



Muturu cattle breed management in the smallholder farming area of the Ouémé district in the south of Benin: rearing practices, objectives, and constraints

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Abstract

An exploratory survey was conducted to understand breeding practices and breeding objectives as well as the constraints as a first step towards developing breeding strategies for the conservation of Muturu cattle breed in Ouémé smallholder farming area of South Benin. Data were generated through randomly interviewing 100 selected Muturu cattle keepers in the municipalities of Adjarra, Adjohoun, Akpro-Misséréte, and Bonou using an electronic animal genetic resource characterization, inventory, and monitoring tool. Results indicated that the Muturu cattle were mainly kept for their meat. The mean herd sizes of 3, 5, 4, and 33 were obtained in Adjarra, Adjohoun, Akpro-Misserete, and Bonou respectively. Cattle keepers were exclusively male in the various municipalities surveyed except for Adjohoun, where 28.57% of cattle keepers were female. Preference was given to this breed because it is less demanding in terms of inputs and well adapted to the local environment. Mating was generally uncontrolled. The animals were fed on a natural pasture exclusively irrespective of the season. Robustness and vigor were the most frequently reported traits in selecting breeding bulls, while breeding females were kept based on their offspring's growth and conformation. The decline in the number of Muturu cattle in the region was largely attributed to the competition for land used for other purposes such as crop cultivation and animal theft. Considering the devastating threat on the Muturu cattle breed, it is recommended that a participatory management scheme be designed and implemented for in situ conservation of the Muturu cattle breed in Benin.

Keywords Community-based breeding · Management · Indigenous · Sustainable use

Introduction

The agricultural sector is the main development driver in Benin, contributing 22.6% to the country's GDP (WB 2018). It is the foundation of food security, industrial and rural development, and job creation. Livestock is important in the agricultural sector and contributes about 2.4% of the national GDP (FAO 2015). In the livestock sector, cattle are the main supplier of animal protein (58%), followed by poultry (21%), small ruminants (13%), and pigs (7%) (Bebay 2006; FAO 2015).

The country has several means that can contribute to livestock development, these include the diversity of animal genetic resources which is made up of indigenous and rustic breeds such as the Muturu cattle. Muturu means humpless in the Hausa language, and so named for the West African shorthorn cattle breed. Generally, two types of Muturu cattle have been identified: a larger Savannah type and a Dwarf-Forest type which appears to have evolved through adaptation to the humid forest environment (Gwaza and Momoh 2016). The Muturu is reported to be the smallest breed of cattle (Maule 1990). Their high fertility, tolerance to trypanosomiasis, and cultural roles make them an important breed wherever they are found (Adeniji 1983). In Benin, they inhabit the wettest areas of the southern part which is heavily infested with tsetse fly, as a result of which this breed has adapted and is naturally selected to be tolerant to trypanosomiasis, ticks, and tick-borne diseases, although it is susceptible to rinderpest and tuberculosis (Codjia 1981; Farougou et al. 2006). For instance, an early report has shown that the Muturu cattle are

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more resistant to trypanosomosis than the Zebu and the Taurine cross-breed product in Benin (Kounonzo 2011).

Although there is some increase in the Beninese national cattle herd, the number of Muturu cattle has significantly declined over time (Megnigbèto 2013). According to the estimates of the Directorate of Agriculture, Husbandry and Fisheries at the departmental level, the number of Muturu cattle in the Ouémé area has decreased from 4015 in 2015 to 1363 in 2018 (DDAEP-Ouémé 2015; DDAEP-Ouémé 2018). Evidence of the introduction of Sahelian cattle genes into the Muturu cattle in southern Benin has been reported using molecular markers (Koudandé et al. 2009). This has been attributed to uncontrolled breeding practices by farmers aiming at enhancing the size and productivity of their animals. However, the Muturu cattle breed is highly valued for the quality of its meat. According to Salifou et al. (2013), Muturu cattle meat is softer than Borgou cattle and Zebu meat and is very popular among consumers. Other qualities of Muturu include high fertility, short calving interval, low mortality rate, and the ability to survive and reproduce in a hot humid environment. It is therefore important that actions are taken for its conservation and also to promote the diversity of our animal genetic resources. The overall objective of this work was to diagnose the livestock management system in the Muturu breed herds of four municipalities in the region of Ouémé in southern Benin and to identify the factors that contribute to the decline of the Muturu cattle in order to design a community-based breeding strategy for its conservation.

Material and methods

Study area and sampling procedures

A household survey was conducted in the Ouémé area known to be the region where the forest type of Muturu breed (Fig. 1) is rifest nowadays. The Ouémé area is located in southeast Benin. It is made up of 9 municipalities namely: Adjara, Akpro-Misséréte, Avrankou, Adjohoun, Bonou, Dangbo, Sèmè-Kpodji, Aguégué, and Porto-Novo distributed over 1281 km².

