by other workers for the Djallonké lamb in Ghana (Baffour-Awuah *et al.,* 2007; Odoom 2012; Ampong *et al*., 2019; Patterson, 2020). Similar birth weights of 2.01kg and 2.25kg have been reported for the same breed in Benin (Bosso *et al*., 2007) and La Cote d'lvoire (Yapi-Gnaore´*et al*. (1997) respectively. The differences in birth weight could be due to differences in dam's nutritional status during pregnancy, climatic conditions that influence the availability of feeds and differences in the way the animals were managed. For instance, during the dry season the nutritional status of ewes tend to decrease because of shortage of good quality feed. This subsequently reduce the availability of nutrients for foetal development. It has also been reported that birth weight of lambs is very important since it strongly correlates with pre-weaning growth rate, lamb preweaning vitality and adult weight (Devendra and McLeroy,1982).

Sex of lamb did not influence birth weight of lambs in the present study corroborating the results of Patterson (2020), who worked with the Djallonke sheep at Livestock and Poultry research Centre of the University of Ghana. However other studies with the Djallonké in Ghana (Baffour-Awuah *et al.,* 2007; Awuah, 2009; Ampong *et al.,* 2019) have indicated that male lambs weighed more than female lambs as a result of their faster skeletal growth within the uterus than female (Robinson *et al.,* 1977).

The weight of lambs born as singles was similar to those born as twins in the present study. Some researchers working with the same breed have however found singly born lambs to be heavier at birth than twin born lambs probably due to the intense competition between foetuses for available space and nutrients in the uterus in the case of multiple foetuses (Robinson *et al*., 1977; Payne, 1990). For example, in the study of Baffour-Awuah *et al*. (2007) with the Djallonké sheep at the Ejura Sheep Breeding Station, the authors observed that single born lambs were heavier than twin born lambs similar to the report of Ampong *et al.* (2019) when they conducted studies with the Djallonke sheep at the Livestock and Poultry Research Centre of the University of Ghana.

Lambs had similar birth weight in the rainy and dry season. Baffour-Awuah *et al.* (2007) and Ampong *et al.* (2019) have had similar observations for the Djallonké sheep at the Sheep Breeding Station in Ejura and the Livestock and Research Centre of the University of Ghana respectively.

Year of birth was a significant source of variation in present study in agreement with the report of an earlier study with the Djallonké at the same station (Baffour-Awuah *et al.*, 2007. The significant variations in birth weights between years may be due to seasonal changes that occurs within years such as delay in annual rains or prolonged droughts which may affect availability and quality of feed for dams and consequently growth and development of foetuses.

5.2 WEANING WEIGHT

Weaning weight enables the estimation of weight gain from birth to weaning of lambs in a flock and therefore provides a more objective basis for culling after correcting for age of dam and sex of lamb effects (Yapi-Gnaore *et al.*, 1997). The overall mean weaning weight of 9.77kg at four months was similar to the value 9.0kg obtained by Baffour-Awuah *et al.* (2007) in an earlier study with the same breed at the same station and was also similar to the 9.40 kg reported by Odoom (2012) for the same breed at CSIR-Animal Research Station at Pokuase but lower than the 11.0 kg reported by Ampong *et al.* (2019) at the Livestock and Poultry Research Centre of the University of Ghana. Average weaning weights of 9.1kg and 8.51kg have been reported for the Djallonké in La Cote d'lvoire (Yapi-Gnaore *et al.*, 1997) and Benin (Bosso *et al.*, 2007). The variation in weaning weight of lamb may be due to differences in the supply of milk by dams to their lambs. Bradford (1972) observed that the milk production capacity of ewes and its supply to lambs can influence lamb weaning weight.

The weaning weight for male lambs (9.50 kg) did not differ from that for female lambs (9.03kg) in the present study in agreement with an earlier report by Baffour-Awuah et *al*. (2007) on the same breed at the same station. This is not surprising because none of the non-genetic factors, except year of birth significantly affected the growth traits in this study. Also, Ampong *et al.* (2019) did not obtain any sex effect on weaning weight when he studied the growth performance of the Djallonke sheep at Livestock and Poultry Research Centre of the University of Ghana.

Single born lambs (9.84kg) had higher ($p < 0.05$) weaning weights than twin born lambs (8.70kg) similar to the findings in an earlier study with the same breed at the same station (Baffour-Awuah *et al.*, 2007). The single lambs may have taken advantage of their higher weights at birth. On the contrary Ampong *et al.* (2019) reported that lambs born as singles had similar weaning weight to those born as twin or triplets in the Djallonké sheep.

Djallonké lambs born in the rainy season were superior in weight (9.57kg) at weaning to their counterparts born in the dry season (8.97kg) in agreement with an earlier report by Baffour-Awuah *et al.* (2007) for the same breed at the same station. The authors reported 9.2 kg for lambs born in the major rainy season and 8.7kg for those born in the dry season. The higher weaning weights of the lambs born in the rainy season may be attributed to the availability of quality feed to the ewes enhancing their milk production capacity for growth and development of their lambs.

