

Review

Review of current knowledge in the Benin native Borgou cattle breed

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Abstract

Filling information gaps is important for setting future research priorities and defining proper strategies for the improvement and conservation of indigenous breeds. This review focuses on a synthesis of knowledge on the Borgou cattle breed farming in Benin. It gathers information about its origin, its physical and ethnological characteristics. It also highlights the characterization of rearing modes, its adaptation to different farming systems, the analysis of its productivity and its genetic improvement. Studies of several authors, reports of various structures that intervene in livestock farming system in Benin have been involved in this review. It should be noted that the Borgou cattle breed is a trypanotolerant taurine breed from northern Benin. The breed has shown by its traits a remarkable adaptation to its natural environment and has the advantage of enhancing natural rangelands and especially wetlands infested with tsetse flies and hostile to zebu cattle farming. If particular attention is paid to livestock farming in rural areas, this breed has the potential to improve and increase production from cattle farming in Benin. Likewise, uncontrolled crossbreeding of this breed with other native breeds or even exotic breeds presents risks of genetic loss to the detriment of crossbreds becoming more and more vulnerable to environmental conditions..

Keywords: Animal resource, Borgou, Cattle, Performance, Benin

Introduction

Benin economy, like West African countries, is based on the primary sector. Livestock farming is practiced by the majority of agricultural populations. It is the second economic activity after cultivation (De Haan et al., 1997). In Benin cattle herd is reared according to two main farming systems, the traditional breeding system (represented by farmers in rural areas using generally natural pastures for feeding animals and low productivity) and the semi-improved breeding system (represented by State farms) . The semi-improved breeding system is characterized by an improvement of the production system, including the management of animals and the organization of production through food, health monitoring, animal genetics ... (Ferrari, 2013). In addition, the cattle population in Benin is approximately 2,380,323 head of cattle (FAOSTAT, 2017), with a variety of local breeds consisting of bulls, the main ones being the Somba, Lagunaire, Borgou and Zebu breeds, mainly Fulani, M'Bororo and Goudali zebu (Youssao, 2015). There are also various types of crossbreds from crossbreeding between local breeds or between local and imported breeds, and also many exotic breeds, especially in the improved livestock farmings that develop around cities (Lombo, 2002). These different breeds provide the bulk of local milk and meat production in Benin. In this way, among all these breeds encountered in Benin, Borgou cattle breed alone represents 88% of this population (Senou et al., 2008), and is used to produce milk, draught power and more than half of the meat consumed in Benin

(Gbangboche and Alkoiret, 2011). Today, there is increasing global concern about the potential long term consequences of loss of domestic animal diversity. Regarding such situation, better knowledge of local animal resources seems to be a tool that can lead to define proper strategies to conserve and develop native animal resources. This literature review was developed with the aim of highlighting information on the Benin native Borgou cattle breed to scientists, the development actors in the livestock sector, and thereby provide ways to orientate policies that could enhance the meat and milk productivities of the local Borgou cattle breed and its genetic improvement.

The bibliographic study synthesis aims to take stock of research achievements in the Borgou cattle farming system in Benin, which constitutes scientific work material. To reach our goal, we performed documentary research on theses, scientific articles and internet sources. The main internet sources investigated were www.scholar.google.com; www.tropicultura.org; www.researchgate.net; www.aginternetwork.net; www.oaesciences.org/fr; www.doaj.org; <http://hal.archives-ouvertes.fr> and <https://www.scopus.com>. Articles and documents published in the interval from 1947 to 2018 were selected. The selected articles were found online using the combination of several key words: Benin, Borgou breed, typology, trypanotolerant breed, taurine, fertility, calving, productivity, milk, freezing, ejaculate, spermatozoa, semen, and bull. Most of the articles selected deal with the analysis of the zootechnical (reproduction and growth) and genetic parameters of the Borgou breed in the different farming systems in Benin with a diversity of results.

Origin of the Borgou cattle breed

The Borgou cattle breed is a local taurine breed encountered in Benin, mainly in the northern departments of the country. Borgou cattle farms are mainly found in the department of Borgou and more and more towards the south of Benin because of cattle trade and transhumance. These animals are found in some West African countries such as Togo, Nigeria and Côte d'Ivoire, with small differences due to environment and selection (Doutresoulle, 1947). For Doutresoulle (1947) and Flamigni (1951), all cattle living in West Africa from Zebu and Taurine are named Borgou. ILCA (1979) noted that in Togo it is difficult to identify a standard type of Borgou cattle, because all the intermediate cattle between zebu and bullfight is grouped under this term. In fact, the Borgou breed is said to derive from a cross between the Zebu white Fulani breed and the N'Dama taurine breed, given the general conformation of the body, as well as the presence of slightly long horns influenced by zebu blood according to Epstein (1971) who compares the Borgou breed with the Keteku breed of western Nigeria, which has similar characteristics, also from the cross between Dwarf Muturu of South Nigeria and Zebu North of Nigeria. In addition, Domingo (1976) agrees with this viewpoint, but for him these bulls are the Lagune or the Somba, since the N'Dama and Muturu are rarely encountered in the Borgou distribution area. On the other hand, for Doutresoulle (1947), the Borgou cattle breed comes from a cross between the N'Dama and Lagune breeds; this could be related to its resistance to trypanotolerance and the difficult and wet environment.

Morphological traits of the breed

The Borgou cattle breed differs in two groups because of its morphology and its geographical position in Benin according to Domingo (1980). The first group is named "True Borgou" or "large format Lagune" that is generally found in the central or coastal regions and the second "Borgou-Zebu" which differs from the previous one by a larger size, a larger boss, a conformation closer to the zebu than the taurine and which is located in the extreme north of the country in its distribution area. Harmonious and fine, the Borgou cattle breed has a straight profile with a slight hump. The height at the withers reaches 110 cm. The dress is clear, generally smooth and speckled. Black, red, black, black and white coats are commonly encountered. The mucous membranes are dark. The size and structure of this animal allow it to reach an average weight of 240 kg on natural pastures. The head is long with a flat forehead. The chamfer is rectilinear. Medium sized ears are worn horizontally. The ears and muzzle ends are usually black. The horns are short to medium, they deviate laterally in half a crescent from a straight bun. The neckline is short and characterized by a slight

bump, fine in the cow while it merges with the muscle bulge in the male. The dewlap is not very developed. The back is long, straight and narrow. It is prolonged by a right kidney and a rump slightly inclined towards the back. The thighs are flat. The chest and ribs are narrow. The hooves are dark with regular feet. The skin is fine and supple. The hair is flush. In females, the udder is poorly developed with medium-sized teats (Dehoux and Verhulst, 1994).

