Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 6, No.3, p. 146-157, 2015
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Characteristics of cattle rearing, herd composition and manifestations of climate change in the municipality of Banikoara in Benin

S. Katé[1], P.V. Houndonougbo[2], U.P. Tougan[3], A. Tchobo[4], N. Gounou[4], O.J. Ogodja[4], B. Tinte[5], E. Ogouwale[5], S. Diarra[6], B.A. Sinsin[2]

[1]*Institut National des Recherches agricoles du Bénin (INRAB), Republic of Benin*

[2]*Faculté des Sciences Agronomiques de l'Université d'Abomey-Calavi, Republic of Benin*

[3]*Ecole Polytechnique d'Abomey-Calavi de l'Université d'Abomey-Calavi, Republic of Benin*

[4]*Ministère de l'Agriculture de l'Elevage et de la Pêche (MAEP), Republic of Benin*

[5]*Faculté des Lettres, des Arts et des Sciences Humaines de l'Université d'Abomey-Calavi, Republic of Benin*

[6]*Université du Mali/Institut Polytechnique Rural de Formation et de Recherche Appliquée de Katibougou, Republic of Mali*

Article published on March 02, 2015

Key words: Banikoara, Benin, cattle production, climate change signs, herds composition.

Abstract

The current study aims to assess the breeding system, the herd structure of the cattle farm and the climate changes in the municipality of Banikoara. It appears that the majority of farmers was from Fulani ethnic group, of 46 years old and married. Livestock farming was their main activity. The main crops produced included maize, sorghum, millet and cotton. The reared animal species were composed of cattle, goats, sheep, pigs, chickens and guinea fowl with the predominance of chicken ($p < 0.05$) . The exploited cattle breeds were Borgou, Somba Zebu Peulh, Barougoudji, Bororo, Kiwali and Kétégui with a predominance of the cattle Borgou ($p < 0.001$). The cattle breeding systems were of traditional type. The reported age at first calving varies between 2.5 and 4 years. The calving interval fluctuates between 8 and 13 months. The best daily milk production per cow was reported in the district of 5 (8.38 liters) and lowest yields was obtained in districts 1 ($p < 0.05$). The longevity of the animals varied between 8 and 14 years. The selection criteria used in the choice of reproductive cattle by farmers were the coat color, format, health, size of limb and conformation of limbs. The climate change manifestations in the municipality of Banikoara were reported as frequent droughts, high winds, excessive heat, scarceness of rains and frequent floods, declines of pastoral productivity, overgrazing, reduction of water resources and crop residues and shrinking corridors.

***Corresponding Author:** Tougan P. Ulbad ✉ ulcaless71@yahoo.fr

Introduction

Agricultural production and the biophysical, political and social systems that determine food security in Africa are expected to be placed under considerable additional stress by climate change (FAO, 2007; FAO, 2008). According to Easterling *et al.* (2007), an increase of temperature may destabilize food production, especially in low latitudes. Therefore, these changes may have negative impacts on natural resources and all sectors of life, including food security, human and animal health (IPCC, 2007). The global production of the livestock sector in sub-Saharan Africa over the last two decades has been far from impressive.

In Benin where the national economy is based on agriculture (Tijani *et al.*, 2006), meat and dairy production relies on native cattle breeds. The cattle production is affected by the increasing environmental degradation caused mainly by climate variation and the high human density (Lo and Lo, 2009). Farmers have lost their former seasonal markers, crop losses are increasing as food insecurity (Hounkponou, 2007).

However, international scientific efforts are increasing to explain climate change and its impacts, and implement strategies to reduce greenhouse gas emissions. Little works were devoted in Benin to perceptions and adaptation means developed by breeders to respond to these changes. Then, it is necessary to investigate on the variation in weather characteristics, their impacts on the crop and livestock production and technical and socio-economic adaptation methods used. Therefore, the objective of this study is to investigate on the cattle breeding characteristics and the manifestations of climate changes observed by the cattle breeders in the municipality Banikoara.

Materials and methods

Study area

The present study was conducted from January 10 to May 10, 2014 in the Municipality of Banikoara (Fig. 1). The Municipality of Banikoara is located in the department of Alibori which is limited in the north by the Niger River, in the south by the department of Borgou, in the east by Nigeria republic and in the west by the Atacora hill and the republic of Burkina Faso. Banikoara is recognizable as the geographical coordinates 11° 18' north latitude and 2 ° 26' east longitude, and covers an area of 4383 km² with a population of 52028 inhabitants (INSAE, 2003). The population density of Banikoara is 35 inhabitants / km².

The Municipality of Banikoara covers nine rural Districts (Founougo, Gomparou, Goumori, Kokey, Kokiborou, Ounet, Sompérékou, Soroko and Toura) and an urban district (Banikoara).

This Commune has a Sudano-sahelian climate with an average rainfall of 850mm. There are two distinct seasons: a rainy season from May to October and dry season from November to April. The vegetation consists of woodland, shrub and herbaceous with beaches thorn in places subject to strong anthropogenic influence. Moreover, along the rivers, there is well wooded vegetation.

Materials

Data collection was conducted with 694 cattle breeders in the Municipality of Banikoara in the Department of Alibori. In this study, the material used is composed of a survey form and a tablet.

The survey form contains the following information:

- ✓ Profile of cattle breeders and crop production
- ✓ Animal species reared by the cattle breeders
- ✓ Variability of cattle breeds reared by farmers
- ✓ Herd structure
- ✓ Characteristic of the flock and production performance of cattle
- ✓ Animal selection
- ✓ Manifestation of climate change reported by cattle breeders in Banikoara.

