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Comparison of growth and milk production performances of the Borgou breed to those of the crossbreeds Gir - Borgou and Girolando - Borgou at the Okpara Breeding Farm in Benin

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Abstract

Benin is deficient in the meat products production because of the low productivity of the local breeds in general and of the cattle in particular. This study aims to improve the production of milk and meat of the Borgou breed by crossing with the exotic breeds Gir and Girolando at the Okpara breeding farm. For this, semen from exotic breeds was used to inseminate 355 Borgou cows and births were recorded. Data were collected on 280 calves for growth performance and on 55 cows for crossbreeds' milk production. The study found that the average weights of crossbreed calves are greater than the average weight of the Borgou calves at the standard age. At 12 months of age, the Borgou weight (101.93 kg) was significantly lower ($p < 0.01$) than those of the Gir-Borgou (171.25 kg) and Girolando-Borgou (175 kg) crossbreeds. However, no significant difference was observed between the 12-month weights of the two crossbreeds. From 0 to 12 months of age, the average daily gain of Gir × Borgou (473.97 g/d) and Girolando × Borgou (488.63 g/d) were higher ($p < 0.001$) than that of the Borgou breed (234.88 g/d). The average daily milk production was 1.25 liters, 6.80 liters and 4.40 liters, respectively for the Borgou breeds and the Gir-Borgou and Girolando-Borgou crossbreeds. The crossing has improved the growth and production performances of the Borgou breed.

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Introduction

Benin has eight agro-ecological zones and its economy is mainly based on the rural sector, which occupy more than 70% of the population. Its agricultural production covers 39% of the Gross Domestic Product (GDP). The livestock counts 2,166,000 of cattle, 1,716,000 of goats, 860,000 of sheep, 414,000 of pigs and 18,198,000 of poultry and represents 16.67% of the agricultural GDP in 2013 (Country Stat, 2016). Its contribution to Benin's food production is estimated to 23,431,000 tons of meat and offal, 12,522 tons of eggs and mostly 107,310 liters of milk per year (Country Stat, 2016). Despite the size of the national livestock, Benin milk and meat production doesn't cover the population expressed needs and this deficit is made up by imports.

In 2014, the volume of imported milk was 229,831 tons and that of meat was 281,394 tons (INSAE, 2014). For this external dependence limitation, national production must be increased, hence the Benin State's will to modernize breeding systems. To achieve this, the Livestock Development Project (Phase III), carried out from 2000 to 2006, has introduced the Girolando dairy cows at Kpinnou Breeding Farm in order to increase the country milk production level (Alkoiret *et al.,* 2011; Doko *et al.,* 2012; Kassa *et al.,* 2016a). The Okpara Breeding Farm, for its part, has been specialized on the genetic improvement of the Borgou breed by selection and crossbreeding with exotic breeds Gir, Girolando and Holstein. The objectives which motivated the choice of this breed were the improvement of growth and milk production performances. In order to reach these objectives, it has been set up a selection scheme that gave the expected results (Youssao *et al*., 2009).

The crossbreeding had the same objectives as the selection. For its implementation, semen from exotic breeds Gir, Girolando and Holstein was used to inseminate Borgou cows at Okpara Breeding Farm.This study aims to evaluate the growth performances and the milk production of the Gir - Borgou and Girolando - Borgou crossbreeds and to compare them with those of the Borgou breed.

Materials and methods

Area of study

The Okpara Breeding Farm is located in the Department of Borgou, township of Tchaourou, District of Kika (2°39-2°53 East longitude and 9°6 - 9°21 North latitude). It is located on the East of Parakou at 15 km from the township and covers an area of 33,000 hectares of which about 10,000 are actually exploited. The climatic is of sudanian type characterized by a succession of a rainy season (May to October) and a dry season (November to April). Average rainfall is 1125 mm per year and the average annual temperatures varies between 26°C and 27°C. On December 31st, 2016, the cattle population of the farm was 709, including 493 Borgou, 85 crossbreed Gir × Borgou, 1 crossbreed Girolando × Borgou, 85 Girolando, 02 crossbreed Holstein × Borgou, 34 Azawak and 10 crossbreed Azawak × Borgou. The relief is made of a crystalline peneplain which has hills with very hard rocks. There are large depressions that foster rainwater mobilization toward Okpara's river and its tributary the Dama. The soil texture is sandy, sandy clay or limous in some places and supports a savanna vegetation dominated by *Andropogongayanus*.