The Ouémé area is characterized by a sub-equatorial climate of four seasons that alternates two rainy seasons and two dry seasons. The two rainy seasons run respectively from April to July and October to November. The dry seasons extend from August to September and from December to March. Temperatures vary from 25 to 30 °C with rainfall ranging from 900 to 1500 mm. The Ouémé area is irrigated by the Ouémé River, the Lake Nokoué, and the Porto-Novo Lagoon. The vegetation is dominated by moist woodlands and savannahs and characterized by woodlands and tree and shrub savannahs with abundant *Isobertinia* spp. and *Butyrospermum parkii* (Karité). The main types of soils are



Fig. 1 A cow showing solid black coat color

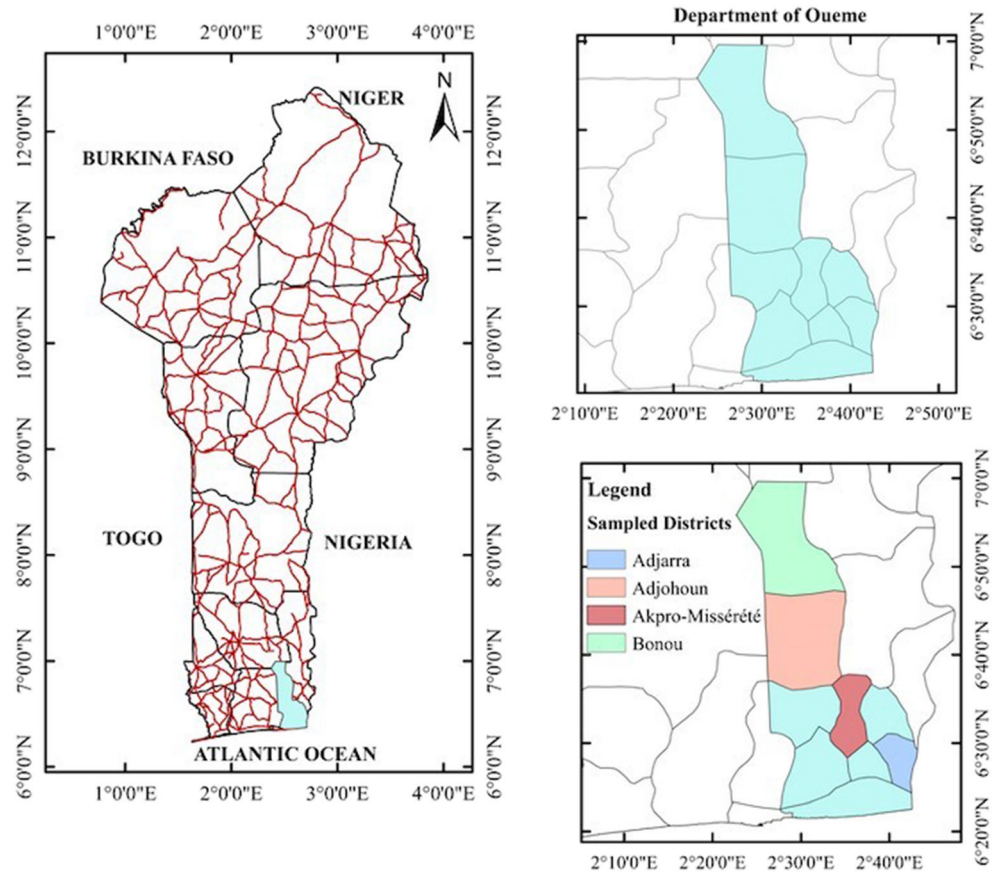
ferrallitic, clay-sandy, and highly degraded, but easy to work on. It is alluvial, hydromorphic, and fertile, but floodable by river floods.

In total, 100 interviews were carried out during 60 days using the animal genetic resource characterization, inventory, and monitoring tool (AnGR-CIM Tool) in 4 municipalities (Fig. 2) including Adjara (53), Akpro-Misséréte (24), Bonou (2), and Adjohoun (21). The AnGR-CIM Tool is a comprehensive tool designed by the African Union Inter-African Bureau for Animal Resources (AU-IBAR) using the Open Data Kit (ODK) software version 1.22.4 to collect data on the indigenous African animal genetic resources. Our population of interest was the Muturu cattle keepers (by Muturu cattle keepers, we mean the farmers interested in maintaining the breed and its characteristics and other cattle farmers with crossbred product were excluded). A chain referral sampling method was used to reach out to the targeted population. In order to ensure sample diversity, different sample seeds were chosen at each location.

Data collection and analysis

The AnGR-CIM Tool was installed on a tablet with the latest version of Android OS. The data collected using the tablet was downloaded from the AnGR-CIM Tool

Fig. 2 Ouémé district map showing the study areas



platform and analyzed using version 3.5.1 of the R software (R-Core Team 2016).

