Research Article

Herd Features in Borgou Cattle Farming Systems in North Benin

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Abstract |Preventing animal genetic resources from genetic erosion implies taking into account their demographic aspects within farming systems with the view to facilitate the interpretation and understanding of livestock systems based on events likely to occur. The aim of this study is to evaluate demographic traits in four Borgou cattle farming systems previously identified in northern Benin using the 12MO retrospective cross-sectional survey method. The results showed that females were dominant (>65%) in "semi-intensive purebred Borgou cattle farming" (SIntPur), "large transhumant of Zebu and Borgou crossbred cattle farming" (LargeZB) and "small transhumant of Zebu and Borgou crossbred cattle farming" (SmallZB) conversely to "sedentary purebred Borgou cattle farming" (SedPur) with less than 20%. SIntPur and SedPur herds presented the best reproduction parameters: higher prolificacy rates (0.967±0.017 and 0.913±0.060 year^{-1} respectively) and parturition rates (0.710±0.049 and 0.685±0.062 year^{-1} respectively). Intake rates were higher in SedPur herds ($p<0.05$). Offtake rates were higher in LargeZB and SmallZB herds (0.055±0.009 and 0.096±0.028 year^{-1} respectively). Regarding Global Demographic Indicators, SedPur herds showed higher multiplication rate (1.392 year^{-1}±0.201). Production rates were higher and positive in SedPur (0.444 year^{-1}±0.081) farms followed by SIntPur (0.202 year^{-1}±0.022) farms while lower and negative in LargeZB and SmallZB farms (-0.036 year^{-1}±0.005 and -0.040 year^{-1}±0.002 respectively). Growth rates were higher and positive in SIntPur (0.271 year^{-1}±0.028) farms followed by SedPur (0.022 year^{-1}±0.201) farms while lower and negative in LargeZB and SmallZB farms (-0.064 year^{-1}±0.013 and -0.032 year^{-1}±0.028 respectively).

Keywords | Demographics, 12MO, Rates, Exploitation, Borgou breed

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INTRODUCTION

Animal demography is an important component of the productivity of animal populations. In developing countries, collecting data in the field is perceived as a difficult task due to the dispersal and mobility of herds and the fact that pastoralists do not keep written records of their herds (Lesnoff, 2009). However, it is useful to be able to quantify this demography in the field according to the types of farms, for example to assess their productive potential (number of animals that can be capitalized or exploited by farmers each year) or the impact of a shock (epidemic, drought) or a technical innovation or for the orientation of political decisions and research programs. In Benin, reports pertaining to describe the functioning of cattle farms in rural areas are poorly available or are only found in old references (Dehoux and Hounsou-Vè, 1993). Thus, a renewed interest in our livestock systems is gradually manifested in the objective of better evaluating the areas and potential for improving cattle farms (Youssao et al., 2013; Chabi Toko et al., 2016; Worogo et al., 2019). In addition, data specific to animal demography in Benin

are only present in the report of Alkoiret et al. (2010) in State farm and those of Chabi Toko et al. (2016) in rural areas. With the view to provide a deep knowledge and promote community-based conservation strategies specific to the Borgou cattle breed, we initially attempted to perform a typological study in its area of origin (Worogo et al., 2019). Thus, the present study is initiated to determine and compare the demographic parameters of Borgou cattle farms based on the four types of farms initially identified in the typology. The first group represented semi-intensive Borgou cattle farming located on station at the Okpara Breeding Farm. The second group was represented by Bariba ethnic group using the Borgou cattle breed mainly for draught. As for the third group, it highlighted the large transhumant herds of Zebu combined with Borgou crossbreds. The last group was represented by the large transhumant herds of Zebu combined with Borgou crossbreds, using their animals for the production of milk and cheese. This study aims to bring out some standardized indicators useful in the description of the biological characteristics related to Borgou cattle farming systems.

METHODOLOGY

Data collection

The demographic traits of the Borgou cattle populations were determined on forty (40) herds (10 herds chosen randomly from each of the four types) identified in the communes of Kalalé, Nikki, Pèrèrè, Parakou, and Tchaourou located in the department of Borgou during the typology (Worogo et al., 2019). The first type was described as " *Semi-intensive purebred Borgou cattle farming* ". This type of cattle farming is characterized by a high number of animals (≥ 85 heads) and specializes in the improvement and conservation of the Borgou cattle breed. The second type identified was "*Sedentary purebred Borgou cattle farming*) with small numbers of cattle (≤ 22 heads). The farmers in this type mainly use this breed for draught purposes. The third type was represented by the " *Large transhumant of Zebu and Borgou crossbred cattle farming* " with large number (around 75 heads) of cattle made up of breeds such as Borgou, Azawak and Yakana. The last type was qualified as "*Small transhumant of Zebu and Borgou crossbred cattle farming*" with herds with medium herd size (around 30 heads). In this study, we have referred to the first group as "SIntPur", the second group as "SedPur", the third one as "LargeZB" and the last one as "SmallZB". These herds have a total number of 1873 heads. The animals were age verified based on dentition. We referred to the retrospective survey method for the last twelve months "12MO" developed by Lesnoff et al. (2013) for data collection in the herds and data were collected from May to June 2020.