Breeding management

Cattle of the Okpara Breeding Farm are reared under a semi-improved system. The monitoring of the cattle is assured by Peuhl cowherds led by a team leader. Animals are housed in cowshed constructed of final materials with a tiled roof and concreted floors and in night parks with mangers and watering places. They are separated by age class and sex. Feeding is based on natural pastures (*Andropogongayanus, Leucaena leucocephala and Stylosantes sp*.), artificial grasslands (*Panicum maximum C1, Brachiaria ruziziensis, Aeschynomene histrix*), food supplements and minerals. In the dry season, animals glean their food on natural rangelands, artificial grasslands and in harvest fields where they eat crop residues made of maize straw, cotton residues, groundnut and cowpea tops. In this season, they also recourse to forest grazing such as *Khaya senegalensis, Afzelia africana, Pterocarpus erinaceus* and forage reserves (hay and

ensilage). Animals are conducted to pasture during the day. When returned in the evening, they are enclosed in a cowshed or in a park where they receive water and salt lick *ad libitum*. Lactating cows receive in addition food supplements (cottonseed meal, Veto feed, crop residues). The Veto food is composed of rice bran, cereals residues, cotton seed and palm meals, BHT (hydroxytoluene butylate: food additive), amino acids, limestone and dicalcium phosphate.This food is formulated by a Beninese public limited company, Veto Services. In the bromatological plan, this complement is composed of protein matter (10%), fats (0.9%), calcium (0.8%), phosphate (0.5%) and starch (8.5%). Calves less than four months old and weak animals are kept in the park and graze around. Animals' watering is mainly provided by a water tower and two water reservoirs. Reproduction is mainly based on organized coitus. Animals are split in herds. Each herd is composed of reproductive females (25 in average) and one reproductive male. The Livestock Development Project (Phase III) had set a genetic improvement plan based on selection and crossbreeding. The crossbreeding consisted mainly in insemination of Borgou females with imported semen.

The health prophylaxis used respects hygienic rules of and is made of daily washing of the watering places and mangers and daily sweeping of the stalling parks and cowshed. The medical prophylaxis plan is characterized by: a) external deworming in a deeping tank monthly in the rainy season and twice the month in the dry season; b) internal deworming done three times the year; however in a case of diarrhea, the concerned animal is automatically dewormed ; c) trypano-prevention every two to three months with Tripadim® (Diminazene Diaceturate) or Tripamidium® (Isometamidium Chloride) produced by the MERIAL laboratory (France); d) vitamin therapy by administering VETOQUINOL stress vitam (vitamins A, D3, E, B1, B6, B5, B3, choline chloride, lysine hydrochloride, glycine); e) vaccinations against foot-and-mouth disease (at the beginning of the dry season), pasteurellosis (at the beginning and at the end of the rainy season) and bovine contagious pleuropneumonia (at the end of the rainy season). Vaccines used are respectively Aftovax, Pastovax or Pastobov and Perivax. Specific treatments are made against occasional diseases depending on the detected clinical cases.

Methodology

For the Artificial insemination, 355 Borgou cows were used as reproductive animals. The semen used was from Gir and Girolando breeds and was stored in liquid nitrogen at -196 °C to preserve their quality. Data were collected on 105 Gir × Borgou calves, 85 Girolodando × Borgou calves from inseminated cows and on 90 Borgou calves born in the same period. During the experiment, artificial insemination was done on natural or induced estrus.

