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Growth Performance at Weaning of Borgou Cattle in Northern Benin

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Abstract: This study focused on the analysis of birth weight (BW), weaning weight (WW), weaning age (WA) and average daily gain (ADG) between birth and weaning of 950 Borgou cattle using data over five years from the Okpara Breeding Farm. The BW, WW, and ADG of animals including 513 males calves and 437 females calves were determined based on the variation factors. A general linear model (GLM) was used to determine the effects of the factors of variation: sex, season of birth, calving number, year of birth, and birth park. The weaning age of animals was also considered as a factor in order to determine its influence on WW and ADG. The results showed that the average weaning age of Borgou cattle was 392.49 ± 71.51 days. The weaning age had an effect on weaning weight and ADG of the animals. The BW and WW ranged from 16.11 ± 0.20 kg to 22.28 ± 0.20 kg and from 107.80 ± 2.50 kg to 125.46 ± 1.17 kg, respectively. As for the ADG, it varied between 212.06 ± 7.56 kg and 330.78 ± 6.47 kg. The sex, birth season, calving number, and park influenced birth weight, the weaning weight, and the average daily gain. The year influenced the weaning weight and the ADG ($p<0.001$) but had no effect on birth weight ($p>0.001$). Male calves showed higher weaning weights and daily weight gains than female calves ($p<0.05$). Animals born during the transition period between the rainy season and the dry season were heavier ($p<0.05$). Animals from 6th calving number had the best birth weights, the best weaning weights and the best ADGs ($p<0.05$).
Keywords: Growth, Weaning, Borgou, Okpara.

INTRODUCTION

To increase the production of meat from cattle breeding, it is essential to focus on the knowledge of the growth potential of the breeds. In Benin, the Borgou breed is known to be the most representative of the cattle breeds. It accounts for 88% of the total cattle population [1]. According to Domingo [1], this breed comes from a stabilized cross between the shorthorn taurines from West Africa (Somba or lagune) and the Zebu White Fulani. According to this same author, the dominant coat of the Borgou breed is white or gray, sometimes black, the extremities are usually black (muzzle, vulva, hollow of the ear, eyebrow and hoof). Doko [3] later proved its trypanotolerance. Since then, several research studies have been carried out to describe the zootechnical performances of this breed as well in rural areas [4, 5] as in ranch [6, 7, 1, 8, 9, 10]. However, data including in particular the growth of Borgou calves are very fragmentary. Thus, the works describing the growth performance of the Borgou breed are based essentially on the determination of the specific age weights and does not take into account the weaning age of this breed. In the field of cattle breeding, the performances recorded before weaning have a very important economic interest because, as part of a genetic improvement, they intervene directly in the establishment of the selection criteria [11]. This study is part of a series of studies on the characterization of the zootechnical potential of the Borgou breed in Benin. Fixed-day weaning involves a difference on weaning ages for all the weaned animals and therefore, description of growth performance should include weaning age of animals. The study presents the weaning growth performance of this breed at the Okpara Breeding Farm (OBF), taking into account the factors of variation likely to influence these performances.

MATERIALS AND METHODS

Study area

The studies were conducted in the Okpara breeding farm (2 ° 39 'and 2 ° 53' East longitude, 9 ° 6 'and 9 ° 21' North latitude) in the Republic of Benin. The climate is tropical with alternating rainy season (June to September) and dry season (December to March). The transition from one season to another is marked by a transition period (April to May and October to November). The annual average rainfall

varies between 857.9 and 1400.1 mm, of which about 1124.85 mm recorded during 1999 to 2014. Average temperatures (25.3 and 30.5 ° C) vary very little during the year: high in March and April, low in December and January.

Animal's management

The conduct of the animals was performed as described by Alkoiret *et al.* [10].

Feeding and watering

From 9a.m to 7p.m animals are conducted on rangelands and artificial grasslands, which composition and evolution of nutritional value vary depending on the season. Grasses dominate the herbaceous layer and are consumed at various stages of development. The artificial grasslands are constituted of *Brachiaria ruziziensis*, *Stylosanthes sp.* and *Andropogon gayanus*. *Brachiaria ruziziensis* is used as ensilage or hay whereas *Stylosanthes sp*. is used for silage. The old plots of artificial grassland are open to growing farms. Approximately 8 to 10 tons of dry matter as dietary supplements (hay, silage and cottonseed cake) are stored in millstones and placed at the disposal of animals in two adjacent parks. Crop residues (maize, sorghum, millet, and cotton) and fodder wood are also used for feeding. Water, lick stone and occasionally cooking salt are given ad libitum. The water comes from the water catchments, the Okpara River and its tributaries.

