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Productivity of Lagoon Cattle Farms on the Islands of the Municipality of Sô-Ava in the South of Benin

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Abstract: This study, which examines the productivity of Lagoon cattle farms located on the islands at risk of flooding in the municipality of Sô-Ava in the Oueme river valley in southern Benin, took place between November and December 2016. It concerns 95 farms of bovine Lagoon distributed on the various islands of the Municipality. These operations have a total of 2496 head of Lagoon cattle herds. It aims to compare the demographic parameters obtained on the different islands during the last year and that of 2010 where the island experienced a flood. Data were collected from a 12-month retrospective survey (12MO). The annual demographic parameters (annual rate, calving, abortion, stillbirth, mortality, annual net growth, annual exploitation rate and annual rate of multiplication) were calculated and analyzed under software R3.3.2. Thanks to the t12mo package. Except for the mortality rate, there were no significant changes in reproductive rates ($p > 0.05$) regardless of the herd of residence of the herds. The annual mortality rate was significantly higher ($p < 0.05$) on the Dekanmey, Houedo and Sô-Ava islands compared to that of the Ahomey Lokpo island (0.124, 0.142, 0.113, vs 0.071an-1). The year had a significant effect on the demographic parameters ($p < 0.05$) as well as on the overall demographic indicators obtained. Implementation of a resilient model to climate shocks would be an incentive for the sustainable management of these farms.

Keywords: Productivity, Demographic parameters, Bovine Lagoon, Sô-Ava, Oueme

INTRODUCTION

In Africa south of the Sahara, livestock farming accounts for one-third of the value of agricultural production[18]. It is recognized that the livestock sector has the potential to make a significant contribution to the problems of food security, poverty and quality of life of small rural households in African countries [1, 2]. In Benin, this sector can contribute up to 44% of agricultural PIB and 12% of national PIB (APRM, 2011). The cattle breeding are much more developed in the northern part of the country, which is home to more than 70% of the national herd population [19]with a diversity of breeds such as the Borgou breed, the Goudali breed, the Somba breed and M'Bororo. In the regions of the center and more particular in the region of the valley of the River Ouémé in the south is also met the breeding of taurins Lagoon. The cattle breeding are quite developed around towns and villages in the fluvio-lacustrine area such as Sô-Ava, Dangbo and Abomey-Calavi, where it contributes 20% of the income of breeders. The herds of the farms in these regions are mainly made up of Lagoon breed taurins which offer remarkable adaptability to poor environmental conditions, in particular the presence of trypanosomiasis vector tsetse, which is one of the factors limiting the development of livestock. The present work aims to evaluate the demographic performances of these Lagoon cattle farms installed on the various islands at risk of seasonal flooding and flooding of the lake municipality of Sô-Ava.

MATERIAL AND METHOD

Study environment

Located in the southern part of Benin in the Atlantic department, the lakeside municipality of Sô-Ava is between 6 ° 24 'and 6 ° 38' north latitude and between 2 ° 27 'and 2 ° 30' longitude east. It occupies part of the lower valley of the river Oueme and the river Sô to which it owes its name. The municipality of Sô-Ava is limited: to the north by the municipalities of Zè and Adjohoun; to the south by the municipality of Cotonou; to the east by the lake municipalities of Aguégués and Dangbo and to the west by the municipality of Abomey-Calavi. The municipality of

Sô-Ava is organized in seven (07) Ilots which encompass 69 villages and covers an area of 218 km2 on which lives a population of 118,497 inhabitants with a density of about 544 inhabitants per km² (RGPH4, June 2013). It enjoys a humid tropical climate characterized by the alternation of two rainy seasons and two dry seasons. The great rainy season extends from March to July and the small one, from September to November. The average annual rainfall is 1200 mm. Temperatures range from a minimum of 22 ° C to a maximum of 33 ° C.