The feeding of inseminated cows was based on natural and artificial pasture as described in the above breeding management. These cows are taken to the pasture by a cowherd. They left in the mornings at 9 am and returned in the evenings, at 5 pm. When arrived from pasture, inseminated cows received each per day in average 2 kg of cotton seed or Veto Service provender in supplementation. The mineral supplementation was made of salt lick distributed constantly and as desired. The health monitoring of cows was identical to that described above in the breeding mode.

Crossbreed and Borgou calves were weighed first at birth and after once a month during the first 12 months to assess their performances. In order to better exteriorize their growth performances, these calves received each daily, from one and a half months of age, in average 1 kg of cottonseed meal or vet service provender for cattle in supplementation. The mineral supplementation was made of salt lick constantly distributed and as desired. In terms of health monitoring, all the monitored calves have benefited of external deworming (in a deeping tank), internal deworming, trypanosomiasis treatments, vaccinations (notably against pasteurellosis and bovine contagious pleuropneumonia) and vitamin supplement following a firm health calendar. Their

also received some punctual cares. These interventions have ensured the survival and the good health to most of them.

Data collecting

Data were collected from animal performances records for the period of 2002-2016 at the Okpara Breeding Farm. For weight performances, these data were collected from 105 Gir × Borgou calves, 85 Girolodando × Borgou calves born from inseminated cows and 90 Borgou calves born during the same period. The collected variables were: birth weight and monthly weights from birth to 12 months of age.

The average daily gains were calculated for the periods of 0 to 3 months (ADG30), of 3 to 6 months (ADG63), of 6 to 9 months (ADG96), of 9 to 12 months (ADG129) and of birth to 12 months age (ADG120). For the milk production, data records were consulted for the same period as for the calves. In total, data on milk were collected from 20 Borgou, 20 Girolando × Borgou and 15 Gir × Borgou breeds during the first three months of lactation. For each cow, the quantity of milk collected was measured using a graduated cylinder and recorded on a data collecting sheet.

Statistical analysis

The Statistical Analysis System (SAS, 2013) software was used for the statistical analysis. For the birth weight, the monthly weights and the average daily gain of calves, a variance analysis with two classification factors was performed and the variation sources were the genetic type (Borgou, Gir × Borgou and Girolando × Borgou) and the sex (male and female).

Means of weights and of average daily gain were compared pairwise by the student t test. For milk production, averages were calculated by genetic type and compared pairwise by the student t test.

Results

Weight performances

The Fig. 1 shows the growth curve of Borgou calves and of crossbreeds Gir × Borgou and Girolando × Borgou.

Table 1. Milk production of cattle breeds Borgou, Gir × Borgou and Girolando × Borgou.

Cattle breeds	Milk production per day and per cow	
	Mean (liter)	Standard deviation
Borgou	1.25c	0.31
Gir - Borgou	6.80a	2.30
Girolando - Borgou	4.40b	2.51

Means of the same colon followed by different letters are significantly different at 5%.

The average weight of Borgou calves increased from 18.12 kg at birth to 101.93 kg at 12 months of age. The average weights of the crossbreed calves are higher than the one of the Borgou calves born during the same period. Indeed, the average weight of the Gir × Borgou crossbreeds increased from 19 kg to 171.25 kg and that of Girolando × Borgou crossbreeds from 19.15 kg to 175 kg.

From birth to 12 months of age, the average weight of the crossbreeds (Gir × Borgou and Girolando × Borgou) was higher than that of the Borgou. In the first two months and between the 4th and the 5th months, there was no significant difference between the average weight of the crossbreeds Gir × Borgou and the one of the Girolando × Borgou. This same observation was made in the 7th month and from there, the growth curve of the Girolando × Borgou crossbreeds is clearly above that of the Gir ×Borgoucrossbreeds.

The average weight of the Girolando × Borgou was significantly higher than that of the Gir × Borgou from the 7th month to the 12th month of age. During

this period the average weight of Gir × Borgou calves increased from 112.25 kg to 171.25 kg while that of Girolando × Borgou increased from 113.75 kg to 175 kg.

