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**Tropical Animal Health and  
Production**

ISSN 0049-4747  
Volume 48  
Number 2

Trop Anim Health Prod (2016)  
48:349-359  
DOI 10.1007/s11250-015-0958-5

Volume 48 · Number 2 · February 2016

**Tropical  
Animal Health  
and Production**



Published in association with the  
Centre for Tropical Veterinary Medicine,  
University of Edinburgh

 Springer

 Springer

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# The indigenous Somba cattle of the hilly Atacora region in North-West Benin: threats and opportunities for its sustainable use

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Received: 16 July 2015 / Accepted: 11 November 2015 / Published online: 21 November 2015  
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**Abstract** The objective of this study was to characterize the declining Somba cattle population in its production system context. Two-hundred-twenty-four (224) cattle farm-households were surveyed in the Boukombe district, the natural habitat of the breed in North-West Benin. Information on their socioeconomic characteristics and on their herd management practices were recorded using a semi-structured questionnaire. In addition, 15 body measurements were recorded from 102 adult cattle. Three types of breeders were distinguished: the owners-herders (54.0 %); the absentee owners (40.2 %) and the professional herders (5.8 %). The average cattle herd sizes were  $4.7 \pm 3.70$  and  $58.6 \pm 22.83$  heads for owner-managed and entrusted herds, respectively. Offtakes were more associated with sociocultural purposes (75.5 %) than market. While crop farming was the main occupation and income source of their owners, the Somba cattle were used for ploughing during the rainy season. In contrast to the widely accepted belief that this indigenous genetic resource is mainly threatened by crossbreeding and/or replacement, our findings suggest high mortalities due to diseases, feed and water shortages and poor reproduction management as the main causes of the decline of this cattle population. Somba cattle generally have short horns and a small body size. However, bulls have significantly ( $P \leq 0.05$ ) longer horns ( $21.2 \pm 16.44$  cm against  $13.9 \pm 7.21$  cm), higher height at withers ( $99.7 \pm 6.97$  cm against  $95.9 \pm 5.76$  cm) and body length ( $149.7 \pm 12.87$  cm against  $146.8 \pm 11.01$  cm) than

cows. All surveyed farmers expressed their willingness and readiness to participate in and contribute materially or financially to any program towards a sustainable use and preservation of this breed which they perceived as hardy and embedded in their culture. We therefore argue that strategies for its sustainable use and conservation should consist of simultaneously improving general herd management practices, organizing farmers and involving them in participatory breed improvement programs.

**Keywords** Crop-livestock systems · Farm animal genetic resources · Management and conservation · Smallholder cattle farms

## Introduction

Cattle supply farm families with milk, meat, manure and fulfil different economic, social and cultural functions in North Benin (De Haan 2000). The Somba cattle breed is one of the four cattle types traditionally kept in Benin, mainly in small herds in the mixed subsistence crop-livestock system around the Atacora mountain area in north-west of the country. This small-sized taurine cattle breed is known for its adaptability to marginal environments and trypanotolerance (Belemsaga et al. 2005). Its number sharply decreased from 58,000 in 1986 to about 17,000 heads in 2000 (CIRDES 2001). Currently, there is no data about its effective population size, explaining its unknown risk status (FAO 2012). But it is considered to be threatened in its belt (Hindar 2001), mostly because of the changes in the breeding practices of the indigenous farmers (Hindar 2001; Kamuanga et al. 2006) and suspected indiscriminate crossbreeding with Zebus. The loss of diversity in the Somba breed, the genetic base for this activity, represents thus a threat to food security and poverty

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alleviation and a loss of cultural heritage. Although the urgent need to prevent its further erosion through conservation and sustainable use was first recognized by the Food and Agriculture Organization (FAO) in 1989 and stressed again in the Benin report on the state of its farm animal genetic resources (DE-MAEP 2004), there is up to date neither a comprehensive characterization of this breed in its production context nor a program for its management in its natural environment (“in situ”) involving the full participation of the local communities. Consequently, very little is known about its current production systems and the decision and management options taken by the local people when making use of it and the threats for its sustainable use. The objectives of the present study were therefore to morphologically characterize this indigenous genetic resource, analyze farmers’ traditional breeding strategies and practices, and identify threats and opportunities for its sustainable use.

## Materials and methods

### Study area and sampling procedure

Household surveys were carried out in two administrative units (Boukombe and Korontiere) representative of the Boukombe district, the original habitat of the Somba cattle breed in the Atacora region in North-West Benin. The climate is of Sudano-Guinean type and characterized by one dry season from November to March and one rainy season from April to October. The average annual rainfall is about 1000 mm, and the temperature ranges from 24 to 36 °C. The major soil types are red loam and black and the vegetation dominated by clear forest, woody and shrubby savannas. The Atacora region is a mountainous region where rocky soils are too fragile and opportunities to engage in conventional cropping activities are relatively limited. Livestock keeping, cattle in particular, represents one of the most important local livelihoods strategies. It plays a valuable role in enhancing cropping activities and is therefore a very important source of food security while providing both market and non-market benefits. Other farm animal species kept included goat, pigs and poultry. The main staple food crops grown are sorghum (*Sorghum bicolor*), millet (*Pennisetum glaucum*), fonio millet (*Digitaria exilis*), rice (*Oryza sativa*), corn (*Zea mays*), cowpea (*Vigna unguiculata*), peanut (*Arachis hypogaea*), yam (*Dioscorea* spp.) and potato (*Ipomoea batatas*). Tobacco (*Nicotiana tabacum*) and cotton (*Gossypium* spp.) are the major cash crops. According to Tchegnon (2006), off-farm activities included petty trade, production of sorghum beer (*Tchoukoutou*) and extraction of butter from the nuts of African shea tree (*Vitellaria paradoxa*) and mustard from the grain of néré tree (*Parkia biglobosa*) and soybean (*Glycine max*).