Distribution area of the Borgou cattle breed

The Borgou cattle are generally found in the north of Benin. Its area of high concentration is the department of Borgou, although it has a tendency to develop throughout the Beninese territory, in the departments of Alibori, Atacora and Collines. This distribution is certainly due to its ease of adaptation to different livestock farming systems in the country. It is also found in northeastern Togo, southeastern Burkina Faso and northwestern Nigeria, where it is called Kéteku (FAO, 1980). Throughout its distribution area in the Kandi, Ségbana, Banikoara, Kalalé and Malanville sectors, this breed is becoming more mixed because of the crossbreeding with different zebu breeds by Fulani herders in rural areas.



Figure 1: Borgou cattle breed in traditional farm in northern Benin
Source: Worogo, 2013



Figure 2: Borgou cow in a night park
Source: Alkoiret et al (2016)

Characterization of different Borgou cattle rearing systems in Benin

• *Semi-improved Borgou cattle farming system*

Borgou cattle breed reared in semi-improved condition farms in Benin can be found at Okpara Breeding Farm, Betecoucou Breeding Farm and Kokoubou Monastery. The most recognized for the rearing of the Borgou cattle breed is the Okpara Breeding Farm in the north of the country in the department of Borgou (area of origin of the breed), receiving support from institutions and financial partners. In this semi-improved type, the herds are constituted according to sex, age and category (bulls, young bulls, cows, heifers and calves). These animals are conducted by drovers during the day grazing and at night in a park equipped with water containers and feeders. The diet is based on the exploitation of natural pastures, residues from crops and artificial meadows. Health monitoring is based on prevention: internal and external deworming, vitamins, trace elements, prevention against trypanosomosis, vaccinations against pasteurellosis and contagious bovine pleuropneumonia (CBPP). Specific treatments against occasional diseases.

Extensive Borgou cattle farming system

Even if typologies of the Borgou cattle breed are not well developed, some information can be drawn from the works of Dehoux and Hounsou-Ve (1993); Alkoiret et al (2009); Youssao et al. (2013); Youssao et al. (2016); Chabi Toko et al (2016) The Borgou cattle farms in traditional environment are encountered in the departments of Alibori, Borgou, Atacora, Zou and Colline and the geographical distribution of these Borgou cattle farms in these departments is not uniform. Borgou cattle rearing is mainly practiced by Fulani

breeders, followed by the Gando, Bariba, Djerma, Dendi and Somba. Most of these peoples are in the majority of Islamic religion and associate in addition to farming agriculture. The herd structure is often average in cows, suckler cows, calves, heifers, bulls, young bulls, oxen and steers. The dominant rearing modes of Borgou cattle in Benin are transhumant and sedentary mode. The animals are housed in open air in night parks around the dwellings of the camp attached to a stake. Animal feeding is reduced to natural pasture, supplemented by crop residues and cooking salt. Animals are watered in streams and reservoirs. Natural mating is used by all breeders and mating is random. Animal health monitoring is generally limited to two vaccinations (contagious bovine pleuropneumonia and bovine pasteurellosis), carried out by livestock management officers.

Adaptability and sanitary conditions of the Borgou cattle breed

Adaptability to trypanosomosis

According to the FAO (1980), the Borgou breed has interesting qualities of adaptation and productivity in area infested by tsetse flies, being a trypanotolerant breed. Adeniji (1985) points in the same direction by saying that the breed would be adapted to life in an infested tsetse fly. A study conducted by Doko (1991) in traditional farming system confirm that the Borgou breed is a trypanotolerant breed in the same way as the Lagune or the N'Dama breeds, but the degree of variation of trypanotolerance is greater. In recent activities at the Okpara Breeding Farm, Doko et al. (2010) has searched parasitological examinations for the dynamics of trypanosome infections on the Borgou breed during a 12-month study. Weight observed during this period in infected animals and uninfected do not have a direct link with trypanosome infections. The International Centre for Research-Development of Animal Husbandry in Subhumid Zones (CIRDES) also shows that the Borgou, like the Lagune, has a high proportion of the alleles (HbA, AlbF) which are carriers of trypanotolerance. On the other hand, for Murray et al. (1983) and Codjia (1981), the Borgou breed is a semi-trypanotolerant breed because it is much more sensitive to trypanosomosis than the Lagune breed with an annual mortality rate due to trypanosomosis of 12.2% and 5.4% for the Lagune breed. According to Dehoux (1993), the Borgou breed would be threatened with extinction after uncontrolled mixing with zebu, nearly 65% of herds in northeastern Benin have a Zebu or mixed Zebu breeding male. The reduction of trypanotolerance and fertility, and the increase of chemoprevention are the main problems related to these interbreeding.

Adaptability to thermal stress

The effect of the temperature and relative humidity index (ITH) on the fertility of Borgou cows was evaluated at the Okpara Breeding Farm and in traditional farms in two production seasons (dry season and the rainy season). The results show that ITH values were high and calving rates were relatively low in both dry season farming systems. With respect to the rainy season, ITHs were low, while calving rates were higher at both Okpara Breeding Farm and traditional farms (Koutinhoun et al., 2009). Fecundity of cows and calving rate are therefore affected by heat stress.

Health management

The Borgou breed is a trypanotolerant taurine breed that adapts to difficult breeding conditions infested with tsetse fly as reported in the previous points. But it is also confronted with infectious and pathological diseases such as trypanosomiasis, foot-and-mouth disease, brucellosis, diarrhea of various origins and ticks which constitute one of the main causes of mortality for this breed both in traditional farming and in semi-improved farming according to the work of Dehoux (1992) and Youssao et al. (2001). Health management is mainly based on preventive treatments. This management has led to the development of animal health monitoring schedules in general in semi-improved farms. For traditional farms, animal health monitoring is generally limited to two contagious bovine pleuropneumonia (CBPP) and bovine pasteurellosis vaccinations

carried out by livestock management officers during the annual vaccination campaigns. Common treatments observed in this breed are presented in Table 1.

Table 1: Common treatments in the Borgou cattle breed

| Diseases | Interventions | Active ingredients |
|-----------------------------------|----------------------------|---------------------------------------|
| Trypanosomiasis | Trypanosomiasis prevention | Isometamidium chloride |
| | Trypanosomosis treatment | Diminazene and isometamidium chloride |
| Pasteurellosis | Vaccination | Pastovax or Pastobov |
| Bovine contagious pleuropneumonia | Vaccination | Perivax |
| Foot-and-mouth disease | Pneumonia vaccine | Aftovax |
| gastro-intestinal parasitosis | Deworming and | Levamisole, Albendazole, |
| External parasites (ticks) | Anticoccidial treatment | Bithionol sulfoxide, Ivermectin, |
| Blood parasites | | Nitroxynil, Fenbendazol |

Sources : Dehoux (1992); Dehoux et Hounsou-Ve (1993); Saka et al. (1991); Dehoux et Hounsou-Ve (1991); Youssao et al. (2001) ; Ladikpo (1981); Youssao (1996); Codjia (1989); Koutinhoun et al. (2003); Youssao et Assogba (2001) ; Idrissou (2004) ; Hounkpevi (2005); Adambi Boukari et al. (2018a).