The Fig. 2 shows the weight evolution of crossbreeds and of Borgou calves by sex. From birth to 12 months of age, the average weight of Borgou males remained higher than that of females. Indeed, the average weight increased from 18.36 kg to 102.75 kg in the males, against from 17.87 kg to 101.11 kg in the females. However, this difference was not remarkable during the first 6 months so that during this period the curves seem to be mixed up.

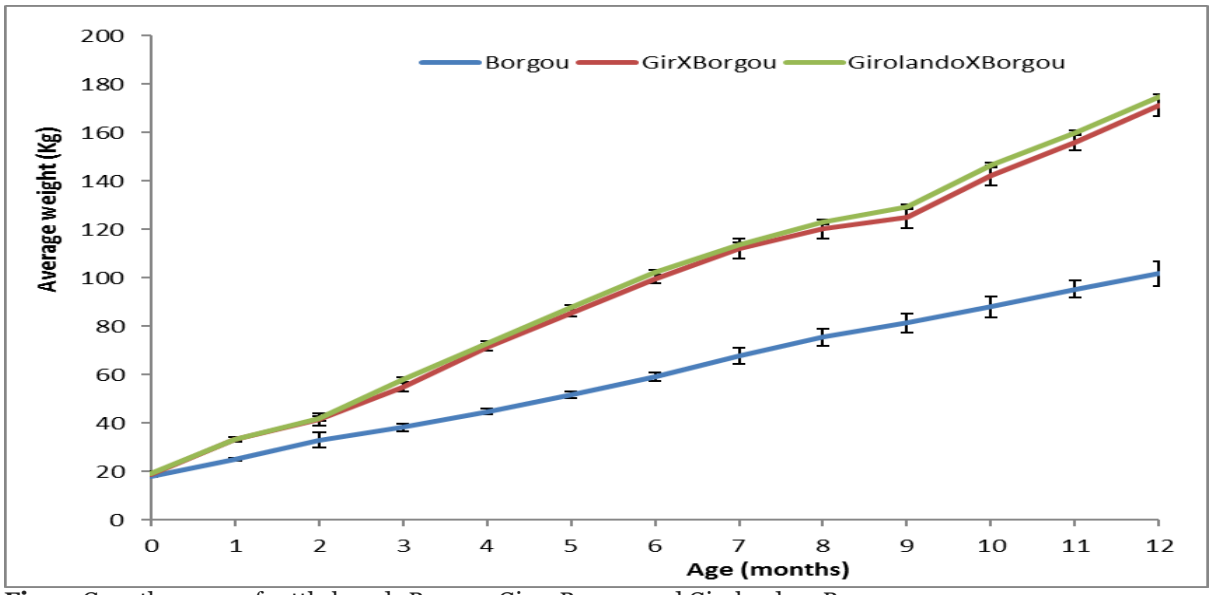


Fig. 1. Growth curves of cattle breeds Borgou, Gir × Borgou and Girolando × Borgou.

It was only from the 7th month that the male curve has been clearly above that of the females. Thus, going from the 7th month, the average weight of males was significantly higher than that of females. Concerning the Gir × Borgou crossbreeds, the average weight of males was also higher than that of females. The average weight of males increased from 19.25 kg to 180 kg, while that of females increased from 18.75 kg to 162.5 kg. Among the Girolando × Borgou, it was from the 10th month going that this superiority was observed; during the first 10 months, the difference in weight between males and females was not significant.

From birth to 12 months of age, the female Girolando xBorgou growth curve was above that of Gir × Borgou females. The average weight of the Girolando × Borgou females was significantly higher than that of the Gir × Borgou females and it was only from the 7th month that this difference was significant. From this month, the average weight increased from 113 kg to 172 kg with the Girolando × Borgou whereas it increased from 112 kg to 162.50 kg with the other.

The growth curves of males crossbreed calves are mixed up; there is no significant difference between the average weight of the males Gir × Borgou and Girolando × Borgou.