The two locations (Boukombe and Korontiere) were chosen for this study out of the seven administrative units (arrondissements) of the district of Boukombe because together they comprised almost half of the Somba cattle population of the district (Gbaguidi et al. 2006). All villages (7) in Korontiere and 7 villages randomly selected out of the total of 16 in Boukombe were included in the study. Because lists of households keeping cattle were not available in both locations, a fully randomized sampling was not feasible. We therefore used a snow-ball approach (Babbie 2009) to select 224 cattle farm-households (122 in Korontiere and 102 in Boukombe).

### Data collection

A structured questionnaire was used to collect information on household characteristics, livestock management, herd size, structure and dynamics as well as the uses and keeper’s perceptions about adaptive traits and productive performance of the Somba cattle. The questionnaire was first pre-tested on 13 farmers to check the clarity and appropriateness of the questions, as corrected. It was then administered individually to heads of selected households in the presence of other members of the household to allow for supplementation of relevant information. The questionnaire was administered in the respondent’s local language with the help of an experienced translator and guide. As part of the questionnaire survey, respondents were asked to rank (1 being the best and 4 the worse) the Somba breed and the three other genotypes commonly found in the study area (Borgou, Zebus and crossbreds) according to selected traits (tolerance to disease, feed shortage and water shortage, walking ability, reproductive performances, temperament, marketing easiness, meat yield and taste, milking easiness, milk yield and taste and draught ability). Each farmer was further asked to identify in his herd four mature and active breeding animals (three cows and one bull) perceived as of pure Somba breed. The maturity of a designated animal was ascertained by examining its dentition. Only animals that possessed four pairs of permanent teeth (3.5 years old and more) were retained and described for various physical traits. A total of 25 traits, both qualitative (10) and morphometric (15), were included in the phenotypic characterization. The qualitative traits described were sex, presence of horn, horn colour, horn shape, head profile, ear shape, ear orientation, body hair coat colour, body hair coat colour pattern and dewlap size. The morphometric traits measured and the measuring devices are described in Table 1. All linear measurements and physical descriptions were taken by one person to minimize between-individual variations. The geographic coordinates of surveyed herds were taken by waypoint with a GPS Vista Garmin.

**Table 1** Description of the 15 quantitative morphological variables recorded on Somba cattle in North-West Benin and of the measuring devices

Number	Variable name	Description	Measuring device	
1	MC	Muzzle circumference	Complete distance around the outside of the mouth	Measuring tape
2	HW	Head width	Distance between the right and left temples	Wooden caliper
3	HL	Head length	Distance from the center of the poll to the tip of the muzzle	Measuring tape
4	EL	Ear length	Length on back side of the ear from its root on the poll to the tip	Measuring tape
5	HOL	Horn length	Distance from the root of the horn to its tip along the outer curvature	Measuring tape
6	CG	Chest girth	Circumference of the body immediately behind the shoulder blades in a vertical plane, perpendicular to the long axis of the body	Measuring tape
7	HC	Hock circumference	Circumference taken just above the hock joint	Measuring tape
8	TL	Tail length	Distance between the base and the apex of the tail	Measuring tape
9	SPW	Shoulder point width	Distance between the right and left shoulder points	Measuring tape
10	RW	Rump width	Distance between the most posterior points of pin bones	Wooden caliper
11	CD	Chest depth	Vertical distance from the chest floor just behind the forelegs to the top of withers	Measuring tape
12	HAW	Height at withers	Vertical distance from the bottom of the front foot to the highest point of the shoulder between the withers	Measuring stick
13	HAS	Height at sacrum	Distance from the top of the bone at the base of the tail to the ground	Measuring stick
14	SIL	Scapula-ischium length	Distance from the point of the shoulder to the point of the buttocks	Measuring tape
15	BL	Body length	Horizontal distance from the point of shoulder to the pin bone	Measuring tape

## Data analysis

All the collected data were processed and analyzed using the IBM®-SPSS® software version 20 (IBM Corp. 2011). Frequencies and chi-square ( $\chi^2$ ) tests for independence were used to describe the qualitative information and explore statistical differences between groups, whereas means and standard deviations were calculated for quantitative data and differences between groups assessed using Mann-Whitney *U* or Kruskal-Wallis tests where appropriate. We used the Friedman ANOVA to find out whether there was a significant difference among respondents in respect of the ranking allotted for the breeds on a particular trait.

## Results

### Production systems

#### Keepers' socioeconomic characteristics

The majority of Somba cattle farmers surveyed were male (94.2 %) and illiterate (81.2 %) from the Otammari ethnic group (70.5 %). Their average age was  $48.4 \pm 14.35$  years. They were heads of households made of  $8 \pm 4.0$  members, of which near the half was active. Livestock keeping (46.5 %) and crop cultivation (48.0 %) were their main activities, the latter being the main source of income for their majority (67.3 %). Each household cultivated an average of  $3.8 \pm 2.43$  ha of land. Corn (*Zea mays*), millet (*Pennisetum glaucum*), cowpea

(*Vigna unguiculata*), fonio (*Digitaria exilis*), sorghum (*Sorghum bicolor*) and yam (*Dioscorea* spp.) were the main crops grown. Only 11.2 % of the interviewed farmers were involved in off-farm activities. Besides cattle, 79 % of them reared poultry, 68.3 % goats, 50 % pigs and 49.1 % sheep. The mean number of goats, sheep and pigs owned per household were respectively  $3.6 \pm 3.78$ ,  $3.2 \pm 5.85$  and  $1.5 \pm 2.78$  heads. More than half (57.1 %) of the heads of households were being keeping cattle since their childhood whereas the remaining 42.9 % was practicing this activity for the last  $15 \pm 11.0$  years. The main modes of acquisition of the breeding stock were inheritance and purchase (46.7 and 39.0 % of respondents, respectively).

