FACTORS INFLUENCING REPRODUCTIVE AND CALF GROWTH PERFORMANCE OF SANGA COWS IN THE ASHANTI REGION, GHANA

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ABSTRACT
A three-year study was conducted to determine the effect of non-genetic factors on the reproductive and calf growth performance of Sanga cows in the Ashanti of Ghana. One hundred and twenty-three (123) Sanga cows were purposively sampled for the study using a longitudinal design. Factors considered in assessing the reproductive and calf growth traits included sex of calf, parity of dam, season of calving, body condition score and level of feed supplementation. Data were analyzed using the Generalized Linear Model procedure of SPSS version 25. Results obtained indicated that sex of calf influenced ($p < 0.01$) calving interval (CI), weaning weight (WW) and pre-weaning growth rate (PWG) but had little effect ($p > 0.05$) on the subsequent number of services per conception (NSPC), gestation period (GP), postpartum interval (PPI), and weaning age (WA). Parity of dam, except for GP, NSPC, CI, WW and PWG, which were insignificantly ($p > 0.05$) affected, masked PPI, birth weight (BW), and WA. The postpartum interval was high at parity one, reduced from parity two to five and then assumed an increase with increasing parity up to parity seven. The birth weight and pre-weaning growth rate increased with increasing parity. Apart from GP, season had little effect ($p > 0.05$) on all other traits assessed. Body condition score (BSC) also affected ($p < 0.01$) all traits except WA. Feed supplementation significantly ($p < 0.01$) improved AFH, GP, AFC, and WA but had little influence ($p > 0.05$) on NSPC, CI, PPI, BW, WW, and PWG. It was concluded that management of body condition through feed supplementation improved most reproductive performances in Sanga cows.

Keywords: *Age at first oestrus, Sanga cows, non-genetic factors, reproductive traits, season*

INTRODUCTION
Reproductive characteristics are important traits that affect cow-calf operations, coupled with the ability to produce one calf per cow per year (Mercadante *et al.*, 2019). The profitability of the beef/dairy industry is directly influenced by a cow's reproductive lifespan, age at first calving, and ability to wean a marketable live calf each year (Vraspir, 2014). The decline in the performance of reproductive traits over the last few decades is believed to have been caused by low fertility in dairy cows due to a shift towards higher milk production per cow, inadequate nutrition, poor reproductive management, increased incidence of metabolic and infectious diseases, and their complex interactions (Soydan

and Kuran, 2017). In sub-Saharan Africa, the reasons for these reproductive lapses include the low genetic potential of indigenous breeds, poor husbandry, and various environmental factors, including high ambient temperature and humidity, seasonal shortages of feed and water, diseases and parasites of which Ghana is not different. These factors negatively affect the reproductive efficiency of indigenous cows including the dominant Sanga cattle breed in Ghana.

The Sanga cattle are crossbred between the humpless taurine breeds (N'Dama and WASH—West African Shorthorn cattle) and the Zebu, usually White Fulani or Sokoto Gudali (Aboagye, 2002; Oppong-Anane, 2013). The Sanga cow is purposely meant for meat and milk production (MoFA, 2004; Oppong-Anane, 2013). Amrahia farms under the Ministry of Food and Agriculture, Ghana, has been mandated to crossbreed Sanga dam and Friesian (Sire) for milk production purposes (Oppong-Anane, 1999; MoFA, 2004; 2007).

The reproductive performance of Sanga cows is well documented on station (Aboagye, 2002; Obese *et al*., 2008). The Mean number of services per conception in Sanga cows has been recorded as 2.17 on-station (Obese *et al*., 2008), and 2.00 on-farm (Obese *et al*., 1999). The mean gestation period for Sanga cows in the Accra plains of Ghana is 282 days (277 – 285 days) and 292 days at the smallholders' level (Obese *et al*., 1999; 2018). Age at first calving for indigenous breeds in Ghana ranges from 35.93 to 49.40 months (Aboagye, 2002).

Although many studies have been done on the effect of farm (herd), season of calving and feed supplementation on the reproductive performance of Sanga cows in smallholder peri-urban dairy farms in the Accra plains (Okantah *et al*., 2005; Obese *et al*., 1999; 2008; 2018), very little is known about non-genetic factors influencing Sanga cows in the Ashanti Region. According to Januś and Borkowska (2013) and Jemal *et al*. (2016), the level of parity, hygiene, age, and management system have an immense influence on the reproductive indices of cows, however, these factors have been given little attention in Sanga cows at the smallholder level in the study area. The paucity of information on calf growth characteristics of the Sanga breed on-farm in the study area cannot be overlooked. On-farm study to assess factors that facilitate better performance of Sanga cattle at the farmers' domain is crucial because the local breeds kept at on-station perform better than those maintained at the smallholders level due to management differences (Aboagye, 2002). Factors that can help improve a successful reproductive management programme (Mercadante *et al.,* 2019) need to be investigated at the farmers' level.

