Adaptation of Azawak cattle in northern Benin

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Abstract

In an effort to improve national meat and milk production, the Benin government imported Azawak zebus from Niger. The aim of the study is to assess the adaptation of these cattle in the northern area of Benin. Data on breeding techniques were collected in the departments of Borgou, Alibori and Donga on Azawak cattle introduced to 18 farms to improve the productivity of local breeds by crossbreeding. Based on the resistance level of the Azawak, the breeders were classified into three groups. In group 1, very few pathologies have been reported and the animals have the same resistance as local breeds despite the lack of breeding infrastructure among breeders in this group. Animals in this group spend the night in the open air and crop residues are used more than concentrates in their diets. In group 3, Azawak are generally less resistant than local breeds and nevertheless have acceptable resistance to disease. However, breeders in this group have livestock infrastructure, artificial pastures and they use food supplements. Group 2 breeders have intermediate characteristics between group 1 and group 3. Azawak Cows produce on average 3.8 liters of milk per day. Generally, Azawak cattle have adapted in the northern part of Benin.

Introduction

In Benin, meat and milk production are respectively 81417 tons and 149277 tons in 2018 ((FAOSTAT, 2020). Theses production are less than the demand expressed by the population and to fill this gap, Benin is obliged to import products of animal origin. In 2016, the volume of milk imports was 10983803 tons and that of meat was 13046078 tons (INSAE, 2019) This low national production is due to the low genetic potential of local breed animals (Kassa *et al.*, 2016). To limit this dependence on the outside world and to combat food insecurity, improved zootechnical performance of local breeds is necessary. In order to improve national meat and milk production, the Benin government, through projects, has implemented programs of genetic improvement of local cattle breeds. Thus, Girolando dairy cows have been introduced to Benin to raise the level of milk production in Benin. These animals were imported from Brazil and installed on the Kpinnou Breeding Farm for the acclimatization phase. The Okpara Breeding Farm has specialized in the genetic improvement of the Borgou breed by selection and by crossing with the exotic breeds Gir, Girolando and Holstein, known for their milk production. The decline in the productivity of the purebred Girolando breed and its sensitivity to dermatosis and other tick-related diseases testify to the difficulties of adapting this breed to the climatic conditions of Benin (Alkoiret, Awohouedji & Yacoubou, 2010; Doko *et al.*, 2012; Kassa *et al.*, 2016; Alassane *et al.*, 2018). In an effort to introduce new breeds that can better adapt to Benin's climatic conditions, the Milk and Meat Support Project (PAFILAV) imported Azawak zebus from Niger. These zebus are intended to be distributed on farms to improve the production of local breeds by crossbreeding. The aim of this study is to assess the adaptation of Azawak cattle introduced to livestock in the northern area of Benin.

1. Study Framework, Materials And Methods

1.1. Study framework

The study was carried out in the departments of Borgou, Alibori and Donga (Figure 1).

The Alibori Department is located in the far north of Benin between 10 degrees 49' 60' and 11.86 degrees North latitude and 2-25' 60' and 3-41' 40' East longitude. It has an area of 26242 km² (23% of the national territory) and an estimated population of 521093 inhabitants. The climate and vegetation are the Sudan-Sahelian type with a rainy season (May to September) and a dry season (November to April). Rainfall ranges from 700 to 1000 mm.

The Borgou Department is located in northeastern Benin between 8-52' 60' and 10'25'60' north latitude and 2'36' 0' and 3'41' 40' east longitude. It covers an area of 25856 km² of which 13962 km2 of arable land, or 54% of the total area of

the department. The climate is of the Sudanese type with alternating rainy season (May to October) and a dry season (November to April) where the harmattan blows between December and February. The average rainfall is 1200 mm.

The Donga Department is located between 8-37' and 9-16' north latitude and between 1-35' and 2-02' longitude. It covers an area of 11166 km² and has a population of 543130 inhabitants. This region of Benin enjoys a Sudan-Guinean climate with two (2) seasons: a dry season from mid-October to mid-April and a rainy season from mid-April to mid-October. The average rainfall is between 1200 mm and 1300 mm.

1.2. Material

The material used in this study consists of Azawak cattle, a graduated test tube and an investigation sheet containing the following information: breeder identification, animal habitat, livestock infrastructure, cleaning of habitat and livestock infrastructure, animal feeding, animal health monitoring, reproduction and behaviour of products from the Azawak crossing with local breeds.

1.3. Methodology

1.3.1. Data collection.

The list of breeders who received Azawak cattle was taken at Okpara breeding farm. Azawak breeders were thus identified in each department. Methodology used for data collection was that of the survey by direct interview with the breeder and observation on the characteristics of the breeding. Each breeder was subjected to a questionnaire. The interview collected information on the breeder's identity, breeding practices (mode of rearing and reproduction, health monitoring), the behaviour (ability to ride, resistance to disease) of Azawak and the resistance of products from their crossing with local breeds.

Data on breeding performance were collected at the Okpara Breeding Farm and the Agropastoral Farm of the Departmental Union of Professional Organizations of Ruminant Breeders / Borgou - Alibori (UDOPER / B - A) in Gogounou. They cover: total herd number, total number of breeding females, number of females who have had abortions, number of females having given birth, total number of products born, number of live products, number of live products at weaning, number of dead products between 0-15 days and between 15 days of age and weaning.

Data on milk production were collected on Azawak cows. For each cow, the amount of milk was measured using a graduated test tube and recorded on a data collection sheet. The milk collection was done on the cows during the study period.

1.3.2. Data processing and statistical analysis

The data collected in the field was coded and recorded on a basis designed with Excel software. The fertility rate, the prolificity rate, the calving rate, the birth rate, the abortion rate, the overall pre-weaning mortality rate and the mortality rate between birth and 15 days were first calculated from the data collected on reproductive performance. Table 1 presents the different demographic parameters used and their determination.

