Trop Anim Health Prod (2009) 41:321–328
DOI 10.1007/s11250-008-9192-8

ORIGINAL PAPER

Comparative studies on growth traits of Sanga and Friesian-Sanga crossbred calves raised on natural pasture on the Accra Plains of Ghana

E. T. Sottie · K. A. Darfour-Oduro · S. A. Okantah

Accepted: 28 May 2008 / Published online: 13 June 2008

Abstract Data collected from 1993 to 2006 at the Animal Research Institute of Ghana was used to compare the performance of Sanga and Friesian-Sanga crossbred calves on natural pasture. Performance traits analyzed were birth weight (BWT), weaning weight adjusted to 210 days (WW7), preweaning average daily gain to 210 days (ADG 1), weight at 12 months adjusted to 365 days (W12), weight at 18 months adjusted to 540 days (W18) and postweaning average daily gain (ADG 2, from weaning to 540 days). Effects in the model describing these traits were breed, season, sex and first-order interactions between these effects. With the exception of heavier birth weight of Friesian-Sanga crossbred calves (19.98 kg vs. 19.18 kg), body weights of Sangas at weaning, 12 months and 18 months exceeded those of the Friesian-Sanga crossbred calves by 3.76 kg, 35.06 kg and 46.24 kg respectively. The Sangas were also superior in preweaning average daily gain (0.35 kg/day vs. 0.26 kg/day) and postweaning average daily gain (0.28 kg/day vs. 0.21 kg/day). There was a tendency of increasing weight difference between the two breeds with advancing age. It was suggested that improved nutrition such as supplementary feeding would be necessary for crossbreds to express their potential for growth.

E. T. Sottie (✉) · K. A. Darfour-Oduro · S. A. Okantah
CSIR-Animal Research Institute,
P.O. Box AH 20, Achimota, Ghana
e-mail: edsottie@yahoo.com

Keywords Accra Plains · Friesian-Sanga · Growth traits · Natural pasture · Sanga

Abbreviations

BWT	Birth weight
WW7	Weaning weight adjusted to 210 days
W12	Weight at 12 months adjusted to 365 days
W18	Weight at 18 months adjusted to 540 days
ADG1	Preweaning average daily gain to 210 days
ADG2	Postweaning average daily gain from weaning to 540 days
MoFA	Ministry of Food and Agriculture

Introduction

Milk produced in Ghana is almost entirely from cattle. However, Ghana is a net importer of dairy products (Okantah et al. 2005), an indication of the fact that indigenous cattle reared in Ghana are not able to meet the ever increasing demand of dairy products. The indigenous West African cattle, despite having the ability to withstand the hot humid climatic conditions, being resistant to the many tropical diseases and further having the ability to survive for long periods during feed and water shortage have slower growth rate and poor milk producing ability (Syrstad 1988 and Bosso 2006). Crossbreeding of the indigenous cattle with the temperate dairy breeds has been resorted to by most African countries, including

Ghana, to increase milk production and at the same time, retain the genes needed for survival in the harsh tropical environment and withstand some tropical diseases.

Towards the late 1980s, the Animal Research Institute of Ghana (ARI) embarked on series of crossbreeding involving exotic Friesian and local cattle to evolve a dual-purpose breed for meat and milk production by farmers on the Accra Plains. ARI set up two separate breeding herds of cattle consisting of the Sanga and Friesian-Sanga crossbreds respectively. The Ghanaian Sanga, a cross between a humped Zebu and humpless cattle such as the West African Shorthorn or the N'dama (Okantah 1990) is used for peri-urban milk production by private farmers. It is the predominant breed on the Accra Plains of Ghana where it represents 79 % of all cattle population (Okantah 1990). The Friesian is an exotic dairy breed used extensively in crossbreeding in the tropics (Ahunu et al. 1995). The cross between the Sanga and Friesian, like any other cross between an exotic and an indigenous breed, impacts body weight and growth rates through additive gene action and heterosis. Weaning weight also reflects the milking ability and mothering ability of the cow while pre- and post-weaning growth are important traits to select for in cattle (Magana and Segura-Correa 2006). There however seems to be a paucity of information on the body weights and gains of the Sanga and Friesian-Sanga crossbreds and the factors that affect these traits of these breeds.

The objective of this work was to compare body weights and average daily gains of Sanga and Friesian-Sanga crossbred cattle on the Accra Plains raised on natural pasture without any form of feed supplementation.