Productivity of the Borgou cattle breed

Reproductive efficiency

Fertility rate in Borgou cattle breed

The fertility of the Borgou cow varies according to the rearing practices (Table 2). In fact, on station study (Youssao et al., 2000) showed a rate of $78 \pm 8.4\%$, while Dehoux (1993) obtained a rate of $65.4 \pm 13.1\%$ in traditional farm. This rate is almost similar to that of Chabi Toko et al. (2016) who found a birth and fecundity rate of 64% in traditional farms in northern Benin. At Okpara breeding farm (on-station), Alkoiret et al. (2010) also found a fecundity rate of $69.2 \pm 8.4\%$ at Okpara breeding farm. These differences in fertility at the level of the two farming systems may be linked to the cause of the good monitoring of the reproduction and the sanitary conditions of the animals in the station. Out of the fertility, Alkoiret et al. (2010) found an abortion rate of $3.9 \pm 1.2\%$ on station for the same breed.

Table 2: Fertility rates recorded in the Borgou cows

| Parameters | Mean \pm SD (%) | References |
|------------------|-------------------|---|
| Calving rate | 64 ± 15 | Chabi Toko et al (2016); traditional |
| Prolificity rate | 83 ± 15 | |
| Fecundity rate | 64 ± 15 | |
| Fecundity rate | 65.4 ± 13.1 | Dehoux and Hounsou-Ve (1993); traditional |
| Calving rate | 70.2 ± 15.2 | Alkoiret et al (2010); on-station |
| Fecundity rate | 69.2 ± 8.4 | |
| Abortion rate | 3.9 ± 1.2 | |
| Fecundity rate | 78 ± 8.4 | Youssao et al (2000); on-station |

Age at first calving in Borgou cattle breed

Several ages at first calving are also recorded (Table 3). Records made in traditional Borgou cattle farming by Dehoux and Hounsou-Ve (1993) revealed that the age at first calving in the Borgou cow is 1260 ± 180 days. In parallel direction, Dehoux and Hounsou-Ve (1993) also obtained an average age at first calving of 1263 days in sedentary farms and 1347 in transhumant farms. Chabi Macco (1992) found an age at first calving of 1419 ± 365 days in traditional farms. Also at the Okpara Breeding Farm, the results of Youssao et al. (2000), Gbangboche et al. (2011) showed 1263 days and 1347 days, respectively, as age at first calving. These results are in the same range as that found at the Betecoucou farm of 1239 ± 180 days observed at first calving by the Cia-Scr (1996). In Adamou N'diaye (2002), the average age at first calving obtained at the farm of Kokoubou monastery in the Borgou department was 1122 ± 257 days. Vallet (1988) mentioned physiological, pathological or conduct of setting to the Reproduction to explain the variation of the age at the first calving. However, it can also be related to diet and genetic factors.

Table 3: Average calving age of the Borgou cattle breed

| Age in days at first calving (mean \pm SD) | References |
|--|---|
| 1263 ± 150 | Youssao et al. (2000) ; on-station |
| 1239 ± 180 | CIA-CSR, 1996 ; on-station |
| 1326.8 ± 13.4 | Gbangboche and Alkoiret (2011) ; on-station |
| 1122 ± 257 | Adamou N'Diaye et al. (2002) ; on-station |
| 1419 ± 365 | Chabi Macco (1992) ; traditional |
| 1260 ± 180 | Dehoux and Hounsou-Ve (1993) ; traditional |

Interval between calvings in Borgou cattle breed

In the OBF, the calving interval of Borgou cows obtained was 441 ± 75 days (Youssao et al. 2000). This result is almost congruent with the 454 ± 35 days found by Chabi Macco (1992) in improved environment and 494 ± 120 days in village environment. Dehoux and Hounsou-ve (1993) in a traditional environment, Adamou-N'diaye et al. (2002) at the Kokoubou Monastery farm also found calving interval averages approximately the same as those of the previous authors, 458 ± 102 days, and 450 ± 132 days, respectively. On the other hand, the interval between calving obtained at the BBF (526 ± 145 days) for the same breed (Cia-Csr, 1996) seems higher. This could be justified by the fact that on the Livestock Farm of Betecoucou the resources are mainly oriented towards the breeding of the small ruminants which would be a factor acting on the management of the reproduction of the cattle. Table 4 presents the calving intervals reported by authors.

Table 4: Average calving intervals of Borgou cows in Benin

| Calving intervals in days (mean \pm SD) | References |
|---|---|
| 455 ± 5 | Ogodja et al. (1990) ; traditionnel |
| 458 ± 102 | Dehoux and Hounsou-Ve (1993) ; traditionnel |
| 494 ± 120 | Chabi Macco (1992) ; traditionnel |
| 454 ± 35 | Chabi Macco (1992) ; on-station |
| 526 ± 145 | CIA-CSR(1996) ; on-station |
| 441 ± 75 | Youssao et al.(2000); on-station |
| 450 ± 132 | N'Diaye et al. (2002); on-station |
| 427.2 ± 3.9 | Gbangboche and Alkoiret (2011); on-station |

Mortalities in Borgou cattle breed

As the above mentioned parameters, some authors reported data about mortalities that occur in the Borgou cattle breed (Table 5). During the period 1994 to 1997 at the OBF, Youssao (2000) obtained an overall mortality rate of $1.2 \pm 0.5\%$; the mortality rate of calves was $2.5 \pm 0.2\%$. In traditional breeding, the

mortality rate was higher with an average of $7.5 \pm 3.2\%$, of that 5.7% in transhumant herds and 9% in sedentary herds, in animals aged 0 to 1 year. Dehoux and Hounsou-Ve (1993) obtained nearly a quarter of mortality rate and nearly 55% of these mortalities occur during the first weeks of life and during weaning, also 30% at 6 months (Dehoux and Hounsou-Ve, 1993). Chabi Toko (2005), obtained 10% in northern Benin (in traditional farming system) as mortality rate of the calves. For Dehoux and Hounsou-Ve (1993), calves mortality would be caused by under-nutrition of cows and trypanosomosis in traditional farming system. One could add the lack of health monitoring and energy losses of cows due to transhumance and lack of forage resources. The mortality rate is often lower in adults, Dehoux and Hounsou-Ve (1993) presented a rate of 3.1 ± 1.2 in traditional farming system. This would be related to a good adaptation of the Borgou cattle breed to its environment. At the Okpara breeding farm (on-station), Alkoiret et al. (2010) found perinatal mortality rate of 2.2% and a mortality rate of 2.7% before weaning while in traditional farms, mortalities reach $23.1 \pm 10.3\%$ for calves under one-year old and $7.5 \pm 3.5\%$ for global mortality (Dehoux et Hounsou-Ve, 1993).