The relative frequencies of the qualitative and quantitative variables were generated and analyzed using the descriptive analysis and then compared using the bilateral Z test. For each relative frequency P , a confidence interval (CI) was calculated using the formula: $CI = 1.96\sqrt{\frac{P(1-p)}{n}}$ where p is the relative frequency and n the sample size (Lesaffre 2009). The mean values were compared using the Turkey test.

Results

Socio-demographic characteristics of the Muturu cattle keepers surveyed

In the four municipalities surveyed, a diversity of ethnic groups of Muturu cattle keepers was noted. The Tori were the dominant ethnic group in Adjarra (98.11%) and Akpro-Missérété (83.33%). The respondents interviewed in the municipalities of Adjohoun and Bonou were all from the ethnic group of Wémé. Most Muturu cattle keepers were illiterate and exclusively male in the various municipalities visited

except in Adjohoun where 28.57% of cattle keepers were female. The majority of respondents from Bonou and Adjohoun were mainly agro-pastoralists. In Akpro-Missérété and Adjarra municipalities respectively, the respondents were mainly traders and crop farmers (Table 1).

Main reason for keeping Muturu cattle breed, production objectives, and membership in a breeder's association

Keeping the Muturu cattle breed is favored by farmers because this breed is less demanding (ability to survive on low-quality feed and limited water supply), that is, (100%) in Bonou, (87.50%) in Akpro-missérété, (75.47%) in Adjarra, and (71.42%) in Adjohoun. Other reasons like passion and the temperament of the animals were mentioned by few people. Although draught power and manure use have been pointed by few of them, meat production was the primary objective of the majority of Muturu cattle keepers. It is worthy to note that Muturu cattle were not milked. Apart from Akpro-Missérété where few respondents claimed to be part of a breeders' association, most respondents do not belong to any group (Table 2).

Table 1 Socio-demographic characteristics of the Muturu cattle keepers surveyed

Locations	Adjarra			Adjohoun			Akpro-misséréte			Bonou		
	n1	%	CI	n2	%	CI	n3	%	CI	n4	%	CI
<i>n</i>	53			21			24			2		
Ethnic												
Tori	52	98.11 ^a	3.67	0	0 ^c	0	20	83.33 ^b	14.91	0	0 ^c	0
Goun	1	1.89 ^b	3.67	0	0 ^b	0	4	16.67 ^a	14.91	0	0 ^b	0
Wémé	0	0 ^b	0	21	100 ^a	0	0	0 ^b	0	2	100 ^a	0
Gender												
Female	0	0 ^b	0	6	28.57 ^a	19.32	0	0 ^b	0	0	0 ^b	0
Male	53	100 ^a	0	15	71.43 ^b	19.32	24	100 ^a	0	2	100 ^a	0
Instruction level												
Illiterate	31	58.49 ^a	13.27	15	71.43 ^a	19.32	22	91.67 ^a	11.06	2	100 ^a	0
Primary	11	20.75 ^a	10.92	3	14.29 ^a	14.97	1	4.17 ^a	8	0	0 ^a	0
Secondary	10	18.87 ^a	10.53	3	14.29 ^a	14.97	1	4.17 ^a	8	0	0 ^a	0
University	1	1.89 ^a	3.67	0	0 ^a	0	0	0 ^a	0	0	0 ^a	0
Main activity												
Crop farming	22	41.51 ^a	13.27	2	9.52 ^b	12.55	4	16.67 ^b	14.91	0	0 ^b	0
Livestock	2	3.77 ^a	5.13	1	4.76 ^a	9.11	2	8.33 ^a	11.06	2	100 ^a	0
Mixed crop livestock	16	30.19 ^b	12.36	12	57.14 ^a	21.17	8	33.33 ^{ab}	18.86	0	0 ^b	0
Trader	3	5.66 ^b	6.22	6	28.57 ^a	19.32	9	37.5 ^a	19.37	0	0 ^b	0

CI, confidence interval; %, frequencies; *n*, households number sampled in each location; *n1*, *n2*, *n3*, *n4*, observed number of cases for each modality at the different location

^{a,b,c} Frequencies within rows with different superscript are significantly ($P < 0.05$) different

Acquisition mode of breeding herd, feeding, watering, and production system

Apart from Bonou, nearly all respondents from the other three municipalities purchased breeding male and female to make their herds. All respondents reported that their animals graze on communal rangelands or farm throughout the year with no supplementation. Usually, animals were tethered on the farm or rangeland during the daytime (small flock) or herded for hours of grazing (big flock). In the rainy season, as well as in the dry season, the spring and the rivers were the most widely used water sources in Bonou, Adjohoun, and Adjarra while wells were more often used in Akpro-Misséréte. The vast majority of the Muturu cattle keepers were agro-pastoral farmers, with crop and plant cultivation dominating (Table 3).