Health and prophylactic measures

The animals are regularly subjected to preventive care of deworming, external deworming to dipping tank, administration of vitamins, trace elements and trypanocide. The national program of prophylaxis in the Republic of Benin against major epizootics (pasteurellosis, contagious bovine pleuropneumonia, anthrax) is of force on the farm. The treatments are systematic against occasional diseases. Screening for brucellosis is organized once a year according to the National Veterinary Laboratory. Traps and screens are used to reduce the pressure of tsetse and other vectors. Two matings are organized annually [6]: those from January to February in anticipation of births in October-November, and from August to October for those of June-July. However, births outside these four months are recorded. The partial milking is manual and is done twice a day (morning and evening) by the drover.

Cattle weaning method

Animals are ear-marked since birth and weighed within 24 hours of birth. At the date of weaning, the animals are again weighed before being randomly alloted within sex groups. Thus, animals have different ages at the weaning date. For the period from 2013 to 2017, ten (10) weaning dates were recorded. These weanings occur in the months of June (year 2013), July (years 2013, 2014, 2015, 2016 and 2017), and October (years 2014, 2015, 2016 and 2017).

DATA COLLECTION

The analyzed data come from the records of the Okpara Breeding Farm. These data include the dates of birth, weaning dates, parks, calving numbers, birth weights and weaning weight. The data are spread over five (05) years (from 2013 to 2017). The weaning age (WA) and the average daily gain (ADG) were recorded from birth records of calves born between 2013 and 2017 at the OBF. Data were classified by sex, birth season, calving number, year, park, and weaning age. The weaning age (WA) of the animals was determined by the difference (in number of days) between the weaning date and the date of birth of each animal. The average daily gain was calculated by the ratio (WW-BW) / WA.

STATISTICAL ANALYSIS

The following general linear model was ajusted to the data to test the effect of the fixed variation factors using the R.3.4.3 software (R Core Team, 2017) [12].

$$Y_{ijklmpn} = \mu + A_i + B_j + C_k + D_l + E_m + F_p + e_{ijklmpn}$$

$Y_{ijklmpn}$: is the performance of the n^{th} calf of sex *i*, born in season *j*, during year *k*, having calving number *l*, of park *m* and having age *p* at weaning;
μ: is the value of the overall mean
A*i*: is the fixed effect of sex *i* (male and female)
B_j: is the effect of the season of birth. The data are spread over four seasons: S1, from December to February (dry season); S2, from March to May (transition between the dry season and the rainy season); S3, June to August (rainy season); S4, from September to November (transition between the rainy season and the dry season);
C_k is the effect of the year of birth of the animal (*k*= 2013, 2014, 2015, 2016 and 2017);
D_l is the effect of the calving number (*l* = 1, 2, 3, 4, 5, 6 and 7);
E_m is the effect of the birth park (m= P1…P12);
F_p is the fixed effect of the weaning age of the animal;
$e_{ijklmpn}$ is the residual effect.

The various variation factors used were submitted to Fisher's test to determine their effects on birth weight, weaning weight and ADG. The SNK test (Student-Newman-Keuls) was used for the comparison of means. The values are presented as Least squares means ± SE on the tables.

RESULTS

Effects of variation factors on birth weight and weaning weight in Borgou cattle

The effects of variation factors (sex, season, year, calving number and park) on birth weight and weaning weight are presented in table 1.

Effects of sex on birth weight and weaning weight

The analysis of the table shows that sex had a significant effect on birth weight and weaning weight ($p<0.01$) of animals. Male calves showed better performances for birth weights and weaning weight ($p<0.05$).

Effect of birth season on birth weight and weaning weight

The birth season had a significant effect on animal birth weights ($p<0.05$) and weaning weights ($p<0.001$).