#### Ownership patterns

Three types of Somba cattle breeders were revealed by the survey: the owners-herders (54.0 %), the absentee owners (40.2 %) and the professional herders (5.8 %) who took on entrusted cattle from absentee owners. All of the professional herders surveyed were from Peulh ethnic group. There was a significant difference between owners-herders and absentee owners ( $P = 0.001$ ) for their ethnic origin. Only 29.7 % of the owners from the Otammari origin had entrusted their cattle against 81.1 % from the other ethnic groups made of Yindé, Lamba and Haoussa. While all absentee owners declared that they entrusted their cattle to avoid theft and to enable their children's schooling, owners-herders gave mismanagement and steal of animals by herders as reasons for not entrusting their herds.

### Herd sizes, composition and dynamics

The average cattle herd sizes were  $4.8 \pm 3.70$  and  $58.6 \pm 22.83$  heads for owner-managed and entrusted herds, respectively. In total, female animals represented about 65 % of the total herd (Table 2), cows being the most numerous followed by castrated bulls. Regardless of categories of herds, the ratio of potential breeding male to breeding female was about 1 to 6. However, about 74.6 % of the surveyed herds (81.0 % of owner-managed herds and 15.4 % of entrusted herds) had no bull. In terms of breeds, the large majority (98.0 %) of the counted animals were identified by the respondents as Somba, 1.10 % as crossbred; 0.75 % as Borgou and 0.15 % as Zébu (*Bos indicus*). Herds of Somba-only animals represented 94.0 % of the total number of surveyed herds and were more commonly owner-managed than entrusted (69.2 %).

Overall, 29.9 % of exits were losses while 21.8 % were for beneficial purposes. Losses were mainly due to mortality (67.9 %) and theft (32.1 %), whereas uses for sociocultural purposes such as sacrifices (41.8 %), feast (18.2 %), payment of dowry (15.4) and sales (24.6 %) were the major reasons given for offtakes.

### Husbandry practices

**Housing** Figure 1 shows the types of housing for cattle by season and herds' categories. In general, animal were housed at night in the ground floor of fortified family houses known as *Tata Somba*, followed by tethering in the yard, kraal and sheds. In contrast to animals in owner-managed herds which were housed differently across seasons, those in all entrusted herds were tethered in the yard all year round.

**Table 2** Average cattle herd sizes and structure by type of herd in the Boukombe district in North-West Benin

	Total (n = 134)	Owner-managed herds (n = 121)	Entrusted herds (n = 13)
	Means $\pm$ SD	Means $\pm$ SD	Means $\pm$ SD
Herd size (n)	10.0 $\pm$ 17.76	4.8 <sup>a</sup> $\pm$ 3.70	58.6 <sup>b</sup> $\pm$ 22.83
Herd structure <sup>c</sup> (%)			
Male calves	4.6 $\pm$ 9.81	4.9 <sup>a</sup> $\pm$ 9.98	10.4 <sup>b</sup> $\pm$ 5.37
Bull-calves	7.2 $\pm$ 12.01	7.2 <sup>a</sup> $\pm$ 12.59	7.3 <sup>b</sup> $\pm$ 3.58
Mature bulls	5.0 $\pm$ 11.34	4.9 <sup>a</sup> $\pm$ 11.83	6.0 <sup>b</sup> $\pm$ 5.09
Oxen	17.9 $\pm$ 28.13	18.4 $\pm$ 29.45	13.6 $\pm$ 8.40
Female calves	5.7 $\pm$ 10.36	5.2 <sup>a</sup> $\pm$ 10.68	10.0 <sup>b</sup> $\pm$ 5.05
Heifers	15.6 $\pm$ 21.38	15.6 $\pm$ 22.30	15.2 $\pm$ 9.60
Cows	43.9 $\pm$ 28.12	44.6 $\pm$ 29.39	37.5 $\pm$ 8.85

<sup>a,b</sup> Means in the same row are significantly different ( $P < 0.05$ ), Mann-Whitney *U* test

<sup>c</sup> Male/female calve (<1 year), bull-calves (<3 years)

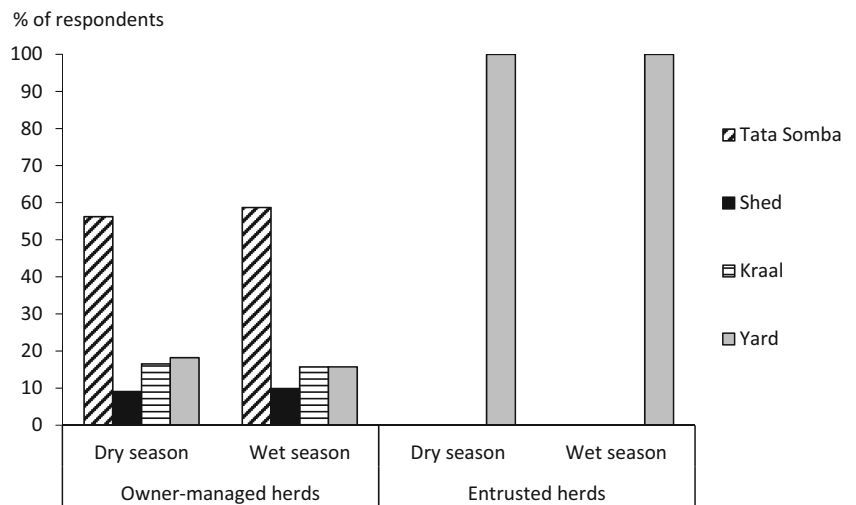
**Feeding and watering** Grazing on communal lands was by far the most common feeding practice. Supplementary feed was provided to 44.0 and 3.7 % of the herds during dry and wet seasons, respectively, and was based on crop residues such as peanut leaves (41.7 %), millet and sorghum stovers (14.3 %) and collected fresh herbs (44.0 %). The latter was used in significantly higher proportion of entrusted than owner-managed herds ( $\chi^2 = 8.22$ ,  $P < 0.05$ ), while crop residues were mainly used in owner-managed herds (Fig. 2). Water was provided to all surveyed herds during grazing. About 26.1 % of respondents, mostly owners-herders, provided additional water to their animals at homestead when they return from grazing. In general, rivers were the most important source of drinking water during both dry and wet seasons, followed by bores (9.2 %) and wells (7.7 %).