The variations in weaning weights between years in the present study may be due to seasonal and management changes that occurs within years affecting the availability and quality of feed for dams and consequently growth and development of their lambs. It has been reported (Baffour-Awuah *et al.*, 2007) that year of birth effects on weight at weaning of lambs for the same breed at the same station.

5.3 PRE-WEANING AVERAGE DAILY WEIGHT GAIN (PrWADG)

The lambs grew averagely at 64.10g/day in the present study. This was similar to the value of 63.1 g/day (Odoom, 2012) and comparable to the value of 59.0g/day (Baffour-Awuah, 2007) reported for the Djallonké sheep at Animal Research Institute Station at Pokuase and the National Sheep Breeding Station of the Ministry of Food and Agriculture at Ejura respectively. The pre-weaning average daily weight gain in the present study was however lower than the value of 76.9g/day (Ampong *et al.*, 2019) and 73.0g/day (Awuah, 2009) reported for the Djallonké sheep at the Livestock and Poultry Research Centre of the University of Ghana.

Average pre-weaning growth rates of 64.89g/day to 90days and 69.6 g/day to 80 days have been reported for the same breed in in Benin (Senou *et al.*, 2009) and La Cote d'lvoire (Yapi-Gnaore *et al.*, 1997).

Male and female lambs had similar average daily weight gains similar to the earlier observation on the same breed at the same station (Baffour-Awuah *et al.*, 2007). The higher average pre-weaning daily weight gain of single born lambs (64.56 g/day) than twin born lambs (56.51g/day) corroborates earlier report by Baffour-Awuah *et al.* (2007) for the same breed at the same station. This may be due to single born lambs taking advantage of their heavier weight at birth and carrying it over to the growth rate period. It has been reported that birth weight is strongly correlated with pre-weaning growth rate (Devendra and McLeroy, 1982).

Lambs born during the period of major rains (63.09 g/day) had higher average daily weight gain than those born during the dry season (57.98 g/day). The availability of more quality feed to ewes during the major rains may have enhanced the capacity of the ewes to supply adequate milk to their lambs for growth and development as suggested by Senou *et al.* (2009). This observation have also been made by other researchers (Tibbo, 2006; Patterson, 2020). For example, Patterson (2020) obtained higher pre-weaning average daily weight gains for Djallonké lambs born in the rainy season (81.09g/day) than those delivered in the dry season (78.56g/day).

The higher pre-weaning average daily weight gain of lambs born in the years 2003 (65.71g/day) and 2005 (68.69g/day) over those delivered in the years 2000 (54.33g/day) and 2002 (53.27g/day) in this study may be due to seasonal changes that occurs within years affecting the availability and quality of feed for dams and consequently growth and development of their lambs. Also, Baffour-Awuah *et al.* (2007) had made similar observations on year of birth effects on pre-weaning average daily gain of Djallonké lambs at the same station.

5.4 YEARLING WEIGHT

Weight at one year averaged 17.02kg. It was comparable to the value 15.87kg obtained for the Djallonké sheep at the CSIR-Animal Research Institute in Ghana but lower than the value 23.97kg reported in Benin (Senou *et al.*, 2009). The differences in systems of management and nutrition may account for the differences.

Sex of lamb, type of birth and season of birth were not important sources of variation for yearling weight in the present study. However, Agbolosu (2003) and Odoom (2012) reported of significant seasonal effect on yearling weight in Djallonké sheep.

The effect of year of birth on yearling weight could in this study could be attributed to the seasonal changes that occurs within years affecting the availability quality feed for the sheep.

5.5 POST WEANING AVERAGE DAILY WEIGHT GAIN

The overall mean post weaning average daily weight gain was 29.60g/day and was higher than 25.60g/d reported by Odoom (2012) in Ghana but lower than the value 50.17g/day reported by Senou *et al*. (2009) in Benin for the same breed. This observation may be attributed to differences in the nutritional status of lambs and their ability to withstand adverse environmental conditions including disease and pest infestation.

The post weaning average daily weight gain of lambs born as twins (37.19g/day) was higher than that of the single-born lambs (28.77g/day). The influence of the dam on the growth of the lamb is minimal after weaning and rather depends on the lamb's own ability. This accounts for the above observation.

The differences in the availability of feed and health status of lambs may account for the variation in post weaning average daily weight gain in lambs born in the years 2002 (38.21g/day), 2009 (28.23g/day) and 2010 (21.83g/day).

Post weaning average daily weight gain was not affected by sex of lamb and season of birth. This agrees with the results obtained for Djallonké sheep at the CISR-Animal Research Institute Station at Pokuase (Odoom, 2012).

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

Birth weight and growth rate of Djallonké lambs at the Sheep breeding station of the Ministry of Food and Agriculture Livestock was optimum, similar to what has been reported for the same breed by other workers in Ghana and in the West African Sub-region.