Table-1: Influence of Variation Factors on Birth Weights and Weaning Weights

Factors	Birth Weights (BW)	Weaning Weights (WW)
Sex	**	**
Male (n=513)	18.70 ± 0,08^{a}	119,64 ± 1.05^{a}
Female (n=437)	18,24 ± 0,08^{b}	113.22 ± 1.05^{b}
Season	*	***
S1 (n=142)	18.35 ± 0,13^{b}	120,54 ± 1,57^{b}
S2 (n=193)	18.49 ± 0,12^{c}	124,84 ± 1,46^{a}
S3 (n=273)	18.32 ± 0,10^{b}	114,77 ± 1,19^{c}
S4 (n=342)	18.62 ± 0,09^{a}	107,89 ±1,11^{d}
Year	NS	***
2013 (n=206)	18.24 ± 0,12^{b}	110,31 ± 1,95^{b}
2014 (n=202)	17.90 ± 0,13^{d}	125,53 ± 1,88^{b}
2015 (n=270)	18.43 ± 0,10^{b}	119,46 ± 1,33^{a}
2016 (n=173)	18.55 ± 0,13^{c}	125,46 ± 1,17^{b}
2017 (n=99)	18.85 ± 0,17^{a}	116,12 ± 1,48^{c}
Calving number	***	***
R1 (n=60)	16.11 ± 0.20^{f}	107.80 ± 2.50^{d}
R2 (n=82)	17.37 ± 0.16^{d}	113.58 ± 2.04^{c}
R3 (n=82)	16.75 ± 0.16^{e}	112.04 ± 2.08^{cd}
R4 (n=302)	17.34 ± 0.09^{de}	117.89 ± 1.19^{b}
R5 (n=303)	19.07 ± 0.09^{c}	116.85 ± 1.16^{bc}
R6 (n=57)	22.28 ± 0.20^{a}	125.24 ± 2.59^{a}
R7 (n=64)	19.85 ± 0.18^{b}	111.31 ± 2.33^{c}
Park	**	***
P1 (n=64)	18.76 ± 0.22^{ab}	114.10 ± 2.77^{bc}
P2 (n=109)	18.25 ± 0.15^{de}	110.27 ± 1.90^{bc}
P3 (n=89)	18.79 ± 0.16^{a}	117.84 ± 2.00^{bc}
P4 (n=56)	18.68 ± 0.30^{ab}	106.47 ± 3.81^{cd}
P5 (n=61)	18.36 ± 0.17^{cd}	116.18 ± 2.15^{b}
P6 (n=98)	18.15 ± 0.15^{de}	110.58 ± 1.98^{bc}
P7 (n=92)	18.06 ± 0.14^{e}	108.08 ± 1.77^{bc}
P8 (n=64)	18.20 ± 0.21^{cde}	112.96 ± 2.64^{d}
P9 (n=91)	18.10 ± 0.20^{c}	121.67 ± 2.49^{b}
P10 (n=47)	18.62 ± 0.14^{bc}	120.42 ± 1.82^{b}
P11 (n=108)	18.72 ± 0.14^{ab}	130.84 ± 1.85^{a}
P12 (n=71)	18.04 ± 0.23^{e}	110.09 ± 2.88^{b}
Weaning Age (392.49 ± 71.51days)		***

The values on the same column followed by different superscripts are significantly different ($p<0.05$); * ($p<0.05$); ** ($p<0.01$); *** ($p<0.001$); S1 - December to March (dry season); S2 - April to May (transition dry season - rainy season); S3 - June to September (rainy season); S4 - October to November (transition rainy season - dry season); R1…R7= calving number; P1…P12=parks

Animals born during the transition period between the rainy season and the dry season (S4) were heavier ($p<0.05$) than animals born during the other seasons followed by animals born during the transition period between the dry season and the rainy season. The effect of the season showed no significant difference ($p>0.05$) for birth weight between animals born in the dry season (S1) and those born during the rainy season (S3).

Animal weaning weights were significantly different between seasons. Animals born during the transition period between the dry season and the rainy season (S2) showed the highest weaning weights (124.84 ± 1.46kg) followed by animals born during the dry season (S1). The lowest weights (107.89 ± 1.11 kg) were recorded in animals born during the transition period between the rainy season and the dry season (S4).

Effect of birth year on birth weight and weaning weight

The birth year influenced very significantly ($p<0.001$) the birth weight and the weaning weight. Birth weights were higher for the year 2017 and lower for the year 2014. These weights were not significantly different for the years 2013 and 2015 ($p>0.05$) but were different from those of 2014, 2016 and 2017 ($P <0.05$). The effect of birth year showed that the weaning weights of animals born in 2015 had higher weaning weight ($p<0.05$). On the other hand, significant differences were not observed between weaning weights for animals born in 2013, 2014 and 2016 ($p>0.05$).