The objective of this study was to determine the effect of non-genetic factors (sex of calf, parity of dam, season of calving, body condition score, and feed supplementation) on the reproductive and calf growth performance of Sanga cows in Ashanti Region. The findings from this study could be tapped to promote and recommend factors that enhance the reproductive and calf growth performance of Sanga cattle production at the farmers' level in Ghana.

MATERIALS AND METHODS

Locations and duration of the study

The study was conducted in three Districts in Ashanti Region viz: Mampong Municipal, Ejura -Sekyedumasi, and Sekyere South based on proximity and convenience of data collection. The duration of the study was from February 2018 to May, 2021. Ashanti Region is located in the transitional zone of Ghana and lies between longitudes 0.15'W and 2.25'W, and latitudes 5.50'N and 7.46'N. The region shares boundaries with six of the sixteen administrative regions (Zurek, 2018); Bono East Region in the north, Eastern Region in the east, Central Region in the south, Ahafo in the west, a small portion of Ahafo Region in the north-west and Western North in the south-west. The Ashanti Region occupies a total land area of 24,389 km^2 representing 10.2% of the total land area of Ghana (Ghana Districts, 2006).

Ashanti is the third-largest (24,389 km^2) region after the Northern and Savannah (70,765 km^2) Regions. The Region has a population density of 148.1 persons per square kilometre, also the third after Greater Accra and Central Regions. More than half of the Ashanti Region lies within the wet, semi-equatorial forest zone. However, due to human activities and frequent bushfires, especially during the dry season, the forest vegetation of parts of the Region, particularly the north eastern area, has been reduced to savannah.

Ashanti Region has an average annual rainfall of 1270 mm and two rainy seasons. The major rainy season starts in late March, with the main peak in May. There is a slight dip in July and a peak in August, tapering off in November. December to February is dry, hot, and dusty (Ghana Districts, 2006). The average daily temperature of the Ashanti Region is about 27^{o}C. Much of the Region is situated between 150 and 300 metres above sea level. The Region is endowed with spectacular geography; lakes, scarps, forest reserves, waterfalls, national parks, birds and wildlife sanctuaries (Ghana Districts, 2006). The common forage species grazed in the rangeland include elephant grass (*Pennisetum purpureum*), guinea grass (*Panicum maximum),* Centro (*Centrocaema pubescens),* giant star grass (*Cynodon plectostachyus*), Gamba grass *(Andropogon gayanus*), and carpet grass (*Axonopus sp)* (Coffie *et al.,* 2015).

Study design

A longitudinal survey design (Lynn, 2009; Coffie *et al.,* 2015) was used to obtain data on the reproductive and calf growth characteristics of the dual-purpose cows in the Region. This study involved collecting data (on age at first heat/oestrus, the number of services per conception, gestation period, age at first calving, calving interval, postpartum interval, birth weight, weaning weight, and pre-weaning growth rate) on multiple occasions (at different seasons, varied levels of supplementation, and parity levels) to assess the trends or changes in traits with time.

Study population and sample size

The study populations were Sanga heifers/cows. The examples of Sanga cattle used for the study are shown in Plates 1 and 2. A hundred and twenty-three (123) Sanga cows were purposively sampled from the three districts in Ashanti Region for the study based on the availability of the Sanga cows. feed supplementation levels, proximity and convenience of traits assessment, and the willingness of farmers to accept the modality for the study design.

Sampling techniques

A purposive sampling procedure (FAO, 2012) was employed for this study in the three districts. The same technique was used to select

Plate 1: Sanga cattle in their Kraal

Plate 2: Sanga cattle in their grazing field

animals based on the availability of Sanga cows at least close to or at the onset of puberty and those at different parities.

Management of animals

Housing and feeding

Animals were kept under three housing conditions: open kraal, open kraal with shelter, and completely roofed kraal (Coffie *et al*., 2015). The Sanga cows were kept in their respective kraals with more than one bull which were either tethered or confined till signs of oestrus were observed at dawn. Young suckling calves were kept in a roofed and protective kraal provided within or outside the main kraal.

The cows were grazed on range grasses, including Elephant/Napier grass, Guinea grass and Centrosema leaves. The cows were sent for grazing at 09:00 hours and returned to their kraal in the evening (17:00 hours GMT). Some farmers fed regular feed supplementations, whilst others provided occasional supplements or relied on the available range forage (Coffie *et al.*, 2015). The feed supplements given to cows included cassava and plantain peels, brewers spent grain, and dried cowpea vines.