**Breeding** Mating was generally uncontrolled in all herds. The majority of surveyed farmers (84.4 %) practiced castration which was usually done when the animals averaged  $3.0 \pm 1.51$  years old either by a veterinarian/livestock technician (45.5 % of herds) or by the farmers themselves or a village operator. Depending on the operator (Fig. 3), it was done using either the Burdizzo method known as “bloodless method” or the knife method (the bloody method) which consists of surgically removing the testicles using a knife. While the Burdizzo method was used by all veterinarians, a significantly fewer proportion of professional herders than owner-herders used the bloody ones ( $\chi^2 = 106.24$ ,  $P < 0.001$ ). The main reasons given by respondents for castration were to prevent their male animals from following cows from other herds and thereby to reduce the risk of losses (35.3 %), to favour carcass composition and weight development (31.0 %), to improve draught ability (25.6 %) and to reduce aggressive temperament (8.1 %).

**Health** Many farmers reported several cases of sudden animal death, suspecting anthrax. Diarrhoea, watery eyes, sneezing, fever, loss in weight, bristling hair and sore and spot on the skin were frequently reported by respondents as main signs of diseases in their herds. While 28.8 % of respondents declared to not do anything to prevent and treat diseases, 41.4 % of them mentioned that they used to consult veterinary services and 16.7 % reported self-medication.

**Reproductive performances** The reported average age at first calving was  $3.6 \pm 1.06$  years. Average fertility, calving and fecundity rates were estimated at 69.2, 46.9 and 42.2 %, respectively. Seventy-nine percent (79.4 %) of the respondents reported that most calving in their herds occurred at the beginning of the dry season between September and December. Average reported calf weaning age was  $23 \pm 9.0$  months.

**Fig. 1** Types of cattle houses by type of herd in Boukombe, North-West Benin



**Main uses of Somba cattle** Milking was done in all of entrusted herds against 42.0 % of owner-managed herds. But irrespective of herd type, no record of milk production was kept. Collected milk was sold raw (42.9 % of milked herds), home-consumed and used to produce cheese (36.5 % of milked herds) and home-consumed only (20.6 % of milked herds). In contrast to the majority of owners-herders, most herders usually sell the collected milk without processing. When cheese was produced, it was either home-consumed (80 % of producing households) or sold. Sixty four percent (64 %) of the cattle owners mentioned that they use their animals also for ploughing their agricultural fields.

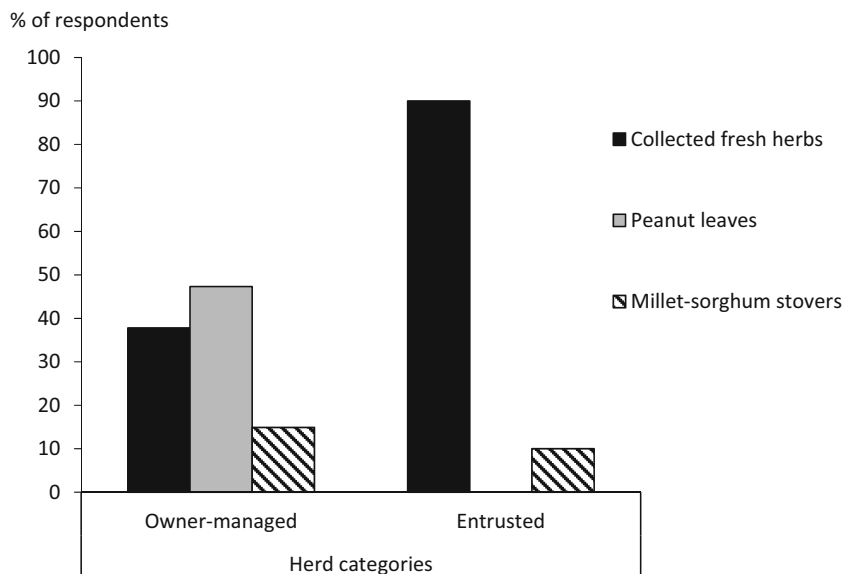
**Production constraints** Disease outbreaks resulting in high mortalities, followed by feed shortage and theft, were the major production constraints reported by the respondents (Fig. 4). Further constraints included conflicts with farmers, inadequacy of cattle housing and shortage of household labour

to take care of cattle. Theft and diseases were reported by a significant fewer proportion of professional herders than absentee-owners and owner-herders, whereas feed shortage and conflicts were reported by a higher proportion of professional herders ( $\chi^2 = 30.34, P < 0.05$ ).