Materials and methods

Breed formation

In 1967, the Ministry of Food and Agriculture, Ghana (MoFA) imported 100 in-calf Friesian heifers and 20 Friesian bulls from the United Kingdom to form a nucleus dairy farm, Amrahia Dairy Farm on the Accra Plains. This was followed by importation of 400 Friesian cattle from Holland, 200 each in 1974 and 1976. The initial stock of Friesians imported was said to be for investigation purposes, no emphasis was placed on obtaining pedigree, registered or recorded stock. The exploratory phase was devoted to survivability and maintenance of fertility status. Some of these animals survived and acclimatized.

In 1989, Animal Research Institute sent 10 Sanga cows to the Amrahia Dairy Farm of MoFA where they were kept and mated with the acclimatized Friesian bulls. Subsequently imported Friesian semen was used to inseminate Sanga cattle. The F1 progeny were inter-mated at the Katamanso Station of ARI to produce the cross breed.

Location and management of cattle herds

The study was based on data on body weight records of two herds of cattle comprising the Sanga and Friesian-Sanga crossbred kept at the Katamanso Station of Animal Research Institute. The area has a bimodal rainfall pattern with a wet season occurring from April to October and dry period spanning November to March. Annual rainfall ranges between 600-1000 mm and temperature 20°C to 34°C (Okantah 1990).

The cattle were housed in open kraals and only the calves had roofing. The two breeds in this study were kept in separate kraals to prevent them from mating with each other. Cattle were grazed from 5.00 hrs to 10.00 hrs and 13.00 hrs to 16.00 hrs daily on natural pastures. Animals were not given any supplementary feed. *Panicum maximum*, *Sporobolus pyramidalis* and *Vertiveria fulvibarbis* constitutes the dominant grass species in the grazing area while thickets (mainly browse species) with *Griffonia simplicifolia*, *Baphia nitida* and *Milletia thoningii* were present (Oddoye et al. 2002). The crude protein content of grasses in this area is about 3 to 4 per cent DM during the dry season and about 10 per cent DM during the rainy season with digestibility of 53 per cent (Sottie et al. 1998). The browse species have crude protein values ranging between 12 to 22 per cent DM with digestibility ranging between 52 to 78 per cent (Sottie et al. 1998; Fleischer et al. 2000). Water was provided twice daily; morning and afternoon. The animals were treated against ecto-parasites mainly ticks, fleas and mange mites using a pour-on parasiticide (Flumethrin 1 % m/v) once a month during the dry season and fortnightly in the wet season and against endo-parasites using an anti-helminth, Albendazole 10 % once a month during the dry season and fortnightly in

Table 1 Analysis of Variance for preweaning growth traits of calves

Source of variation	d.f.	Mean square BWT	Mean square WW7	Mean square ADG1
Breed	1	40.12	556.73	0.37
Season	1	26.26	787.26	0.05
Sex	1	2.29	1730.58*	0.61
Breed X Season	1	22.09	1.13	0.19
Breed X Sex	1	79.50*	348.56	0.04
Season X Sex	1	15.86	241.43	0.43
Error BWT	340	10.40		
WW7	243		397.08	
ADG 1	243			0.29

BWT=birth weight, WW7=weaning weight, ADG1=preweaning average daily gain.

* Significant at ($p<0.05$)

the wet season. They were treated against diseases as the need arose and vaccinated against Contagious Bovine Pleuropneumonia (CBPP) once a year.

Data collection and statistical analysis

Data were taken from calf weight record books from 1993 to 2006. For each calf, records included breed, sex, dates and weights from birth till animal was sold or died. Calves were weighed monthly after birth. Parameters analyzed were calf birth weight (BWT), weaning weight adjusted to 210 days (WW7), preweaning average daily gain to 210 days (ADG1), weight at 12 months adjusted to 365 days (W12), weight at 18 months adjusted to 540 days (W18) and postweaning average daily gain (ADG2, from weaning to 540 days). Monthly live weight values were regressed on corresponding ages to obtain growth rates.

After eliminating records on calves with missing birth dates and sex, there were birth records on 347 calves, 250 records on calves that survived up to weaning. These were used for analysis on preweaning average daily gain and weaning weight. There were 160 records available for analysis on body weight at 12 months and 81 records for analysis on postweaning average daily gain and weight at 18 months.