Selection criteria, mating system, and habitat type

The ranking of important traits as perceived by Muturu cattle keepers for males and female's animals are summarized in Table 4. Progeny's growth and conformation were the main criteria for selecting the breeding females in all the municipalities. With regard to the bulls,

robustness is the key selection criterion mentioned by respondents in all 4 municipalities. However, some other criteria were also important for a significant number of respondents. For instance, male vigor was pointed out as an important selection criterion for a number of respondents in Adjohoun (52.38%) and coat color in Akpro-Misséréte (45.83%). No respondents reported controlled mating. Except for Bonou, the majority of the respondents in the other areas had no fences and if available, they were in poor condition.

Reproductive lifespan and average age at first calving

In general, selected animals for breeding were kept in the flocks for a long time. In total, 80.95% of Adjohoun cattle keepers, 64.15% of Adjarra cattle keepers, and 62.50% of Akpro-Misséréte cattle keepers claimed to keep the females for up to 10 years. Concerning the locality of Bonou, the females were kept for up to 20 years. However, males were released earlier (2 to 5 years) by the majority of cattle keepers in all localities. Most of the herds' heifers gave birth for the first time at the age of 33 months in the four municipalities (Table 5).

Table 2 Main reason for keeping Muturu cattle, production objectives, and membership in a breeders' association

Locations	Adjarra			Adjohoun			Akpro-misséréte			Bonou		
	n1	%	CI	n2	%	CI	n3	%	CI	n4	%	CI
<i>n</i>	53			21			24			2		
Main reason for keeping Muturu cattle												
Passion	12	22.64 ^a	11.27	3	14.29 ^a	14.97	2	8.33 ^a	11.06	0	0 ^a	0
Less demanding	40	75.47 ^a	11.58	15	71.42 ^a	19.32	21	87.5 ^a	13.23	2	100 ^a	0
Temperament	1	1.89 ^b	3.67	3	14.29 ^a	14.97	1	4.17 ^{ab}	8	0	0 ^b	0
Production objectives												
Milk	0	0 ^a	0	0	0 ^a	0	0	0 ^a	0	0	0 ^a	0
Meat	52	98.11 ^a	13.28	20	95.24 ^a	14.90	24	100 ^a	0	2	100 ^a	0
Draught power	7	13.20 ^a	12.25	2	9.52 ^a	15.33	3	12.50 ^a	19.37	0	0 ^a	0
Manure use	2	3.77 ^b	7.80	1	4.76 ^b	8.70	1	4.17 ^b	14.78	1	50 ^a	30.15
Member of a breeders' association												
Yes	0	0 ^a	0	0	0 ^a	0	1	4.17 ^a	8	0	0 ^a	0
No	53	100 ^a	0	21	100 ^a	0	23	95.83 ^a	8	2	100 ^a	0

CI, confidence interval; %, frequencies; *n*, households number sampled in each location; *n1*, *n2*, *n3*, *n4*, observed number of cases for each modality at the different location

^{a,b,c}Frequencies within rows with different superscript are significantly ($P < 0.05$) different

Table 3 Acquisition mode of breeding herd, feeding, watering, and production system

Locations	Adjarra			Adjohoun			Akpro-misséréte			Bonou		
	n1	%	CI	n2	%	CI	n3	%	CI	n4	%	CI
<i>n</i>	53			21			24			2		
Acquisition mode of breeding herd												
Purchase	49	92.45 ^a	7.11	20	95.24 ^a	9.11	22	91.66 ^a	11.06	0	0 ^a	0.00
Fostering	2	3.77 ^a	5.13	0	0 ^a	0.00	1	4.17 ^a	8.00	0	0 ^a	0.00
Inherited	2	3.77 ^a	5.13	1	4.76 ^a	9.11	1	4.17 ^a	8.00	2	100 ^a	0.00
Feeding												
Natural pasture	53	100 ^a	0.00	21	100 ^a	0.00	24	100 ^a	0.00	2	100 ^a	0.00
Watering (wet season)												
Spring	34	64.15 ^a	12.91	15	71.43 ^a	19.32	1	4.17 ^b	7.99	2	100 ^a	0.00
River	34	64.15 ^a	12.91	15	71.43 ^a	19.32	1	4.17 ^b	7.99	2	100 ^a	0.00
Water well	31	58.49 ^a	13.27	3	14.29 ^b	14.97	19	79.17 ^a	16.25	1	50 ^{ab}	69.30
Borehole	21	39.62 ^a	13.17	5	23.81 ^a	18.22	5	20.83 ^a	16.25	0	0.00 ^a	0.00
Watering (dry season)												
Spring	32	60.38 ^a	7.11	15	71.43 ^a	19.32	1	4.17 ^b	7.99	2	100 ^a	0.00
River	49	92.45 ^a	5.13	15	71.43 ^a	19.32	1	4.17 ^b	7.99	2	100 ^a	0.00
Water well	2	3.77 ^c	5.13	3	14.29 ^{bc}	14.97	19	79.17 ^a	16.25	1	50 ^{ab}	69.30
Borehole	2	3.77 ^b	5.13	5	23.81 ^a	18.22	5	20.83 ^a	16.25	0	0.00 ^b	0.00
Production system												
Mixed crop livestock	53	100 ^a	0.00	21	100 ^a	0.00	24	100 ^a	0.00	2	100 ^a	0.00