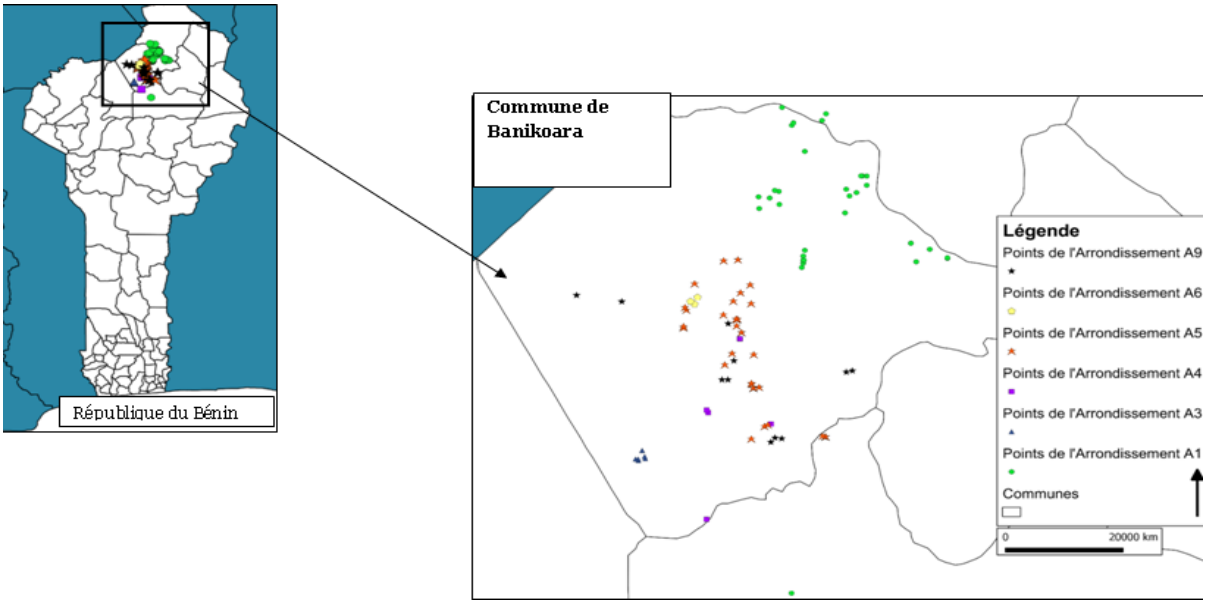

Fig. 1. Study area (Municipality of Banikoara in Benin).

Methodology

The methodology used in the current study was the investigation by retrospective interview with the cattle breeders. The survey collected information on the cattle breeders, their herd characteristics and the impact of climate change on agricultural production. The sample size (N) (number of investigated herds) for the study was determined from the formula of Dagnelle (1998):

$$N=\frac{Pi(1-Pi)*U1-\alpha/2}{d^2}$$

Where:

Pi is the proportion of households with herd. In this study, P = 20.44% (2188 agricultural households had cattle herds on 10703). The sample size to investigate from these data was then 694 herds. Size of farm households with herd to investigate each district was determined by considering the proportion of agricultural households in each district based on the total number of farm households throughout the municipality of Banikoara. A total of 694 cattle were interviewed in the municipality of Banikoara.

Counting and Statistical Analysis

The recount was an operation in which data collected during the survey were reviewed, coded and stored in a database designed using the software Excel 2010.

The data collected were analyzed using SAS 9.2 (Statistical Analysis System, 2013) software. The means and variances were calculated using the GLM procedure and frequencies were calculated using the procedure *Proc freq* of SAS. Frequencies were compared using the Chi square test and bilateral test of Z.

For each frequency P, a confidence range (ICP) at 95% was calculated using the formula:

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

Where:

P is the relative frequency and N is the sample size.

Results and discussion

Profile of cattle breeders and crop production

The proportion of 72% of cattle breeders were of Fulani ethnic group. Only 18% was of Bariba ethnic group (Table 1). Animal rearing is their main activity in 60-85% of cases with a predominance noted in the district 8 ($p < 0.05$). Similarly, their secondary activity is agriculture with the highest frequency recorded in the district 8 ($p < 0.05$; Table 1). This result is similar to that obtained by Alkoiret *et al.* (2009) in cattle in the Municipality of Gogounou and profile of traditional poultry breeders in the same area reported

by Tougan, (2008). Somda *et al.* (2004) in Guinea-Bissau have also confirmed the importance of Fulani cattle in with a proportion of 96.2% of the farmers. The existence of a secondary activity to livestock production shows that the cattle are rarely the sole household livelihood of farmers. In fact, livestock is one of many integrated and complementary activities of the farming system that contributes to the overall well-being of rural population in West Africa (FAO, 2004). In this context, the cattle in the municipality of Banikoara contribute to the diversification of rural incomes. Furthermore, all breeders of cattle found in the municipality of Banikoara are male and married (Table 1). The lack of female herd owner is due to sociological parameters of the municipality. The social organization of Fulani assigns exclusively cattle breeding to men (FAO, 2011). In addition, the traditional cattle system is characterized by the practice of transhumance, activity remains dominated by men (Dehoux and Hounsou-Ve, 1993). The same observation was made in Guinea-Bissau in dairy cattle farms (Somda *et al.*, 2004).

Table 1. Profile of the cattle breeders.

Variables		District 1		District 2		District 3		District 4		District 5		District 6		District 7		District 8		District 9		District 10		Test of Khi²
		%	CR	%	CR	%	CR	%	CR	%	CR	%	CR	%	CR	%	CR	%	CR	%	CR	
Ethnie	Peulh	69.89	6.74	68.67	9.98	80.95	8.40	78.79	13.95	81.48	8.41	72	17.60	80.65	9.83	85.2	13.4	66.67	14.1	83.61	9.2	NS
	Bariba	30.11	6.74	31.33	9.98	19.05	8.40	21.21	13.95	18.52	8.41	28	17.60	19.35	9.83	14.8	13.4	33.33	14.1	16.39	9.2	NS
Main activity	Breeding	69.1	6.79	59.04	10.58	77.38	8.95	72.73	15.19	71.95	9.72	72	17.60	82.26	9.51	85.2	13.4	67.44	14	81.97	9.6	*
	Agriculture	30.9	6.79	40.96	10.58	22.62	8.95	27.27	15.19	28.05	9.72	28	17.60	17.74	9.51	14.8	13.4	32.56	14	18.03	9.6	*
Secondary activity	Breeding	35.39	7.02	39.76	10.53	21.43	8.78	27.27	15.19	26.83	9.59	24	16.74	17.74	9.51	14.8	13.4	32.56	14	18.03	9.6	*
	Agriculture	64.61	7.02	60.24	10.53	78.57	8.78	72.73	15.19	73.17	9.59	76	16.74	82.26	9.51	85.2	13.4	67.44	14	81.97	9.6	*
Sex	Male	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100	0	NS
	Female	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	NS
Situation matrimoniale	Married	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100	0	NS
	Non married	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	NS

% : Percentage, **CR** : confidence range; **NS** : Non Significant; * : P<0.05. ** : P<0.01. *** : P<0.001.