Two seasons were defined based on monthly rainfall distribution: dry (November to March) and wet (April to October). The data were analyzed using the Generalized Linear Model (GLM) procedure of SAS (1999). Differences among means of a trait for different factors were analyzed by PDIFF/SAS. The statistical model for the traits was as follows:

$$Y_{ijk1} = U + B_i + S_j + C_k + (BS)_{ij} + (BC)_{ik} + (SC)_{jk} + e_{ijk1}$$

Table 2 Analysis of Variance for postweanimg growth traits of calves

Source of variation	d.f.	Mean square W12	Mean square W18	Mean square ADG2
Breed	1	29450.85*	13480.22*	0.0371*
Season	1	16020.04*	1646.83	0.0265*
Sex	1	6172.19	4538.12	0.0173
Breed X Season	1	117.37	978.73	0.0038
Breed X Sex	1	2017.33	140.65	0.0009
Season X Sex	1	8155.10*	8162.43*	0.0161
Error W12	153	1903.47		
W18	74		1500.04	
ADG 2	74			0.0066

W12=weight at 12 months, W18=weight at 18 months, ADG2=postweaning average daily gain.

* Significant at ($p<0.05$)

Where:

Y_{ijkl} is the individual observation of body weight at a given age, preweaning average daily gain and postweaning average daily gain.
B_i is the effect of the ith breed.
S_j is the effect of the jth season.
C_k is the effect of the kth sex.
$(BS)_{ij}$ is the interaction between breed and season
$(BC)_{ik}$ is the interaction between breed and sex.
$(SC)_{jk}$ is the interaction between season and sex.
e_{ijkl} is the random error term associated with each observation.

Results were considered statistically significant when $p<0.05$.

Results

Mean squares and tests of significance for the main effects and interactions among the effects are presented in Tables 1 and 2. Least square means and their standard errors for breed, season, sex and interactions among these main effects are shown in Table 3 for birth weight, weaning weight and preweaning average daily gain. Table 4 shows the weights at 12 months and 18 months and postweaning average daily gain.

Breed

All post-weaning traits considered in this study were significantly influenced by breed of animal (Fig. 1)

Table 3 Least squares means ($\bar{x}$) and standard errors (SE) for breed, season, sex and their interactions effects on preweaning growth traits of calves

Effect		n	BWT (kg) $\bar{X}\pm$ SE	n	WW7 (kg) $\bar{X}\pm$ SE	n	ADG1 (kg/day) $\bar{X}\pm$ SE
Overall		347	19.58±0.18	250	83.61±1.27	250	0.32±0.03
Breed							
F/Sanga		135	19.98±0.34	91	80.09±2.76	91	0.26±0.07
Sanga		212	19.18±0.23	159	83.85±1.66	159	0.35±0.04
Season							
Wet		234	19.90±0.21	173	84.26±1.54	173	0.28±0.04
Dry		113	19.25±0.36	77	79.68±2.88	77	0.32±0.08
Sex							
Male		168	19.67±0.27	130	85.10[a]±1.95	130	0.36±0.05
Female		179	19.49±0.30	120	78.84[b]±2.46	120	0.24±0.07
Breed X	Season						
F/Sanga	Dry	28	19.35±0.62	17	77.71±5.01	17	0.24±0.14
F/Sanga	Wet	107	20.62±0.31	74	82.46±2.31	74	0.27±0.06
Sanga	Dry	85	19.15±0.35	60	81.65±2.65	60	0.41±0.07
Sanga	Wet	127	19.20±0.29	99	86.05±2.02	99	0.30±0.05
Breed X	Sex						
F/Sanga	F	65	20.40[a]±0.48	41	78.23±4.01	41	0.21±0.11
F/Sanga	M	70	19.57[ab]±0.43	50	81.94±3.19	50	0.30±0.09
Sanga	F	114	18.58[b]±0.32	79	79.44±2.47	79	0.28±0.07
Sanga	M	98	19.77[a]±0.33	80	88.26±2.23	80	0.42±0.06
Season X	Sex						
Dry	F	49	19.40±0.51	27	75.42±4.37	27	0.22±0.12
Dry	M	64	19.11±0.44	50	83.94±3.19	50	0.43±0.09
Wet	F	130	19.58±0.29	93	82.26±2.12	93	0.27±0.06
Wet	M	104	20.24±0.31	80	86.26±2.23	80	0.30±0.06

BWT=birth weight, WW7=weaning weight, ADG1=preweaning average daily gain.

Means not followed by common superscripts are significantly different.

[a,b] Rows within the same categories of effect on growth traits (column for interactions) showing different superscripts indicate statistical significance.

with estimated values from Table 4 indicating that Sangas outperformed the crossbreds in weight by 35.06 kg at 365 days and 46.24 kg at 540 days. Sanga calves also grew faster after weaning (0.28 kg/day vs. 0.21 kg/day).

Season

Season had significant effect on weight at 365 days and postweaning average daily gain with calves born in the wet season gaining more (180.27 kg vs. 152.11 kg; 0.28 kg/day vs. 0.21 kg/day) than those born in the dry season (Table 4).