Table1: Calculated Demographic parameters

Demographic parameters	Formulas
Mortality rate between birth and 15 days	$(\frac{deadproductsbetween0-15days}{totalproductsborn})*100$
Overall mortality rate before weaning of Azawak calves	$(\frac{deadproductsbetween0-15daysand15days-weaning}{productsbornalive})*100$
Viability at weaning of Azawak calves	$(\frac{productsaliveatweaning}{productsbornalive})*100$
Abortion rate	$(\frac{femaleshavingaborted}{totalbreedingfemales})*100$
Fertility rate	$(\frac{productsbornalive}{breedingfemales})*100$
Birth rate	$(\frac{totalproductsborn}{breedingfemales})*100$
Calving rate	$(\frac{femaleshavinggivenbirth}{breedingfemales})*100$
Prolificity rate	$(\frac{totalproductsborn}{femaleshavinggivenbirth})*100$

These demographic parameters were then analyzed with the SAS software (2013). The frequencies were calculated by the *proc freq* procedure of the SAS software and were compared by the Chi-square test and the bilateral Z test. For each frequency, a 95% confidence interval (CI) was calculated according to the formula:

$$CI = 1{,}96\sqrt{\frac{[P(1-P)]}{N}}$$

Where P is the relative frequency and N the number of the sample.

The FactoMineR package of the R software was used for the Correspondence Factorial Analysis (CA). The variables that were taken into account in assessing the adaptation levels of Azawak zebus were : habitat, open-air parking, presence of containment corridor, cattle scale, silage pit, feeders, drinkers, artificial grazing availability, use of cotton seeds, use of veto-service feed, use of peanut leaves, cassava peels and silage, distance between pasture areas and barns (3 to 5 km and more than 5 km), presence of dermatosis, foot-and-mouth disease, respiratory diseases and trypanosomosis, resistance to pathologies (low, acceptable and good), resistance to local breeds (less resistant, more resistant, same resistance), riding type (free and organized), riding ability (good and bad), use of dietary supplements in the rainy season. The levels of adaptation of the Azawak were then identified and characterized. For milk production, the *procedure* proc means was used for descriptive statistics.

2. Results

2.1. Livestock characteristics

2.1.1. Habitat and livestock infrastructure

Table 2 shows the habitat and livestock infrastructure of Zebu Azawak in the northern part of Benin. In the majority of farms surveyed (72.22%), animals are parked in the open air and in 22.22% of farms, they are housed in modern buildings (livestock buildings built of cement-based walls and covered with sheet metal or tile) compared to 5.56% of farms that have traditional buildings (makeshift livestock buildings built from sheet metal sheets and wooden support) (Figure2). The cattle scale is used only in the Okpara breeding farm. Nearly half of the Azawak herders surveyed have

feeders and drinkers on their farms. The containment corridor is found in 22.22% of breeders and the silage pit in 11.11% of respondents. All breeders using feeder and drinkers ensure their cleanliness so wash them regularly.

Table2: Habitat and Livestock Infrastructure

Habitat and livestock infrastructure		Number of farm	Percentage (%)	CI
Habitat Type	Modern	18	22.22 a	19,21
	Traditional	18	5.56 b	10,58
	Open air	18	72.22 c	20,69
Livestock infrastructure	Containment corridor	18	22.22 a	19,21
	Cattle scale	18	5.56 b	10,58
	Silage pit	18	11.11 ab	14,52
	Feeders	18	55.56 c	22,96
	Drinkers	18	55.56 c	22,96
Infrastructure cleaning	Cleaning feeders and drinkers	18	55.56 a	22,96
	Sweeping habitat	18	94.44 b	10,58

CI: Confidence interval, Intra-class percentages followed by different letters differ significantly at the 5% threshold

2.1.2. Food

Table 3 shows how Azawak feeds in northern Benin. Feeding the animals is provided by natural pasture, artificial pasture and food supplements. All breeders of Zebu Azawak use natural pasture for the feeding of their animals. Some breeders (72.22%), in addition to natural pasture, use artificial pasture. The most common artificial pasture used by herders is the *maximum Panicum C1.* Fodder corn is used by 11.11% of respondents and 5.56% use cowpea leaves in the Azawak diet. However, the proportion of farmers using cowpea leaves was not significantly different from that of those using fodder corn. For farms using artificial pasture, the area of forage space is often small. In fact, 44.44% of these farms have an area of less than 2 hectares. Only one herder has 2 ha of *Panicum C1* and only one also has more than 5 ha of *Panicum C1.* As for food supplements, the most commonly used are crop residues, peanut leaves, cassava peels, Veto-Service food and cotton seeds. Among these supplements, crop residues are those used in all farms (100%) while peanut leaves, cassava peels, Veto-Service food and cotton seeds are used by 55.56% respectively; 38,89% ; 38.89% and 27.78% of the farms surveyed. Silage is used by 11.11% of the farmers surveyed. Brewers' grains, cereal brans, soya cakes, and waste from cotton ginning are used by 5.56% of farms, respectively. Dietary supplements, other than those mentioned above, are used by 16.67% of farms. In total, crop residues are used more in the diet of Azawak than peanuts leaves. However, these leaves are more used ($P<0.05$) than the Veto Service food and cassava peels. Finally, brewers' grains, cereal bran and soya cakes are the least used ($P<0.05$) in the diet of the Azawak in the northern area of Benin.

On all farms, dietary supplements are used in the dry season, when natural grazing is scarce. However, 11.11% of farms provide food supplements to animals during the rainy season.

In most (94.44%) of the farms surveyed, animals travel a distance of more than 5 km in search of fodder against a minority (5.56%) travelling a distance of between 3 and 5 km. In all the farms surveyed, the duration of grazing during the day is more than 6 hours.

Table 3
Azawak feed

Feeding		Number of farm	Frequency (%)	CI
Feeding mode	Natural pasture	18	100.00a	0,00
	Artificial pasture	18	72.22a	20,69
Artificial grazing	*Panicum C1*	18	72.22a	20,69
	Cowpea leaves	18	5.56b	10,58
	Fodder corn	18	11.11b	14,52
Area of artificial forage space	Less than 2 ha	18	44.44a	22,96
	2 ha	18	16.67ab	17,22
	3 to 5 ha	18	0.00b	0,00
	Plus 5ha	18	16.67ab	17,22
Food supplements	No complement	18	0.00a	0,00
	Cotton seeds	18	27.78b	20,69
	Brewer's grains	18	5.56ab	10,58
	Veto-Service Food	18	38.89b	22,52
	Cereal bran	18	5.56ab	10,58
	Soya cakes	18	5.56a	10,58
	Peanut leaves	18	55.56c	22,96
	Cassava peels	18	38.89b	22,52
	Crop residues	18	100.00d	0,00
	Ensilage	18	11.11a	14,52
	Other supplements	18	16.67a	17,22
Period of use of the supplement	Dry season	18	100.00a	0,00
	Rainy season	18	11.11b	10,58
Distance grazing area-stable	3 to 5 km	18	5.56b	10,58
	more than 5 km	18	94.44a	10,58
	Less than 6 km	18	0.00b	0,00
	more than 6 km	18	100.00a	0,00

CI: Confidence interval, intra-class percentages followed by different letters differ significantly at the 5% threshold.