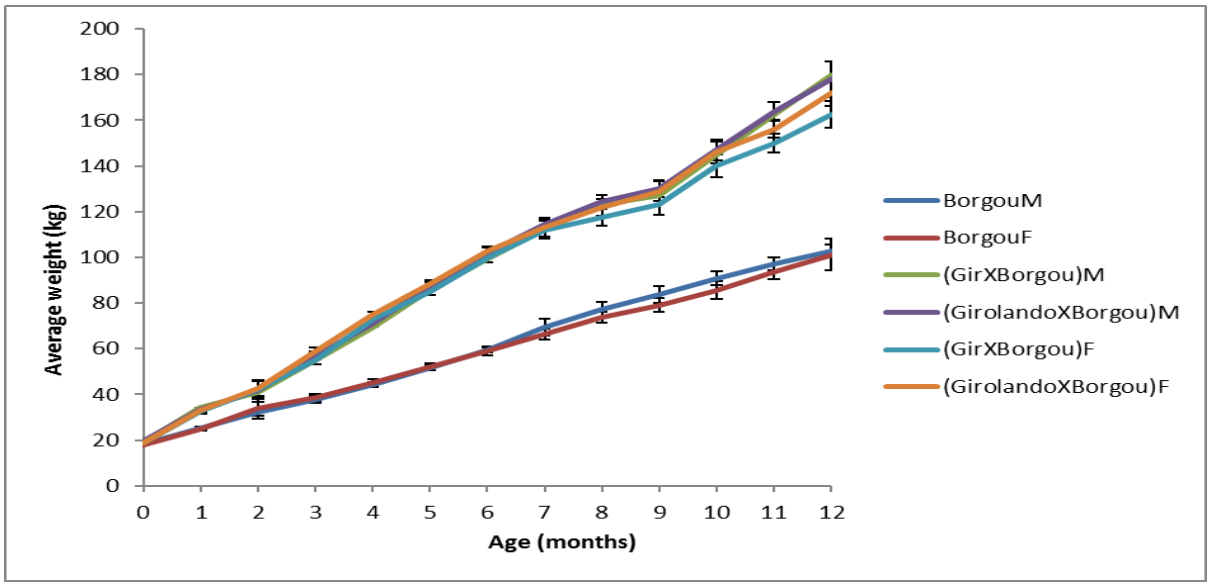
During the first 3 months, the ADG of crossbreeds was significantly higher ($p<0.05$) than that of the Borgou calves (Fig. 3). There was no significant difference between the crossbreeds ADG. The same observation is made for ADG63, ADG129. From the 6th to the 9th month, the Girolando × Borgou ADG was significantly higher than that of the Borgou and no significant difference was observed between the ADG of the Borgou and that of the Gir × Borgou.

From 0 to 12 months of age, the ADG was 234.88 g/d for the Borgou calves, 473.97 g/d for the Gir × Borgou crossbreeds and 488.63 g/d for the Girolando ×

Borgou crossbreeds. The crossbreeds ADG was significantly higher than the one of the Borgou. However, there was no significant difference between the ADG of the cross Gir × Borgou and the cross Girolando × Borgou. The Fig. 3 shows the average daily gains (ADG) of the cattle breeds Borgou, Gir × Borgou and Girolando × Borgou by classes of ages.

Milk production

The milk production of the Borgou breed and of the Gir × Borgou and Girolando × Borgou crossbreeds was evaluated at the Okpara Breeding Farm (Table 1). The daily production was 1.25 ± 0.31 liters in the Borgou breed.



M :Mâle F : Femelle

Fig. 2. Growth curves of cattle breeds Borgou, Gir × Borgou and Girolando × Borgou by sex.

It was 6.80 ± 2.3 liters with the Gir-Borgou cows and 4.40 ± 2.5 liters with the Girolando-Borgou crossbreeds. The disadvantage of these crossbreeds is their fragility facing diseases as the dermatosis which influences the lactating cows' production.