The main crops grown by the breeders outside livestock production include corn, sorghum, millet and cotton (Table 2). Cultivated areas for corn vary significantly according to the district and fluctuate between 2 and 5 hectares with the widest area recorded in District 4 (p <0.001). The superficies grown in the 10 districts of Banikoara for sorghum and millet are similar and vary respectively between 2.6 and 4.7 hectares and between 0.01 and 0.46 hectare (p> 0.05). As for the cotton production, cultivated surfaces vary significantly depending on the district and fluctuate between 1.6 and 4.8 hectares with the greatest superficies found in District 4 (p <0.001). These observations confirm that the Banikoara is largely a farming area like the other cities of Benin. According to DE (2011), the economy of the Republic of Benin depends primarily on the rural sector which devoted over than 70 % of the population.

Table 2. Age of cattle breeders and their crop production.

Variables	District 1		District 2		District 3		District 4		District 5		District 6		District 7		District 8		District 9		District 10		ANOVA
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	
Age of breeders (year)	46.32	1.01	47.30	1.46	46.97	1.46	44.12	2.32	47.21	1.47	44.56	2.67	44.83	1.71	46.70	2.72	45.79	2.03	52.50	1.73	**NS**
Corn (Ha)	3.44^{abc}	0.29	4.84^{abc}	0.43	3.13^{a}	0.43	5.14^{abc}	0.69	2.64^{ab}	0.44	4.89^{bc}	0.80	2.10^{ab}	0.51	2.41^{c}	0.76	3.66^{ab}	0.61	4.24^{ab}	0.51	***
Sorghum (Ha)	3.54	0.24	3.69	0.35	3.63	0.35	4.67	0.56	2.98	0.36	3.85	0.65	2.61	0.41	2.83	0.62	3.35	0.49	4.23	0.41	NS
Ground nuts (Ha)	0.08^{a}	0.03	0.23^{a}	0.04	0.09^{ab}	0.04	0.10^{a}	0.07	0.15^{a}	0.04	0.46^{a}	0.08	0.07^{b}	0.05	0.00^{a}	0.07	0.10^{a}	0.06	0.10^{a}	0.05	**
Millet (Ha)	0.05	0.11	0.46	0.16	0.01	0.16	0.01	0.26	0.02	0.16	0.24	0.30	0.18	0.19	0.97	0.29	0.08	0.23	0.002	0.19	NS
Cotton (Ha)	3.71	0.43	4.69	0.65	2.59	0.62	4.83	1.004	2.20	0.63	3.91	1.15	1.64	0.73	2.33	1.11	3.79	0.87	2.72	0.73	NS
Others	0.33	0.05	0.38	0.07	0.51	0.07	0.37	0.12	0.21	0.08	0.67	0.14	0.24	0.09	0.08	0.14	0.50	0.11	0.38	0.09	NS

SE : Standard Error ; NS : Non Significant; * : P< 0.05. ** : P< 0.01. *** : P< 0.001.

Animal species reared by the cattle breeders

Table 3 shows the composition of the herd by species and by region. Animal species reared by farmers in Banikoara consist of cattle, goats, sheep, pigs, chickens and guinea fowl. Excepting oxen, sheep and pigs populations which did not vary significantly according to the study areas, the number in reproductive cattle, goats, chickens and guinea fowl were affected by the region. Indeed, reproductive cattle are more numerous (P <0.05) in the district 7 (46.5 animals) and lowest in the district 3 (29 animals). Similarly, the highest average numbers of goats (17), chicken (32) and guinea fowl (38) were obtained respectively in districts 2 and 6 (Table 3). This diversity of the species reared by herd confirms the observations of FAO (2011) on the characteristics of family farming in West Africa. Mixed farming systems combining several species can be an important track search methods of adaptation to climate change because the increase in the diversity of animal resources constituting the same farm livestock managed by farmers increases the flexibility of farms and thus can reduce their sensitivity to climate hazards through different and complementary skills of each animal category (Nozieres *et al*., 2011).

Table 3. Reared species and amount.

Variables	District 1		District 2		District 3		District 4		District 5		District 6		District 7		District 8		District 9		District 10		ANOVA
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	
Breeding cattle	43.77^{a}	2.53	46.22^{ab}	3.70	29.30^{a}	3.68	42.27^{b}	5.88	41.13^{ab}	3.73	33.72^{ab}	6.75	46.46^{ab}	4.28	35.16^{ab}	6.50	40.74^{ab}	5.15	42.95^{ab}	4.32	*
Oxen	3.85	0.30	4.69	0.45	2.77	0.44	3.33	0.71	3.07	0.45	4.00	0.82	4.19	0.52	3.55	0.78	3.81	0.62	3.98	0.52	NS
Sheeps	17.02	1.10	21.03	1.61	15.28	1.60	16.09	2.56	14.63	1.62	21.32	2.94	15.74	1.86	15.77	2.83	14.37	2.24	18.47	1.88	NS
Goat	12.02^{ac}	0.83	17.06^{abc}	1.22	11.63^{b}	1.22	12.96^{ab}c	1.94	11.15^{abc}	1.23	10.84^{c}	2.24	12.30^{abc}	1.42	16.62^{abc}	2.15	16.04^{abc}	1.70	12.40^{abc}	1.43	**
Pigs	0.10	0.18	0.34	0.26	0.75	0.26	0.00	0.42	0.41	0.26	0.72	0.48	0.16	0.30	0.00	0.46	0.72	0.36	0.16	0.31	NS
Chickens	21.52^{a}	1.69	23.80^{ab}	2.47	31.89^{ab}	2.46	23.09^{b}	3.92	19.43^{ab}	2.49	31.36^{a}	4.51	23.35^{ab}	2.86	18.07^{ab}	4.34	26.16^{ab}	3.44	25.67^{ab}	2.88	*
Guinea fowls	17.92^{ac}	1.36	16.85^{ac}	1.99	23.88^{ac}	1.98	16.42^{a}	3.16	15.19^{ac}	2.01	38.04^{ac}	3.64	11.58^{b}	2.31	16.88^{c}	3.50	14.74^{ac}	2.77	16.34^{ac}	2.33	***
Others species	5.19	1.11	6.32	1.63	2.75	1.62	4.24	2.59	3.13	1.64	7.96	2.97	2.90	1.89	1.00	2.86	4.65	2.27	9.32	1.90	NS

SE : Standard Error ; NS : Non Significant; * : P< 0.05. ** : P< 0.01. *** : P< 0.001.