2.1.3. Reproduction

Table 4 presents the reproductive abilities of Azawak cattle from the farms surveyed. In 88.89% of farms, animals are used as broodstock. The riding was free in 87.50% of the farms while it was organized at 12.50% of the farms. On farms where Azawak cattle are used for breeding, 93.75% believe that they have a good riding ability compared to 6.25% who say that the ability to ride is not satisfactory.

The females most used for crossbreeding were the Borgou. They are used by 93.75% of farms, while the Somba, Goudali, Azawak and Yakana breeds are used by 6.25%, 6.25%, 18.75% and 6.25% of the farms surveyed respectively. Females used as breeders support the Azawak bull well according to 93.75% of the breeders surveyed. Regardless of which female is used, no problems have been recorded during gestation and calving is easy and is done without the intervention of the breeder.

Table 4
Reproduction of Azawak

Variables		Number of farms	Percentage	CI
Reproduction	Animals used as breeders	18	88,89	14,52
Riding	Free riding	16	87.50a	16,21
	Organized riding	16	12.50b	16,21
Ability to riding	Bad	16	6.25b	11,86
	Good	16	93.75a	11,86
Females used for breeding	Borgou	16	93.75a	11,86
	Somba	16	6.25b	11,86
	Goudali	16	6.25b	11,86
	Azawak	16	18.75b	19,13
	Yakana	16	6.25b	11,86
Females react to riding	Support the male	16	93.75a	11,86
Problems during gestation	Problems during gestation	16	0,00	0,00

CI: Confidence interval, intra-class percentages followed by different letters differ significantly at the 5% threshold

2.1.4. Health monitoring of Azawak

Table 5 presents the results of the health monitoring of Azawak. Dermatosis are the most recorded diseases ($P<0.05$) by Azawak cattle producers in the northern area of Benin. Next came trypanosomiasis (27.78%) and the least cited diseases ($P<0.05$) are foot-and-mouth disease (16.67%) and respiratory diseases (5.56%).

On all farms, animals benefit from preventive treatments, namely: internal and external deworming, vaccinations against PPCB and bovine pasteurellosis, trypanoprevention and vitaminoprevention.

Azawak have low disease resistance according to half of the breeders while 38.89% believe they have good resistance to disease and 11.11% say they have acceptable resistance. The difference is not significant between the proportions of exploitation that the Azawak have low resistance and those who feel they have good resistance. Azawak are less resistant than local breeds according to 55.56% of breeders while 44.44% say they have the same resistance. Similarly, the difference between these two percentages was not significant and no breeder found Azawak to be more resistant than local cattle.

Table5: Azawak Health Monitoring

Variables		Number of farms	Percentage	CI
Registered diseases	Dermatosis	18	50.00a	23,10
	Foot-and-mouth disease	18	16.67b	17,22
	Respiratory diseases	18	5.56 b	10,58
	Trypanosomiasis		27.78c	20,69
Preventive treatments	Vaccination	18	100,00	0,00
	Internal deworming	18	100,00	0,00
	External deworming	18	100,00	0,00
	Trypanoprevention	18	100,00	0,00
	Vitaminoprevention	18	100,00	0,00
Azawak resistance to diseases	Low	18	50.00a	23,10
	Acceptable	18	11.11b	14,52
	Good	18	38.89ab	22,52
Resistance of the Azawak against local breeds	Less resistant	18	55.56a	22,96
	Even resistant	18	44.44a	22,96

CI: Confidence interval, intra-class percentages followed by different letters differ significantly at the 5% threshold

2.1.5. Behaviour and health monitoring of crossbred

In the 18 farms surveyed, crossbred births were recorded in 10 with a high crossbred survival rate in 70% of farms, an acceptable rate in 10% of farms and a low rate in 20% (Table 6). However, there were no significant differences between the last two rates. Diseases recorded at the crossbred level were trypanosomiasis (10% of farms), nodular dermatosis (10%), diarrhea (10%), dermatophilosis (20%) and digestive disorders (10%). The difference between these percentages was not significant. In 70% of farms, farmers rated the resistance of the crossbreds as good while 20% said it is acceptable and 10% that it is weak. However, the difference between the last two percentages was not significant. In case of diseases, the reaction of the crossbreds to the treatments was described as poor by 66.67% of breeders and very good by 33.33%. All breeders who have received Azawak are in contact with the supply structure (Okpara Livestock Farm or UDOPER) and 43.75% of breeders say they received training or advice to the acquisition of the animals.

Table 6
Survival Rates, Diseases Encountered and Resistance to Cross-Growth Diseases

Variables		Number of farms	Percentage	CI
Crossbred Survival Rate	Low	10	20.00a	24,79
	Acceptable	10	10.00a	18,59
	High	10	70.00b	28,40
Crossbred Diseases	Trypanosomiasis	10	10.00a	18,59
	Nodular Dermatosis	10	10.00a	18,59
	Diarrhea	10	10.00a	18,59
	Dermatophilosis	10	20.00a	24,79
	Digestive disorders	10	10.00a	18,59
Crossbred resistance to disease	Low	10	10.00a	18,59
	Acceptable	10	20.00a	24,79
	Good	10	70.00b	28,40
Reaction to treatment	Poor	3	66.67a	53,34
	Very good	3	33.33a	53,34

*CI: Confidence interval, Intra-class percentages followed by different letters differ significantly at the 5%*threshold.

2.1.6. Population parameters

On the Okpara and UDOPER farms, fertility and calving rates were 90% each. Prolificity and birth rates were 100%. The abortion rate was 10%, and the mortality rate between birth and 15 days was 0%. The overall pre-weaning mortality rate was 5.56% (Figure 3).