Identification

Apart from two farms, one in Sekyere South district (Karimah farms) and the other in Mampong Municipal (AAMUSTED farms) that used ear tags for identification of some of the cows, all other farms studied had no animal identification scheme (ear notching, ear tagging, or tattooing). Instead, the Fulani herdsmen used colour and other characteristics in identifying their animals. However, permanent/indelible markers were used to number all cattle on which records were obtained.

Health care

Farmers accessed veterinary services. Cattle were de-wormed with Albendazole 10 % at the three-month interval. Other farmers hardly treat their cattle. Some farmers/herdsmen resorted to self-medication and used ethnoveterinary (indigenous) means in treating their animals. Special routine practices such as hoof trimming, dehorning, disbudding, dipping, and castration were not practised by farmers.

Methods of data collection

Record on each Sanga cow's fixed factors included parity of cow, season of calving, sex of calf, body condition score, and level of feed supplementation. A datasheet was developed for reproductive and calf growth traits data collection. Data obtained from each cow included age at first heat/oestrus (AFH), number of services per conception (NSPC), gestation period (GP), age at first calving (AFC), calving interval (CI), and postpartum interval (PPI). The calf growth traits assessed included birth weight (BW) of calf, weaning weight (WW), and pre-weaning growth rate (PWG).

Age at first oestrus was monitored through close observation of heifers at 12 months of age, considering the possibility of precocious heifers below 12 months. The first oestrus in heifer was determined by the observation of the overt signs of heat including licking and rubbing each other; sniffing the vagina of another cow; mutual chin resting; lining up to mount another cow, with subsequent standing to be mounted at 05:00 – 06:00 and 18:00 – 19: 00 GMT.

The number of services per conception (NSPC) was estimated by the rate of total number of services to the number of pregnancies observed (Jemal *et al*., 2016).

Gestation period (GP) was assessed as the period from conception to parturition (Aboagye, 2002) or the time interval from fertilisation to birth.

Age at first calving **(AFC)** was estimated as the day a dam was born minus the day it first calved.

The sex of calf was observed immediately after birth by the dam.

Calving interval **(CI)** was estimated as the time interval (in months) between two successive calvings.

Postpartum Interval **(PPI)** was determined as the difference between the day of calving and the day the cow experienced its first oestrus.

Birth weight **(BW)** of a calf was determined as the weight of the calf immediately after calving.

Weaning weight **(WW)** was determined as the weight of the calf at seven months of age.

Pre-weaning growth rate **(PWG)** was estimated as the ratio of the difference between weaning weight minus birth weight to the number of days from birth to weaning, expressed in grams/day or

$$\frac{\textit{Weaning weight - birth weight}}{\textit{No. of days from birth to weaning}}$$

Weaning Age was the age of calf in months in which it was weaned.

Season of calving was defined as (i) Rainy season – April to July; (ii) Minor rainy season – August to November; and Dry season – December to March.

Body condition score (BCS) was assessed at the time of calving and in the heifer before the onset of puberty/oestrus. A five-scale BCS described by Coffie *et al*. (2015) was used in this study.

Statistical analysis

Data on reproductive traits of the Sanga cows were subjected to least squares (LS) analysis using Generalized Linear Model (GLM) Type III Procedure of IBM-SPSS version 25 (SPSS, 2017) on the following fixed model:

$$Y_{ijklmn} = \mu + B_i + C_j + P_k + S_l + X_m + e_{ijklm}$$

Where:

Y_{ijklmn} = the dependent variable or the trait being measured (reproductive traits: AFH, AFC, GP, NSPC, CI, and PPI; calf growth trait: BW, WW, PWG, and WA);

μ = the population mean;

B_i = the fixed effect of the i^{th} BCS,

i = 1, 2, 3, …, 5;

C_j = the fixed effect of the j^{th} sex of calf,

j = male, female;

P_k = the fixed effect of k^{th} parity of dam,

k = 1, 2, …,7;

S_l = the fixed effect of l^{th} season of calving,

l = major rain, minor rain, or dry season;

X_m = the fixed effect of m^{th} feed supplementation (FS),

m = regular FS, occasional FS, or no FS;

e_{ijklmn} = the error mean term.

RESULTS AND DISCUSSIONS

Effect of sex of calf, parity and season on reproductive and calf growth traits of Sanga cows

Results on the effect of sex of calf, parity and season of calving on reproductive traits of Sanga cows in Ashanti Region are presented in Table 1.