Table 4. Distribution of male and female cattle populations by breed and by district.

Variables		District 1		District 2		District 3		District 4		District 5		District 6		District 7		District 8		District 9		District 10		ANOVA
		Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	
Amount of Males	Borgou	11.35^{a}	0.75	12.06^{ab}	1.10	5.58^{a}	1.09	6.66^{b}	1.74	6.62^{ab}	1.10	6.92^{b}	2.00	9.81^{ab}	1.28	7.03^{ab}	1.89	10.72^{ab}	1.53	8.13^{ab}	1.31	***
	Somba	0.01^{a}	0.13	0^{ab}	0.19	0.01^{a}	0.19	1.30^{a}	0.30	1.17^{bc}	0.19	0.08^{c}	0.35	0^{abc}	0.22	0^{a}	0.33	0.41^{abc}	0.27	0.13^{abc}	0.22	***
	Zebu	0^{a}	0.31	0.37^{a}	0.45	0.07^{a}	0.45	0.90^{a}	0.72	0.60^{ab}	0.45	4.00^{a}	0.83	0^{b}	0.53	0^{a}	0.78	0.18^{a}	0.63	0.08^{a}	0.53	**
	Barougoudji	0^{a}	0.11	0.20^{a}	0.16	0^{a}	0.16	0^{a}	0.25	0^{a}	0.16	0^{a}	0.29	0^{a}	0.18	1.25^{a}	0.28	0^{b}	0.22	0^{a}	0.19	*
	Taurin	0.03^{a}	0.04	0^{a}	0.06	0^{a}	0.06	0.45^{a}	0.10	0.26^{b}	0.06	0^{ab}	0.12	0^{ab}	0.07	0^{a}	0.11	0^{ab}	0.09	0.01^{ab}	0.07	**
	Boro	0.06	0.06	0.02	0.09	0	0.09	0.48	0.15	0.18	0.09	0.48	0.17	0	0.11	0	0.16	0	0.13	0.05	0.11	NS
	Kiwali	5.75^{a}	0.87	2.71^{ab}	1.28	0.70^{ab}	1.27	17.18^{b}	2.03	1.01^{c}	1.28	1.24^{ab}	2.33	1.08^{ab}	1.49	0.53^{ab}	2.20	5.72^{ab}	1.77	0.50^{ab}	1.50	***
	Ketegui	0.33	0.59	0.32	0.86	0.38	0.85	1.63	1.37	3.35	0.86	0	1.57	0	1.00	3.03	1.48	0	1.20	0.61	1.01	NS
Amount of Females	Borgou	26.67^{ac}	1.85	30.92^{abc}	2.71	18.85^{ac}	2.69	9.66^{ab}	4.30	18.73^{b}	2.73	12.48^{ab}	4.94	35.73^{ab}	3.16	18.35^{c}	4.67	23.32^{abc}	3.77	23.15^{abc}	3.19	***
	Somba	0.18^{a}	0.28	0^{a}	0.42	0.10^{a}	0.41	3.93^{a}	0.66	1.53^{b}	0.42	0^{ab}	0.76	0^{a}	0.49	0^{a}	0.72	0^{a}	0.58	0.55^{a}	0.49	***
	Zebu	0.42	0.43	0.28	0.63	0.98	0.63	0.93	1.01	1.95	0.64	4.32	1.16	0	0.74	0	1.09	0.39	0.88	0.65	0.74	NS
	Barougoudji	0.02^{a}	0.36	2.15^{ab}	0.53	0^{bc}	0.53	0^{ab}	0.84	0^{abc}	0.53	0^{ab}	0.97	0^{abc}	0.62	3.85^{ab}	0.91	0^{c}	0.74	0^{ab}	0.62	***
	Taurin	0^{a}	0.03	0^{a}	0.04	0^{a}	0.04	0^{a}	0.07	0.24^{ab}	0.04	0^{b}	0.08	0^{ab}	0.05	0^{a}	0.08	0^{ab}	0.06	0^{ab}	0.05	**
	Boro	0	0.04	0	0.06	0	0.06	0	0.10	0.21	0.06	0	0.11	0	0.07	0	0.11	0	0.08	0	0.07	NS
	Kiwali	0	0.34	0	0.50	1.63	0.49	0	0.79	0.95	0.50	0	0.91	0	0.58	1.50	0.86	0	0.69	0	0.59	NS
	Ketegui	0^{a}	0.26	0.68^{a}	0.38	1.16^{a}	0.38	0.09^{ab}	0.61	0.20^{a}	0.38	0^{a}	0.70	0^{a}	0.45	3.28^{a}	0.66	0^{b}	0.53	0^{a}	0.45	***

SE : Standard Error ; NS : Non Significant; * : P< 0.05. ** : P< 0.01. *** : P< 0.001.

Variability of cattle breeds reared by farmers and Herd structure

The cattle breeds reared varied according to the sex and the region of survey (Table 4). Male and female cattle breeds met in the surveyed farms include Borgou, Somba Zebu Peulh, Barougoudji, Bororo, Kiwali and Ketegui with a predominance of cattle of Borgou breed. The greatest numbers of males Borgou (11-12 heads) were recorded in the districts 1 and 2 and the lowest were obtained in the district of 3 (p <0.001). Males cattle of Kiwali breed are more strongly represented in the district 4 (p <0.001)

compared to other study areas where only 1-2 heads of Kiwali males were met. As for the females, they are mainly represented by the Borgou breed in all farms surveyed. The largest numbers of female bovines Borgou (11-12 heads) were recorded in the districts 2 and 7 and the lowest was obtained in the district 4 (p <0.001). The mix of bovine species in farms found in the current study confirms observations of Hounkpevi (2005). According to this author, the cattle herd of Benin is composed of the species Borgou, N'Dama, Somba, Lagumaire and Zebu (M'Bororo, Goudali and White Fulani).