2.1.7. Milk production

Milk production of the Azawak cow in northern Benin averaged 3.8 liters per day.

2.2. Levels of adaptation of zebus Azawak

Three axes were selected for the interpretation of the results of the factor analysis of the matches (χ^2= 258.46). In the first factor axis, breeders who believe that the resistance of Azawak to diseases is good and that their resistance is similar to that of local breeds oppose those who find that the Azawak are sensitive to dermatosis and trypanosomiasis and have a low resistance compared to the local breed. In this axis, breeders Alidou, Bani, David, Mouedassou, Sara and SK are met. A minority of these herders use artificial pasture, while most use peanuts leaves and cassava peels.

In the second axis, the identical resistance of Azawak compared to local breeds, the corridors of restraint, the organized riding, and the presence of cattle scale, oppose the free riding, the open habitat, the reported presence of dermatosis and respiratory diseases. This axis discriminates against the breeders Aboumon, Bania, Bariki, Bata, Dakaora, El-hadj Alassane and Kigani.

Finally, animals that have acceptable resistance to disease are represented in Axis 3. This axis is represented by the Monastery Farm, the “Trois rivières Farm”, the Okpara Farm, the UDOPER Farm and the Zakaria Farm. These farms are

characterized by modern habitat, the presence of a silage pit, the use of Azawak females, the use of vet food service and cotton seeds as dietary supplements and the presence of foot-and-mouth disease.

Figure 4 shows Zebu Azawak's levels of adaptation on the factor plane represented by axes 1 and 2. Three levels have been identified based on the characteristics of the farms and each level corresponds to a group of breeders. Group 1 is made up of Mouedassou farms, Sara, Bani, Alidou, David and SK who believe that the resistance of Azawak to diseases is good and that their resistance is similar to that of local breeds, while group 2 is made up of the farms of Bania, Bata, Bariki, Elhadj Alassane, Dakaora, Zakaria and the “Trois rivières” who think that the Azawak are less resistant than the local breeds; they have low resistance to disease. Finally, the Okpara Breeding Farms, monastery, UDOPER, Kigani and Aboumon are group 3. In this group, Azawak are less resistant than local breeds; however, they are acceptable resistance to disease. The frequencies and confidence intervals of livestock characteristics based on adaptation levels are reported in Tables 7 to 9.

Apart from the characteristics of the breeding of Azawak cattle that discriminate three levels of adaptation, common breeding practices are also recorded. Thus, all breeders in the three groups all use natural pasture and crop residues and dietary supplements are used in the dry season. The duration of grazing during the day is more than 6 hours and the animals are vaccinated against diseases according to the national vaccination program. They do preventive treatment for trypanosomosis, gastrointestinal parasitosis and ectoparasitos and make vitaminoprevention. The ability to ride is good according to all breeders, matings are done with the Borgou cow or sometimes in purebred (between Azawak at FEO, UDOPER and Kigani). Borgou cows support Azawak males well and gestation is smooth.

2.2.1. Habitat and livestock infrastructure by group

In all Group 1 farms, the animals are parked in the open area. In this group, there is a small presence of livestock infrastructure. In fact, 16.67% of these farms have a containment corridor and 33.33% have a feeder and drinkers (Table 7). The cattle scale and the silage pit is non-existent. All breeders ensure the cleanliness of the infrastructure they have. The clean-up of these infrastructures is done on a daily basis.

On the other hand, group 2 consists of 85.71% of farms where animals are parked in the open air and 14.29% are housed in traditional habitats. The containment corridor does not exist on farms, so does the cattle scale and the silage pit is non-existent. In this group, 42.86% of farms have feeders and drinkers that are cleaned daily. Finally, all breeders in this group sweep the animal lodge on a daily basis.

Group 3, on the other hand, consists of 80% of farms where animals are housed in modern habitats, 20% of farms where they are parked in the open air. In this group, there is an existence of livestock infrastructure: In fact, more than half of the farms (60%) have containment corridor, 20% have cattle scale and 40% have silage pit. All farms in this group have feeders and drinkers and these facilities are cleaned daily.

Table 7
Habitat and Livestock Infrastructure by Group

Variables		Group 1			Group 2			Group 3			Test
		N	%	CI	N	%	CI	N	%	CI	Statistical
Types of habitat	Modern	6	0b	0,00	7	0b	0,00	5	80a	35,06	**
	Traditional	6	0	0,00	7	14,29	25,93	5	0	0,00	Ns
	Open air	6	100a	0,00	7	85.71a	25,89	5	20b	35,06	**
Livestock infrastructure	Containment corridor	6	16.67b	29,82	7	0ab	0,00	5	60a	42,94	**
	Cattle scale	6	0	0,00	7	0	0,00	5	20	35,06	Ns
	Silage pit	6	0	0,00	7	0	0,00	5	40	42,94	Ns
	Feeder	6	33.33b	37,72	7	42.86ab	36.66a	5	100a	0,00	**
	Drinkers	6	33.33b	37,72	7	42.86ab	36,66	5	100a	0,00	Ns
Cleaning of livestock infrastructure	Cleaning feeder and drinkers	6	33.33b	37,72	7	42.86ab	36,66	5	100a	0,00	Ns
	Sweep lodge	6	100	0,00	7	100	0,00	5	80	0,00	Ns

N: Total staff; %: Percentage; CI: Confidence interval. The percentages of the same line followed by different letters differ significantly at the 5% threshold

2.2.2. Food and reproduction of Azawak by group

Panicum C1 is used in all groups. It is used in all Group 3 farms compared to 57.14% of Group 2 farms and 66.67% of Group 1 farms (Table 8). Group 3 breeders also use cowpea leaves (20%) and feed corn (40%). However, there is no significant difference between these percentages.

No Group 1 farm uses cotton seeds in animal feed. On the other hand, this supplement is used by 57.14% of breeders in group 2 and 20% of breeders in the group3. Silage is absent in groups 1 and 2 farms, but is used in 40% of Group 3 farms. Peanuts leaves are used by 83.33% of group 1 breeders compared to 42.86% for group 2 and 40% for group 3. The Veto service food and cassava peels are also used by breeders in all three groups. In addition to these supplements, some breeders offer other supplements to their animals.