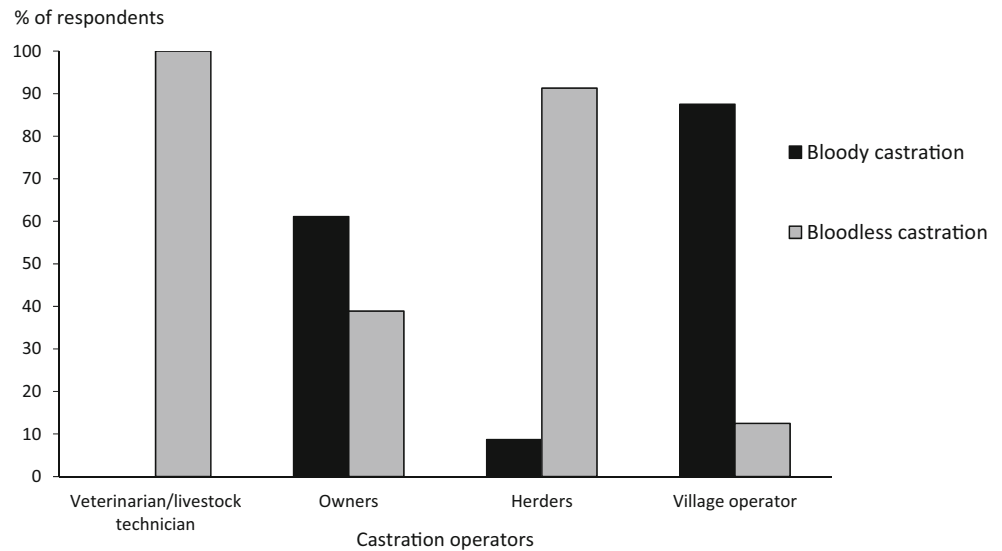
**Farmers’ valuation of Somba and other cattle breeds**

Table 3 displays the results of the respondents’ rankings of the different breed/genotypes according to selected traits/attributes. Most respondents ranked the Somba cattle better than the other locally available breeds for most of the attributes. Being the unique indigenous breed in the location, its high cultural value was mentioned by 30.4 % of the respondents. But it was given the lowest ranks for meat yield, milk yield and milking easiness. Compared to other genotypes, it was also considered as having a significant ( $P < 0.001$ ) lower market values (including marketing easiness). But according to

**Fig. 2** Feed supplements by type of herd in Boukombe, North-West Benin



**Fig. 3** Methods of castration by type of operator in Boukombe, North-West Benin



27 % of the respondents, it is their low market prices compared to other breeds that make them accessible to smallholders.

**Conservation perspectives for the Somba cattle and its habitat**

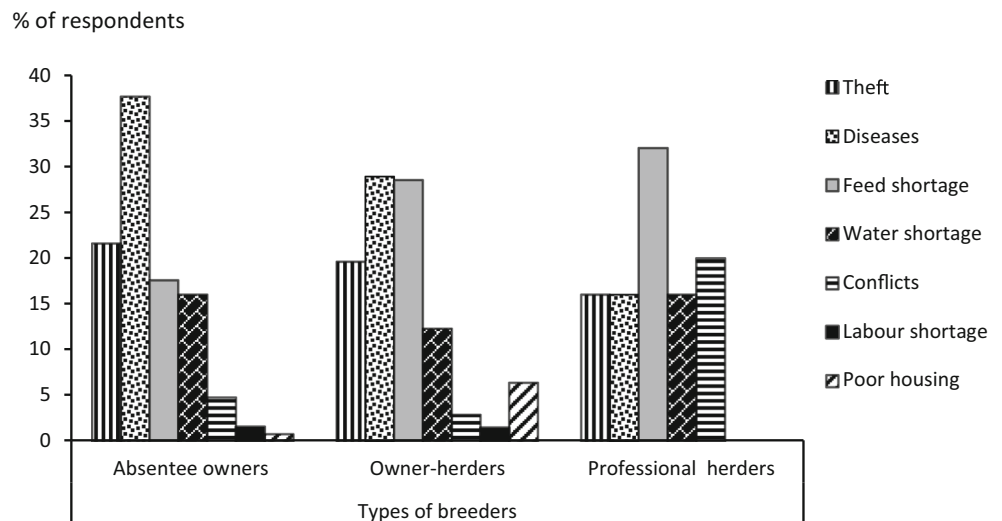
About 81.7 % of the breeders perceived that the population size of the Somba cattle was in decrease. The main reasons given by respondents for this decrease were mortalities caused by diseases (44.7 % of the respondents), theft (39.8 %), followed by feed and water shortage (7.7 %), entrustment (4.6 %) and others (3.2 %) such as the declining interest in cattle keeping in the region. The large majority of farmers interviewed (80.4 %) were willing to participate in any program aiming at maintaining this breed; 92.6 % of them were

willing to participate financially. The respondents indicated that actions towards a sustainable use of the breed should mainly help them to reduce herd mortalities through diseases prevention and treatment (50.5 %), to reduce theft (21.8 %) and restore degraded grazing areas and water points (17.8 %).

**Morphological characteristics of the Somba cattle breed**

Table 4 presents the mean values for the measured morphometric traits. Except for MC, CG, TL, SPW, RW and CD, all the other measurements were significantly ( $P < 0.05$ ) higher for the bulls than for the cows. Similarly, the proportion of measured cows having smaller dewlap size (56 %) was significantly higher ( $\chi^2 = 9.79$ ,  $P < 0.05$ ) than that of bulls (21 %). Somba cattle had a straight head profile and rounded lateral ears. Most of the animals (94.2 %) were horned, the

**Fig. 4** Main constraints in Somba cattle production per type of breeder in Boukombe, North-West Benin



**Table 3** Farmers' ranking of cattle traits/attributes by locally available breed in Boukombe district, North-West Benin ( $n = 224$ )