12MO is a retrospective cross-sectional survey method used to estimate the demographic parameters for a given domestic ruminant herd (annual reproduction, mortality and exploitation rates). Like all retrospective methods based on the memory and declarations of farmers, 12MO consists of reconstructing the demography of the herd in the period of the last twelve months preceding the survey. The 12MO tool offers a complete chain going from the field protocol to the calculation of zootechnical parameters and has two sub-questionnaires (Q1 and Q2). The first one (Q1) is for collecting information on herd structure and reproduction data while Q2 allows to collect the various events that occurred in the herd during the last 12 months. Questions are asked to the farmer in the presence of his animals. These animals were listed for a certain number of basic data (such as breed, sex, age, etc.) as well as demographic events (births, deaths, sales, etc.) that occurred during the 12 last months.

Data processing and statistical analysis

The demographic parameters were calculated using the t12mo package of the 12MO tool under software R.4.0.2 (R Core Team, 2020). Three types of demographic parameters were estimated from the data collected (Lesnoff et al., 2013): i) variables describing the condition of the herd at the time of the survey (herd size, age classes according to sex); ii) annual demographic rates such as natural rates (parturition, abortion and mortality) and management rates (exploitation and import) and iii) overall demographic indicators highlighting the dynamics and productions of the herd over the 12 months (such as annual multiplication rate, annual growth rate and annual production rate). The non-parametric (Mann-Whitney U) test was used for comparison of means between herd types

RESULTS

Herd structure

The structure of the Borgou cattle populations in the herds surveyed is presented according to farm type in Table 1. With regard to females, farm type had a significant effect on all categories of female. The proportions of calves in SIntPur and SmallZB herds did not show any significant difference ($p>0.05$) but were greater than those of SedPur and LargeZB herds. The proportions of Heifers 1 were similar ($p>0.05$) when comparing SIntPur and LargeZB farms. These proportions were lower in SedPur and higher in Small ZB ($p>0.05$). As for the proportions of Heifers 2 and cows, they were similar and more important in SIntPur, LargeZB and SmallZB herds.

With regard to males, farming type also had a significant effect ($p<0.05$) on all categories in the herds surveyed. The proportion in male calves in LargeZB were lower (3.1%, $p<0.05$) than those of the other types. The proportions of

Table 1: Composition (Mean±SD) of Borgou cattle herds according to the types of farm

Animal category	SIntPur	SedPur	LargeZB	Small ZB	S
Female					
Female calf (0-1 year)	10±0.55^{a}	3.7±0.66^{b}	6.1±0.73^{b}	13.3±0.63^{a}	*
Heifer 1 (1-2 years)	13.7±1.12^{b}	3.6±0.49^{c}	12.4±0.61^{b}	20.1±0.54^{a}	*
Heifer 2 (2-4 years)	16.9±1.49^{a}	3±0.39^{b}	15±1.14^{a}	19.8±0.67^{a}	*
Cow (>4 years)	31±1.25^{a}	6.8±0.44^{c}	38.7±1.43^{a}	14.1±1.71^{b}	*
Total of females	71.6±1.92^{a}	17.1±1.16^{c}	72.2±1.36^{a}	66.3±1.84^{b}	*
Males					
Male calf (0-1 year)	7.5±0.5^{a}	7.2±0.29^{a}	3.1±0.27^{b}	7.4±0.30^{a}	*
Bull calf 1 (1-2 years)	6.7±0.40^{b}	12.3±0.39^{a}	5.7±0.62^{b}	10.2±0.62^{a}	*
Bull calf 2 (2-4 years)	6.7±0.94^{b}	40.8±0.50^{a}	10.6±0.61^{ab}	12.4±0.56^{a}	*
Bull (>4 years)	5.3±0.47^{c}	22.6±0.22^{a}	8.4±1.50^{b}	3.7±0.71^{c}	*
Total of males	28.4±1.15^{b}	82.9±0.84^{a}	27.8±2.90^{b}	33.7±1.01^{b}	*

a,b,c, the values on the same row with different letters are significantly different at 5%. SIntPur: Semi-intensive purebred Borgou cattle farming, SedPur: Sedentary purebred Borgou cattle farming, LargeZB: Large transhumant of Zebu and Borgou crossbred cattle farming, SmallZB: Small transhumant of Zebu and Borgou crossbred cattle farming. S: Significance. *: p<0.05