Effect of calving number on birth weight and weaning weight

The calving number has a very significant effect on birth weight and weaning weight ($p<0.001$). The heaviest animals at birth are those from the 6th calving number followed by animals from the 7th calving number. Animals from the first calving number had the lowest birth weights. No significant difference was observed between the birth weights of the animals from the 3rd and 4th calving number ($p>0.05$). Similarly, birth weights between animals from the 2nd calving number and those from the 4th row were not significantly different ($p>0.05$). The most significant weaning weights were recorded in animals from the 6th calving followed by those of 4th calving number. Animals from first calving had the lowest weights at weaning. However, no significant difference was observed between the weaning weights of the 2nd, 3rd, 5th and 7th calving number ($p> 0.05$). Similarly, weaning weights of animals in the first, 3rd calving number were not significantly different ($p>0.05$).

Park effect on birth weight and weaning weight

The park has a significant effect on birth weight ($p<0.01$) and also on weaning weight of animals ($p<0.001$). Birth weight varied by park in general. The highest birth weights are recorded in the park P3 and the lowest in the park P7. However, differences in birth weight were not significant between Parks 11, P1, P10, P3 and P4 ($p>0.05$) as well as between birth weights recorded in parks P12. , P2, P6, P7 and P8 ($p>0.05$). For weaning weight, the parks P11 and P9 presented the heaviest animals at weaning. Differences in weaning weight of animals born in the P9, P10, P12, P5, P3, P6, P2, P1 and P7 were not significant($p>0.05$).

Influence of variation factors on average daily gain

The effects of variation factors on the average daily gain of cattle are presented in Table 2.

Influence of sex on the average daily gain

Sex had a significant effect on animals' average daily gain ($p<0.001$). Male calves showed better performance compared to female ($p<0.05$).

Influence of the season on the average daily gain

The analysis of the table shows that the season had a very significant effect on the average daily gain of the animals ($p<0.001$). The highest ADGs were recorded in animals born in the dry season (S1). Animals born during the transition period between the dry season and the rainy season (S2) and those born during the rainy season (S3) had the lowest ADGs. No significant difference was observed between the ADGs of these two periods ($p>0.05$). Animals born during the transition period between the rainy season and the dry season (S4) presented intermediate ADGs.

Influence of the year of birth on the average daily gain

The ADG of animals has not increased as the years have changed. It was higher for animals born on the year 2015 and lower for those of 2017. Significant differences were not observed between the weight gains for those of years 2013, 2014, and 2016 ($p>0.05$).

Influence of calving number on average daily gain

The calving number had a highly significant effect on the average daily gain of the animals ($P <0.001$). Animals from 6th calving number had the highest ADGs (301.63 ± 9.06g/d). Variations were observed for the ADGs presented by calves from other calving numbers, but they are not statistically different from each other.

Influence of the park on average daily gain

The grouping park had a very significant effect on the ADG of the animals ($p<0.001$). However, it was the park P11 that presented animals with higher ADGs. The ADGs of animals born in parks P10, P2, P3, P4, P5, P6 and P7 were not significantly different ($p>0.05$) and the lowest ADGs were recorded in animals born in Park P1 and P8.

Table-2: Influence of Variation Factors on average daily gain (ADG)

Factors	Average daily gain (ADG)
Sex	***
Male (n=513)	257.90 ± 3,69[a]
Female (n=437)	241.99 ± 3.69[b]
Season	***
S1 (n=142)	270.37 ± 5,72[a]
S2 (n=193)	232.85 ± 5,35[c]
S3 (n=273)	242.10 ± 4,47[c]
S4 (n=342)	254.46 ± 4,04[b]
Year	***
2013 (n=206)	250.83 ± 5.47[b]
2014 (n=202)	262.61 ± 5.71[b]
2015 (n=270)	271.92 ± 4,49[a]
2016 (n=173)	252.30 ± 5.67[b]
2017 (n=99)	212.06 ± 7.56[c]
Calving number	***
R1 (n=60)	232.51 ± 8.73[b]
R2 (n=82)	248.48 ± 7.13[b]
R3 (n=82)	239.32 ± 7.28[b]
R4 (n=302)	242.62 ± 4.17[b]
R5 (n=303)	251.39 ± 4.06[b]
R6 (n=57)	301.63 ± 9.06[a]
R7 (n=64)	233.65 ± 8.13[b]
Park	***
P1 (n=64)	235.22 ± 9.66[d]
P2 (n=109)	245.45 ± 6.63[bcd]
P3 (n=89)	255.90 ± 6.99[bc]
P4 (n=56)	222.60 ± 13.28[bcd]
P5 (n=61)	257.00 ± 7.50[bc]
P6 (n=98)	242.47 ± 6.93[bcd]
P7 (n=92)	239.11 ± 6.20[bcd]
P8 (n=64)	233.23 ± 9.22[d]
P9 (n=91)	258.21 ± 8.70[b]
P10 (n=47)	257.76 ± 6.35[bc]
P11 (n=108)	330.78 ± 6.47[a]
P12 (n=71)	221.60 ± 10.05[cd]
Weaning Age (392.49 ± 71.51days)	***