The growth performance of the Djallonké sheep was influenced by type of birth, season of birth and year of birth. Year of birth was a significant source of variation for birth weight, while type of birth and season of birth and year of birth were significant sources of variation for weaning weight. Furthermore, type of birth, season of birth and year of birth influenced growth rates in the Djallonké sheep.

This study will provide useful information to enhance the development of management strategies to improve the productivity of the breed in a bid to increase animal protein intake in the country.

6.2 RECOMMENDATIONS

- There is the need to improve husbandry practices especially nutrition, particularly during the dry seasons of the animals at the station to enhance the productivity of the Djallonké sheep.
- It will be very useful if feed conservation measures such as hay and silage making could be pursued more vigorously as a way of addressing feeding problems during the lean seasons.

- Crop residues and agro-industrial bye-products can also be explored for use as dry season feed supplements.
- Identification system of animals should be improved upon and missing tags should be replaced with the same identification number for consistency and avoidance of multiple duplication.
- Data on the animals need to be updated regularly and stored on electronic devices like computers to prevent losing some data.

6.3 LIMITATIONS OF THIS STUDY

One of the main obstacles encountered in the course of this study was the inadequate attention paid to record keeping on the animals at the station. For instance, records for the year 2004 and 2006 were not available to the research team. Another problem noticed was that some animals lost their ear tags and were replaced with ear tags without recourse to their original identification numbers.

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APPENDICES

APPENDIX 1:

Analysis of variance for evaluation of factors affecting birth weight (BW) in Djallonke sheep at Ejura Breeding Station

Source of Variation	**df**	**MS**	**F value**	**P > F**
Year of Birth	8	1.18	12.25	>.0001**
Type of Birth	1	0.86	8.95	0.0029**
Season of Birth	1	0.01	0.05	0.8147
Sex	1	0.0001	0	0.9641
YOB×Sex	8	0.087	0.91	0.5102
TOB×Sex	1	0.14	1.51	0.2199
SOB×Sex	1	0.01	0.09	0.77
Error	603	0.10		
Total	**624**			

******** *Significant at 0.01 alpha level*

APPENDIX 2:

Analysis of variance for evaluation of factors affecting weaning weight (WW) in Djallonke sheep at Ejura Breeding Station

Source of Variation	**df**	**MS**	**F value**	**P>F**
Year of Birth	8	36.82	7.09	<.0001**
Type of Birth	1	38.41	7.39	0.0067**
Season of Birth	1	32.17	6.19	0.0131**
Sex	1	6.023	1.16	0.2821
YOB×Sex	8	6.55	1.26	0.261
TOB×Sex	1	0.000008	0	0.999
SOB×Sex	1	4.50	0.87	0.3521
Error	603	5.20		
Total	**624**			

******** *Significant at 0.01 alpha level*

APPENDIX 3:

Analysis of variance for evaluation of factors affecting pre-weaning average daily gain in Djallonke sheep at Ejura Breeding Station

Source of Variation	df	MS	F value	P > F
Year of Birth	8	2200.98	6.27	<.0001**
Type of Birth	1	1929.21	5.49	0.0194**
Season of Birth	1	2291.55	6.52	0.0109**
Sex	1	423.02	1.2	0.2729
YOB×Sex	8	404.06	1.15	0.3274
TOB×Sex	1	9.89	0.03	0.8668
SOB×Sex	1	286.72	0.82	0.3666
Error	603	351.24		
Total	**624**			

******** *Significant at 0.01 alpha level*

APPENDIX 4:

Analysis of variance for evaluation of factors affecting yearling weight in Djallonke sheep at Ejura Breeding Station

Source of Variation	df	MS	F value	P > F
Year of Birth	8	55.69	6.74	<.0001**
Type of Birth	1	15.42	1.87	0.1724
Season of Birth	1	0.35	0.04	0.8369
Sex	1	4.36	0.53	0.4678
YOB×Sex	8	10.96	1.33	0.2273
TOB×Sex	1	14.33	1.73	0.1884
SOB×Sex	1	2.16	0.26	0.6093
Error	559	8.26		
Total	**580**			

******** *Significant at 0.01 alpha level*

APPENDIX 5:

Analysis of variance for evaluation of factors affecting post weaning average daily gain in Djallonke sheep at Ejura Breeding Station

Source of Variation	df	MS	F value	P > F
Year of Birth	8	1358.69	6	<.0001**
Type of Birth	1	1838.41	8.12	0.0045*
Season of Birth	1	279.42	1.23	0.2671
Sex	1	356.30	1.57	0.2102
YOB×Sex	8	237.43	1.05	0.3979
TOB×Sex	1	250.95	1.11	0.2929
SOB×Sex	1	0.51	0.0	0.962
Error	559	226.38		
Total	**580**			

******** *Significant at 0.01 alpha level;* ******* *Significant at 0.05 alpha level*