Effect of Sex of calf on reproductive and calf growth performance of Sanga cows

Sex of calf significantly ($p < 0.01$) influenced calving interval (CI), weaning weight (WW) and pre-weaning growth rate (PWG). The male calf triggered higher ($p < 0.01$) calving interval in the dam than the female. This is contrary to the finding of Obese *et al*. (2008), observing insignificant differences in sex of calf with respect to calving to the first artificial insemination of Sanga cows in the Accra Plains. However, the mean value obtained in males (14.8 ±0.18 months) is similar to the 14.8 months of CI recorded by Obese *et al*. (1999). In addition, the male calf had a heavier ($p < 0.01$) weight at weaning and faster ($p < 0.01$) pre-weaning growth rate than the female counterpart, which also differed from that obtained by Obese *et al*. (2008). The sex of calf did not affect AFH, NSPC, GP, and AFC since these traits are related to the female calf.

Effect of parity of dam

Parity of dam influenced ($p < 0.01$) postpartum interval (PPI), birth weight (BW) and weaning age (WA) of the calf. The postpartum interval was high at parity one, reduced from parity two to five and then assumed an increase in PPI with increasing parity up to parity seven. The mean values of PPI observed in this study (Table 1) are comparable to the findings of Obese *et al*. (1999). However, the mean values of PPI ob-

Table 1: Effect of sex of calf, parity, and season on reproductive traits of Sanga cows

		FIXED FACTORS									
Sex of Calf	**N**	**AFH (months)**	**NSPC**	**GP (days)**	**AFC (months)**	**CI (months)**	**PPI (days)**	**BW (kg)**	**WW (kg)**	**PWG (g)**	**WA (months)**
Male	70	–	1.7±0.11	290.0±0.33	–	14.8±0.18[a]	100.5±1.12	21.2±0.24	103.0±0.56[a]	389.4±2.03[a]	7.1±0.04
Female	53	–	1.6±0.12	289.6±0.36	–	14.2±0.20[b]	99.4±1.20	20.9±0.25	100.9±0.61[b]	380.7±2.18[b]	7.2±0.04
p-value		***NA***	***=0.399***	***=0.174***	***NA***	***<0.000***	***=0.259***	***=0.224***	***<0.000***	***<0.000***	***=0.329***
Parity of Dam											
1	27	–	1.6±0.31	289.8±0.91	–	14.9±0.50	107.8±3.08[a]	20.3±0.65[c]	99.8±1.55	378.4±5.58	6.9±0.09[b]
2	37	–	1.3±0.23	289.4±0.69	–	14.6±0.38	100.8±2.32[b]	21.7±0.49[b]	101.0±1.17	377.4±4.19	6.9±0.07[b]
3	24	–	1.1±0.21	288.1±0.63	–	14.3±0.35	91.5±2.14[c]	22.9±0.45[a]	103.6±1.08	383.8±3.87	7.0±0.07[b]
4	11	–	1.4±0.23	289.4±0.70	–	14.7±0.38	95.2±2.36[bc]	22.1±0.50[b]	103.9±1.19	388.9±4.27	7.1±0.07[b]
5	10	–	2.0±0.31	290.0±0.93	–	14.7±0.51	99.0±3.14[bc]	20.1±0.66[c]	102.6±1.58	393.0±5.69	7.4±1.00[a]
6	9	–	2.0±0.39	290.7±1.16	–	13.8±0.64	101.9±3.93[b]	19.9±0.83[c]	101.6±1.98	388.7±7.12	7.4±0.12[a]
7	5	–	2.4±0.45	291.5±1.35	–	14.5±0.74	103.3±4.56[b]	20.5±0.96[c]	101.4±2.29	385.2±8.24	7.4±0.14[a]
p-value		***NA***	***=0.125***	***=0.094***	***NA***	***=0.326***	***<0.000***	***<0.000***	***=0.121***	***=0.396***	***=0.019***
Season											
Major	32	27.6±0.70	1.7±0.23	291.3±0.69[a]	37.4±0.92	14.5±0.38	104.0±2.33	21.1±0.49	101.9±1.17	384.4±4.22	7.1±0.07
Minor	37	26.9±0.58	1.7±0.20	289.7±0.59[b]	36.7±0.78	14.8±0.32	100.3±1.98	21.5±0.42	101.3±1.00	379.9±3.58	7.1±0.06
Dry	54	25.2±0.88	1.6±0.30	288.4±0.89[b]	35.9±1.18	14.1±0.49	95.5±3.02	20.6±0.64	102.7±1.52	390.8±5.46	7.2±1.00
p.value		***=0.171***	***=0.954***	***=0.006***	***=0.615***	***=0.412***	***=0.069***	***=0.468***	***=0.649***	***=0.173***	***=0.846***

AFH = age at first heat/oestrus; NSPC = number of services per conception; GP = gestation period; AFC = age at first calving; CI = calving interval; PPI = postpartum Interval; BW = birth weight; WW = weaning weight; and PWG=pre-weaning growth rate; NA = Not Applicable.

tained in this study are higher than 60 – 90 days reported in Friesian cows by Reece *et al*. (2015) but lower than that of 373.4 – 536.9 days in Sokoto Gudali (Tawah and Rege, 2006). The differences in marginal mean values observed might be due to the age and poor nutrition of cows which predispose Sanga cows to lactational anoestrus through inadequate feed availability to support the dam bringing a competing calf into this environment (Whittier *et al*., 2008). Cows of parities 6 – 7 had similar ($p > 0.05$) and prolong PPI which can lead to increase in CI resulting in reduced calving rate.