Characteristic of the flock and production performance of cattle

The characteristics of the flock are shown in Table 5. The breeding systems where animals are exploited were of traditional type and confirm the results of Hounkpevi (2005) who reported that the farming system used by cattle breeders of Benin is of traditional extensive type. After the morning milking, animals were driven to the pasture from 8 to 9 o'clock by young shepherds and come back between 18 and 19 o'clock. During the dry season the main rearing mode reported by cattle breeders was the transhumance as noted by Buldgen (2000a) and Morou *et al.* (2004). After completion of harvest, animal feed consists mainly of crop residues (corn stalk, millet, sorghum, cotton).

Table 5. Characteristic of the flock and production performance of cattle.

Variables	District 1		District 2		District 3		District 4		District 5		District 6		District 7		District 8		District 9		District 10		ANOVA
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	
Age at the first calving	3.11	0.16	4.32	0.23	4.27	0.24	3.12	0.37	3.79	0.24	3.12	0.42	3.56	0.27	3.00	0.40	2.58	0.32	3.77	0.27	***
Calving intervalle	10.83	0.56	9.22	0.81	13.29	0.83	13.09	1.31	11.05	0.83	9.82	1.54	7.88	0.94	8.51	1.42	9.55	1.13	8.39	0.97	***
Daily milk production by cow	0.91	1.04	1.13	1.49	1.38	1.55	1.73	2.37	8.38	1.52	1.8	2.75	1.46	1.92	1.44	2.63	1.45	2.01	1.34	1.78	*
Longevity	9.63	0.46	13.02	0.67	8.67	0.71	12.43	1.09	12.01	0.72	12.60	1.20	11.11	0.77	11.66	1.15	13.65	0.91	8.63	0.78	***
Exploitation age of draught oxen	3.14	0.18	3.49	0.26	3.00	0.25	4.45	0.41	3.25	0.27	2.84	0.46	4.12	0.29	2.72	0.44	3.18	0.35	2.30	0.29	***
Exploitation duration of draught oxen	5.92	0.31	5.85	0.44	5.37	0.44	8.00	0.73	5.94	0.47	10.08	0.80	5.11	0.50	5.22	0.77	6.48	0.61	4.36	0.51	***
Exploitation age of genitors	2.88	0.18	3.10	0.27	2.43	0.28	2.91	0.50	3.21	0.35	2.57	0.52	2.49	0.31	2.41	0.49	3.11	0.37	1.57	0.34	*
Exploitation duration of genitors	5.26	0.30	4.25	0.44	3.16	0.46	5.58	0.79	5.02	0.58	9.71	0.85	3.25	0.50	4.00	0.79	6.45	0.60	2.54	0.55	***

SE : Standard Error ; NS : Non Significant; * : P< 0.05. ** : P< 0.01. *** : P< 0.001.

In this study, age at first calving reported by farmers varies from one farm to another and fluctuates between 2.5 and 4 years. The most advanced age at first calving was recorded in the district 2 while the earlier was noted in the district 9 (p <0.001). The calving interval fluctuates between 8 and 13 months. The longest calving interval was obtained in the district of 3, while the shortest was recorded in the district of 7 (p <0.001). The daily milk production per cow varied significantly from one region to another with the best productions reported in the district of 5 (8.38 liters / day / cow) and lowest yields obtained in districts 1, 2 and 3 (p <0.05). The difference found in the calving interval and the milk production could be associated not only to the difference observed in the health and medical prophylaxis used among the surveyed cattle farms but also to the variability of the cattle breeds used by cattle breeders. According Adamou-N'Diaye *et al.* (2001), the cattles of Borgou breed have 3 aptitudes: meat production, milk production and work; this cattle breed provides more than half of the meat consumed in Benin with a carcass yield of 56%. Milk production in the Borgou cow in 365 days, based on a live weight of 100 kg, is

221 litres (Dehoux *et al.*, 1993). From October to December, the daily milk production of Borgou cow of Okpara farm in Benin is 1.70 liters per day per cows (Idrissou, 2004).

In the current study, the longevity of the animals in the surveyed herds differs from one district to another between 8 and 14 years old. The highest longevity in cattle were reported in the districts of 2 and 9 (p <0.001), while the lowest was reported in the districts of 3 and 10. Draught oxen are exploited earlier (from the age of 2.4 years) in the districts of 6, 8 and 10 comparatively to other study areas where the exploitation age was over than 4 years (p <0.001). The exploitation age of genitors ranges between 1.57 and 3.2 years. The duration of draught oxen exploitation varies significantly by region. It is higher in districts 4 and 6 (8-10 years) and lower in the others (5-6 years) (p <0.001). The exploitation duration of genitors varies between 3 and 10 years with the maximum recorded in the district 6.

Animal selection

Almost all breeders are based on well-defined criteria in the choice of their animals (table 6). The selection criteria used in the choice of reproductive cattle by farmers of all 10 districts of Banikoara are variable and consist of the color of the body coat, the format, health status, size of limb, conformation of limbs, the movements of the animal when be touched. Overall, the format, health status are the most commonly used criteria (94 to 99% of cases), followed by the size and conformation of the limbs (60 to 62% of cases). The coat color is most used in the district 5 while animal's format is mostly adopted as a selection criterion in the district 9 (P<0.001). The size and conformation of the limbs are most used in district 2 while the health condition and movements of the animal are most considered in District 4 (P<0.001). The selection criteria used by the cattle breeders in the current study area similar to those described by FAO/IAEA (2009), Dooley *et al.* (2005), Weigel (2006) and Williams (2005). One of the first steps in developing a breeding program is to consider which phenotypic traits are of importance (FAO/IAEA, 2009). From a practical standpoint, traits with a measurable or at least readily recognizable economic value are generally to be given the most emphasis, although traits that provide a less tangible utility for cultural or other reasons may also be considered important. The economic traits are typically those that affect either the income obtained or the costs of production. In the South Asia Pacific region and West Africa countries, the sale or home consumption of milk, meat, dung, and skin of the animals and the sale of surplus animals for breeding and meat are the main sources of economic returns of cattle and buffalo farmers (FAO/IAEA, 2009).