Table 5: Mortalities recorded in Borgou cattle breed

| Parameters | Mean \pm SD (%) | References |
|------------------------------------|-------------------|---|
| Global mortality | 7.5 ± 3.5 | |
| Mortality rate of calves (0-1year) | 23.1 ± 10.3 | Dehoux and Hounsou-Ve (1993) ; traditionnal |
| Mortality rate of adults | 3.1 ± 1.2 | |
| Mortality rate of calves (0-1year) | 10 ± 13 | Chabi Toko (2005) ; traditionnal |
| Mortality rate of calves (0-1year) | 3 ± 1 | Alkoiret et al (2016) ; on-station |
| Mortality rate of calves (0-1year) | 2.57 ± 1.3 | |
| Global mortality | 1.86 ± 0.7 | Alkoiret et al (2010) ; on-station |
| Mortality rate of adults | 0.82 ± 0.6 | |
| Global mortality | 1.2 ± 0.5 | Youssao et al. (2000); on-station |

Dairy production performance and lactation in Borgou cattle breed

Several studies have been conducted to show the effect of breed or genetic type on milk production (Boujenane et Aïssa, 2008, Gbangboche and Alkoiret 2011, Ouédraogo 2013, Saidou, 2004, Gbodjo et al., 2013). In Benin, Gbangboche and Alkoiret (2011) reported that Borgou cows have a higher production than N'Dama cows at the OBF. Another study conducted on the same farm by Kassa et al. (2016) involving many cattle breeds revealed the highest average milk production in the Girolando cows, followed by the Borgou, Azawak x Lagune and Lagune. During the lactation period, the Borgou cow daily produces 1.2 liters on average during the rainy season, compared to an average production of 1.18 liters per day during the dry season (Senou et al. 2008; Gbangboche and Alkoiret, 2011). In traditional environment, Dehoux (1993) obtains in the rainy season (July to August) a daily production of 840 ml. This is justified according to Kassa et al. (2016) by the fact that the rainy season is a period of fodder abundance and availability ad libitum in water whereas in dry season, fodder and water become rare. Senou et al. (2008) showed that supplementing Borgou cows with cottonseed cakes produced better milk yield (up to 2.0 ± 0.9 l/d) or rationing cows with a combination of *Panicum maximum*, *Brachiaria ruziziensis*, *Aeschynomene histrix* and cottonseed cakes (up to 1.9 ± 0.9 l/d) compared to cows grazing on natural pasture.

Gbangboche and Alkoiret (2011) state that the milk production of Borgou cows progresses from the first to the fourth lactation. Kassa et al. (2016) also reported the same results of the 1st and 4th rank of calving. Dairy yields reach the peak and fall from the 5th rank of calving. However Senou et al. (2008) trying alternative feeding on lactating Borgou cows, obtained a significantly higher milk production of 2.4 ± 1.1 l/d at 1st stage of lactation, 1.5 ± 0.5 l/d at the 2nd stage of lactation and 1.5 ± 0.3 l/d at the 3rd stage of lactation. This

would be explained by the fact that udder development leads to an increase in milk production and udder aging causes its decline. In addition calving rank would be a physiological factor of variation in milk production.

In Benin, Borgou cow's daily milk production has risen from 1.3 liters to 2 liters in a semi-improved environment when it benefits of a supplement of cottonseed (Senou et al. 2008) in addition to natural grazing. If the Borgou cows are supplemented with cottonseed and soy cakes, their production reaches 4.2 kg of milk (Alkoiret et al., 2011). For Chabi Toko (2005), ingestion of cottonseed cake resulted in an increase of 78.5% in milk production for Borgou cows. This result may be related to the good value of this food. The work of Ogodja and Hounsou-Ve (1992) on Borgou suckler cows supplemented in traditional breeding with cottonseed (1 kg of cottonseed per cow and per day) resulted in an improvement in milk production of 27%. So we can say that the cow Borgou has a potential to valorize agro-industrial by-products.

Weight growth and body measurements

On station (at the Okpara Breeding Farm), Youssao et al. (2000), Alkoiret et al. (2016) and Worogo et al. (2018) presented a better birth weight for the Borgou calves compared to calves in traditional rearing system, they found respectively 19.0 kg and 18.7 kg for males and 18.3 kg and 18.1 kg for females according to the two first authors and these weights vary from 16.1 kg to 22.2 kg according to the latter. At Betecoucou Farm, the birth weight of Borgou cattle is 16.7 kg in the male and 15.5 kg in the female with a significant difference. In traditional farming, according to Chabi Macco (1992) the average birth weight is 16.5 kg in the north of the Borgou department and south of 14.5 kg according to Ogodja et al. (1990). At three months age, the calves in semi-improved farming still present a higher weight than those of the traditional farming, Dehoux and Hounsou-ve (1993) obtained 30.6 kg in traditional farming whereas in semi-improved system, Alkoiret et al. (2016) got a weight of 39.5 kg for males and 38.4 for females. These results are similar to those found at the Livestock Farm of Betecoucou where calves weigh 39.4 kg and the vines 40.4 kg (Cia-Csr, 1996) and those of Youssao et al. (2000) which seem higher 42.6 kg for males and 41.1 for females. We can also retain that weight of 12-month-old calves in traditional husbandry conditions is 60.3 kg (Chabi Macco, 1992) against 103.2 kg for males and 98.9 kg for females in OBF with a difference between the two sexes (Youssao et al., 2000). Most of the information available on Borgou breed weights performances (Chabi Macco, 1992; Youssao et al., 2000; Youssao et al., 2013; Alkoiret et al., 2016; Worogo et al., 2018) show the superiority of males on females. On the other hand, some authors (Auer, 1984, Symoens and Hounsou-Ve, 1991, Dehoux and Hounsou-Ve, 1993, Youssao et al., 2000) have proposed equations to predict the weights of Borgou cattle according to some body measurements, but they often only take into account all the animals or equations were established according to sex. Recently, a study conducted by Youssao et al. (2013) presented sex-specific equations by age group; which brings a better use of these equations. However, these studies have shown that thoracic perimeter and tourniquet height are frequently used to determine weight prediction models in Borgou cattle. The study by Youssao et al. (2013) states that the best explanatory variable in males is the height at the withers and the thoracic perimeter in females. On Table 6, both weights and average daily weight gains are presented.