CI, confidence interval; %, frequencies; *n*, households number sampled in each location; *n1*, *n2*, *n3*, *n4*, observed number of cases for each modality at the different location

^{a,b,c}Frequencies within rows with different superscript are significantly ($P < 0.05$) different

Table 4 Selection criteria, mating system, and habitat type

Locations	Adjarra			Adjohoun			Akpro-misséréte			Bonou		
	n1	%	CI	n2	%	CI	n3	%	CI	n4	%	CI
<i>n</i>	53			21			24			2		
Selection criteria of cows												
Calves' growth rate	48	90.57 ^a	7.87	19	90.48 ^a	12.56	21	87.50 ^a	13.23	2	100.00 ^a	0.00
Calves' Body conformation	48	90.57 ^a	7.87	19	90.48 ^a	12.56	22	91.67 ^a	11.06	2	100.00 ^a	0.00
Milk production	0	0.00 ^b	0.00	3	14.29 ^a	14.97	2	8.33 ^a	11.06	0	0.00 ^b	0.00
Coat color	0	0.00 ^a	0.00	0	0.00 ^a	0.00	1	4.17 ^a	7.99	0	0.00 ^a	0.00
Disease resistant	0	0.00 ^a	0.00	0	0.00 ^a	0.00	0	0.00 ^a	0.00	0	0.00 ^a	0.00
Precocity	0	0.00 ^b	0.00	2	9.52 ^a	12.56	1	4.17 ^a	7.99	0	0.00 ^b	0.00
Selection criteria of bulls												
Body size	15	28.30 ^b	12.13	2	9.52 ^b	12.56	7	29.17 ^a	18.18	2	100.00 ^a	0.00
Robustness	34	64.15 ^a	12.91	17	80.95 ^a	16.80	21	87.50 ^a	13.23	2	100.00 ^a	0.00
Disease resistant	1	1.89 ^b	3.66	0	0.00 ^b	0.00	5	20.83 ^a	16.25	0	0.00 ^b	0.00
Vigorous	13	24.53 ^b	11.58	11	52.38 ^a	21.36	3	12.50 ^b	13.23	1	50.00 ^{ab}	69.30
Growth rate	3	5.66 ^a	6.22	0	0.00 ^a	0.00	1	4.17 ^a	7.99	0	0.00 ^a	0.00
Body conformation	2	3.77 ^a	5.13	0	0.00 ^a	0.00	1	4.17 ^a	7.99	0	0.00 ^a	0.00
Coat color	8	15.09 ^a	9.64	2	9.52 ^a	12.56	11	45.83 ^a	19.93	1	50.00 ^a	69.30
Mating system												
Controlled	0	0.00 ^a	0.00	0	0.00 ^a	0.00	0	0.00 ^a	0.00	0	0.00 ^a	0.00
Uncontrolled	53	100.00 ^a	0.00	21	100.00 ^a	0.00	24	100.00 ^a	0.00	2	100.00 ^a	0.00
Habitat type												
Habitat with fence	1	1.89 ^b	11.28	1	4.76 ^b	12.17	1	4.17 ^b	14.45	2	100.00 ^a	0.00
Habitat without fence	52	98.12 ^a	13.16	20	95.24 ^a	15.25	23	95.83 ^a	16.22	0	0.00 ^b	0.00

CI, confidence interval; %, frequencies; *n*, households number sampled in each location; *n1*, *n2*, *n3*, *n4*, observed number of cases for each modality at the different location

^{a,b,c}Frequencies within rows with different superscript are significantly ($P < 0.05$) different