Table 2: Demographic rates (Instantaneous rate ± Standard Error) in Borgou cattle farms

Parameters (year^{-1})	SIntPur	SedPur	LargeZB	Small ZB	S
Natural rates					
Stillbirth rate	0.016±0.009^{c}	0.05±0.035^{c}	0.333±0.092^{a}	0.215±0.075^{b}	*
Overall mortality rate	0.015±0.003^{c}	0.101±0.016^{a}	0.060±0.004^{b}	0.094±0.012^{ab}	*
Abortion rate	0.016±0.004^{a}	0.012±0.012^{a}	0.025±0.003^{a}	0.026±0.011^{a}	NS
Parturition rate	0.710±0.049^{a}	0.685±0.062^{a}	0.067±0.008^{a}	0.622±0.068^{b}	*
Prolificacy rate	0.967±0.017^{a}	0.913±0.060^{a}	0.522±0.131^{b}	0.667±0.114^{a}	*
Management rates					
Offtake rate	0.039±0.0048^{b}	0.044±0.010^{b}	0.055±0.009^{ab}	0.096±0.028^{a}	*
Intake rate	0.074±0.0075^{b}	0.222±0.026^{a}	0.024±0.005^{b}	0.062±0.015^{b}	*

a,b,c, the values on the same row with different letters are significantly different at 5%. SIntPur: Semi-intensive purebred Borgou cattle farming, SedPur: Sedentary purebred Borgou cattle farming, LargeZB: Large transhumant of Zebu and Borgou crossbred cattle farming, SmallZB: Small transhumant of Zebu and Borgou crossbred cattle farming. S: Significance. NS: Non significant. *: p<0.05

Table 3: Demographic indicators (Instantaneous rate ± Standard Error) in Borgou cattle farms

Paramètres (year^{-1})	SIntPur	SedPur	LargeZB	Small ZB	S
Multiplication rate	1.271±0.028^{b}	1.392±0.201^{a}	0.935±0.013^{b}	0.967±0.028^{b}	*
Production rate	0.202±0.022^{b}	0.444±0.081^{a}	-0.036±0.005^{c}	-0.004±0.020^{c}	*
Growth rate	0.271±0.028^{a}	0.022±0.201^{b}	-0.064±0.013^{c}	-0.032±0.028^{c}	*

a,b,c, the values on the same row with different letters are significantly different at 5%. SIntPur: Semi-intensive purebred Borgou cattle farming, SedPur: Sedentary purebred Borgou cattle farming, LargeZB: Large transhumant of Zebu and Borgou crossbred cattle farming, SmallZB: Small transhumant of Zebu and Borgou crossbred cattle farming. S: Significance. *: p<0.05

Bull calf 1 were similar in SIntPur and LargeZB herds (p>0.05) but lower (p<0.05) than those of the other two types which presented similar proportions (p>0.05). As for the proportions of Bull calf 2, they were higher in SedPur herds followed by those of SmallZB herds. Finally, Bulls were less represented in SIntPur and SmallZB but more represented in SedPur followed by LargeZB.

Annual demographic parameters

These rates are displayed in Table 2. Herd type had a significant effect (p<0.05) on stillbirth rates, overall mortality rate, calving rate, prolificacy rate). Stillbirth rates were similar in SIntPur and SedPur herds while lower than those of the two other groups. Overall mortality rates were lower in SIntPur herds and higher in SedPur herds (p<0.05).

Prolificacy rates were better and similar between SIntPur, SedPur and SmallZB herds. Abortion rates were not significantly influenced by farming type ($p>0.05$). As for parturition rate, it was lower in SmallZB herds ($p<0.05$).

Management rates (Offtake rate and Intake rate) were also influenced by the type of farming ($p<0.05$). The Intake rates of SIntPur, LargeZB and Small ZB herds did not show any significant difference ($p>0.05$) but these rates were lower than that of SedPur. Offtake rates were higher in SmallZB herds and lower in SIntPur and SedPur herds.