In all groups 1 and 3, Azawak were used as breeding stock. In group 2, on the other hand, they were used as breeding stock in 71.43% of farms. Rinding is free on all groups 1 and 2 farms. In Group 3, it is free in 60% of farms and organized in 40% of farms. The Azawak's riding ability was described as good in all groups 1 and 3 farms. But in group 2, 20% of breeders say that the ability to ride of Azawak is poor compared to 80% who say it is good. In all groups 1 and 2 farms, the females used for breeding are local breeds. On the other hand, in 60% of group 3 farms, Azawak females are used for breeding, i.e. Azawak are bred as purebred on these farms.

Table 8
Feeding and Breeding Azawak Zebus by group

Variables		Group 1			Group 2			Group 3			Testing
		N	%	CI	N	%	CI	N	%	CI	Significance
Artificial grazing	*Panicum C1*	6	66,67	37,72	7	57,14	36,667	5	100	0,00	Ns
	Cowpea leaves	6	0	0,00	7	0	0,00	5	20	35,06	Ns
	Fodder Corn	6	0	0,00	7	0	0,00	5	40	42,94	Ns
Food supplements	Cotton seeds	6	0b	0,00	7	57.14a	36,66	5	20ab	35,06	**
	Veto Service Food	6	16,67	29,82	7	28,57	33,47	5	80	35,06	Ns
	Peanut leaves	6	83,33	29,82	7	42,86	36,66	5	40	42,94	Ns
	Cassava peels	6	66,67	37,72	7	28,57	33,47	5	20	35,06	Ns
	Silage	6	0	0,00	7	0	0,00	5	40	42,94	Ns
	Other	6	0 a	0,00	7	14,29	25.92a	5	40	42.94b	**
Distance grazing area-stable	3 to 5 km	6	16,67	29,82	7	0	0,00	5	0	0,00	Ns
	Plus 5 km	6	83,33	29,82	7	100	0,00	5	100	0,00	Ns
Reproduction	Yes	6	100	0,00	7	71,43	33,46	5	100	0,00	Ns
Type of riding	Free riding	6	100	0,00	5	100	0,00	5	60	42,94	Ns
	Organized riding	6	0	0,00	5	0	29,82	5	40	42,94	Ns
Ability to riding	Bad	6	0	0,00	5	20	35,06	5	0	0,00	Ns
	Good	6	100	0,00	5	80	35,06	5	100	0,00	Ns
Female used	Azawak	6	0	0,00	5	0	0,00	5	60	42,94	Ns

p ≤ 0.01; N: Total staff; NS: Not significant; CI: Confidence interval. The percentages of the same line followed by different letters differ significantly at the 5% threshold

2.2.3. Diseases of the Azawak by group

Dermatosis were registered in 85.71% of group 2 farms and in 60% of group 3 farms, but it is totally absent in group 1 farms (Table 9). The difference between these percentages is significant (0.01). Foot-and-mouth disease, respiratory diseases and trypanosomiasis are also absent in group 1. On the other hand, these diseases are recorded in 28.57% of group 2 and 20% of group 3 for foot-and-mouth disease and 42.86 and 40% for trypanosomiasis. Respiratory diseases are recorded in 20% of the group's farms

Table9: Registered Diseases and Animal Resistance by group

Variables		Group 1			Group 2			Group 3			Testing
		N	%	CI	N	%	CI	N	%	CI	Significance
Registered diseases	Dermatosis	6	0 b	0,00	7	85.71a	25,93	5	60a	42,94	**
	Foot-and-mouth disease	6	0	0,00	7	28,57	33,47	5	20	35,06	Ns
	Respiratory diseases	6	0	0,00	7	0	0,00	5	20	35,06	Ns
	Trypanosomiasis	6	0	0,00	7	42,86	36,66	5	40	42,94	Ns
Animal resistance to disease	Low	6	0 b	0,00	7	85.71a	25,93	5	60a	42,94	**
	Acceptable	6	0	0,00	7	14,29	25,93	5	20	35,06	Ns
	Good	6	100 a	0,00	7	0b	0,00	5	20b	36,06	**
Resistance of the Azawak against local breeds	Less resistant	6	0 b	0,00	7	100a	0,00	5	60a	42,94	**
	More resistant	6	0	0,00	7	0	0,00	5	0	0,00	Ns
	Same resistance	6	100 a	0,00	7	0b	0,00	5	40a	42,94	**

p ≤ 0.01; N: Total staff; NS: Not significant; CI: Confidence interval. The percentages of the second line *followed by* different letters *differed significantly at the 5% threshold*

3. Discussion

3.1. Livestock characteristics

Azawak cattle are bred under the same conditions as the Borgou breed on all the farms visited. The habitat and breeding infrastructure, feeding method, reproduction and health monitoring of Azawak are identical to those of the Borgou breed (Youssao *et al.* 2013a). The only peculiarity is the presence of forage crops on most farms (77.22%) where the Azawaks are. In 88.89% of farms, animals are used as breeding stock. It is mainly males that are distributed to breeders for crossbreeding with local breeds in general and especially the Borgou cow. The purpose of crossbreeding may be to enhance heterosis in offspring and to genetically improve a breed. It also enhances the complementarity between race (Jussiau *et al.* 2013). The female zebu Azawak is considered the best dairy in West Africa (Issa *et al.* 2014). The local breed Borgou is considered to be a fairly resistant animal to the harsh climatic conditions of its living environment (Youssao *et al.* 2013a) and has a fairly good resistance to trypanosomiasis, which is endemic to Benin (Alkoiret *et al.*, 2016). The product from the cross between the Azawak bull and the Borgou cow, will therefore benefit from the complementarity of the two breeds. It will benefit from resistance to diseases, especially trypanosomiasis, which will be transmitted to it by the Borgou breed and the ability to produce milk given to it by Azawak.

Several breeders have said that Azawaks have low resistance to disease certainly because of their susceptibility to dermatosis and trypanosomosis. Indeed, these diseases are the most recorded among the Azawak in the farms surveyed and this is explained by the fact that the northern area of Benin is wetter than Toukounous where these Azawak come from (Ousseina *et al.*, 2015; Kassa *et al.* 2019) .