Traits/attributes	Genotype/breed				$\chi^2$ value	$P \leq$
	Somba	Borgou	Zebu	Crossbred/Métis		
	Mean rank <sup>a</sup>					
Keeping easiness	1.16 <sup>b</sup>	2.50 <sup>c</sup>	3.56 <sup>d</sup>	2.79 <sup>c</sup>	231.38	0.001
Disease tolerance	1.11 <sup>b</sup>	2.29 <sup>c</sup>	3.56 <sup>d</sup>	2.84 <sup>c</sup>	225.59	0.001
Tolerance to feed shortage	1.06 <sup>b</sup>	2.56 <sup>c</sup>	3.62 <sup>d</sup>	2.77 <sup>c</sup>	261.16	0.001
Tolerance to water shortage	1.04 <sup>b</sup>	2.57 <sup>c</sup>	3.62 <sup>d</sup>	2.77 <sup>c</sup>	262.79	0.001
Ability to walk long distances	1.54 <sup>b</sup>	2.50 <sup>c</sup>	3.19 <sup>d</sup>	2.77 <sup>cd</sup>	105.99	0.001
Reproductive performances	1.41 <sup>b</sup>	2.48 <sup>c</sup>	3.32 <sup>d</sup>	2.79 <sup>c</sup>	141.74	0.001
Good temperament	1.25 <sup>b</sup>	2.54 <sup>c</sup>	3.53 <sup>d</sup>	2.69 <sup>c</sup>	180.26	0.001
Marketing easiness	2.65 <sup>cd</sup>	2.15 <sup>bc</sup>	2.14 <sup>b</sup>	3.06 <sup>d</sup>	42.36	0.001
Meat yield	3.00 <sup>d</sup>	2.08 <sup>c</sup>	1.79 <sup>b</sup>	3.13 <sup>d</sup>	97.07	0.001
Meat taste	1.02 <sup>b</sup>	2.64 <sup>c</sup>	3.68 <sup>d</sup>	2.66 <sup>c</sup>	247.24	0.001
Milking easiness	2.69 <sup>cd</sup>	2.38 <sup>c</sup>	1.72 <sup>b</sup>	3.02 <sup>d</sup>	30.59	0.001
Milk taste	1.08 <sup>b</sup>	2.77 <sup>c</sup>	3.51 <sup>d</sup>	2.64 <sup>c</sup>	74.90	0.001
Milk yield	3.29 <sup>d</sup>	2.10 <sup>c</sup>	1.33 <sup>b</sup>	3.27 <sup>d</sup>	76.78	0.001
Draught ability	1.10 <sup>b</sup>	2.46 <sup>c</sup>	3.69 <sup>d</sup>	2.75 <sup>c</sup>	229.31	0.001

<sup>a</sup> The lower the value, the higher is the rank of the breed for the specific attribute

<sup>b,c,d</sup> Means in the same row are significantly different ( $P < 0.05$ ), Friedman test

horns being often brown and curved. Their body coat colour was mainly spotted and dominated by black, white or fawn (Table 5).

**Table 4** Mean and standard deviation of body measurements (cm) of mature Somba cattle in North-West Benin

Traits	Total ( $n = 102$ )	Cows ( $n = 75$ )	Bulls ( $n = 27$ )
MC	40.2 ± 4.16	40.0 ± 4.03	40.5 ± 4.56
HW	17.6 ± 2.74	17.1 <sup>a</sup> ± 2.29	18.9 <sup>b</sup> ± 3.36
HL	41.5 ± 2.85	40.9 <sup>a</sup> ± 1.96	43.2 <sup>b</sup> ± 4.09
EL	12.3 ± 1.42	12.1 <sup>a</sup> ± 1.15	13.0 <sup>b</sup> ± 1.85
HOL	15.8 ± 10.88	13.9 <sup>a</sup> ± 7.21	21.2 <sup>b</sup> ± 16.44
CG	160.8 ± 11.38	160.4 ± 9.87	162.0 ± 15.09
HC	48.3 ± 6.65	47.6 <sup>a</sup> ± 6.53	50.3 <sup>b</sup> ± 6.74
TL	87.4 ± 8.92	86.3 ± 7.07	91.0 ± 12.62
SPW	24.8 ± 2.38	24.6 ± 1.98	25.4 ± 3.22
RW	32.4 ± 4.07	32.3 ± 4.27	32.7 ± 3.53
CD	51.5 ± 4.99	51.2 ± 4.63	52.6 ± 5.91
HAW	95.9 ± 5.76	94.7 <sup>a</sup> ± 4.74	99.7 <sup>b</sup> ± 6.97
HAS	102.1 ± 5.96	100.8 <sup>a</sup> ± 4.11	106.1 <sup>b</sup> ± 8.51
SIL	98.2 ± 6.97	97.1 <sup>a</sup> ± 5.44	101.6 <sup>b</sup> ± 9.64
BL	146.8 ± 11.01	145.8 <sup>a</sup> ± 10.22	149.7 <sup>b</sup> ± 12.87

MC muzzle circumference, HW head width, HL head length, EL ear length, HOL horn length, CG chest girth, HC hock circumference, TL tail length, SPW shoulder point width, RW rump width, CD chest depth, HAW height at withers, HAS height at sacrum, SIL scapula-ischium length, BL body length

<sup>a,b</sup> Means in the same row are significantly different ( $P < 0.05$ ), Mann-Whitney  $U$  test

## Discussion

### Somba cattle morphological characteristics

Though published morphological information on cattle breeds in Benin and more particularly on Somba breed is very scanty, the body measurements recorded in this study confirms the general perception that the Somba cattle is a small-bodied or stocky animal with relatively long and narrow head. The estimate values obtained for height at withers fall within the range of 0.90 up to 1 m reported by Adanléhoussi et al. (2003) and are comparable to the value of 0.97 obtained by Domingo (1976). Generally, Somba female animals tend to have smaller features than males. In contrast to Domingo (1976) who observed that Somba cows have a narrower rump than their males, no difference was observed in this study. The average value of 32.35 cm recorded for the rump width in Somba cows is close to the value of 33.32 cm reported by Yakubu et al. (2010) for the Nigerian White Fulani cows, whereas Somba bulls tend to have wider rump than White Fulani ones. As the rump width is related to conception rate and calving ease (Sawa et al. 2013), these findings might explain the successful partial absorption of this breed by the White Zebu Fulani through crossbreeding resulting in the creation of the Borgou breed (Porter 2002; Felius et al. 2014; Flori et al. 2014).