Discussion

Weight performances

The weight performances have varied according to the genetic type and this variation is from genetic origin and not related to environmental factors because all the animals were reared under the same conditions (feeding, health monitoring, etc.). In the Borgou breed, the birth weight of Borgou (18.12kg) in the present study is similar to the one (18.24kg) recorded by Youssao *et al.* (2009) at the same farm. On the contrary, at 12 months, the Borgou bull-calves weigh 101.93kg, against 112.84 kg reported by Youssao *et al.* (2009). The weight of the crossbreeds from these different crossing is higher than that of the Borgou. However, at birth, there was no significant difference between these different genetic types, and it was only from the first month that the differences appeared.

The average weight of the cross Girolando × Borgou (19.5 kg) at birth is lower than that of the Girolando (26 kg) recorded by Alassane (2015) at the Kpinnou breeding farm. It was also the same thing for the 12-month weight, which is 175 kg for the crossbreeds and 209 to 228 kg for the Girolando (Toukourou and Senou, 2010; Alassane*et al.*, 2017). This value of the crossbreeds is higher than the half-sum of the two parental breeds, the Girololando being reared under the same conditions as the crossbreeds and the Borgou. This superiority can be explained by the heterosis effect. Heterosis is the expression of the genotype of individuals of the first generation (F1) born from individuals of different breeds. It is generally higher than the half-sum (average) of the parental genotype values, contrary to what would occur if there was a simple addition of characters.

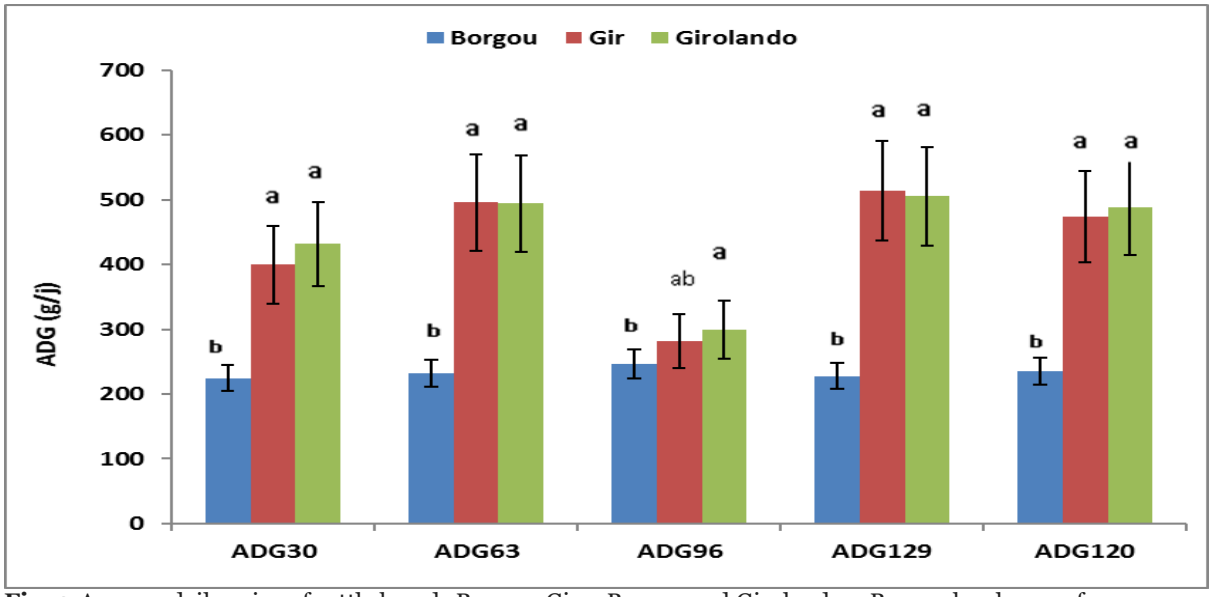


Fig. 3. Average daily gains of cattle breeds Borgou, Gir × Borgou and Girolando × Borgou by classes of age.
ADGij = Average daily gain from jth month to ith month; the average daily gain between classes followed by the different letters differ significantly at the threshold of 5%.