Table 5 Reproductive lifespan and age at first calving

Locations	Adjarra			Adjohoun			Akpro-misséréte			Bonou		
	n1	%	CI	n2	%	CI	n3	%	CI	n4	%	CI
<i>n</i>	53			21			24			2		
Breeding career of cows												
2 to 10 years	34	64.15 ^{ab}	12.91	17	80.95 ^a	16.80	15	62.50 ^{ab}	19.37	0	0.00 ^b	0.00
11 to 20 years	19	35.85 ^{ab}	12.13	4	19.05 ^b	9.11	9	37.50 ^{ab}	17.32	2	100.00 ^a	0.00
Breeding career of bulls												
2 to 5 years	45	84.91 ^a	9.64	17	80.95 ^a	16.80	19	79.17 ^a	16.25	2	100.00 ^a	0.00
5 to 10 years	8	15.09 ^a	3.66	4	19.05 ^a	0.00	5	20.83 ^a	11.06	0	0.00 ^a	0.00
Age at first calving												
27 months	5	9.43 ^a	7.87	1	4.76 ^a	9.11	5	20.83 ^a	16.25	0	0.00 ^a	0.00
33 months	40	75.47 ^{ab}	11.58	20	95.24 ^a	9.11	19	79.17 ^{ab}	16.25	1	50.00 ^b	69.30
39 months	8	15.10 ^{ab}	9.64	0	0.00 ^b	0.00	0	0.00 ^b	0.00	1	50.00 ^a	69.30

CI, confidence interval; %, frequencies; *n*, households number sampled in each location; *n1*, *n2*, *n3*, *n4*, observed number of cases for each modality at the different location

^{a,b,c}Frequencies within rows with different superscript are significantly ($P < 0.05$) different

Table 6 Average number of cattle own per herd

Locations	Adjarra		Adjohoun		Akpro-Missereté		Bonou		Significant
	M	ES	M	ES	M	ES	M	ES	
Average number of cattle	3.33a	0.34	5.19a	1.31	4.12a	0.56	33b	24	***

M, mean; ES, standard error

^{a,b,c} Mean within rows with different superscript are significantly ($P < 0.001$) different

Average herd size

Based on the phenotypic characteristics, only the Muturu cattle breed was kept by the respondents interviewed in the four municipalities visited. Apart from Bonou where we encountered big herd size, the average number of cattle own per respondent in the other localities varied from 3 to 6 (Table 6).

Health care and breeding constraints

As shown in Table 7, most Muturu cattle keepers provided health care for their animals particularly helminth control and immunization against endemic diseases. Tick control was barely done. On the other hand, land use competition with crop farming, animal theft, and animal disease were the main constraints reported.

Discussion

According to Hanotte et al. (2000), introgression with Zebu cattle in West African taurine cattle populations is common and is diluting progressively the African taurine genetic background of these breeds. However, it is recognized that animals

of these breeds are well adapted to their local environments and remain productive in areas where Zebu or crossbreeds are often unable to survive (Uza 1997). The phenotypic traits of these animals are the result of hundreds of years of natural selection in relation to the local environments under permanent tsetse, ticks, and helminth challenges. Koudandé et al. (2009) have reported that Muturu cattle breed is under threat of extinction due to uncontrolled breeding practices by farmers aiming to enhance the size and the productivity of their animals and suggest the implementation of strategies aiming at increasing the productivity of the Muturu cattle breed while avoiding losses in trypanotolerance ability. According to Baker and Gray (2004), designing and implementation of community-based breeding programs require a good understanding of the production system and the alternative importance of the different constraints in the system, clear understanding of selected breeding objectives supported by the farmers, and accurate methods of identifying the superior genotypes. This is the knowledge gap we intend to fill through this survey focusing on the Muturu cattle breed management in the Ouémé smallholder farming area of south Benin. Our study revealed that cattle-herding households were male headed except in the municipality of Adjohoun where we met female Muturu cattle keepers who inherited herds from their fathers or deceased husbands. This is due to the

Table 7 Health care and breeding constraints

Locations	Adjarra			Adjohoun			Akpro-misséréte			Bonou		
	n1	%	CI	n2	%	CI	n3	%	CI	n4	%	CI
Health care												
Tick control	3	5.66 ^b	13.92	2	9.52 ^{ab}	15.66	3	12.50 ^{ab}	20.31	1	50.00 ^a	0.00
Helminth control	27	50.94 ^a	11.12	11	52.38 ^a	10.12	11	45.83 ^a	19.36	2	100.00 ^a	0.00
Immunization	37	69.81 ^a	11.11	17	80.95 ^a	16.88	19	79.17 ^a	11.06	2	100.00 ^a	0.00
Breeding development constraints												
Land use competition	52	98.11 ^a	16.64	20	95.24 ^a	20.80	23	95.83 ^a	17.24	2	100.00 ^a	0.00
Theft	37	69.81 ^a	11.66	12	57.14 ^a	16.88	17	70.83 ^a	11.06	2	100.00 ^a	0.00
Disease	10	18.87 ^b	9.64	5	23.80 ^b	19.36	5	20.83 ^b	14.15	2	100.00 ^a	0.00

CI, confidence interval; %, frequencies; n, households number sampled in each location; n1, n2, n3, n4, observed number of cases for each modality at the different location

^{a,b,c} Frequencies within rows with different superscript are significantly ($P < 0.05$) different

requirements of raising big size animals such as cattle. Women in those places were perceived as weak and unable to handle cattle herds.