Overall demographic indicators

Farming type significantly affected the overall demographic indicators of the herds ($p<0.05$) (Table 3). The multiplication rates were similar between SIntPur, LargeZB and SmallZB farms but higher in SedPur farms. The best production rates were observed in SIntPur and SedPur herds compared to those of LargeZB and SmallZB herds ($p<0.05$). The growth rate appeared to be higher in SIntPur farms followed by SedPur farms.

DISCUSSION

Herd composition

Herd structure (Corniaux et al., 2012) is considered to be a relevant indicator for studying farm dynamics while revealing the potential of the production tool. In this study, the composition of the animals varied according to farming type. Females are much more represented in SIntPur, LargeZB and Small ZB herds (around 70% of the herd composition) while SedPur herds have less than 20%. Conversely, SedPur farms have a higher proportion of males (>80%) compared to others (around 30%). This can be linked to the production objectives. In fact, animal-drawn cultivation is widely practiced by SedPur farmers and they generally use males to perform this task. In addition, farmers of the other types have more females to ensure the sustainability of their herds. In semi-intensive system, it is mainly by conservation objective that a high proportion of females is maintained, whereas in traditional environments, some authors (Dehoux & Hounsou-Vê, 1993; Youssao et al., 2000; Ezanno et al., 2002; Alkoiret et al., 2010) attribute this to the fact that the traditional farmers are interested in the size of their herd which represents their wealth and arouses their admiration and pride. Other authors from the West African zone (Akpa et al., 2012) argue that it is for milk production purposes that farmers keep a larger proportion of females. Considering the mobility aspect, it should be noted that herds prone to transhumance (LargeZB and SmallZB) showed a greater number of females compared to sedentary herds (SedPur). This is in accordance with the report of Sounon et al. (2019) who state that mobile herds have more females than sedentary herds.

Natural rates

Reproduction and mortality parameters constitute fundamental data in the characterization of the productivity of animal populations in extensive farming systems in tropical zones (Lesnoff, 2009). In our study, the mortality parameters in SIntPur and SedPur herds are significantly lower than those of LargeZB and SmallZB. These results could be explained by the farming methods used. In fact, SIntPur farmers practice semi-intensive mode farming with high numbers and benefit from more regular monitoring given the almost permanent presence of technicians and veterinary agents. SedPur farmers are all sedentary farmers with low numbers and have fewer females. LargeZB and SmallZB herds have larger numbers and are more prone to transhumance with health monitoring much more based on traditional medicine. Similar results have been reported by Dehoux and Hounsou vê (1993) who show that the various causes of mortality take their toll in transhumant herds than sedentary herds. This is strengthened in the reports of Assani et al. (2015) and Chabi Toko et al. (2016) who argued that herds more prone to transhumance are much more likely to register more animal losses given the importance of their movements.

The overall mortality rate recorded in our study (1.5±0.3%) is almost similar to that of Youssao et al. (2000) (1.2±0.5%) during the period 1994 to 1997 at the Okpara Breeding Farm but their calf mortality rate is higher. This can be explained by the improved conditions for treating herds in this system almost two decades later. On the other hand, in SedPur, LargeZB and SmallZB farms, the overall mortality rates are 10.1%; 6% and 9.4% respectively; and the stillbirth rates are 5% in SedPur herds; 33.3% and 21.5% in LargeZB and SmallZB herds respectively. As it can be noticed, these types are extensive farming systems. Thus, the mortality rates are certainly due to feed constraints and also uncontrolled mating leading to inbreeding in traditional livestock farming.

Herds of SIntPur and SedPur presented the best reproduction parameters. Such situation in SedPur herds could be explained by the fact that the numbers of herds in this farming system being small, they benefit from better care from herdsmen. SIntPur farms was distinguished by high prolificacy (96.7±1.7%), parturition (71±4.9%) and lowest abortion rate (0.6±0.4%). These rates may be justified by the fact that in the Okpara Breeding Farm, the reproduction is controlled and the matings are performed in a group way and females also benefit from an artificial insemination program. Based on a study of Borgou cattle at the Okpara farm by Youssao et al. (2000), the reproduction parameters are characterized by a calving interval of 441±75 days or 14.7±2.5 months, an age at first calving of

42.1±5 months. In SedPur, LargeZB and SmallZB (traditional farming), the abortion rates recorded in our study were 1.2%, 2.5% and 2.6% respectively. These rates are lower compared to those of Assani et al. (2015) in North Benin on transhumant herds entering the classified forest of the upper Alibori and also lower than those recorded by Alkoiret et al. (2011) in the Ouaké regions where abortion rates ranged from 5.36% to 9.75%. These differences may be attributed to the study zones, herd compositions. In addition, SmallZB herds exhibited lower calving rates compared to those of LargeZB. We attribute this to the fact that SmallZB herds are less mobile and benefit from fewer feed resources. This is supported by Chabi Toko et al. (2016) and Sounon et al. (2019) who argued that mobile herds have better calving rates since they are likely to benefit from better feeding by mobile farmers and their pastoral know-how, such as herd management on rangelands and night grazing.