Parity significantly ($p < 0.05$) affected weaning age (WA) such that the WA increased with increasing parity. Sanga cows of parity 3 had the highest ($p < 0.01$) birth weight (BW) followed by parities 4 and 2. Parities 1, 5 to 7 had similar ($p > 0.05$) BW values with lower ($p < 0.05$) BW compared to cows at parity 2, 3 and 4. These findings are comparable to higher BW recorded in Bali cattle at parities 2, 3, and 4 with parity 5 having a reduced BW in Indonesia (Gunawan and Jakaria, 2011). Hoka *et al.* (2019) also observed the highest average BW (39.0 kg) in Friesian cows at parity 4. The increase in calf growth traits, especially, BW, and WW might be attributed to the enhanced reproductive and productive capacity of cows with increasing parities up to 4, and the decline in these traits at higher parities with increasing age (Reece *et al*., 2015). However, parity had little effect ($p > 0.05$) on NSPC, GP, CI, and WW indicating that parity is not a good determinant of these traits in this study.

Effect of season of calving

Season of calving significantly ($p < 0.01$) affected GP (Table 1). The rainy season recorded the highest gestation followed by minor and dry seasons in descending order. This trend can be attributed to the fact that cows calving in the early to mid-rainy season might have spent their last trimester of gestation, characterized by exponential growth in the developing foetus in the dry season in which feed is scarce and inferior in quality. This, thereby, may delay the foetus' development, hence prolonging the gestation period. Therefore, prenatal management, especially with supplementary feeding, is crucial during the late pregnancy, since Mao *et al*. (2008) observed that over 70 % of foetal growth occurs in the last trimester of cows' gestation, hence influencing birth weight. Season of calving, however, did not affect all other parameters (Table 1) measured, which is consistent with the findings of Okantah *et al*. (2005) and Obese *et al*. (2008).

Effect of body condition score and feed supplementation on reproductive traits

Results on the effect of body condition score and feed supplementation on the reproductive and calf growth traits of Sanga cows are presented in Table 2.

Effect of body condition score

Body condition score (BCS) (before the onset of the first oestrus and at the time of calving) significantly ($p < 0.01$) influenced all reproductive traits (Table 2) except in calf growth characteristics, weaning age (WA) which was not affected ($p > 0.05$). Cows having BCS 2 lately ($p < 0.01$) experienced their first heat or oestrus (AFH). Age at first oestrus (onset of puberty) reduced with the increasing BCS up to point 4, with BCS 3.5 recording the least value for AFH. The observed differences in AFH suggest that lower BCS (= 2) and higher BCS (= 4) might not support profitable reproductive management and hence dairying.

It has been indicated that a calving BCS of at least 3 or above would help achieve a successful reproductive programme in dairy production enterprises (Bayram *et al*., 2012; Walker *et al*., 2013). The body condition score is an essential tool for assessing the energy reserves of a cow and, therefore, plays a crucial role in determining reproductive and productive indices (Roche *et al.*, 2007) obtained in this study.

Mean values of GP in days NSPC, AFC, CI, and PPI, were significantly ($p < 0.01$) high at BCS 2 and reduced with increasing BCS from 2.5 to 4.

Table 2: Effect of body condition score and feed supplementation on reproductive traits of Sanga cows