Our findings corroborate with those of Yisehak (2008) who reported that males were generally the decision makers for livestock production and were responsible for the overall herd management. FAO (2012) reported similar results, stating that in many African communities, animals such as cattle were owned and controlled by males.

The majority of respondents interviewed in the four municipalities were illiterate. This is a result of low enrolment rate which was also noted among small-scale farmers in other regions of the country (Dossa and Vanvanhossou 2016), as it was in many other African countries. The illiteracy problem could be explained by a lack of resources and when available, access is restricted leading individuals to take up parental business such as farming and livestock rearing. Also, the proximity of the targeted municipalities to Nigeria has favored the choice of many local farmers to abandon their study and go for business.

Generally, Muturu cattle keepers purchased breeding stock (bulls and cows) to make their herds; this testifies to the importance these farmers give to the rearing of that specific breed which was perceived to be easier to manage in terms of feed, water, and health care requirements. However, the purchase of the bulls and cows as breeding stock was purely based on phenotypic characteristics and does not take into consideration the genetic merit of an animal. Although the Muturu bulls were used sometimes for draught, the Muturu cattle were particularly kept for its meat that is extremely appreciated by consumers due to its organoleptic characteristics. This is valuable because early reports showed that meat of the Muturu cattle breed seems to be better than that of Zebu and Borgou based on the fatty acid profile (Salifou et al. 2012). Income is generated when the bull reaches the marketing age of 2 years or above. They are slaughtered for sales or ceremonies or sold live to middlemen or brokers who in turn slaughter them and sell the meat. This observation was also reported in Nigeria where the Muturu cattle are reared on free range for sales and traditional ceremonies such that ritual restrictions surround their management (Adebambo 2001). Cows are rarely sold unless they are sick or not performing well. Contrary to the farmers in peri-urban areas in Ouagadougou (Burkina Faso) for whom milk production represented the primary breeding objective (Roessler 2019), the Wémé and Tori ethnic groups who are the custodian of the Muturu cattle in the study area did not practice cow milking. In fact, due to the low milk production of the Muturu cow, they were taught from generation to generation in these communities that cow milking might prevent the calves to get enough milk for their growth. The average milk yield of the Muturu cow in Benin is about 0.36 l per day in a semi-intensive production system which is lower than that of other locally adapted cattle breeds (Kassa et al. 2016). However, it was proved that even a cow from beef

breed will increase production in response to being milked and continuing to milk after the calf has been weaned will result in the cow continuing to produce milk (Wilkie 1964; Phillips 2009). In Benin, milk products, particularly the traditional cheese, are very appreciated by the consumers. Unfortunately, the traditional cheese is expensive particularly during the dry season in the South because most of the cheeses that are sold are produced in the north of the country that holds 2/3 of the national cattle herd. If milk production is encouraged in the Muturu cattle keeper community, this will reduce the cost of milk product production in the South and generate more revenue for the Muturu cattle keeper who will get better involved in conserving the breed.

The lack of interest in being part of a breeders' association reported in this study implies that the respondents are not aware of the benefits related to membership. This calls for awareness towards breeders.

The main criterion for the selection of bull was robustness which indicates that cattle keepers prefer animals of big size. Body conformation was also highly ranked as a preferential trait among Nguni cattle breeders in South Africa (Tada et al. 2013). Similar trends were observed among Ankole cattle breeders in Burundi, Rwanda, Tanzania, and Uganda (Wurzinger et al. 2006; Kugonza et al. 2012). Contrary to farmers in the sub-humid eastern coast and temperate southern highlands of Tanzania for whom milk yield, fertility, temperament, feed requirement, and disease resistance are important criteria for cow selection (Chawala et al. 2019), farmers in the Ouémé area select females based on the growth and conformation of their offspring. Those clearly show the desire of Muturu cattle keepers to have cows giving birth to calves of good conformation with a good growth rate. These desired traits must be considered as part of any future breeding objectives for Muturu cattle.

With regard to the feeding and watering modes, it has been noted in the study area that the animals were generally fed exclusively on natural pasture irrespective of the season. Opposite findings were reported by Dossa and Vanvanhossou (2016) in northern Benin where after grazing animals received feed supplements especially during the dry season. This seems reasonable because the climate in southern Benin (alternating two dry and rainy seasons) compared with that of northern Benin (alternating one dry and one rainy season) is more favorable to the permanence of natural pasture. In addition, the herds of Muturu cattle in the investigated regions are generally small in size (3–6 animals), which makes feeding management easier for those small-scale farmers.

The average age at first calving was 33 months in most herds in the study area. This is different from the observations of Domingo (1976) who reported age at first calving of 36–42 months for Muturu cattle reared in a traditional production system. Alkoiret and Gbangboche (2005) published higher figures (48 months) for animals reared in an intensive

production system. This variability between different observations may be due to the influence of the environment. As defined by Oldenbroek and Van der Waaj (2014), the environment is anything that influences the animal's performance that is not related to the genetic makeup of the animal, starting at the earliest possible moment in life, even before conception.