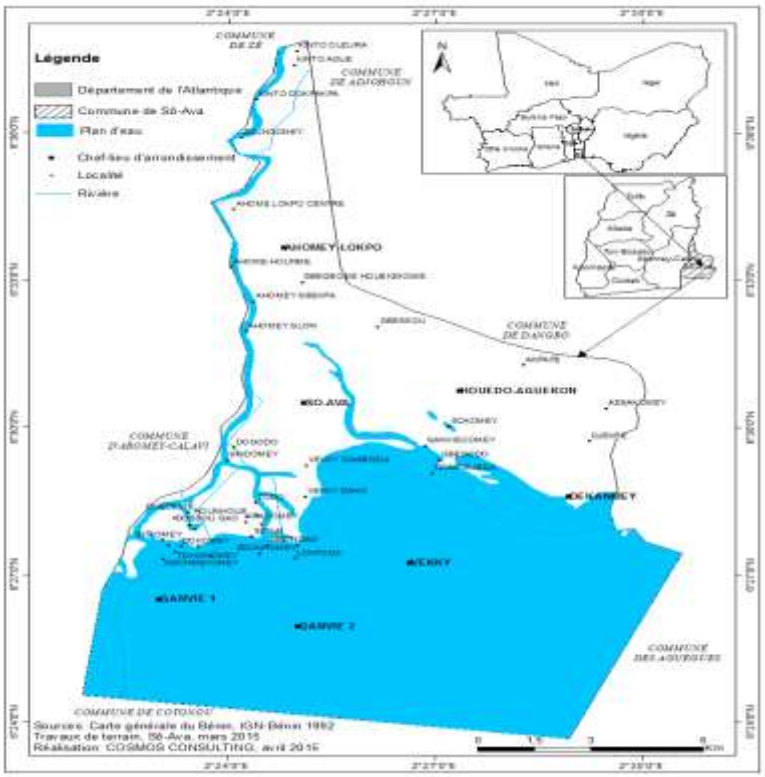

Fig-1: Map of the municipality of Sô-Ava

Methodology

The study was carried out on the Lagoon breeding farms on the various islands of the Sô-Ava lake municipality in the Oueme river valley region. It takes place between November and December 2016. The 12-month retrospective survey method "12MO" developed by Lesnoff *et al* [3] was used to determine the zootechnical parameters of the taurine farms Lagoon encountered on the different islands. 12 MO is a retrospective cross-sectional survey method used to estimate the demographic parameters of a domestic ruminant herd (annual reproduction, mortality and exploitation rates). This method is based on interviews with breeders and their memory of the demographic events in the herds. The interviews are carried out in a single visit in each breeding with the breeders in the presence of the animals. The 12 MO methods consists of reconstructing the herd's demographics in the 12 months preceding the survey and has been developed to quantify the impact of shocks (eg droughts, floods or epizootics) or development projects on the short term. This method considers that the herd consists of only one species. If the farmer owns more than one species, the "herd" is limited to the animals of the target species chosen to be surveyed in this farm (in this study, it is Laguniare cattle) [3]. This method has been used in several Sahelian countries, both locally and nationally, in numerous studies to determine the zootechnical parameters of ruminant herds [4-6]. This tool was also used by ILRI in four countries in West Africa (Gambia, Guinea, Mali, Senegal) as part of a project on the conservation of endemic breeds of domestic and small ruminants PROGEBE) [7]. The 12 MB demographic questionnaire consists of two sub-questionnaires: the Q1 sub-questionnaire, which provides information on herd structure and reproduction over the last twelve months, and the Q2 sub-questionnaire which provides information on the entry and exit of animals occurred in the herd always during the last twelve months was used to collect the demographic movements taking place in flocks during the year.

Data analysis

At the end of the retrospective survey carried out on the 12MO questionnaires, the data collected were entered in the Access database and then analyzed under the software R. The various parameters were then calculated from the t12mo package to the software R.3.3.2. Three types of demographic parameters were estimated from the data collected [8]. These include:

- Variables describing herd status at the time of survey (herd size, age classes by sex);
- Annual demographic rates (including natural rates such as parturition, abortion and mortality, as well as management rates such as exploitation and import rates); and
- General demographic indicators summarizing the dynamics and productions of the herd over the 12 months (such as annual growth rates and production rates).

The demographic parameters determined are summarized in Table 1.