The major coat colours recorded in this study are consistent with observations by Adanléhoussi et al. (2003). However, the non-negligible proportion of recorded animals having dominant fawn coat colour and/or lyre-shaped horns which are

**Table 5** Characteristics (frequency) of coat colour and horn shape in Mature Somba cattle (n = 102)

Variables	Percentage of animals
Body hair coat colour pattern	
Plain	11.7
Patchy/pied	23.4
Spotted	64.9
Dominant body hair colour	
Black	21.4
White	35.9
Black and white	10.7
Black and fawn	3.9
White and fawn	3.9
Grey	6.8
Fawn	17.5
Secondary body hair colour	
Black	40.5
White	24.0
Grey	15.7
Fawn	19.8
Horn shape	
Straight	24.0
Curved/crescent	43.8
Lyre-shape	24.0
Drooping	8.3
Horn colour	
Black	2.6
Brown	39.5
White	1.3
Black and brown	22.4
Black and white	7.9
Brown and white	21.1
Black, brown and white	5.3

typical characteristics of the medium-sized N'Dama cattle introduced in the area in 1952 (Youssao et al. 2000) may be the result of further hybridization of the Somba population.

### Production system, threats and opportunities for conservation

In contrast to observations made in many locations in North Benin where the large majority of cattle breeders are from the Peulh ethnic group (Djèntonin et al. 2004; Karim et al. 2012), cattle keeping in the study area is mainly done by the autochthonous Otammari people who represent 92.4 % of the Boukombe population. Furthermore, the fact that 67 % of the interviewed cattle farmers depend primarily on crop farming for their livelihood is consistent with earliest observation by van Liere et al. (1995) and Olson (1996) who noted that

Otammari people are subsistence crop farmers. They have diversified in rearing livestock probably because of repeated crop failures associated with climate variability (Turner 2000). Djèntonin et al. (2004) reported similar trends in north-east Benin and argued that diversification to agropastoralism was mainly due to environmental and institutional changes.

The high proportion of Otammari people who diversify into agropastoralism with cattle farming in our study demonstrates the potential complementary between cattle farming and cropping staple food. Furthermore, the scope for integration is evident through the use of the animals for ploughing, the use of their manure to fertilize crop fields and the valorization of crop residues as feeds.

The association of offtakes with sociocultural purposes rather than market as observed in our study is in line with previous observations by Adanléhoussi et al. (2003) and confirms that the decision to keep Somba is not simply based on economic parameters.

Herd entrustment by Otammari people to Peulh herders is not a new phenomenon and has been previously reported by Hall et al. (1995) and by Padenou and Barrué-Pastor (2006). But the high proportion of absentee owners in the current study seems to corroborate Sinsin's (2000) view that this practice has increased since 1950s. Likewise, the finding that almost all owner-managed herds were exclusively composed of Somba breed is consistent with those by Hall et al. (1995) and suggests the attachment of the Otammari people to this breed, attachment that could favour its conservation. As reported by Bedibete et al. (2007), pure Somba animals are important in traditional ceremonies. Similar observations were made by Mopaté et al. (2014) regarding the Baoulé cattle breed among the Lobi people of Burkina Faso. However, the increasing employment of Peulh herders by absentee owners to look after their herds in replacement of the children who were traditionally assigned this role (Rege et al. 1994) but now attend school will bring the Somba animals into greater contact with zebu preferably kept by the Peulh, thereby increasing the degree of introgression of zebu genes in this small cattle population. To avoid indiscriminate crossbreeding in entrusted herds and to prevent further dilution of the Somba breed, castration of males from other breeds kept together with the Somba breed should be systematically promoted among cattle breeders as being the case for the Baoulé cattle (Mopaté et al. 2014).

The small size of holdings generally means that there is a great variation between individual herds. The size of owners' managed herds observed in this study, significantly smaller than that of entrusted herds, is comparable to observations by Hall et al. (1995). As argued by Djèntonin et al. (2004) and by Rivera-Ferre and López-i-Gelats (2012), a small herd size means a good potential for efficient management and use of feed resources which become scarce. We therefore argue that in Boukombe where feed resources are particularly scarce, smallholdings should be encouraged.

The observed high proportion of castrated Somba bulls in the herds could be explained by the fact that nearly two-thirds of the surveyed keepers plough their crop fields with their animals and that most of them castrate the animals to improve their draught ability. Similar reasons for castration were reported by Hall et al. (1995) and by Mwambene et al. (2012a) for Fippa cattle. Contrary to cattle breeders in Southern Ethiopia (Banerjee et al. 2014), Somba cattle farmers do not select animals in their herds for breeding purposes. In contrast, they tend to castrate their best bulls for draught purposes. This might represent a serious threat to the sustainable use of the Somba breed since uncontrolled castration practices hamper systematic selective breeding (Mwambene et al. 2012a). It is therefore important to improve farmers' awareness of the importance of selection and of keeping superior bulls for breeding purposes. Moreover, the bloody castration which is practiced by several farmers predisposes animals to lethal infections and should be discouraged.

Nevertheless, the average ratio of potential breeding male to breeding female observed in this study is higher than the recommended values for traditional herds and suggests that Somba sires are being underexploited. However, the absence of sires in some herds means delays in serving females. As a result, fecundity rate is low and age at first calving is late. This probably explains the low proportion of calves in the surveyed herds, in spite of the predominance of breeding females. Furthermore, the fact that in most herds the cows are randomly mated during grazing explains why most of calving occurs at the onset of dry season, when feed becomes scarce. In fact, mating is recurrent during the dry season because the animals are left to wander freely during this period (Hall et al. 1995) and mix with those from others herds on communal grazing lands. However, random mating in communal areas might be advantageous for the maintenance of genetic diversity as it minimizes the occurrence of inbreeding effects particularly in herds of small size (Mwambene et al. 2012a).