Table 6: Weights and average daily weight gains in Borgou cattle breed

| Age (months) | Weight | | References |
|--------------------------|--------|--------|--|
| | Male | Female | |
| At birth | 16.5 | - | Dehoux and Hounsou-Ve (1993); traditional |
| | 19 | 18.3 | Youssao et al. (2000) ; on-station |
| | 18.7 | 18.1 | Alkoiret et al. (2016) ; on-station |
| | 18.7 | 18.2 | Worogo et al. (2018) ; on-station |
| | 18.3 | 17.8 | Adambi Boukari et al. (2018b) ; on-station |
| 3 | 16.5 | - | Dehoux and Hounsou-Ve, (1993), traditional |
| | 42.6 | 41.1 | Youssao et al. (2000) ; on-station |
| | 39.5 | 38.4 | Alkoiret et al. (2016) ; on-station |
| 6 | 61.4 | 60.4 | Alkoiret et al. 2016 ; on-station |
| 12 | 60.3 | - | Dehoux and Hounsou-Ve, (1993), traditional |
| | 103.2 | 98.9 | Youssao et al. (2000) ; on-station |
| | 101.5 | 97.0 | Alkoiret et al. (2016) ; on-station |
| | 102.7 | 101.1 | Adambi Boukari et al. (2018b) ; on-station |
| 24 | 156 | 151 | Youssao et al. (2013) ; on-station |
| | 161.2 | 161.2 | Alkoiret et al. (2016) ; on-station |
| 36 | 211 | 204 | Youssao et al. (2013) ; on-station |
| 45 | 259 | 249 | Youssao et al. (2013) ; on-station |
| Average Daily Gain (ADG) | | | |
| Intervals | Male | Female | References |
| 0-3 | 239 | 254 | Youssao et al. (2000) ; on-station |
| | 220 | 230 | Youssao et al. (2013) ; on-station |
| | 230.3 | 233.3 | Alkoiret et al. (2016) ; on-station |
| 3-6 | 239 | 224 | Youssao et al. (2013) ; on-station |
| | 241.2 | 230 | Alkoiret et al. (2016) ; on-station |
| 0-12 | 199 | 181 | Youssao et al. (2000) ; on-station |
| 6-12 | 231.7 | 219.1 | Alkoiret et al. (2016) ; on-station |
| 3-12 | 189 | 160 | Youssao et al. (2000) ; on-station |
| 12-24 | 190 | 183 | Youssao et al. (2013) ; on-station |
| 36-45 | 177 | 167 | Youssao et al. (2013) ; on-station |
| Birth-weaning | 257.9 | 241.9 | Worogo et al. (2018) ; on-station |

The average daily gains from birth to 12 months obtained by Youssao et al. (2000), are 229.0 ± 0.1 g/d for males and 214.0 ± 0.1 g/d for females without a significant difference. The results obtained by Chabi Macco (1992) then Ogodja and Hounsou-Ve (1992), show that overall, growth rates are below 200g/d in traditional breeding. Sintondji (1986) reports an ADG of 266 g/d for Borgou oxen weighing between 200 and 250 kg and reared on natural pastures. Alkoiret et al. (2016) states that as age increases, the growth rate decreases inversely from 230.3 ± 7.2 g (ADG0-3) to 110.3 ± 1.8 g (ADG18-24) for the Borgou breed. At OBF, Worogo et al. (2018) found that the ADG of Borgou cattle varies between 212.0 ± 7.5 kg and 330.7 ± 6.4 kg with 392.4 ± 71.5 days as average age at weaning.

Genetic improvement of the Borgou cattle breed

Artificial insemination

Artificial insemination is a very powerful way to improve the productivity of local breeds, particularly the Borgou breed, several studies have been conducted in this way, Konfe (2014), at the International Centre for Research-Development of Animal Husbandry in Subhumid Zones (CIRDES) studied the spermatic characteristics of different local breeds for cryopreservation. The volume of ejaculate recorded in Borgou is close to that reported by Gbangboche et al. (2011) and Adamou-N'diaye et al. (2000) in the same breed. The

mass motility recorded in the Borgou is lower than that reported by Gbangboche et al. (2011) and Adamou-N'diaye et al. (2000) in Borgou aged 4 to 6 years in Benin. The sperm concentration recorded in male Borgou corroborates that recorded by Adamou-N'diaye et al. (2000) and Gbangboche et al. (2011). The percentage of spermatozoa alive in the Borgou corroborates that recorded by Adamou-N'diaye et al. (2000) and Gbangboche et al. (2011) in the same breed in Benin. The results obtained by each author are summarized in the table 7.

Table 7: Sperm characteristics of the Borgou breed

| Volume (ml) | Mass Motility | Concentration | Percentage of viable spermatozoa | References |
|-------------|---------------|---|----------------------------------|-----------------------------|
| 3.1 ± 0.5 | 4.2 ± 0.5 | 775.7 ± 188.0 (x10 ⁶ spz/ml) | 90.1 ± 3.6 | Adamou N'Diaye et al.(2000) |
| 3.1 ± 0.5 | 4.3 ± 0.5 | 775.7 ± 188.0 (x10 ⁶ spz/ml) | 90.2 ± 3.6 | Gbangboche et al. (2011) |
| 3.4 ± 0.8 | 2.5 ± 0.5 | 0.7 ± 0.4 (x10 ⁹ spz/ml) | 86 | Konfe 2014 |
| 3.6 ± 0.8 | 4.5 ± 0.6 | 1.3 ± 0.4 (x10 ⁹ spz/ml) | - | Akpo et al. (2018) |

Crossbreeding with imported breeds and response to artificial insemination

Several crosses were made at the Okpara Breeding Farm (Houunkpevi 2005; Idrissou 2004) Subjects Gir or Girolando were imported. These animals reproduced to give a pure breed, which allowed an independence of the seed production. Then a crossbreeding between Borgou and the Giror Girolando breed was realized. The male calves resulting from this cross were sold and shot; on the other hand the females of the first generation F1 were crossed again with the males Gir or Girolando and the second generation with a Borgou male to increase the resistance to diseases of the offspring. Very recently, Boukari et al (2018) have tested the response of Borgou cows to natural or induced estrus with semen from Gir and Girolando at the OBF. In inseminated cows on induced estrus, the pregnancy rate was 30% and that of abortion was 9.5%. The fertility rate was 28.5% and those of live births and mortality were, respectively, 105.2% and 5% in these cows. As for inseminated cows on natural estrus, the pregnancy rate was 75.7% and the one of calving was 88.8%. The fertility rate recorded with natural estrous was 66.6% and was significantly higher than the one recorded with insemination on induced estrus. The live births and the birth-weaning mortality rates were, respectively, 98.9% and 11.5% in inseminated cows on natural estrus. Boukari et al (2018).

Meat characteristics in the Borgou cattle breed

A recent study (Salifou et al., 2013) on the study of the technological and organoleptic qualities of Borgou, Lagune and Fulani Zebu cattle reared on natural pastures revealed that the meat of Borgou beef is lighter than that of Lagune and Zebu Peulh on the day of slaughter. The same trend was obtained for the brightness of the meats of the three breeds on the 2nd and 8th day post mortem. The luminosity of Borgou beef ranged from 34.4 to 36.4, a red index of 22.6 to 15.6, a yellow index of 10.3 to 9.9, a hue that ranged from 2.1 to 1.4 and chromaticity from 24.9 to 18.6 from the 2nd and 8th days. Borgou cattle meat was considered less tender than that of the Lagune. Taking into account the flavor, juiciness and tenderness, the consumer acceptance score of the Borgou breed was lower than that of the Lagune. However, the study showed that tenderness was strongly correlated with flavor in the Borgou breed.