The various demographic parameters were subjected to a two-factor analysis of variance (herd residence and environmental impact) using the general linear model (GLM). The gml function of the R.3.3.2 software was used for this purpose and when the probability was significant ($p<0.05$), the Student Newman and Keuls test (SNK) was used to compare the averages. The results were presented as the mean of the least squares of the instantaneous ± standard error (SE) and expressed in Year-^{1}.

$$Y = \mu + I_i + E_j + \varepsilon_{ij}$$

Yij = Demographic parameters
μ = instantaneous average rate,
Ii = Fixed effect of the island of residence of bullfighting herds Lagoon,
Ej = Fixed year effect
εij = Residual random effect

The instantaneous rate (h), also referred to as the instantaneous risk rate, is estimated for a particular category of animals (eg all animals, all males over one year of age, etc.) by the formula:

$$h = m / T$$

where m is the number of events (eg, number of mortalities, number of animals entering the herd, etc.) occurring during the 12 months, and T is " total time at risk " by animals in the category in the last 12 months). T is approximated by averaging the number of animals in this category for 12 months (nt-1), and the current number of animals in this category. nt-1 for a particular age class (i) is calculated as follows:

$$nt\text{-}1,i = nt,i+1 - ((ment,i - mexi,i)/2) - ((ment,i+1 - mexi,i+1)/2)$$

where ment and mexi are respectively the inputs and outputs in the age class i during the last 12 months. nt, i is known from the data.

Table 1: Estimated demographic parameters for the "12 months" retrospective survey [8]

Natural Rates	
Abortion rate	Instant annual rate of abortion risk (expected number of abortions per female when staying all year in the herd, an abortion is a gestation that has not reached its end). It is also calculated on the complete reproductive history of the females (in the form of a regression curve adjusted between ages and parities of the females present in the herd)
Prolificacy rate	Average number of products (stillbirths or live births) per parturition
Mortality rate	Annual instantaneous rate of risk of natural death (natural death concerns all types of death except slaughter)
Management Rates	
Offtake rate	Instant annual rate of exploitation risk (traction, slaughter, sales, loans, gifts etc.)
Intake rate	Immediate annual import risk rate (purchases, loans, grants, etc.)
Additional demographic rates derived from basic annual demographic rates	
Net Prolificity Rate	Average number of products born alive per parturition, calculated directly or by: Prolificacy rate * (1 - stillbirth rate)
Fertility rate	Average number of products (live or stillborn) per reproductive female per year, calculated directly or by: Parturition rate * Prolificacy rate.
Net fertility rate	Average number of products born per reproductive female per year, calculated either directly or by: parturition rate * Net prolificacy rate
General demographic indicators	
Annual multiplication rate	Annual multiplication rate, calculated as follows: Herd size at time of survey / Herd size 12 months before. A value> 1 indicates a positive growth rate in the year

Annual growth rate	Rate of annual population growth, calculated as follows: 100 * (Annual rate of multiplication -1)
Annual production rate	Annual production rate in the form P / N where P is (Herd size at time of survey - Herd size 12 months before) + (Number of harvests during the year - Number of imports during the year - Year), and N mean herd size during the year. Note that the numerator (P) represents the difference between the number of births and the number of deaths.

RESULTS

Structure of herds

The graphs in the figure below show the structure of Lagoon bull herds in a transient flood situation and flood shock in the Sô-Ava lake community.

These graphs show that the overall structure of herds is almost identical whatever the environmental situation of this lake region. The total number of herds encountered is approximately two-thirds (2/3) of females, compared to one-third (1/3) males with a high proportion of cows, 37% in the transient flood period and 33% in the d 'flood. In the ranks of males, the proportion of males is decreasing from juveniles to sub-adults and bulls. Bulls represent only 5% of the animal population. The category of juveniles, ie calves and bulbs, represents about 12% of the herd. The proportions of sub-adult females represented by the first and second-generation heifers and the first and second bulls represent respectively 19.8% of sub-adult females and 13.8% of sub-adult males.