The average rate of stillbirths reported by the respondents in this study is high and undermines herd productivity. The higher stillbirth rates observed in entrusted herds compared to owners' managed herds point to a mismanagement of entrusted animals as previously observed by Bassett (1994) and Moritz (2012). We therefore argue that poor reproductive management and herd entrustment are important factors constraining the productivity of the Somba cattle herds and could be considered as serious threats to the sustainable use of this breed.

The average mortality rate in Somba herds reported in the current study is far higher than the average value of 3.4 % reported by Adanléhoussi et al. (2003) in the same area. But it is in harmony with the high prevalence of diseases and/or symptoms as reported by farmers. In recent years (2007, 2009, 2012 and 2013), anthrax outbreaks were reported in the area

by the local authorities and resulted in deaths and slaughters for disease control. Unfortunately, specific information on the genotypes of affected animals was not available. But since this area is the belt of the Somba breed, this breed might be severely affected by these outbreaks. A good health management program is therefore necessary for the sustained use of this breed.

Communal grazing lands are the main source of feed for Somba cattle, and supplementary feeding made of crop residues and agroindustrial by-products is provided to the animals mainly in dry season. However, the continuous shrinkage of grazing lands as reported by most of the respondents is linked to the considerable expansion of cultivation and increased urbanization and human settlement that have taken place in this area during the last two decades (Burger 2005). Hence, although there are diverse animal feed sources available, namely crop residues, grazing lands and woodlands, their amounts are not sufficient to meet the requirements. Feed shortage, because it significantly and negatively affects animal productivity and production (Lamy et al. 2012), should be considered as an important resource-related threat (Pilling 2010) to the sustainable use and conservation of this local animal genetic resource. This threat needs to be appropriately addressed through a combination of improved management of communal grazing lands, enhanced use of crop residues and fodder development interventions. Yet, while smallholder farmers' usually have limited knowledge of fodder technologies, Ayele et al. (2012) showed that local fodder innovation platforms can be successfully established by bringing different stakeholders together for knowledge sharing, joint planning, development and implementation of interventions.

Our study reveals the readiness of the Somba cattle owners to join any well-designed improvement programme that effectively address the production constraints while conserving this native breed. There is thus a good local potential for the conservation and sustainable use of this breed despite its perceived lower market values and lower meat and milk productivity compared to other common breeds (Zebus, Borgou and their crossbreds). The main key driver for owners' willingness to conserve this indigenous genetic resource is its strong cultural values, the breed being considered as an integral part of the owners' cultural heritage. This finding is similar to those reported by Mwambene et al. (2012b) for Fippa cattle in Tanzania and by Banerjee et al. (2014) among indigenous communities of Southern Ethiopia.

FAO (2013) advises the implementation of selection programs for such a small population. However, while selection to improve productivity of small local breeds is critical for their long-term survival (Biscarini et al. 2015), it is sustainably enhanced when combined with other innovations and value-chain activities (McDermott et al. 2010). Furthermore, implementing a selection program requires a good recording system which is currently lacking. Considering the current

poor management practices observed among surveyed farmers, we argue that prior to the development of any selection scheme, improvement programs should first focus on feeding, healthcare and reproduction management aspects and on the design of a simple recording system tailored to farmers socioeconomic circumstances, for instance, to their low literacy. According to Mueller et al. (2015), to be sustainable the recording system should be linked to activities that are for immediate value to the farmers. Then, as recording and management practices improve, a central breeding nucleus scheme could be recommended because it usually results in higher genetic gain and profit than dispersed schemes (Mueller et al. 2015).

Now, while the conservation of local breeds requires appropriate national policies, governmental institutions in Benin still show little awareness of the genetic and sociocultural values of local cattle breeds and their current policies undermine their conservation. For instance, while there is a complete lack of direct support to the conservation of the local cattle breeds, the government is promoting, since 2003, a cattle improvement scheme whereby cows and bulls from imported Brazilian breeds are kept on governmental farms with the goal to make them available to local farmers. There is thus an urgent need to create awareness at the governmental decision-making levels on the detrimental impacts of such policies on local cattle breeds, especially on the Somba breed.

Local farmers can also play a useful role in the conservation of local breeds through the creation of farmers' groups or breed associations/organizations (Mopaté et al. 2014). Felius et al. (2014) go further to argue that the management of a breed depends on the combined effort of breeders and the breeding organization. But as evidenced by lessons learned from many case studies, the success of conservation initiatives in delivering benefits to local people depends on the creation of effective local institutions (Dossa et al. 2009; FAO 2009; Mueller et al. 2015). We argue that the Somba cattle farmers surveyed in this study will develop and implement the required local institutions toward the conservation and sustainable use of this native breed if they are given the necessary support needed for.

## Conclusions

This study applies a system approach to analyze the cattle production system in Boukombe in the Atacora region in North-West Benin and identify threats and opportunities for the sustainable use of the native Somba cattle breed. While keeping cattle is an important livelihood strategy for the local people, high mortalities due to diseases, feed and water shortages and poor reproduction management were identified as the most important production challenges. However, our findings suggest that there is a good potential for the sustainable

use and conservation of the native small-bodied taurine Somba breed, despite being perceived as of low market value. Its strong cultural value is the main driver of the willingness of the farmers to continue keeping this breed and to pay for its conservation. An integrated system approach to genetic improvement and conservation of this breed is thus desirable, but it requires an enabling national policy and the development of strong local institutions. Organizing the Somba cattle farmers in breeders' association could be a good starting point, to be followed by comprehensive phenotypic and molecular studies to further improve our knowledge about the breed, especially with regards to its productivity and specific functional and adaptive traits.

**Acknowledgments** We are grateful to the cattle farmers in Boukombe for their time and willingness to participate in our survey.

## Compliance with ethical standards

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

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