Sex

Male calves were significantly heavier at weaning than the female (85.10 kg vs. 78.84 kg) as shown in Table 3. In all other traits, male and female calves were statistically similar.

Interactions

Breed by sex interaction significantly influenced birth weight with female Friesian-Sanga calves being significantly heavier than their Sanga counterparts (20.40 kg vs. 18.58 kg) (Table 3). Birthweights of

Table 4 Least squares means ($\bar{x}$) and standard errors (SE) for breed, season, sex and their interactions effects on postweaning growth traits of calves

Effect		n	W12 (kg) $\overline{X}$±SE	n	W18 (kg) ±SE	n	ADG2 (kg/day) ±SE
Overall		160	180.98±3.72	81	208.49±5.11	81	0.27±0.01
Breed							
F/Sanga		51	148.66^{b}±7.99	19	169.65^{b}±14.54	19	0.21^{b}±0.03
Sanga		109	183.72^{a}±4.74	62	215.89^{a}±5.10	62	0.28^{a}±0.01
Season							
Wet		113	180.27^{a}±4.31	51	200.85±5.95	51	0.28^{a}±0.01
Dry		47	152.11^{b}±8.67	30	184.69±14.21	30	0.21^{b}±0.03
Sex							
Male		87	174.43±5.26	43	202.68±9.09	43	0.26±0.02
Female		73	157.95±7.80	38	182.87±10.03	38	0.22±0.02
Breed X	Season						
F/Sanga	Dry	11	133.45±14.54	2	167.8±27.39	2	0.19±0.06
F/Sanga	Wet	40	163.87±6.93	17	171.51±9.78	17	0.23±0.02
Sanga	Dry	36	170.77±7.99	28	201.59±7.62	28	0.24±0.02
Sanga	Wet	73	196.67±5.12	34	230.20±6.82	34	0.33±0.01
Breed X	Sex						
F/Sanga	F	24	144.45±12.29	7	161.44±18.30	7	0.18±0.04
F/Sanga	M	27	152.87±8.81	12	177.87±16.94	12	0.23±0.04
Sanga	F	49	171.44±7.54	31	204.30±7.41	31	0.27±0.01
Sanga	M	60	196.00±5.68	31	227.49±7.04	31	0.30±0.01
Season X	Sex						
Wet	F	61	180.83^{a}±5.80	27	202.22^{a}±8.85	27	0.27±0.02
Wet	M	52	179.70^{a}±6.33	24	199.48^{ab}±7.93	24	0.28±0.02
Dry	F	12	135.06^{b}±14.19	11	163.51^{b}±17.11	11	0.18±0.04
Dry	M	35	169.16^{a}±8.27	19	205.87^{a}±16.25	19	0.25±0.03

W12=weight at 12 months, W18=weight at 18 months, ADG2=postweaning average daily gain.

Means not followed by common superscripts are significantly different.

a,b Rows within the same categories of effect on growth traits (column for interactions) showing different superscripts indicate statistical significance.

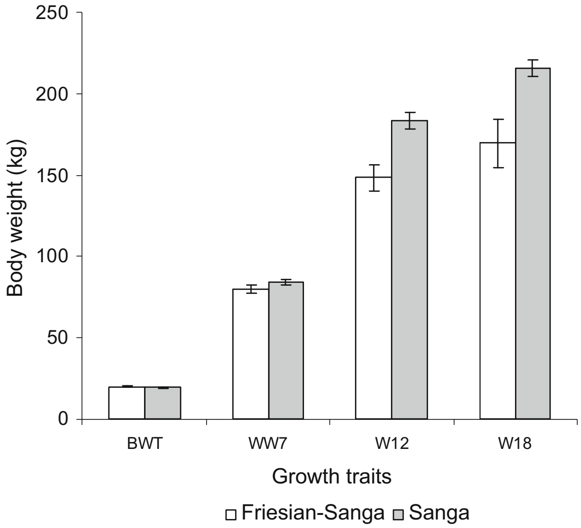

Fig. 1 Body weights of Friesian-Sanga and Sanga calves at birth (BWT), weaning weight (WW7), weight at 12 months (W12) and weight at 18 months (W18) months

male Sanga calves were significantly heavier than their female counterparts (19.77 kg vs. 18.58 kg) as presented in Table 3.

Weights at 365 days and 540 days were significantly influenced by season by sex interaction. Male calves born in the dry season were significantly heavier at 365 days (169.16 kg vs. 135.06 kg) and 540 days (205.87 kg vs. 163.51 kg) than female calves (Table 4). In the wet season however, weights at 365 days and 540 days for the two sexes were statistically similar.