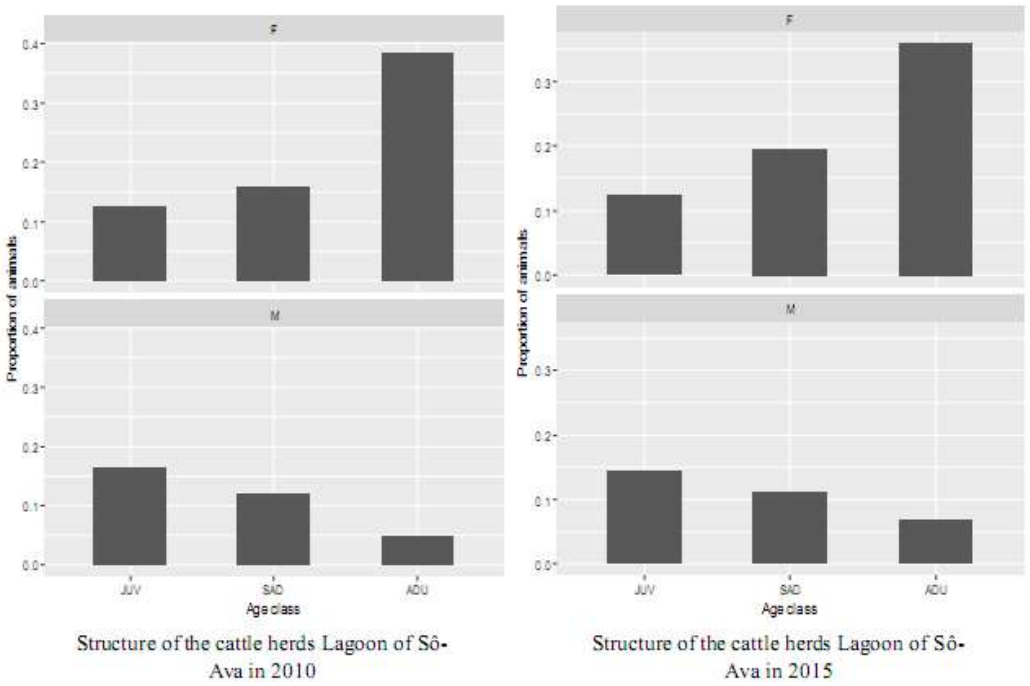

Fig-2: Structure of Lagoon cattle herds in a transient flood situation and flood shock in the Sô-Ava lake community.

Annual demographic parameters of the various Lagoon farms encountered on the islands of the Sô-Ava lake community

Table 2 presents the reproductive demographic parameters of the Lagoon bull herds present on the different islands (Ahomey Lokpo, Dékanmey, Houédo and Sô-Ava) in the Sô-Ava lake community. This table shows that the location island of the farms had no significant effect (p> 0.05) on calving, fertility, net prolificacy, as well as rates of abortion and stillbirth animals. However, the overall annual mortality rate was significantly better (p <0.05) in Ahomey-Lokpo Island than in the Dekanmey, Houedo and Sô-Ava islands. On the islet of Ahomey Lokpo, out of 100 subjects only 07 cases of mortality were recorded, compared with 12 cases in the dekanmey islet farms, 14 cases on the island of Houedo and 11 cases in the the island of Sô-Ava.

The herd demographic parameters also showed a significant variation (p <0.05) as a function of the year. These parameters were better on all islands of the Sô-

Ava lake community during 2015. During this year, out of 100 cows in the herds, more than 75 cows calved against only 60 cows for the year 2010. The overall mortality was barely of 01 subject out of 100 compared to twenty (20) deaths in 2010.

Table 2: Annual demographic parameters (in Year^{-1} ± SE) according to the location of Lagoon cattle herds and the year

Demographic parameters Variation factors	Parturition rate	Net fecundity rate	Net Prolificacy rate	Abortion rate	Mortinatility rate	Mortality rate
	LSM ± SE	LSM ± SE	LSM ± SE	LSM ± SE	LSM ± SE	LSM ± SE
Island of residence of herds						
Ahomey Lokpo	0,693 ± 0,028^{a}	0,665 ± 0,029^{a}	0,955 ± 0,019^{a}	0,007 ± 0,016^{a}	0,044 ± 0,019^{a}	0,071 ± 0,012^{b}
Dekanmey	0,693 ± 0,028^{a}	0,675 ± 0,029^{a}	0,973 ± 0,019^{a}	0,026 ± 0,019^{a}	0,026 ± 0,019^{a}	0,124 ± 0,012^{a}
Houedo	0,666 ± 0,129^{a}	0,614 ± 0,913^{a}	0,915 ± 0,008^{a}	0,034 ± 0,007^{a}	0,084 ± 0,008^{a}	0,142 ± 0,005^{a}
Sô-Ava	0,674 ± 0,029^{a}	0,636 ± 0,031^{a}	0,942 ± 0,019^{a}	0,029 ± 0,017^{a}	0,057 ± 0,019^{a}	0,113 ± 0,013^{a}
Years						
2010	0,607 ± 0,016^{b}	0,565 ± 0,017^{b}	0,922 ± 0,011^{b}	0,041 ± 0,009^{b}	0,077 ± 0,011^{a}	0,211 ± 0,007^{a}
2015	0,756 ± 0,016^{a}	0,730 ± 0,017^{a}	0,970 ± 0,011^{a}	0,019 ± 0,009^{a}	0,029 ± 0,011^{b}	0,014 ± 0,007^{b}