Except for Bonou where we had identified some large herds (33), the largest average herd size in any of the other three locations was 5.19. Owners of larger herds are among the rare farmers in the area whose livelihoods are specialized around keeping Muturu cattle. A similar observation was made in Nigeria by Gwaza et al. (2018). The case of Bonou can be considered as exceptional because the respondents in Bonou were among the rare farmers who still keep the Muturu cattle in the area. They inherited their stock from their parents and have been carrying such activity for more than 25 years. Male and particularly female animals were kept for a very long time. The existence of uncontrolled mating in all municipalities added to small flock sizes and long reproductive lifespan would potentially increase the level of inbreeding, as indicated by Nitter (2000). This calls for designing a selection scheme applicable at the community level to avoid a within-breed selection. An open nucleus breeding scheme could be a good alternative. Regarding health management, tick control was not frequent, which confirms the resistance of the breed to ticks and its adaptation to the local environment.

The survey identified several constraints with land use competition with crop farming being rated highest. In fact, based on its soil fertility, the valley of Ouémé was ranked the world's second richest valley after the Nile (AFDB 2017). It has great agricultural potential with the possibility of three crops cycles per year. However, less than 30% of this area is exploited. Therefore, in order to use more efficiently the potential of the valley and alleviate poverty for the rural communities, policy makers have implemented different cropping development strategies in the area for years. As a result, local people give nowadays more credit and allocate more time to cropping than any other activity. Similar to the case of Liberian farmers (Karnuah et al. 2018), theft is a major challenge for many cattle keepers. Lack of fences and the common feeding system (animals were tethered alone all day long in open areas) were the main causes. These limiting factors constitute a barrier to the development of the Muturu cattle breeding in these areas. Sikhweni and Hassan (2014) noted similar trends and concluded that significant correlations exist between cattle theft, cattle death, and herd size. The current status of the Muturu cattle in Benin is unknown according to the Domestic Animal Diversity Information System of the Food and Agriculture Organization (DAD-IS 2019). However, based on the yearly report of the directorate of Agriculture, Husbandry and Fisheries at the departmental level, the number of Muturu cattle in the Ouémé area has decreased over the years (DDAEP-Ouémé 2018). Compared

with the estimation of the overall number of cattle farmers provided by the directorate of Agriculture, Husbandry and Fisheries at the departmental level, the number of Muturu cattle keepers we were able to interview in the study areas was quite low. This is the result of several years of implementation of breeding strategies and policies that encourage the replacement of indigenous breeds with exotic breeds. The Muturu cattle are in a precarious condition and need to be conserved due to its trypanotolerance, ability to survive on low-quality feed and limited water supply, adaptation to a humid environment, and cultural roles. As an input for setting up sustainable community-based breeding strategy targeting the breed conservation, the present survey identified several limiting factors that should be addressed. These include small flock sizes with long lifespan for breeding male and female, uncontrolled mating, feeding based on natural pasture only all year long, land use competition with cropping, theft due to absence of fences, and communal grazing making breeding control difficult.

In conclusion, the organization of farmers into association is required to open perspectives to help conserve the Muturu breed for the socioeconomic wellbeing of the cattle keepers. A community-based breeding program aiming at conserving the Muturu cattle should be implemented and requires the involvement of three main groups of actors: group 1 composed of researchers providing scientific support and ensuring economic evaluation, as well as technological development; group 2 composed of State, NGOs, and donors to cover roles in financing, subsidizing, and capacity building; and group 3 represented by a breeders' association in charge of breeding program management, genetic progress, and breed conservation. In order to curb animal theft, improvements in housing infrastructure and fencing for livestock are needed. Best breeding bull exchange systems should be established between the members of the group to minimize within-herd inbreeding level. It is also important to improve the milk production of the Muturu cattle breed as this could boost the motivation of the cattle keepers to conserve the breed. Strong extension service is required to convince farmers and to develop an interest in cow milking and milk processing. To improve genetic and economic efficiency in the Muturu cattle breeding, AI and ET technologies could be used as suggested by Gicheha et al. (2019). A contest and show program with good prizes could be a way of attracting cattle keepers in that region to recognize the effort they are deploying on this breed. In order to fully get the benefits of the strategy, non-genetic factors should be improved and farmers' indigenous knowledge and preferred traits should be considered. Indeed, a survey on the molecular diversity of the Muturu cattle in Benin should be carried out to best define which animals should be conserved.

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Compliance with ethical standards

Statement of animal rights The manuscript does not contain clinical studies or patient data.

Conflict of interest The authors declare that they have no conflict of interest.

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