BCS	FIXED FACTORS										
	N	**AFH (months)**	**NSPC**	**GP (days)**	**AFC (months)**	**CI (months)**	**PPI (days)**	**BW (kg)**	**WW (kg)**	**PWG (g)**	**WA (months)**
2	32	27.9±0.40[a]	2.0±0.13[a]	292.1±0.40[a]	38.2±0.53[a]	15.4±0.22[a]	104.1±1.35[a]	19.4±0.28[b]	99.0±0.68[b]	378.6±2.44[b]	7.2±0.04
2.5	23	26.7±0.47[b]	1.6±0.16[b]	289.7±0.46[b]	36.3±0.62[b]	14.4±0.26[bc]	100.1±1.57[b]	21.5±0.33[a]	102.2±0.79[a]	384.1±2.84[a]	7.2±0.05
3	24	26.6±0.47[b]	1.5±0.16[b]	289.5±0.48[b]	36.6±0.63[b]	14.2±0.26[bc]	99.6±1.61[b]	21.4±0.34[a]	102.5±0.81[a]	386.1±2.92[a]	7.2±0.05
3.5	18	25.0±0.47[c]	1.5±0.16[b]	288.8±0.47[b]	35.5±0.63[b]	14.0±0.26[c]	95.9±1.59[c]	21.8±0.33[a]	104.4±0.79[a]	392.7±2.87[a]	7.2±0.05
4	26	26.0±0.45[bc]	1.7±0.15[b]	289.1±0.44[b]	36.7±0.58[b]	14.5±0.24[b]	100.0±1.49[b]	21.2±0.31[a]	101.9±0.75[a]	383.8±2.69[b]	7.1±0.05
p-value		***=0.001***	***=0.019***	***<0.000***	***=0.002***	***<0.000***	***=0.001***	***<0.000***	***<0.000***	***=0.001***	***=0.152***
FEED SUPPL.											
	37	24.9±0.41[c]	1.6±0.14	289.0±0.41[b]	34.9±0.55[c]	14.3±0.23	100.4±1.38	21.4±0.29	102.6±0.70	386.4±2.50	7.1±0.04[b]
	63	26.8±0.37[b]	1.6±0.12	290.1±0.37[a]	36.8±0.49[b]	14.5±0.20	99.5±1.25	21.0±0.26	102.1±0.63	386.0±2.26	7.1±0.05[b]
	23	27.9±0.45[a]	1.9±0.15	290.4±0.45[a]	38.3±0.60[a]	14.7±0.25	99.9±1.53	20.8±0.32	101.3±0.77	382.8±2.77	7.3±0.04[a]
p-value		***<0.000***	***=0.192***	***=0.014***	***<0.000***	***=0.432***	***=0.806***	***=0.295***	***=0.343***	***=0.455***	***=0.005***

BCS = Body condition score; Feed Suppl = Feed supplementation (1=regular; 2=Partial/occasional; 3=No feed supplementation); AFH = Age at first heat/oestrus; NSPC = Number of services per conception; GP = Gestation period; AFC = Age at first calving; CI = Calving interval; PPI = Post-partum Interval; BW = Birth weight; WW = Weaning weight; and PWG=Pre-weaning growth rate.

It was noted in this study that the best mean values of reproductive performances were recorded in BCS 3 to 3.5. Gergovska *et al*. (2011) also observed a similar optimal performance at BCS ≥ 3.5. Cows that fall within this range of the BCS (3 to 3.5) have adequate body reserves to support foetal growth, development and associated challenges. Therefore, a herd of cattle in good body condition (BCS ≥3) will produce more and be less susceptible to metabolic disorders, diseases, mastitis, and reproductive problems (Patton *et al*., 1988). According to Bayram *et al.* (2012), cow BCS at calving determines the length of time from calving until the return to oestrus, or PPI. To maintain a calving interval of one calf every year, cows should have PPI of 80 – 85 days (Walker *et al*., 2013). Based on the BCS and corresponding PPI of these indigenous dairy herds, maintaining one calf per year would be challenging without nutritional intervention.

Birth weight, WW and PWG were influenced by BCS such that the least mean values of weight indices were observed in BCS 2 while significantly ($p < 0.01$) sustained increases in weights were obtained from BCS 2.5 to 4. These trends might be attributed to the adequacy of the body reserves to support reproduction. Also, the birth weight of calves from good condition or heavy frame dams and sires have heavier BW than calves from medium-sized dams or sires (Reece *et al.*, 2015).

Effect of feed supplementation

Feed supplementation had an immense ($p < 0.01$) influence on AFH, GP, AFC, and WA. The AFH, and AFC decreased with regular feed supplementation, followed by occasional/partial feed supplementation. The gestation period was short ($p < 0.01$) in supplemented cows, while cows that received partial and no supplementation had a similar ($p > 0.05$) gestation period. Sanga cows provided with regular and partial feed supplementation had lower ($p < 0.01$) WA compared to those without feed supplementation. Differences observed in WA with feed supplementation may be attributed to additional energy obtained by dams from the supplemented feed for more milk production for enhanced calves' growth performance (McDonald *et al.,* 2011).

The better performance obtained from cows given feed supplements results from good nutrition, enhancing metabolizable energy for production and boosting reproductive performance (McDonald *et al.,* 2011). The effect of good nutrition at the various stages of the reproductive cycle and especially in the third trimester of pregnancy is crucial (Mao *et al.*, 2008). Adequate nutrition is required to meet cows' energy for production (McDonald *et al.,* 2011). It has been identified that higher milk yield coupled with negative energy feedback resulting from poor nutritional management extends the number of services per conception (Siatka *et al*., 2017).