Current state and threats on the Borgou breed in Benin

In Benin, several local breeds belonging to Benin's animal genetic heritage are threatened with extinction. In 1983, a review paper on endangered cattle breeds in Africa was published by the Expert Committee on Animal Genetic Resources in Africa (Adeniji, 1983). The Somba and Pabli breeds have even been reported as almost non-existent. Although it is credited with occupying nearly half of the national cattle herd and being used for draught power, milk and meat (MAEP, 2007) and also being the cattle breed whose meat is more consumed in Benin (Gbangboche and Alkoiret, 2011), the Borgou cattle breed is reduced in terms of purebred. Although in-depth studies have not yet been conducted in this way, there is a gradual genetic dilution of the Borgou cattle breed in its cradle of origin both in station and in rural areas and it could soon have the same status like the Somba and Pabli breeds. Today in Benin, the Borgou breed remains the breed most subject to crossbreeding with other breeds from countries in the sub-region such as Nigeria, Togo, Niger, Burkina Faso, etc. Local breeders are increasingly introducing other generally larger breeds from these countries to obtain heavier offsprings and thus improve their income from the sale of animals. These genetic mixtures contribute to the reduction of purebred Borgou cattle population and threaten the survival of this species in the coming years if nothing is done. Besides, according to Dehoux and Hounsou-Ve (1993), the Borgou cattle breed would be threatened with extinction following uncontrolled mixing with zebus, nearly 65% of herds in northeastern Benin have a zebu or mixed zebu breed. As a result, it becomes increasingly difficult to identify and therefore protect the Borgou cattle breed from genetic introgression even in its area of origin.

Conservation and improvement policies for the Borgou cattle breed in Benin (apart from the annual vaccination programs) seem to be limited to the conservation nuclei of this breed in State Farms. Moreover, most of the studies on the Borgou cattle breed was carried out on state farms or in development projects where the breeding method is semi-improved (Youssao et al., 2013). As a result, knowledge about the potential and improvement of this breed in the real world is still at an early stage. Regarding these threats, the indigenous Borgou cattle breed in Benin is an example of animal genetic resource currently at risk of extinction. The Borgou cattle breed is thought to have superior adaptive attributes to local environmental stresses (such as resistance to disease and drought) compared to imported exotic breeds in Benin. This is as said by Rege and Gibson (2003), the introduction of exotic breeds and other social and economic pressures have exposed locally adapted indigenous breeds to the risk of extinction and could lead to a loss of potentially valuable genetic diversity.

Conclusion

The Borgou cattle breed is a Benin native cattle breed that seems to be adapted to its natural environment and achieves productivity similar to that of other trypanotolerant breeds. While the Borgou cattle breed is threatened like many other trypanotolerant breeds due to the uncontrolled crossbreedings in rural farming in Benin, it is worth to focus on policies that could act directly on the genetic improvement of that breed while preventing it from genetic loss if we want to boost production at the national level. Thus, given its characteristics and the fact that it constitutes an important part of Benin's animal genetic resources, especially in rural areas, this breed should be given special attention in order to guarantee its survival in the face of the various threats it undergoes. In addition, the endogenous knowledge of local breeders could contribute to the achievement of these objectives. So, policies could be oriented towards in situ conservation with the traditional cattle farmers who hold the major part of this breed.

Author Contributions

Worogo SSH and Rachidi R conceived the original idea and co-write the review paper. Assani SA helped supervise the work and contributed to the final manuscript. Alabi CDA, Adjassin SJ and Azalou M

contributed to the organization of information included in this review, Youssao AKI read and corrected the paper, Alkoiret IT supervised the work

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References

- Adambi Boukari ZF. Alkoiret TI. Tobada P. Akpaki V. Ahissou A. Touré FZ. Yacoubou AM. Bonou GA. Dotché IO. Youssao AKI.** 2018b. Comparison of growth and milk production performances of the Borgou breed to those of the crossbreeds Gir - Borgou and Girolando - Borgou at the Okpara Breeding Farm in Benin. *Int. J. Agron. Agri. R. (IJAAR)* Vol. 12, No. 5, p. 27-35
- Adambi Boukari ZF. Alkoiret TI. Toléba SS. Ahissou A. Touré FZ. Yacoubou AM. Bonou GA. Dotché IO. Akpaki V. Youssao AKI.** 2018a. Reproductive performances of the Borgou cow inseminated on natural or induced estrus with semen from Gir and Girolando at the Okpara Breeding Farm, *Veterinary World*, 11(5): 693-699.
- Adamou-N'diaye M. Gbangboche AB. Adjovi A. Hanzen CH** 2000. Caractéristiques spermatiques des taureaux de race Borgou au Bénin. *Annales des Sciences Agronomiques du Bénin* 2 (1) : 71-83.
- Adamou-N'diaye M., Gbangboche AB. Ogodja O. Hanzen C** 2002. Fécondité de la vache Borgou au Bénin : effet de l'âge au premier vêlage sur l'intervalle entre vêlages. *Revue Elev. Méd. Vét. Pays trop.*, 55 (2) : 159-163
- Adeniji KO.** 1983. Review of endangered cattle breeds in Africa. *Proceedings of Expert Committee Meeting on Animal Genetic Resources in Africa.* OAU/STRC/IBAR publication, 1985. pp. 20-32.
- Akpo Y. Mehounou CGL. Yessinou RE. Alkoiret IT. Kpodekon MT** 2018. Évaluation de la qualité des semences issues des taureaux de races Borgou, Azawak et Girolando utilisés au Centre National d'Insémination Artificielle Bovine au Bénin. *Ann. UP, Série Sci. Nat. Agron*; Vol.8 (No.1) : 13-21. ISSN 1840-8494 eISSN : 1840-8508
- Alkoiret IT. Awohouedji DY. Yacoubou AM** 2010. Paramètres démographiques des cheptels de bovins Borgou et N'Dama à la Ferme d'Élevage de l'Okpara au nord-est du Bénin. *Int. J. Biol. Chem. Sci.* 4(5): 1657-1666. ISSN 1991-8631.
- Alkoiret TI. Radji M. Gbangboche AB. Mensah GA** 2011. Productivity of cattle farms located in the common of Ouake northwest of Benin. *Intertional Journal of Science and Advance Technology* <http://www.ijst.com>
- Auer J** 1984. Suivi de troupeaux témoins dans l'Atacora. Rapport annuel 1983/84.-Cotonou : Direction de l'Élevage. -40 p
- Boujenane I. Aissa H** 2008. Performances de reproduction et de production laitière des vaches de races Holstein et Montbéliarde au Maroc. *Revue d'Élevage et de Médecine vétérinaire des Pays tropicaux.* Vol. 61 (3-4), 191-196.
- Chabi Macco Y** 1992. Etude de quelques paramètres de productivité de la race bovine Borgou. Mémoire d'Ingénieur agronome, Université nationale du Bénin, Cotonou, Bénin, 137p.
- Chabi Toko R** 2005. Aspects zootechniques et économiques de l'utilisation des feuilles de *Vitellariaparadoxa* et de tourteau de coton en supplémentation sur la production laitière de la vache Borgou en saison hivernale. THESE Pour l'obtention du diplôme d'Ingénieur Agronome à la Faculté des Sciences Agronomique (FSA), Université d'Abomey-Calavi du Bénin.
- Chabi Toko R. Adégbidi A. Lebailly P** 2016. Démographie et performances zootechniques des élevages bovins traditionnels au Nord Bénin. *Revue d'élevage et de médecine vétérinaire des pays tropicaux*, 69 : 8-10 page
- CIA-CSR** 1996. Contribution à la connaissance des paramètres de reproduction et de production des bovins de races Borgou et Lagunaire. Rapport Final. Cotonou, Bénin, Université nationale du Bénin, Fsa/Cia, 44 p.