Table 6. Selection criteria used by cattle breeders.

Variables		District 1		District 2		District 3		District 4		District 5		District 6		District 7		District 8		District 9		District 10		Test
		%	CR	%	CR	%	CR	%	CR	%	CR	%	CR	%	CR	%	CR	%	CR	%	CR	X2
Cattle performance improvement by sélection		97.13	2.45	93.83	5.18	89.29	6.61	100	0.00	100	0.00	100	0.00	98.36	3.16	88.46	12.05	90.7	8.68	94.74	5.60	**
Selection criteria reported	Coat color	45.2	7.31	46.91	10.74	70.24	9.78	66.67	16.08	76.83	9.13	66.67	18.48	44.26	12.36	26.92	16.73	69.77	13.73	43.33	12.44	***
	Format	94.35	3.39	96.3	4.06	86.9	7.22	93.94	8.14	98.78	2.38	96	7.68	91.8	6.83	73.08	16.73	100	0.00	96.67	4.50	***
	Animal health	98.31	1.89	98.77	2.37	89.29	6.61	100	0.00	97.56	3.34	100	0.00	91.8	6.83	76.92	15.89	95.35	6.29	81.67	9.71	***
	Limbs Size	61.58	7.15	88.89	6.76	65.48	10.17	66.67	16.08	71.95	9.72	72	17.60	83.61	9.21	50	18.86	83.72	11.03	55	12.48	***
	Limbs Profile	60.45	7.18	81.48	8.36	35.71	10.25	63.64	16.41	58.54	10.66	68	18.29	65.57	11.83	26.92	16.73	76.74	12.63	36.67	12.09	***
	Animal behavior after be touched	41.81	7.25	61.73	10.46	44.58	10.63	87.88	11.14	45.12	10.77	76	16.74	52.46	12.43	34.62	17.95	60.47	14.61	50	12.55	***

% : Percentage, **CR** : confidence range; **NS** : Non Significant; * : P< 0.05. ** : P< 0.01. *** : P< 0.001

Production traits (Body size or weight, Growth rate, Carcass quality, Age and weight at slaughter, Leanness, carcass percentage) and physical appearance (Body colour, shape, dimensions, structural traits and body condition) are therefore some good criteria for cattle selection as found herein.

According to FAO/IAEA (2009). Animal health is important for a number of reasons. First, sick animals require costs for treatment. Healthy animals also tend to produce more meat and milk and reproduce more regularly. The climatic conditions of many of the West Africa countries can be demanding, with high temperatures, both extremes in precipitation and high risk for disease, so animals that are naturally resistant to problems associated with these adverse conditions are of high value (Dooley *et al.*, 2005; Weigel, 2006; Williams, 2005).

Finally, different aspects of physical appearance may be important. As already mentioned, body size is important for both beef and draft purposes. Coat colour or traits of the horns may be of importance for traditional or cultural reasons and thus may affect the market value of an animal. Udder traits may be associated with milk production, resistance to mastitis or ease of milking (Dooley *et al.*, 2005; Weigel, 2006; Williams, 2005).

Manifestation of climate change reported by cattle breeders in Banikoara

The signs of climate change were observed by almost all farmers surveyed in this study (table 7). They show as evidence of climate changes: frequent droughts, high winds, excessive heat, or the rare late rains and floods frequently observed during the rainy season. Frequent droughts are most reported ($p < 0.001$) in districts 2, 4, 5, 6, 7 and 9 compared to other study areas. Regardless of major droughts noted, 8 to100% of farmers reported episodes of strong winds in the Municipality of Banikoara with a predominance noted in the district 4 ($p < 0.001$). Similarly, the majority of farmers have reported excessive heat in the Municipality of Banikoara with the highest frequencies recorded in the districts 4 and 6. The whole of the cattle breeders (100%) of the 6th district of Banikoara had reported cases of late rains to 73-92% of farmers in other districts surveyed in Banikoara ($p < 0.001$). During the rainy season, farmers have reported frequent episodes of flooding with a predominance observed in the districts 4 and 6 ($p < 0.001$; table 3).

Table 7. Manifestation of climate change reported by cattle breeders in the municipality of Banikoara in Benin.

Variables		District 1		District 2		District 3		District 4		District 5		District 6		District 7		District 8		District 9		District 10		Chi-square test
		%	CR	%	CR	%	CR	%	CR	%	CR	%	CR	%	CR	%	CR	%	CR	%	CR	
Perception of climate change		97.19	2.43	100	0	98.8	2.33	100	0	100	0	100	0	100	0	100	0	100	0	98.36	3.19	NS
Evidence of perception of climate change	Drought	79.78	5.90	97.56	3.32	83.33	7.97	96.97	5.85	95.12	4.66	100	0.00	95.16	5.34	85.19	13.40	95.35	6.29	80.33	9.98	***
	Winds	81.46	5.71	93.9	5.15	91.67	5.91	96.97	5.85	85.37	7.65	100	0.00	96.1	4.82	88.89	11.85	90.7	8.68	81.97	9.65	*
	Heat	87.64	4.84	96.34	4.04	79.76	8.59	100	0.00	81.71	8.37	100	0.00	80.65	9.83	70.37	17.22	86.05	10.36	73.77	11.04	***
	Late rain	90.45	4.32	93.9	5.15	97.62	3.26	96.97	5.85	87.8	7.08	100	0.00	96.77	4.40	96.3	7.12	95.35	6.29	73.33	11.10	***
	Flooding	24.16	6.29	50	10.76	63.1	10.32	42.42	16.86	31.71	10.07	68	18.29	62.9	12.02	48.15	18.85	20.93	12.16	40	12.29	***
Impacts of climate change on pastoral resources and animal production	Decline of pastoral productivity	91.01	4.20	95.12	4.64	94.05	5.06	96.97	5.85	89.02	6.77	100	0.00	96.77	4.40	92.59	9.88	97.67	4.51	81.97	9.65	*
	Overgrazing	76.97	6.19	89.02	6.73	95.24	4.55	96.97	5.85	87.8	7.08	100	0.00	91.94	6.78	85.19	13.40	90.7	8.68	90.16	7.47	***
	Water resources decrease	87.08	4.93	97.56	3.32	96.43	3.97	96.97	5.85	85.37	7.65	100	0.00	85.48	8.77	81.48	14.65	90.7	8.68	85.25	8.90	**
	Narrowing of corridors	85.39	5.19	97.53	3.34	85.71	7.48	84.85	12.23	84.15	7.90	100	0.00	87.1	8.34	74.07	16.53	83.72	11.03	81.67	9.71	*
	Reduction of crop residues	76.4	6.24	89.02	6.73	93.98	5.09	93.94	8.14	80.49	8.58	60	19.20	80.65	9.83	62.96	18.22	86.05	10.36	64.41	12.02	***