In terms of demographic parameters, the rate of prolificity of zebu Azawak is 100% in this study. In Burkina Faso, Boly *et al.* (2000) reported prolificity rates of 98.39% in 1993, 100% for 1994 and 98.68% in 1995 at the Loumbila station. This station has the same breeding practices as that of the group 3 breeders. Similarly, the fertility rate of zebu Azawak is 90%

and this rate is 70% in its ecological niche of Toukounous, in the agropastoral zone in Niger (Oumarou, 2004). Achard and Chanono (1997) reported an average fertility rate of 78% for the period 1987 to 1992 on the Toukounous station (extremes 73.3 and 86.4%). These differences in results between Achard and Chanono (1997) and that of this study could be explained by better monitoring of animals on the Okpara and UDOPER farms because the Azawaks are imported from Toukounous and benefit from a vital importance and a substantial financial means for their follow-up. However, it is important to remember that the results obtained by Achard and Chanono (1997) date back 20 years. In 20 years, breeding techniques have evolved in livestock farms thanks to integrated health and medical prophylaxis programs, the control of infectious pathologies and reproductive pathologies, etc. If these performances were evaluated today, it is likely that the results obtained in our study are identical to those of Toukounous. In addition, the results obtained in our study and in Burkina Faso, were obtained from herd numbers of fewer than 100 heads, while in Toukounous, the Azawak cattle herd is greater than 2000 head (Chanono, 2003). With a small number, there may not be significant differences between all these rates due to a likely high confidence interval in small herds in Burkina Faso and northern Benin.

The overall mortality rate was 5.56%. The overall mortality rate for Azawak is 4.9% at the Toukounous station (Achard and Chanono, 1997). High mortality rate (15.5%) was recorded at the Toukounous station in the 1960s (Pagot *et al.* 1985). These deaths were due to cases of enteritis, diarrhea, coccidiosis, milk indigestion, Rickettsiosis, sepsis, pneumonia, tetanus (Achard and Chanono, 1997). In the northern part of Benin, health monitoring of Azawak zebus is more improved, resulting in a reduction in calf mortality.

As for dairy production, it averaged 3.8 liters per day. This production is close to that (3.95 kg) recorded by Saidou (2004) at the Experimental Sahelian station in Toukounous (SSET) in Niger. On the other hand, it is lower than the productions (5.28; 6.88; 6.98 and 7.11 liters) recorded by Barthe (2014) Barthe at the Sahelian Experimental Station of Toukounous (SSET) in 2013 on cows having done 'subject of an experimental study replacing cottonseed cakes by Acacia raddiana pods. The cows that were the subject of Barthe's study are elite cows from the Toukounous station, whereas this study involved only 11 cows that also receive food supplementation but are not necessarily the best producers of these breeding stations.

The average milk production of Azawak in this study is also lower than that recorded by Abdou (2007) at the kirkissoye dairy cooperative in Niger. This could be due to the nature of the supplements used in feeding cows. Indeed, the cows in this study received a supplement based on cotton seed or the veto service food while those that were the subject of Abdou's experimentation (2007) received the fresh brewer’s grain and the medium wheat bran. In addition, productions(1.78 l and 2.3 l) below the average production of this study were recorded in real-world areas where animals are fed only on natural pasture by and on cows fed solely on *Echinochloa stagnina* at the kirkissoye station (Abdou, 2007). Moreover, in resorts, under breeding conditions similar to those of the Okpara and UDOPER farms, Oumarou (2004) reports a daily milk production of 3.56 liters, close to that recorded on these two farms in the northern zone of Benin.

3.2. Levels of adaptation of zebus Azawak

Three groups of breeders corresponding to three levels of adaptation were identified during our study. Group 3 breeders have livestock infrastructure, artificial pasture and use food supplements. These breeders most often have the financial resources from technical and financial partners. This is the case, for example, with the Okpara breeding Farm and the UDOPER Farm. On the other hand, in group 1, herders are characterized by a lack of livestock infrastructure. Animals spend the night in the open air. Breeders in this group have few resources and are not supported by Technical and Financial Partners. They use crop residues, peanut leaves and cassava peels more than concentrates because of limited

means. *Panicum C1* occurs on all Azawak livestock farms, but the area under cultivation depends on the financial means of the breeders and it is for this reason that the group 3 farmers have more forage plots than those in Group 1. Despite the absence of breeding facilities among group 1 breeders, very few pathologies have been observed and the animals have the same resistance as local breeds, unlike the group 3 breeders who have a well-followed health and medical prophylaxis program on the one hand, and qualified human resources on the other. This could be explained by the stalling of the animals and their confinement in barns and parking areas. In group 3, the animals are housed in barns. The dung is picked up every morning, but the crawl space is virtually unrealized. The accumulation of droppings and urine deposits and other physiological fluids in barns is a factor that would promote the development of pathogenic germs. In addition, in these barns the animals can be confined, which would increase the risk of contagion within the herd. On the other hand, among group 1 breeders, animals do not have habitat. The breeders in this group are mostly transhumant breeders. So they move from one park to another. Thus, when the breeder finds that the soil of the site is too wet and contaminated by the droppings and urine of the animals, he moves his animals to another site, thus keeping them away from pathogens. In addition, at these sites, the widened perimeter allows animals to stay at a distance from each other.

Group 1 breeders are characterized by a lack of livestock infrastructure. The animals spend the night in the open area. They use peanut leaves and cassava peels as a dietary supplement. In this group, animals are exposed to bad weather. The absence of a cattle scale livestock and a containment corridor is a hindrance for zootechnical and sanitary monitoring of animals. It would be difficult to have zootechnical follow-up sheets; this could make it difficult to see any idea of animal genetic improvement in this group. The lack of artificial grazing and forage reserves force animals to travel long distances in the dry season in search of food. This leads to a reduction in the production of animals in this group. These movements, tire animals, weaken them and make them more vulnerable to opportunistic diseases (Doko *et al.* 2010). Under these breeding conditions, the animals will not be able to express their full potential. As a result, they will have low productivity.

Group 3 herders have livestock infrastructure, including modern habitat, containment corridors, cattle scale, silage pit, drinkers and feeders. They frequently clean these drinkers and feeders. In terms of food, they have an artificial pasture composed of *Pannicum C1* and they use cotton seeds and the veto service food as a supplement. Diseases such as dermatosis, foot-and-mouth disease, respiratory diseases and trypanosomosis are found in these animals. Azawaks are generally less resistant than local breeds and nevertheless possess acceptable resistance. Group 3 farms have everything they need for good animal productivity. The presence of livestock infrastructure makes it easier to track animals. Food availability allows for an increase in the production of animals. As the animal's habitats are modern, the animals live in stables. The same spaces are used all the time during all seasons; which facilitates the development of bacteria, parasites and other disease-causing agents.