The values on the same column followed by different superscripts are significantly different (p <0.05); * (p <0.05); ** (p<0.01); *** (p <0.001); S1 - December to March (dry season); S2 - April to May (transition dry season - rainy season); S3 - June to September (rainy season); S4 - October to November (transition rainy season - dry season); R1…R7= calving number; P1…P12=parks

DISCUSSION

Some studies have focused on the study of the weight performances of Borgou cattle in Benin. These studies often take into account the effects of variation factors on specific weights to characterize calf growth. The birth weights obtained in this study are congruent to those reported by Youssao *et al*. [6] and Alkoiret *et al.* [10] on the same breed. The Borgou breed has higher birth weights than those reported for the N'Dama bull breeds [11, 13, 10]; Lagune [14, 15]; Namchi [16]; Kapsiki [17]. These performances remain lower than those of Akou Zebu Njoya *et al*. [18]; Arab zebu [18, 19], Goudali [18, 16, 20]; Mbororo [18]; Azawak [21]. The analysis of the results showed the superiority of male calves compared to female when regarding the birth weights; weaning weights and average daily gain. This dominance of males on females at birth is due to a genetic difference [22]. Similar results showing the superiority of males to females have been reported by Njoya *et al*. [18]; Youssao *et al*. [6]; Gbangboché *et al*. [15]; Ouedraogo [23]; Koussou *et al*. [19]. The effect of sex has also been observed in the Lagune bull Gbangboché *et al*. [15]; N'Dama [24]; the Arab zebu [19], the Boran zebu [25]; Gudali and Wakwa [26, 20].

In this study, the birth season significantly influenced all the growth parameters. The best performances for birth weight during the transition

period between the rainy season and the dry season (S4) may due to the fact that mothers have gone through periods of forage abundance before calving. For weaning weight, it decreased gradually as the transition between seasons occurs. Animals born in S2 were heavier at weaning. This may be due to the fact that they have maintained their superiority over the others. The effect of the season was also reported in the work of Youssao *et al*. [6] on the Borgou breed, those of Ezanno *et al*. [27] on N'Dama, Alkoiret *et al*. [10] on the Borgou and N'Dama breeds.

Birth weights, weaning weights and average daily gain were significantly influenced by the year but did not follow a gradual evolution following the evolution of the years in this study. This could be due to the different feeding conditions of the animals according to the evolution of time, by the climatic effects on the animals, the conditions of pasture driving. Youssao *et al*. [6], Ebangi *et al*. [16], Gbangboché *et al*. [15], and Mouslim *et al*. [28] also noted that the year has a significant influence on the growth of animals.

This study revealed that the calving number had a very significant effect on the birth weights, weaning weights and average daily gain of Borgou cattle. A study by Mouslim *et al*. [27] also showed that calving number had an influence on the birth weight of *Santa Gertrudis* calves in Morocco. N'joya [18] also showed that calving number had an influence on the birth weight of calves in Cameroon.

The weaning weight and the average daily gain of the animals were significantly influenced by the weaning age of the animals. The average weaning age of Borgou cattle is lower than that of Lagune cattle in Benin (472.26 ± 16.46 days) reported by Gbangboché *et al*. [15]. The works of Gbangboché *et al*. [15] and Ebangi *et al*. [17] and Assogba *et al*. [29] also show that weaning age influences the growth parameters of Lagune and Goudali cattle, respectively. This result could be due to the fact that the heavier animals at birth maintained this superiority until weaning.

CONCLUSION

This study allows characterizing the growth potential of Borgou cattle at weaning at the Okpara Breeding Farm in northern Benin. The study showed that the factors studied (sex, birth season, birth year, calving number, park, and weaning age) showed their influence on the growth parameters of the animals. Males showed better growth performance than females for birth weights, weaning, and for average daily gain. The weaning age observed in this study shows considerable variation for all the animals considered. Further studies should be carried out by defining fixed weaning ages for Borgou cattle to determine the optimum age at which this breed has the best weight gain while having a relatively short weaning age.

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