% : Percentage, **CR** : confidence range; **NS** : Non Significant; * : P< 0.05. ** : P< 0.01. *** : P< 0.001.

These results confirm the predictions of FAO (2008), Nelson *et al.*, 2009 and IFPRI (2009) on the impact of climate change on food production in the world from 2000 to 2050. According to Easterling *et al.* (2007), Stainforth *et al.* (2007), Rubio *et al.* (2009) and Nelson *et al.* (2009), an increase of 1 to 3 ° C

temperature destabilize food production, especially in low latitudes with recurring droughts and more floods will affect local production especially in arid and tropical ecosystems (FAO, 2008). This will have a negative impact on food security, farmers, shepherds and fishermen practicing a subsistence as is the case today in the municipality of Banikoara in Benin. According to Jones and Hennessy (2000), when cattle are under heat stress, farmers can expect their stock to have reduced grazing time (because animals might be seeking shade), reduced feed intake, increase in body temperature, increased sweating and panting and weight loss.

The predictions of the IPCC (2001) and Orgeval (2008) on climate changes are observed today in the municipality of Banikoara. Indeed, climate changes have not spared pastoral resources and livestock production in the Municipality of Banikoara. In fact, 76 to 100% of the farmers reported declines of pastoral productivity, overgrazing, reduced water resources, shrinking corridors and reduced masses of crop residues. Declines in pastoral productivity, overgrazing, declining water resources and shrinking corridors were more reported in the district 6 than the others, while weight reduction of crop residues were most observed in the districts 3 and 5 ($p < 0.001$). These results confirm the report of Gregory *et al.* (2005) and Rubio *et al.* (2009) which reported that the threats associated with climate variability and environmental degradation are likely to undermine the social and political stability as well as migration. It is directly connected to the security of the population.

The high diversity of reared animal species by household confirms the observations of FAO (2011) on the characteristics of family farming in West Africa. The mixed farming systems, combining several species can be an important avenue of research methods of adaptation to climate change because the increase in the diversity of biological animal resources constituting the same farm livestock, whether more races or more species managed by farmers increases flexibility and farms can reduce their sensitivity to hazards due to the different and complementary skills of each animal category (Boko *et al.*, 2007; Nozieres *et al.*, 2011).

Conclusion

It appears that livestock production is the main activity of cattle breeders in the municipality of Banikoara. The main crops produced by the cattle breeders apart from livestock production included maize, sorghum, millet and cotton. The reared animal species were composed of cattle, goats, sheep, pigs, chickens and guinea fowl with the predominance of chicken. The breeds of exploited cattle were Borgou, Somba Zebu Peulh, Barougoudji, Bororo, Kiwali and Ketegui with a predominance of the cattle Borgou. The cattle breeding systems were of traditional type. The reported age at first calving varies between 2.5 and 4 years. The calving interval fluctuates between 8 and 13 months. The highest daily milk production per cow was of 8.38 liters. The longevity of the animals varied between 8 and 14 years. The selection criteria used in the choice of reproductive cattle by farmers were the coat color, format, health and the size and conformation of limbs. The climate change manifestations in the municipality of Banikoara were reported as frequent droughts, high winds, excessive heat, scarceness of rains and frequent floods, declines of pastoral productivity, overgrazing, reduction of water resources and crop residues and shrinking corridors.

Methods of adaptation may be considered to prevent damage caused by climate change on agricultural production.

Acknowledgement

The authors thank very much all cattle breeders of the municipality of Banikoara for their contribution.

References

Adamou-N'diaye M, Ogodja O, Gbangboche A, Adjovi A, Hanzen C. 2001. Intervalle entre vêlage

chez la vache Borgou au Bénin. Annales de Médecine Vétérinaire, **145,** 130-136.

Alkoiret IT, Awohouedji DYG, Akossou AYJ, Bosma RH. 2009. Typologie des élevages traditionnel de bovins de la commune de Gogounou au Nord-est du Bénin Annal des sciences agronomiques du bénin ; Vol **2,** 25p.

Boko M, Niang I, Nyong A, Vogel C, Githeko A, Medany M, Osman-Elasha B, Tabo R, Yanda P. 2007. Africa in Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge UK, 433-467.

Buldgen A. 2000. Technique d'élevage en milieu tropical. Notes de cours du DES interuniversitaire GRAVMT. Faculté Universitaire des Sciences Agronomiques de Gembloux- Zootechnie.

Dehoux JP, Hounsou-Vê G. 1993. Productibilité de la race bovine Borgou selon les systèmes d'élevage traditionnels au Nord-Est du Bénin, World Animal Review, **74/75**, 36-48.

Direction de l'Elevage/Bénin. 2011. Rapport annuel d'activité 2011 (MAEP/DE). Cotonou, République du Benin, 29p.

Direction de l'Elevage/Bénin. Rapport annuel d'activité 2001 (MAEP/DE). Cotonou, République du Benin, 45p.