a and b: the instantaneous rates on the same line with different letters are significantly different at 5% (0.05); LSM: mean of least squares, SE: standard error.

Demographic management parameters

Table 3 presents the demographic parameters for the management of Laguna Bull herds located on the various islands of the Sô-Ava lake community. The herd exploitation rate was significantly ($p < 0.05$) influenced by the herd of residence of the herds. In the flocks of the islands of Dekanmey, Houedo, and Sô-Ava, approximately 3 animals are harvested per year out of a total of 100 herd-cattle subjects, against just 1 subject in the herds of Ahomey Lokpo. The import rate was close to what is identical whatever the island of residence of the flocks.

The year had no significant effect ($p > 0.05$) on the annual exploitation and import rates in the different herds.

Table 3: Annual Demographic Parameters of Herd Exploitation (in Year^{-1} ± SE) according to the islands of residence of the Lagoon herds and the years

Demographic parameters Variation factors	Offtake rate	Intake rate
	LSM ± SE	LSM ± SE
islands of residence of herds		
Ahomey Lokpo	0,003 ± 0,007^{b}	0,021 ± 0,005^{a}
Dekanmey	0,031 ± 0,007^{a}	0,008 ± 0,005^{a}
Houedo	0,036 ± 0,003^{a}	0,012 ± 0,002^{a}
Sô-Ava	0,037 ± 0,008^{a}	0,009 ± 0,005^{a}
Year		
2010	0,029 ± 0,004^{a}	0,014 ± 0,003^{a}
2015	0,024 ± 0,004^{a}	0,011 ± 0,003^{a}

a and b: the instantaneous rates on the same line with different letters are significantly different at 5% (0.05); LSM: mean of least squares, SE: standard error.

Global demographic indicators

Table 4 presents the aggregate demographic indicators of the lagoon cattle herds in the Sô-Ava lake municipality, according to the islands of the residences of these farms and the year. The overall demographic indicators obtained in these different farms did not vary

(p> 0.05) whatever the island of residence of the herds. The multiplication rate was greater than 1 in the different herds.

However, the year significantly influenced (p <0.05) the demographic indicators observed in these herds. Thus the demographic multiplication, production and annual growth rates obtained in 2015 were better (p <0.05) than those obtained in 2010.

Table 4: Overall demographic indicators of livestock farming Lagoon according to the area of residence of herds and the year

Demographic parameters Variation factors	Annual multiplication rate	Annual production rate	Annual growth rate
	LSM ± SE	LSM ± SE	LSM ± SE
Island of residence of herds			
Ahomey Lokpo	1,305 ± 0,027[a]	0,274 ± 0,018[a]	0,305 ± 0,027[a]
Dekanmey	1,227 ± 0,027[a]	0,236 ± 0,018[a]	0,227 ± 0,027[a]
Houedo	1,224 ± 0,012[a]	0,222 ± 0,008[a]	0,224 ± 0,012[a]
Sô-Ava	1,252 ± 0,028[a]	0,247 ± 0,018[a]	0,252 ± 0,028[a]
years			
2010	1,142 ± 0,015[b]	0,150 ± 0,015[b]	0,142 ± 0,015[b]
2015	1,362 ± 0,15[a]	0,339 ± 0,010[a]	0,362 ± 0,015[a]

a and b: the instantaneous rates on the same line with different letters are significantly different at 5% (0.05); LSM: mean of least squares, SE: standard error.