Depending on the level of adaptation of Azawak cattle, three breeding groups were identified. In group 1 farms, pathologies are rare; animals have the same resistance as local breeds. In group 3, diseases such as dermatosis, trypanosomiasis are recorded; animals are generally less resistant than local breeds and nevertheless have acceptable resistance. Group 2 breeders have intermediate characteristics between those of breeder groups 1 and 3. The reproduction performance of the Azawak is good. The same is true for the viability of calves. The milk production of the Azawak cow in the northern zone of Benin is similar to its production in its native environment. Overall, the Azawak have adapted well in the northern part of Benin. However, regular and frequent disinfection of modern habitats of group 3 and the installation of litter and its regular renewal in traditional habitats would reduce the development of pathogens in habitats and thereby reduce the risk of animal contagion and thus improve their level of adaptation. In Group 1, the construction of livestock infrastructure such as habitat, cattle scale, containment corridor, the cultivation of fodder species, fodder reserves, will improve feeding, health and zootechnical monitoring of animals, thereby improving herd productivity and the implementation of animal breeding programs.

Declarations

Statements & Declarations

i. Funding

The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

ii. Conflicts of interest/Competing interests

There are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

iii. Ethics approval

Not applicable

iv. Consent to participate

Not applicable

v. Consent for publication

Not applicable

vi. Availability of data and material

The datasets generated during and/or analysed during the current study are not publicly available but are available from the corresponding author on reasonable request.

vii. Code availability

viii. Authors' contributions

All authors contributed to the study conception and design. The manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us.

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Figures

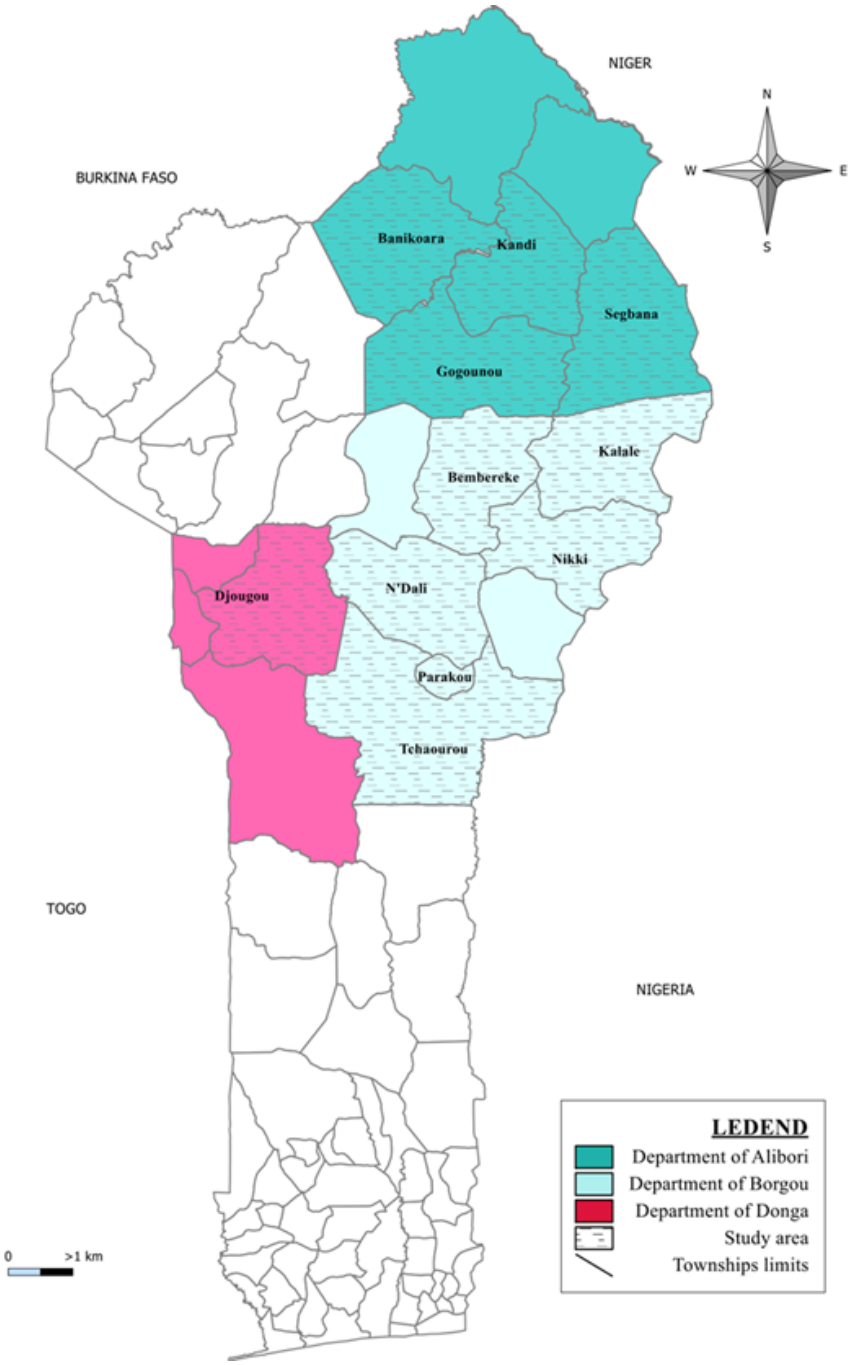

Figure 1

Study area

Figure 2

Livestock buildings (a: traditional buildings, b: modern building)