CONCLUSION

It was concluded that sex of calf influenced the calving interval, weaning weight and postpartum interval but had little effect on the number of services per conception, gestation period, postpartum interval, and weaning age. Parity of dam greatly influenced postpartum interval, birth weight and pre-weaning growth rate, but had insignificant effect on the gestation period, number of services per conception, calving interval and weaning weight. The postpartum interval was high at parity one, reduced from parity two to five and then assumed an increase with increasing parity up to parity seven. The birth weight and pre-weaning growth rate increased with increasing parity. Apart from the gestation period, season had little effect on all other reproductive traits assessed. Except for weaning age, body condition score affected all traits in that Sanga cows in good condition had improved reproductive and calf growth performance. Feed supplementation significantly improved age at first calving, gestation period, age at first calving, and shortened weaning age. Feed supplementation had little influence on number of services per conception, calving interval, postpartum interval, birth weight, weaning weight, and pre-weaning growth rate. It is recommended that the management of body condition through feed supplementation should be encouraged for improvement in reproductive and calf growth performances in Sanga cows. This study should be repeated in all the indigenous breeds in Ghana, considering the effect of geographical locations on all reproductive traits.

REFERENCES

Aboagye, G.S. (2002). Phenotypic and genetic parameters in cattle populations in Ghana. *International Livestock and Research Institute*. Retrieved March 11, 2013 from: http://agtr.ilri.cgiar.org/index.php?option=com_content&task=view&id=153&Itemid=179.

Bayram, B., Aksakal, V. and Akbulut, Ö. (2012). Effect of the body condition score on some reproduction and milk yield traits of Swedish Red and White cows. *The Journal of Animal & Plant Sciences*, 22(3): 545 – 551.

Coffie, I., Annor, S.Y., Kagya-Agyemang, J.K. and Bonsu, F.R.K. (2015). Effect of breed and non-genetic factors on milk yield of dual-purpose cattle in Ashanti Region, Ghana. *Livestock Research for Rural Development*, 27: 134.

Food and Agriculture Organisation (FAO) (2012). *Phenotypic characterization of animal genetic resources*. FAO Animal Production and Health Guidelines No. 11. Rome.

Gergovska, Z., Mitev, Y., Angelova, T., Yordanova, D. and Miteva, T. (2011). Effect of changes in body condition score on the milk yield of Holstein-Friesian and Brown Swiss cows. *Bulgarian Journal of Agricultural Science,* 17(6): 837 – 845.

Ghana Districts (2006). A repository of all districts in the Republic of Ghana. Public-Private Partnership Programme between Ministry of Local Government, Rural Development and Environment and Maks Publications and Media Services. Retrieved May 11, 2017 from, http://www.ghana districts.com/districts/?news&r=10&_=47

Gunawan, A. and Jakaria, J. (2011). Genetic and Non-Genetics Effect on Birth, Weaning, and Yearling Weight of Bali Cattle. *Media Peternakan, Agustus* 2011: 93-98. DOI: 10.5398/medpet.2011.34.2.93.

Hoka, A.I., Gicheru, M. and Otieno, S. (2019). Effect of Cow Parity and Calf Characteristics on Milk Production and Reproduction of Friesian Dairy Cows. *Journal of Natural Sciences Research,* 9 (10). DOI: 10.7176/JNSR/9-10-06

Januś, E. and Borkowska, D. (2013) The effect of selected non-genetic factors on key fertility indices in high-yielding Montbéliarde cows. *Acta Scientiarum Polonorum Zootechnologia,* 12: 21 – 32.

Jemal, H., Lemma, A. and Bekana, M. (2016). Assessment of the reproductive performance of dairy cows in smallholder dairy farms using artificial insemination. *Livestock Research for Rural Development,* 28 (5).

Lynn, P. (Ed.), (2009). *Methodology of longitudinal surveys*. Wiley series in survey methodology. University of Essex. UK., pp 414. Retrieved April 11, 2014, from http://eu.wiley.com/WileyCDA/WileyTitle/productCd-0470018712.html.

Mao, W.H., Albrecht1, E., Teuscher, F., Yang, Q., Zhao, R.Q. and Wegner, J. (2008). Growth- and Breed-related Changes of Fetal Development in Cattle. *Asian-Australian. Journal of Animal Science* 21(5): 640-647.

McDonald, P., Edwards, R.A., Greenhalgh, J.F.D., Morgan, C.A., Sinclair, L.A. and Wilkinson, R. G. (2011). *Animal Nutrition*. Seventh (edn.), Pearson, Prentice Hall UK. 692 pp.

Mercadante, V.R.G., Dias, N.W., Timlin, C.L., Pancini, S. and Alvaro, F.F. (2019). Characteristics of Successful Reproductive Management Programs. *Proceedings, Applied Reproductive Strategies in Beef Cattle;* August 20-21, 2019; Knoxville, TN.

Ministry of Food & Agriculture (MOFA). (2004). Livestock Development in Ghana: Policies and Strategies. Animal Production Directorate, Veterinary Services Directorate and Livestock Planning and Information Unit, Accra, Ghana, 122 pp.