DISCUSSION

Structure of herds

The Lagoon cattle herds encountered on the various islands of the Sô-Ava Lake community were generally two-thirds (2/3) of the females and one third (1/3) of the males. This result is consistent with that obtained in many bovine farms in tropical environments. Cattle herds encountered in the boreal forest regions of northeastern Alibori have the same structure as that reported in our study [4]. Studies carried out by the same authors in the Zebu Goudali farms in the far north of Benin show that in these herds, two (02) animals out of three (03) are females. Alkoiret *et al*. [9, 10] also observed sedentary, semi-sedentary and transhumant Borgou herds in Gogounou and Ouake, in northern Benin, respectively, for one third of males, compared with two thirds of females. However, Dehoux and Hounsou-Ve [11] in their work in a natural environment in the eastern part of Borgou in public Nikki and Kalalé indicate that cattle herds in these areas are composed of three quarters / 4) female and a quarter (1/4) of males. According to these authors, herds have one male for three females, 26.9% of males for 73.1% of females.

The size of the herds studied is the average of the other studies carried out in the Ferlo region of Senegal [12]. The age and sex structure of lagoon flocks in the Sô-Ava lake municipality is comparable to that of Marshall et al. [20], but with a higher proportion of juveniles (21%) compared with 27.5% in seasonal floods and 26% during the flood period.

Demographic parameters

The demographic parameters obtained in the herds did not vary regardless of the island of residence of the herds. This could be explained by the fact that the adopted farming practices were the same on all the islands. In the Sô-Ava Lacustre area, Lagoon bull farming remains the specialty of the Toffin fishing communities, all of which are free-ranging animals [13].

Cases of mortality were more frequent in the flocks of the Dékanmey, Houédo and Sô-Ava islands. These mortality cases go from one to two from the farms of the islet of Ahomey Lokpo (0.071 / year), to the islands of Sô-Ava (0.113 / year); Houédo (0.124 / year) and Dékanmey (0.142 / year). This gap could be explained by the geographical position of the island of Ahomey Lokpo. The islet of Ahomey Lokpo is located at an elevation in relation to the shore of Lake Nokoué which comes out of its nest seasonally, all of which could affect the health status of the herds and thus increases the mortality in the farms of the islands of Sô-Ava, Dekanmey and Houedo closer to the shore of Lake Nouké.

The mortality rates obtained on the different islands were generally higher than those obtained by sedentary and semi-sedentary ranching in tropical regions by other authors. This rate varies between 4 and 9% in riparian cattle ranching in the Upper Alibori Range Forest [4]. In the Zebu Goudali farms in the Malanville and Karimama regions in the Far North region of Benin, the mortality rates were 2.5%; 3.8%

and 4.7% respectively in sedentary, semi-sedentary and transhumant farms [14]. Alkoiret *et al.,* [9, 15] also observed relatively lower mortality rates in sedentary and semi-sedentary Borgou cattle in the Gogounou regions (1.59 to 5.87%), respectively. and Ouaké (0.6 to 1.73%). This slight discrepancy in Lagoon bull farming in the different islands of the Sô-Ava lake region could be explained by the difference in breeding practices between the northern and the Sô-Ava lakes. Indeed, the herds of the regions of Northern Benin are guarded by the peulh breeders recognized as traditionally a community of cattle breeder and therefore professionals in the matter.

The breeders of the Sô-Ava lake region, fishermen by profession, focus more on fishing, do not invest all their hope, their time and attention to the management of the herd, which could negatively impacted the health status of herds anything that could cause mortality. Better Peulh farms with lower mortality rates are those with relatively small numbers. The overall mortality rate in the Ferlo region of Senegal by Thibaut Jorat [12] was 0.11 ± 0.01 / year, which is much closer to our results.

The prolificacy rate varies between 91% and 97% with a fertility rate varying between 61% and 67% depending on the island of herds. This could be explained by the availability of grazing areas on the island to enable the cattle to feed well. In cattle farms in Niger, the rate of prolificacy of 0.95% and an instant killing rate of 0.644 calving cases per year [16] compared with 0.666 to 0.697 calving cases for our study. According to the study of Borgou cattle at the Okpara farm [17], breeding parameters are characterized by a fertility rate of 78 ± 8.4%, a calving interval of 441 ± 75 days, ie 14.7 ± 2.5 months, an age at first calving of 42.1 ± 5 months. The abortions recorded on lagoon cattle in the various islands ranged between 1 and 3.4%. These results are lower than those obtained by Assani *et al*. [4, 14] in northern Benin on transhumant herds entering the Upper Alibori Forest. The highest abortion rate was 3.4% and was obtained in the Houodo islet farms.