Djenontin AJ, Houinato M, Toutain B, Sinsin B. 2009. Pratiques et stratégies des éleveurs face à la réduction de l'offre fourragère au Nord-Est du Bénin. Sécheresse 2009, **20 (4),** 346-53.

Dooley AE, Parker WJ, Blair HT, Hurley EM. 2005. Implications of on-farm segregation for valuable milk characteristics. Agricultural Systems **85,** 82–97.

D'Orgeval T. 2008. Impact du changement climatique sur la saison des pluies en Afrique de l'Ouest : que nous disent les modèles de climat actuels? Sécheresse *2008*, **19,** 79-85.

Easterling, WE, Aggarwal PK, Batima P, Brander KM, Erda L, Howden SM, Kirilenko A, Morton J, Soussana J-F, Schmidhuber J, Tubiello FN. 2007. Food, fibre and forest products. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution du Groupe de travail II au quatrième Rapport d'évaluation du Groupe d'experts intergouvernemental sur l'évolution du climat,M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden et C. E. Hanson (sous la direction de), Cambridge University Press, Cambridge (Royaume-Uni), pp. 273-313.

FAO. 2008. Changements climatiques et production alimentaire ; 2p.

FAO. 2011. Family poultry communications. International Network for Family Poultry Development 20 (2), 57p; www.fao.org/ag/againfo/themes/en/infpd/home.html.

FAO/IAEA. 2009. Selection and Breeding of Cattle in Asia: Strategies and Criteria for Improved Breeding. 57p.

FAO-CILSS. 2008. Climat, Changements climatiques et pratiques agro-pastorales en Zone sahélienne ; Synthèse régional – Club du Sahel et de l'Afrique de l'Ouest; 8p.

GIEC. 2001. Incidences de l'évolution du climat dans les régions : Rapport spécial sur l'Evaluation de la vulnérabilité en Afrique. Island Press, Washington. 53p.

GIEC. 2007. Résumé technique. In: changements climatiques 2007: Les éléments scientifiques. Contribution du groupe de travail I au quatrième Rapport d'évaluation du Groupe d'experts intergouvernemental sur les changements climatiques [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, Royaume-Uni et New York, NY, Etats-Unis d'Amérique ; 85p

Gregory PJ, Ingram JSI, Brklacich M. 2005. Climate change and food security. Philosophical Transactions of the Royal Society, Vol. **36,** 2139-2148.

Hounkpèvi AG. 2005. Elevage et amélioration génétique de la croissance des bovins Borgou de la ferme Okpara en République du Bénin, Mémoire en Gestion des ressources animales et végétales en milieux tropicaux DES, Université de Liège, 89p.

Hounkponou. 2007. Savoirs endogènes et changements climatiques au Bénin : Les communautés rurales en marche vers l'adaptation !

IFPRI. 2009. Changement climatique. Institut international de recherche sur les politiques alimentaires (IFPRI) Washington, D.C. 30p.

IPCC. 2007. Summary for Policymakers. In: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 7-22.

Jones RN, Hennessy KJ. 2000. Climate change impacts in the Hunter Valley: a risk assessment of heat stress affecting dairy cattle, CSIRO Atmospheric Research, Aspendale, Victoria, Australia.

Morou I, Rippstein G. 2004. Développement des cultures fourragères dans le bassin de l'arachide au Sénégal : typologie des paysans, production de fourrages. Animal Production Research Working Paper No 1. ITC (International Trypanotolérance Centre), Banjul, the Gambia, 53 p.

NelsonGerald C, Rosegrant MW Koo J, Robertson R, Sulser T, Zhu T, Ringler C, Msangi S, Palazzo A, Batka M, Magalhaes M, Valmonte-Santos R, Ewing M, Lee D. 2009. Changement climatique: impact sur l'agriculture et coûts de l'adaptation. Institut international de recherche sur les politiques alimentaires (IFPRI) Washington, D.C. 30p.

Nozières MO, Moulin CH, Dedieu B. 2011. The herd, a source of flexibility for livestock farming system faced with uncertainties? Animal, **5, 9,** 1442-1457.

OCDE (Club du Sahel et de l'Afrique de l'Ouest). 2008. Élevage et marché régional au Sahel et en Afrique de l'Ouest : Potentialités et défis ; 182p.

Rubio J, Safriel U, Daussa R, Blum W, Pedrazzini F. 2009. Water scarcity, Land Degradation and Desertification in the Mediterranean Region, Environmental and Security Aspects, NATO Science for Peace and Security Series - C Environmental Security, Springer.

Salinger J, Sivakumar MVK, Motha RP. 2005. Increasing Climate Variability and Change: Reducing the Vulnerability of Agriculture and Forestry. Reprinted from Climatic Change, Vol. **70,** Nos. 1-2, 2005, VI, 362 p., Hardcover.

Somda J, Kamuanga M, Mendes A, Gomes J. 2004. Caractéristiques socio-économiques et performances économiques des élevages laitiers en Guinée Bissau: cas des régions de Bafata et Gabu. Socio-economic Research Working Paper No 4, ITC (International Trypanotolerance Centre), Banjul, The Gambia, 48 pp.

Stainforth DA, Downing TE, Washington R, Lopez A, New M. 2007. Issues in the Interpretation of Climate Model Ensembles to Inform Decisions. Philosophical Transactions of the Royal Society, **365,** pp. 2163-2177.

Statistical Analysis System. 2006. SAS/STAT User's guide, vers, 6, 4th ed, Cary, NC, USA, SAS Inst, 2006.

Tidjani AD, Djegga D, Lothore A, Delmas P. 2006. Les marchés de bétail autogérés : un exemple Béninois. Dynamiques Paysannes, **10,** 8 p.

Tougan PU. 2008. Enquête sur les systèmes d'élevage et le polymorphisme moléculaire des populations locales de volaille de l'espèce *Gallus gallus* au Nord et au Sud du Bénin. Mémoire DIT, Ecole Polytechnique d'Abomey-Calavi. 98p.

Weigel KA, 2006. Prospects for improving reproductive performance through genetic selection. Animal Reproduction Science **96,** 323–330.

Williams JL. 2005. The use of marker-assisted selection in animal breeding and biotechnology. Revue Scientifique et Technique **24,** 379–391.