- Codjia V 1981.** Trypanotolérance et immunité. Recherches sur les taurins de la République populaire du Bénin. Thèse : Méd.Vét : Dakar ; 11.
- Codjia V 1989.** Prospection entomologique et étude de l'incidence de la trypanosomose animale africaine et autres hémoparasitoses du bétail dans les districts de Nikki, Kalale et Segbana. -Cotonou : Direction de l'Elevage et des industries animales, 20p
- De Haan C. Steinfeld H. Blackburn H 1997.** Livestock and the environment: Finding a balance. European Commission Directorate-General for Development: Brussels.
- Dehoux J. Verhulst A 1994.** Une race trypanotolerante méconnue: la borgou. Animal Genetic Resources Information, 13, 39-45. doi:10.1017/S1014233900000262
- Dehoux JP 1992.** Contributions à l'étude de la fièvre aphteuse et de la brucellose bovine au nord-est du Bénin. Rapport d'étude n°5. Projet de Développement de l'Elevage dans le Borgou –Est.-Cotonou : Ministère du développement rural.-15 p
- Dehoux JP 1993.** Productivité de la race bovine Borgou en milieu traditionnel au Nord-Est du Bénin. Mémoire M.Sc., IMT, Antwerpen, Belgique, 97 p. (n°98)
- Dehoux JP 1993.** Productivité de la race bovine Borgou en milieu traditionnel au nord-est du Bénin. Mémoire MSc : Institut de Médecine Tropicale : Antwerpen
- Dehoux JP. Hounsou-Ve G 1991.** Epizootie de fièvre aphteuse au nord-est du Bénin durant la saison sèche 1990/1991. Rev. Elev .Méd.Vét. Pays trop.,44 (3) : 261-262
- Dehoux, JP. Hounsou-Ve G 1993.** Productivité de la race bovine Borgou selon les systèmes d'élevage traditionnels au nord-est du Bénin. Rev. Mond. Zootech. 74/ 75, 36–48.
- Doko AS. Farougou S. Salifou S. Ehilé E. Geerts S. 2010.** Dynamique des infections trypanosomiennes chez des bovins Borgou à la ferme de l'Okpara au Bénin. Tropicultura, 28(1): 37- 43.
- Doko SA 1991.** Etude de la trypanosomiose et de la trypanotolérance bovine au Bénin. Mémoire MSc, Institut de médecine tropicale, Anvers, Belgique, 86 p. (N°14)
- Domingo AM 1976.** Contribution à l'étude de la population bovine des Etats du golfe du Bénin. Thèse Doct. vét.,Eismv, Dakar, Sénégal, 148 p.
- Domingo AM 1980.** Contribution à l'étude de la population bovine des états du Golfe du Bénin. Agence de Coopération Culturelle et Technique. Paris.
- Doutressoulle G 1947.** L'élevage en Afrique occidentale française. –Paris :Maissoneuve et Larose :- 298 p.
- Epstein H., 1971.** The origin of the domestic animals of Africa: vol 1.-New York : Pub. Africana.- 30 p.
- FAO 1980.** Le bétail trypanotolérant en Afrique Occidentale et Centrale. Volume 2- Etude par pays. - Rome : FAO, PNUD. - 311p
- FAO 2017.**FAOSTAT, Banque de Données en Ligne. Consulté à l'adresse, www.FAOSTAT.org
- Ferrari S 2013.** Comparaison de la compétitivité prix et hors-prix entre l'élevage semi-intensif et l'élevage intensif de la filière laitière locale dans la région de Dakar (Sénégal). Mémoire de Master en Sciences de la Population et du Développement. Faculté des Sciences Sociales et Politiques, Université Libre de Bruxelles, Bruxelles, Belgique, 93 pages.
- Flamigni A 1951.** Le gros bétail au Mayumbe. Bull, agric. Congo beige, 42: 91-106.
- Gbangboche AB. Alkoiret TI. Toukourou Y. Kagbo A. Mensah GA 2011.** Growth curves for different body traits of Lagune Cattle. Research Journal of Animal Sciences 5(2) 17-24.
- Gbangboché AB. Alkoiret TI 2011.** Reproduction et production de lait des bovins de race Borgou et N'Dama au Bénin. Journal of Applied Biosciences. Vol. 46, 3185-3194.
- Gbodjo ZL. Sokouri DP. N'goran KE. Soro B 2013.** Performances de reproduction et production laitière de bovins hybrides élevés dans des fermes du « Projet Laitier Sud » en Côte d'Ivoire. Journal of Animal & Plant Sciences. Vol. 19 (3), 2948-2960.
- Houkpevi DA 2005.** Elevage et amélioration génétique de la croissance des bovins Borgou de la ferme Okpara en République du Bénin. Mémoire : DES inter-universitaire GRAVMT : Faculté de Médecine Vétérinaire : Liège.