Management rate

In this study, the offtake rate was higher in SmallZB farms and secondarily in LargeZB. These rates are lower in SIntPur and SedPur farms. These results bear witness to the fact that SmallZB farmers and LargeZB are more inclined to operations involving more accentuated animal exits (sale, donation, slaughter, loan, etc.). Farmers report that in offtake operations, males are the most exported category. This can be explained by their wish to meet needs at the level of their households given their practices (transhumance). In addition, the lower rates in the other types of farming (SIntPur and SedPur) may be justified by the fact that for SIntPur farmers, the objective is much more linked to the improvement and conservation of the Borgou breed while SedPur farmers mainly exploit the Borgou breed for draught purposes.

On the other hand, the intake rate was significantly higher in SedPur farms compared to the other types. This can be justified by their production objective. These farmers are much more interested in importing better-yielding animals in terms of draught power; therefore, the most imported animals are males. In fact, it is reported in this context that the exploitation of herds varies a lot according to the categories of livestock with a more accentuated sale of males already at their young age, while females are kept longer to ensure reproduction (Dehoux et Hounsou-Ve, 1993; Youssao et al., 2000; Alkoiret et al., 2010). Futhermore, it is also reported that management parameters are closely related to the size of the herd (Upton, 1986, Lybbert et al., 2004).

Global demographic indicators

In this study, the annual growth rates were positive for herds of SIntPur and SedPur and negative for herds of LargeZB and SmallZB. Note that multiplication rate superior to 1 (m>1) is considered to be positive (Lesnoff et al., 2013). These results mean that the exploitation of herds of LargeZB and Small ZB exceeds their reproductive capacities than those of SIntPur and SedPur on the one hand and the fact that the overall growth in the herds may be related to the production system on the other hand. The Multiplication rate of SIntPur approximates that of the riparian medium transhumant livestock (1.2 ± 0.01) while the Multiplication rate of SedPur recorded in this study approximates that of riparian small transhumant livestock (1.4 ± 0.03) reported by Assani et al. (2016) in the Classified Forest of Upper Alibori Supérieur in northern Benin. In addition, the Multiplication rates of SmallZB and LargeZB (although less than 1) are similar to those of national great transhumant livestock and cross-border transhumant when referring to the same authors. This shows that herds with a large transhumance character tend to have a lower multiplication rate. The Production rate obtained in our study for SIntPur are similar to those of riparian small transhumant livestock (0.208 ± 0.02) reported by Assani et al. (2016). On the other hand, the values recorded for LargeZB and SmallZB are lower than those of all types reported by these authors. But we note that the value obtained for SedPur in our study is greater than that (0.114 ± 0.01 to 0.208 ± 0.02) of all the types identified by Assani et al. (2016).

As for the Growth rate, the values obtained in our study in of SIntPur are greater than all those (0.142 ± 0.01 to 0.237 ± 0.02) reported on the types identified by Assani et al. (2016). On the other hand, all the values reported by these same authors for the four types of herds they identified are higher than those for the SedPur, LargeZB and SmallZB we identified. These differences in the Growth rate and Production rate parameters could be explained by the differences in herd composition and study areas.

However, we cannot generalize this trend given the fact that we do not have data relating to inter-annual variations of these parameters according to the type of system; the parameters being likely to vary from year to year (Ba et al., 2011; Lesnoff et al., 2013).

CONCLUSION

In short, this study on the demography of Borgou cattle farming systems in northern Benin has certainly provided a number of results on the functioning of farms. Semi-intensive systems and sedentary farms are distinguished by their appreciable reproduction parameters and lower mortality rates. On the other hand, large transhumant herders and small transhumants show higher exploitation rates and lower production rates on the farms. However, this study only covered a single year of follow-up, and herd de-

mographic parameters are likely to vary from year to year. On this, it would be necessary to extend the collection of data over several consecutive years to have more refined estimates and a better understanding of the dynamics of the different forms of exploitation.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

AUTHORS CONTRIBUTION

SHSW participated to project design, data collection, data analysis, drafted and revised the manuscript. EA and TLFO were involved in project design, data analysis and revised the manuscript. RI, ASA, CDAA and YI participated to data collection, data analysis and revised the manuscript. IT was involved in the project design, data analysis and revised this manuscript.

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