Discussion

Breed

The significantly higher W12, W18 and ADG2 of the Sanga as compared with the Friesian-Sanga could be due to the fact that the Sanga cattle were more adapted to the Accra Plains than the Friesian crossbreds and therefore better able to utilize the feed resources available on the natural pastures. It is also likely that the feed resources available on the natural pastures alone were not adequate to provide the feed required by the Friesian-Sanga. Unlike the Sanga, the Friesian-Sanga crossbreds have not had such a long time to adapt to tropical diseases and this can militate against their growth. Friesian-Sanga calves could also have succumbed to the heat stress characteristic of the Accra Plains resulting in inferior postweaning growth performance as compared with the Sanga counterparts. Heat stress has been reported to affect cattle breeds on the Accra Plains Okantah et al. (1993). Aboagye (2002) attributed the primary cause of heat stress on the Accra Plains to high relative humidities and high ambient temperatures. The poor nutrition (grazing only) and high ambient temperatures might have contributed in restricting the performance of the high potential crossbred genotype. It is known that genotype environment interactions occur when genotypes are poorly matched with the (nutritional) environment (Okantah and Curran 1982). According to Mamah (personal communication), the Friesian-Sanga involved in this study tend to eat less as compared with their Sanga counterparts when hot conditions prevail, a situation that has necessitated the planting of shady trees at the Institute where the animals are kept.

Season

The effect of season on calf body weights and growth is related to the availability of feed (Okantah and Curran 1982). The non significant effect of season on preweaning traits involved in this study is in agreement with observations made by Oddoye et al. (1999) on birth weight and preweaning average daily gain of Sanga. In contrast however, Okantah (1990) reported significant effect of season on birth weight of Sanga calves. Milk produced by dams to nourish their calves could have been enough to offset seasonal differences in preweaning traits of calves involved in this study. The significantly heavier weight of animals born in the wet season at 12 months compared with their dry season counterparts could be attributed to the presence of abundant high quality grazing material during the wet season. Postweaning average daily gain of 0.28 kg/day for calves born in the wet season was the same as the preweaning average daily gain (Tables 3 and 4). A uniform growth pattern was therefore observed for calves born in the wet season. Ahunu and Grieve (1980) also observed a uniform growth pattern for calves born in the wet season from birth to 24 months. However, calves born in the dry season did not have a uniform growth pattern. The preweaning average daily gain of 0.32 kg/day was higher than the postweaning average daily gain of 0.21 kg/day.

Sex

The non significant effect of sex on birth weight in this study is in agreement with observations by Diack et al. (2004) and Bosso (2006). That males were significantly heavier at weaning than females but differences between male and female weights at 12 months and 18 months were not significant could be due to the sale of fast growing males right after weaning. This is the cattle management practice at the Institute, hence the possibility of the records of fast growing males not being included in this study.

Interactions

The non significant effect of breed by season interaction on pre- and post-weaning traits in this study indicates that both breeds are responding in the same way to the effects of season. That breed by sex interaction significantly affected birth weights in this study is in agreement with observations made by Chase et al. (2004) on some crossbred calves in the subtropics. The generalization that males are heavier than females at birth is confirmed by the significantly lower Sanga females' birth weight as compared with their male counterparts.

Female calves born in the dry season have lower weights at 12 months and 18 months than their male counterparts. Season by sex interaction effect on W12 and W18 was due in part to a very large difference in weights between male and female calves born in the dry season as compared with the difference observed for their counterparts born in the wet season. Female animals at these ages were adversely affected more by the mature and less digestible pastures in the dry season than their male counterparts. Supplemental feeding of animals in the dry season will have to be tested to verify whether it will have any effect on this interaction.

Conclusion

The development of the Friesian-Sanga cattle with the potential of surviving the harsh tropical environment holds a promise for the cattle industry in Ghana. Under a management system of improved nutrition, the Friesian-Sanga cattle is likely to improve the meat and milk production of cattle farmers on the Accra Plains of Ghana. This has economic implications for cattle farmers in Ghana, in that it will enhance their productivity and cause more meat and milk to be produced.

It is recommended that further studies be carried out on the productivity of the Friesian-Sanga and Sanga cattle when given feed supplements.

Acknowledgements The authors wish to thank all the members of the Ruminant Production Division of Animal Research Institute, Ghana and particularly Messrs A. Mamah, A. Alhassan and S.A. Quaye for their assistance in collecting data for this study.

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