- Idrissou N 2004.** Amélioration Intégrée de la Production Laitière de la Vache Borgou au Bénin. Mémoire : DES inter-universitaire GRAVMT : Faculté de Médecine Vétérinaire : Liège.
- ILCA 1979.** Trypanotolerant livestock in West and Central Apical Vol. 1 : General studies. International Livestock Centre for Africa (ILCA) Mono. No 2. - Addis Ababa : ILCA. - 148 p.
- Kassa KS. Ahounou S. Dayo G. Salifou C. Issifou MT. Dotché I. Gandonou PS. Yapi-Gnaoré V. Koutinhoun B. Mensah GA. Youssao AKI 2016.** Performances de production laitière des races bovines de l'Afrique de l'Ouest. *Int. J. Biol. Chem. Sci.* 10(5): 2316-2330 : 6-10 page.
- Konfe H 2014.** Etude spermiologique des bovins de races locales de l'Afrique de l'Ouest : cas du Borgou, du taurin Lagunaire, du taurin N'Dama et du Zébu Peulh. Université Polytechnique De Bobo-Dioulasso, Mémoire De Fin De Cycle, N°: -2014/MaPIA.
- Koutinhoun B. Youssao AKI. Houéhou AE. Agbadje PM 2003.** Prévalence de la brucellose bovine dans les élevages traditionnels encadrés par le projet pour le Développement de l'Elevage (PDE) au Bénin. *Revue Méd. Vét. Paystrop.*, 154 (4): 271-276.
- Koutinhoun GB. Youssao AKI. Tobada P. Kpodekon TM. Adimatin V 2009.** Influence de l'indice de température et d'humidité relative de l'air sur la fécondité de la vache Borgou élevée selon deux modes d'élevage au Bénin. *Int. J. Biol. Chem. Sci.* 3(6) : 1336-1345
- Koutinhoun GB. Youssao AKI. Tobada P. Kpodekon TM. Adimatin V 2009.** Influence de l'indice de température et d'humidité relative de l'air sur la fécondité de la vache Borgou élevée selon deux modes d'élevage au Bénin. *Int. J. Biol. Chem. Sci.* 3(6): 1336-1345.
- Ladipko E 1981.** Nématodose digestives des veaux en République populaire du Bénin. Thèse. Méd. Vét. Dakar ;5
- Lombo Y 2002.** Cartographie des races bovines dans la zone du CIRDES. Mémoires d'ingénieur agronome-zooteknicien. Université de Lomé, Ecole supérieur d'agronomie Lomé, Togo. 134 P.
- MAEP 2007.** Rapport synthèse de la mission conjointe de suivi des projets et programmes de développement agricole 64 pages.
- Murray M. Trail JCM. Turner DA. Wissocq Y 1983.** Productivité animale et trypanotolérance; manuel de formation pour les activités de réseau.-Addis-Abeba : ILRAD/CIPEA/ICIPE.-40 p.
- Ogodja JO. Hounsou-Ve G 1992.** Effet de complémentation en graine de coton sur la production laitière et la croissance des veaux des vaches allaitantes de race Borgou au Bénin. *Bull. Anim. Health Prod. Afr.*, 41 : 51-56.
- Ogodja OJ. Adamou-N'diaye M. Fonton N. Chrysostome C 1990.** Intervalles de vêlages chez la vache Borgou dans deux types de troupeaux au Bénin-Cotonou : Faculté des Sciences agronomiques, Département de Production animale et agro-nutrition.- 46 p
- Ouédraogo A 2013.** Etude des performances laitières des vaches zébus et de la croissance pondérale des veaux des noyaux de Ouagadougou et Komsilga. Mémoire d'Ingénieur de Conception en Vulgarisation Agricole. Institut du Développement Rural, Université Polytechnique de Bobo-Dioulasso, Bobo-Dioulasso, Burkina-Faso, 76 pages.
- Rege JEO. Gibson JP 2003.** Animal Genetic Resources and Economic Development: Issues in Relation to Economic Valuation. Ecological Economics, forthcoming.
- Saidou O 2004.** Influence de la production laitière sur l'évolution pondérale des vaches et des veaux chez le Zébu Azawak à la station sahélienne expérimentale de Toukounous (Niger). Mémoire de diplôme d'études approfondies de productions animales. Ecole Inter-Etats des Sciences et Médecine Vétérinaire, Université Cheick Anta Diop de Dakar, Dakar, Sénégal, 42 pages.
- Saka GS. Atchade JC. Gounou BS 1991.** Etude des données zootechniques et socio-économiques du programme d'hydraulique pastorale. Rapport de mission. -Cotonou : Ministère du développement rural.- 35p
- Salifou CFA. Dahouda M. Boko KC. Kassa SK. Houaga I. Farougou S. Mensah GA. Salifou S. Toléba S.S. Clinquart A. Youssao AKI 2013.** Evaluation de la qualité de la viande de bovins des races Borgou,

- Lagunaire et Zebu sur pâturages naturels. Journal of Applied Biosciences 63: 4736 – 4753. ISSN 1997–5902
- Senou M. Toléba S. Adandédjan C. Poivey JP. Ahissou A. Touré FZ. Monsia C 2008.** Increased Milk Yield in Borgou Cows in Alternative Feeding Systems. *Revue d’Elevage et de Médecine vétérinaire des Pays tropicaux*. Vol. 61 (2), 109-114.
- Sintondji B 1986.** De l’évolution pondérale du bovin africain sur pâturages naturels en milieu fermier. Cas des types Lagunaire et Borgou au ranch de Samiondji, au Bénin. *Revue Elev. Méd. vét. Pays trop.*, 39 : 103-106.
- Symoens C. Hounsou-Ve G 1991.** Mesures baryométriques chez le bétail Borgou dans le Nord-Est Bénin. *Revue Elev. Méd. vét. Paystrop.*, 44 : 487-490.
- Vallet A 1988.** L’infécondité en troupeau allaitant. *Rec.Méd.vét.*, 164 : 6-7
- Worogo SSH 2013.** Contribution à l’amélioration de la productivité numérique au sevrage du cheptel bovin de la ferme d’élevage bovin de Tèbo (Commune de Nikki). Mémoire de Licence Professionnelle. Faculté d’Agronomie, Université de Parakou, 51 pages.
- Worogo SSH. Idrissou Y. Assani AS. Assogba BCG. Alkoiret IT 2018.** Growth Performances at Weaning of Borgou Cattle in Northern Benin. *Haya: Saudi J. Life Sci.*, Vol-3, Iss-6: 474-480.
- Youssao 2015.** Programme National d’Amélioration Génétique. Rapport annuel du Projet d’Appui aux Filières Lait et Viande (PAFILAV). Cotonou, Bénin, 344 pages.12.
- Youssao AKI 1996.** Contribution à l’étude épidémiologique de la fasciolose bovine à *fasciolagigantica* dans le département du Borgou : période d’octobre 1995 à mars 1996. Mémoire : Ingénieur des Travaux des productions animales : Université nationale du Bénin/Cpu : Cotonou
- Youssao AKI. Ahissou A. Idrissou ND. Michaux C. Touré Z. Leroy PL 2001.** Viabilité des bovins de race Borgou à la ferme élevage de l’Okpara au Bénin. *Tropicultura*, 19 : 65-69.
- Youssao AKI. Ahissou A. Michaux C. Farnir F. Touré Z. Idrissou ND. Leroy PL 2000.** Facteurs non génétiques influençant le poids et la croissance de veaux de race Borgou à la ferme d’élevage de l’Okpara au Bénin. *Revue Elev. Méd. Vét. Pays trop.*, 53 : 285-292.
- Youssao AKI. Ahissou A. Touré Z. Leroy PL 2000.** Productivité de la race bovine Borgou à la ferme d’élevage de l’Okpara au Bénin. *Revue Elev. Méd. Vét. Pays trop.*, 53 : 67-74.
- Youssao AKI. Assogba MN 2002.** Prévalence de la fasciolose bovine dans la vallée du fleuve Niger au Bénin. *Revue Elev. Méd. Vét. Pays trop.*, 55 : 105-108.
- Youssao AKI. Dahouda M. Attakpa EY. Koutinhoun GB. Ahounou GS. Toleba SS. Balogoun BS 2013.** Diversité des systèmes d’élevages de bovins de race bovine Borgou dans la zone soudanienne du Bénin / *Int. J. Biol. Chem. Sci.* 7(1) :125-146 page.