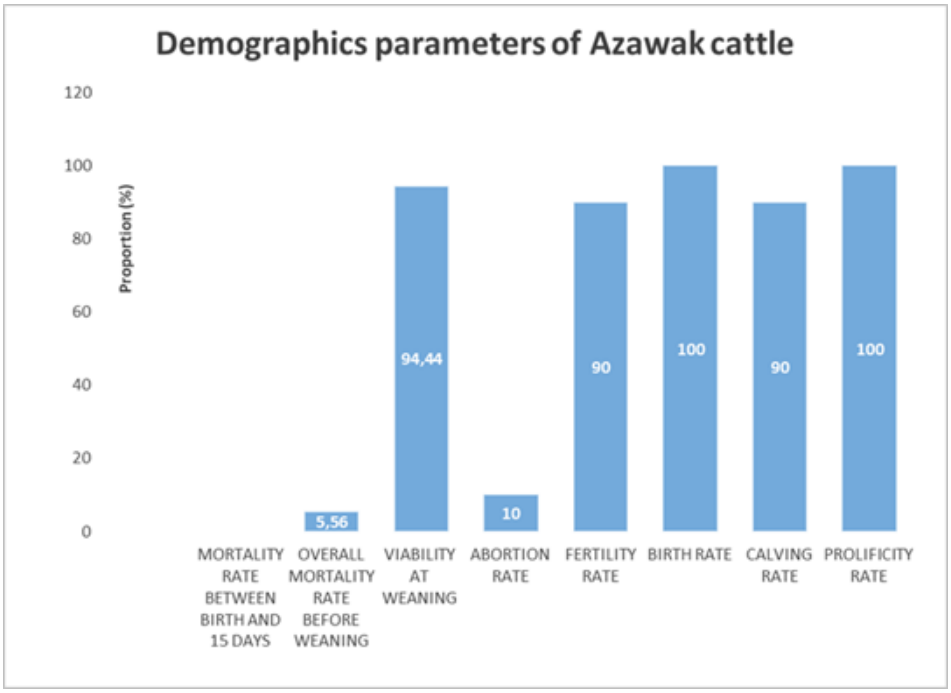

Figure 3

Azawak Cattle Demographics

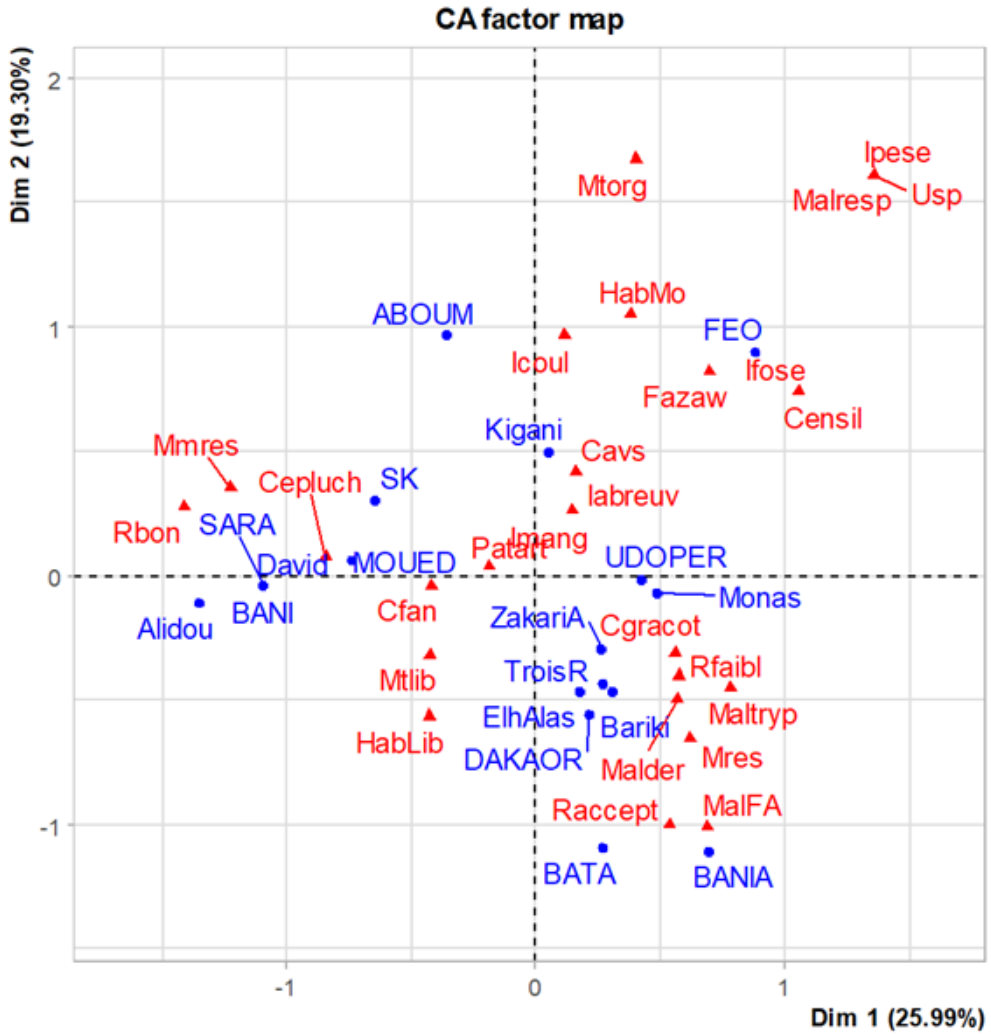

Figure 4

Zebu Azawak adaptation levels in the northern area of Benin based on breeding characteristics.

MalFA: *foot-and-mouth disease;* ***MalDer:*** *Dermatosis;* ***MalRes:*** *Respiratory diseases;* ***MalTryp:*** *trypanosomiasis;* ***HabLib:*** *Open Habitat;* ***HabMo:*** *Modern Habitat;* ***Ifos:*** *Silage pit;* ***Icoul:*** *Containment* ***corridor; Ipese*** *:Cattle scale;* ***Imang:*** *feeder;* ***Iabreuv:*** *Drinkers****; Patart:*** *Artificial grazing;* ***Cgrac:*** *cotton seed;* ***Censil:*** *ensilage;* ***CAvs:*** *veto service Food;* ***Cepluch:*** *Cassava peels;* ***Usp:*** *Use of supplement in rainy season;* ***Raccept:*** *Acceptable Resistance of Azawak;* ***Rbon:*** *Good Resistance of Azawak;* ***Rfaible:*** *Weak Resistance of Azawak;* ***Mmres:*** *same resistance as local breeds;* ***Mres:*** *less resistant* than local *breeds* ***Mtlib:*** *Free Riding;* ***Mtorg:*** *Organized riding;* ***Fazaw:*** *Female Azawak.*