The year had a significant effect on the different demographic parameters of reproduction and mortality of the different herds. The demographic parameters of reproduction and mortality varied significantly between 2010 and 2015. Those obtained in 2015 were better than those obtained in 2010. This variation could be explained by the environmental events that the region experienced in 2010. Indeed, during this year, following the torrential rains, the island experienced an exceptional flood that decimated a good part of the flock and would act on the fertility of the cows. The effect of the year on the variation of demographic parameters was also described by Jorat [12] in the Ferlo region of Senegal.

Demographic management parameters

The animals were more exploited in the flocks of the islands of Dekanmey, Houedo and Sô-Ava compared to those of the herds of the island of Ahomey Lokpo. Indeed, the islet of Ahomey Lokpo is farther from the bank and therefore more difficult to access, the animals of this islet are practically exploited only by the population of this island for the ceremonies. The other islands closer to the bank welcome buyers coming from the neighboring towns of Abmoey Calavi and the big city of Cotonou. However, the exploitation rate of the animals of the Lagoon cattle remains low and varies from 1 to 3 animals exploited per year in a herd of 100 subjects or in probability a rate of 1 to 3% of animals exploited per year. These rates are closer to those obtained by Assani *et al* [4] in 2016 in transhumance cattle herds in the Upper Aliborie Range Forest. These rates were 0.5%; 1.3%; 2.7% respectively on herds of type 1, 2 and 3 but higher in large transhumant flocks, ie 8%. In the Ferol region of Senegal, Thibaut Jorat [12] obtained an overall exit rate of 0.17 / year (0.09 / year and 0.41 / year for females and males respectively) by 16% much higher than in our study. The exploitation of animals, which preferably involves males, allows livestock keepers to empirically improve the performance of their herds by supplying new blood. Numerical exploitation varies greatly according to cattle categories: males are often sold very young, while females are kept for a long time for breeding [17].

Animal use and import practices did not change as a function of the year. However, the import rate was relatively higher in 2010. It could be expected that livestock buyers would buy more animals during the flood shock of 2010 to replenish their herds. But weaken by the disaster of the flood they lack financial means to inject in the purchase of new subject in replacement of those decimated by the flood.

Overall demographic indicators

The island of residence of the different herds had no significant effect on the overall demographic indicators obtained in the different livestock farms. However, the multiplicative rate was greater than 1 whatever the island of residence of the farms. This shows that the different flocks have increased in size over the year. The net annual growth was also positive in these different farms. These rates vary between 22 and 30% depending on the island of residence of the herd. Similar results were obtained by Assani *et al.,* [4] in sedentary riparian cattle in the Upper Alibori Ranged

Forest as well as semi-transhumant breeding in the forest during the lean season.

CONCLUSION

Lagoon bull farms located on the various islands of the Sô-Ava lake municipality in the Ouémé river valley in southern Benin have the same structure as the Sahelian suckling herds. This structure, characterized by a predominance of females, makes it possible to perpetuate the herd and manage it sustainably. The demographic parameters obtained in the different island farms were relatively identical and relatively high, with a significant annual rate of calving and fertility and a relatively high mortality rate. However, the exploitation of flocks' still low remains in line with the management strategies put in place in these different livestock farming. These strategies are much more geared towards stocking and replenishment than to the market. Nevertheless, these animals are used for the slaughter and allow supplying the markets of the region before the arrival of the animals of the north and the Sahelian countries. The zootechnical performances recorded in the different islands in this Sudan-Guinean climate, which is recognized as hostile to cattle breeding, testifies to the good adaptation of Lagoon taurins to their natural environment. However, it should be noted that these farms are threatened by the climatic events observed during the various years which have negatively affected the demographic dynamics of the livestock of the Sô-Ava lake region. The implementation of a management model resilient to these climatic shocks in these times of climate change is therefore necessary for the safeguarding of this already threatened cattle breed.

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