The heterosis is explained by the fact that the crossing reduces the frequency of homozygous alleles (pair of identical genes) and increases the number of heterozygous alleles. As a result, most of the recessive, unfavorable traits are masked by dominant, favorable traits (Bouyer, 2006, Kassa *et al.*, 2016b). The average weight of the crossbreeds is therefore intermediate between that of their parents Borgou and Girolando. The crossings have therefore improved the weight of the descendants compared to the Borgou.

From 8 to 12 months of age, the weight of the Girolando × Borgou crossbreeds is higher than that of the Gir × Borgou crossbreeds, although this difference is not significant. The observation was the same for the weight at 12 months. These results are comparable to those obtained by Youssao *et al.* (2000) (19.0 kg for males and 18.3 kg for females at birth and 103.2 kg *vs* 98.9 kg at 12 months).

From 0 to 12 months of age, the ADG was 234.88 g/d for Borgou calves, which is lower than 259.17 g/d recorded by Youssao *et al.* (2009) at the same farm. It is also lower than 473.97 g/d for the cross Gir × Borgou and 488.63 g/d for the Girolando x Borgou crossbreeds recorded in the current study. The crossbreeds ADG120 is higher than 284.45 g/d recorded by Youssao *et al.* (2009), in selected Borgou calves. Comparing the ADG of the crossbreeds with that of the selected Borgou calves, the gap is very large. Even with a rigorous selection on Borgou cattle for years on several generations, an ADG of 400g/d can't be observed while the crossing has permit to reach this threshold in one generation. The crossing has therefore accelerated the genetic progress.

Milk production

The cross Gir-Borgou have a higher milk production than the Girolando-Borgou. All these crossbreeds have a better production than the Borgou breed. The superiority of the milk production of the Gir × Borgou to the one of the Girolando × Borgou is due to the adaptation. Indeed, the Girolando breed came from the crossing between the Gir breed and the European breed Holstein. Due to the presence of Holstein blood in its genetic heritage, it can't have the same resistance and the same adaptability to the environment like the Gir breed which is from India, a tropical region. The Gir × Borgou crossbreeds will be more resistant to diseases and will adapt better to the farm conditions than the Girolando × Borgou crossbreeds. This adaptation difficulty is the cause of the low milk production of Girolando reared in pure-

bred under Benin climate. In this breed, the average milk collected was 5.32 liters/day for cows that calved during the long rainy season, 4.72 liters/day for cows that calved in the long dry season and 4.31 liters/day for those which calved in short rainy season (Kassa *et al.*, 2016a). The milk production of Girolando isn't therefore different from that of crossbreeds because of the pathologies that this breed faces. Almost all of Girolando cattle in Benin have been infested by ticks and particularly by the *Rhipicephalus microplus* species. Other pathologies were: lumpy skin disease characterized by the appearance of nodules on the skin, Trypanosomiasis and streptothricosis with respective herd frequencies of 30.10%, 7.77% and 3.88% (Kassa *et al.*, 2016a). In the 34 lactating cows, diseases that specifically affect milk production were: mastitis characterized by a visible inflammation of the udder (3.88%), agalactia (1.94%) and milk fever (3.88%) (Kassa *et al.*, 2016a).

Conclusion

This study has permitted to evaluate the growth performance and milk production of the Borgou breed to those of the Gir - Borgou and Girolando - Borgou crossbreeds at the Okpara breeding farm. The crossbreeds have a better growth than the one of the Borgou breed reared under the same conditions. The growth curve of the Girolando × Borgou females is above that of the Gir × Borgou females and the growth curves of the crossbreed calves males are mixed up. The Gir-Borgou crossbreeds have a higher milk production than the Girolando-Borgou. All these crossbreeds have a better production than that of the Borgou breed. The crossing has improved the growth and production performances of the Borgou breed.

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