Ministry of Food & Agriculture (MoFA). (2007). Ghana Livestock Development Policy. Ministry of Food and Agriculture, Accra, Ghana.

Obese, F.Y., Darfour-Oduro, K.A., Bekoe, E., Hagan, B.A. and Gomda, Y. (2008). Reproductive status following artificial insemination in Sanga cows in the Accra Plains of Ghana. *Livestock Research for Rural Development, 20 (12).*

Obese, F.Y., Dwumah, K., Adjorlolo, L.K. and Ayizanga, R.A. (2018) Effects of feed supplementation on growth, blood parameters and reproductive performance in Sanga and Friesian-Sanga cows grazing natural pasture. *Tropical Animal Health and Production*, 50: 1739–1746.

Obese, F.Y., Okanta, S.A., Oddoye, E.O.K. and Gyawu, P. (1999). Postpartum reproductive performance of Sanga cattle in smallholder peri-urban dairy herds in the Accra plains of Ghana. *Tropical Animal Health and Production*, 31(3): 181 – 190.

Obese, F.Y., Dwumah, K., Adjorlolo L.K. and Ayizanga, R. (2018). Effects of feed supplementation on growth, blood parameters and reproductive performance in Sanga and Friesian-Sanga cows grazing natural pasture. *Tropical Animal Health and Production*, 50 (8):1739-1746.

Okantah, S.A., Obese, F.Y., Oddoye, E.O.K., Karikari, P.K., Gyawu, P. and Bryant, M.J. (2005). The effect of farm (herd) and season of calving on the reproductive performance of Sanga cows in smallholder peri-urban dairy farms in the Accra Plains. *Ghana Journal Agricultural Science* (NARS Edition 1), 1: 37-42.

Oppong-Anane, K. (1999). Dairy Industry Development in Ghana: Current Status and Improvement. Commission by the Food and Agricultural Organisation of the United Nations.

Oppong-Anane, K. (2013). Review of the livestock/meat and milk value chains and policy influencing them in Ghana. Support to policy initiatives for the development of livestock/meat and dairy value chains in West Africa (TCP/SFW/3402). *FAO/ ECOWAS Final Draft.* 47 pp.

Patton, R.A., Bucoltz, H.F., Schmidt, M.K. and Hall, F.M. (1988). Body Condition Scoring—A Management Tool. Department of Animal Science, Michigan State University, East Lansing, Michigan. pp. 6.

Reece, W.O., Erickson, H.H., Goff, J.P., and Uemura, E.E. (Eds.). (2015). *Dukes' physiology of domestic animals*, 13th (Edn.), John Wiley & Sons, Inc. Ames, Iowa, USA. 763 pp.

Roche, J.R., Macdonald, K.A., Burke, C.R., Lee, J.M. and Berry, D.P. (2007) Associations among body condition score, body weight, and reproductive performance in seasonal-calving dairy cattle. *Journal of Dairy Science*, 90: 376 – 391.

Siatka, K., Sawa, A., Czopek, S.K., Piwczyński, D. and Bogucki, M. (2017) Effect of Some Factors on Number of Services per Conception in Dairy Cows. *Journal of Veterinary Science and Technology*, 8: 465.

Soydan, C. and Kuran, M. (2017). Calving season and reproductive performance of dairy cows, *Mljekarstvo,* 67 (4): 297 – 304.

SPSS (2017). IBM SPSS version 25 for windows. IBM SPSS Corporation 2017.

Tawah, C.L. and Rege, J.E.O. (2006) White Fulani (and Sokoto Gudali) Cattle of *West and Central African Agriculture,* 17: 127 – 166.

Vraspir, R. (2014). Effects of pubertal status and number of oestrous cycles prior to breeding in beef heifers, average daily gain on reproductive performance and comparison of two fixed time A I estrus synchronization protocols. A Thesis in the Department of Animal Science, University of Nebraska. NE.

Walker, J., Perry, G. and Rusche, W. (2013). Influence of Body Condition on Reproductive Performance of Beef Cows, I Grow, A Service of SDSU Extension. Retrieved May 26, 2018 from https://igrow.org/up/resources/02-2000-2013.pdf.

Whittier, J.C., Berardinnelli, J. and Anderson, L. (2008). Understanding Post-partum Anestrus and Puberty. Retrieved October 30, 2017 from http://www.appliedre prostrategies. com/2008/pdfs/02d_whittier.pdf.

Zurek, K. (2018). Confirmed Results of the 2018 Referendum on new regions. *Graphic Online*. Retrieved on December 28, 2018 from https://www.graphic.com.gh/news/politics/confirmed-results-of-the-2018-referendum-on-new-regions.html.