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Impact of climate change on cattle production and adaptation in the municipality of Banikoara in Benin

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Abstract

This study aims to determine the composition of cattle herds, the perception of cattle breeders on climate changes and adaptation means used in the municipality of Banikoara in Benin. It appears that 69-85% of cattle breeders are from Fulani ethnic group. Livestock production is their main activity (60-85%; $p < 0.05$). Their secondary activity was agriculture. The number of males by herd varied between 9 and 15 with the highest amount recorded in district 9 ($p < 0.05$). The number of females by herd varied from 20 to 34 with the greatest amount met in the district 10 ($p < 0.05$). The highest amount of introduced females (3) was found in district 4 ($p < 0.05$). The average amount of males and females kept by cattle breeders one year ago had decreased respectively from 18 to 16 and from 35 to 31 ($p < 0.05$). All breeders were married. 98.5% of breeders indicate a significant impact of climate change on livestock production. The reported indicators of climate change were: frequent droughts, winds, excessive heat, the late rains and frequent floods. 76-100% of farmers reported overgrazing, pastoral productivity reduction, water resources declining, narrowing corridors and crop residues reduction. The adaptation means used by breeders include transhumance, enhancement of crop residues, medical prophylaxis, strengthening of the committees of transhumance corridors management, creation of water dams and installation of fodder reserves, introduction of new breeds, and improvement of cattle performances by selection.

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Introduction

Climate change is a complex biophysical process since it is not possible to predict precise future climate conditions (Stockholm Environment Institute, 2008). However, the scientific consensus is that global land and sea temperatures are warming under the influence of greenhouse gases, and will continue to warm regardless of human intervention for at least the next two decades (FAO, 2007; IPCC, 2007). The increasing concentrations of greenhouse gases in the atmosphere are mainly due to the 80 per cent increase in annual CO_2 emissions since 1970. Most of this historical increase emanated from the industrial activities of developed countries in Europe, North America and Japan, although the burgeoning economies of Brazil, China, India and South Africa have contributed significantly in the past decade (Stockholm Environment Institute, 2008). Developing countries, especially those on the African continent have contributed little to the observed global warming. The relatively low levels of economic activity on the continent result in low aggregate emissions. The same lack of economic activity and poverty, render African countries, and especially the poorest communities in these countries, disproportionately vulnerable to climate change impacts.

In regions of West Africa, this vulnerability is further heightened by the large number of households that depend on the already marginalized natural resource base for their livelihoods. 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 1 to 3 °C 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).

In Benin, the national economy is based on agriculture which occupies more than 70% of the population (Tijani *et al.*, 2006). Livestock is the second largest economic activity after crop production particularly in the Departments of Alibori and Borgou. This activity is based on the exploitation of cattle and small ruminants which constitute the bulk of livestock species in these Departments. Indeed, in 2011, these two departments together accounted for more than half of the national population (1309540 heads of cattle) (DE, 2011). This cattle breeding 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 determine the structure of cattle herds, the perception of climate changes and adaptation means used by the cattle breeder in the municipality Banikoara to mitigate and develop appropriate coping measures to address the negative impacts of climate change on agriculture.

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.

Municipality of Banikoara in Benin

Fig. 1. Study area.

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 river, 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:

- ✓ Identification and profile of farmers;
- ✓ Herd structure and composition;
- ✓ Characteristic of the flock;
- ✓ Perception of climate change on agro farmers by district;
- ✓ Climate change impact on livestock production and adaptation

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

The majority of cattle breeders (69-85%) were of Fulani ethnic group. Only 14-33% was of Bariba ethnic group (Table 1). Animal rearing is the main activity of farmers in 60-85% of cases with a predominance noted in the district 8 ($p < 0.05$). Similarly, the secondary activity of is agriculture farmers faced with high 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 cattle assigns exclusively 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.

Herd composition and dynamic

The herd's dynamic is given in table 2. The amount of males in the herds visited varied between 9 and 15 with the highest amount recorded in the district 9 (15 males; $p < 0.05$). The number of females in each herd varied from 20 to 34 with the greatest amount met in the district 10. Only 1 to 3 females were purchased by herd whatever the district with the highest amount of introduced females found in the district 4 ($p < 0.05$). The average amount of males kept by cattle breeders one year ago had decreased significantly from 18 to 16 at the time of survey. Similarly, the average amount of

females kept by cattle breeders one year ago had decreased significantly from 35 to 31. According to the cattle breeders (100%), the main reason of these deceasing of herd is the mortality caused by several cattle pathologies and lack of natural pasture due to the changes in precipitations. This finding confirms the report of FAO (2008) showing that in many parts of Africa, it seems that warmer climates and changes in precipitation will destabilize agricultural production. This is expected to undermine the systems that provide food security (Gregory *et al.*, 2005).

Table 2. Herd composition.

Variable	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	
Total number of males	14.16	0.94	13.64	1.37	8.55	1.36	11.61	2.18	12.71	1.38	10.96	2.5	9.03	1.6	13.57	2.36	14.93	1.91	12.12	1.61	*
Number of males born in the herds	12.54	0.87	12.89	1.28	5.04	1.27	9.27	2.03	6.47	1.29	6.36	2.33	6.28	1.5	9.14	2.21	12.53	1.78	9.07	1.51	***
Number of purchased males	1.4	0.22	1.14	0.31	0.68	0.31	0.58	0.5	1.06	0.32	1.72	0.57	0.89	0.37	4.25	0.54	0.56	0.44	0.53	0.37	***
Total number of males imported	0.22	0.18	0.45	0.27	0.45	0.26	0	0.42	0.29	0.27	0	0.48	0	0.31	1.54	0.46	0.44	0.37	1.18	0.31	**NS**
Total number of females	33.35	2.31	31.14	3.38	20.51	3.36	32.09	5.35	29.12	3.4	21.92	6.15	27.23	3.94	24.39	5.81	31.33	4.69	34.13	3.97	**NS**
Number of females born in the herds	28.51	2.35	30.24	3.44	13.43	3.42	31.12	5.46	20.05	3.46	20.64	6.27	21.85	4.01	18.86	5.92	23.51	4.78	27.15	4.05	*
Total number of purchased females	2.01	0.4	1.29	0.58	1.38	0.58	2.61	0.92	1.34	0.59	2.04	1.06	0.66	0.68	5.39	1	0.6	0.81	1.05	0.69	*
Total number of females imported	0.24	0.53	0.8	0.78	0.39	0.77	0.82	1.23	0.79	0.78	7.08	1.41	0.3	0.9	1.25	1.34	0	1.08	0.32	0.91	**
Number of male one year ago	19.76	2.06	14.33	3.01	9.32	3	14.06	4.78	24.94	3.03	13.56	5.49	13.33	3.52	19.82	5.19	29.52	4.19	12.82	3.55	**
Number of deaths in males/year	19.76	2.06	14.33	3.02	9.32	3	14.06	4.78	24.94	3.03	13.56	5.49	13.33	3.52	19.36	5.19	29.51	4.19	12.81	3.55	**
Number of males used for consumption	0.08	0.03	0.11	0.05	0.02	0.05	0.21	0.07	0.15	0.05	0.16	0.08	0	0.05	0.18	0.08	0.02	0.06	0	0.05	**NS**
Number of males used for ceremony	0.44	0.08	0.35	0.12	0.08	0.11	0	0.18	0.28	0.12	0.4	0.21	0.07	0.13	0.21	0.2	0.07	0.16	0.05	0.14	**NS**
Number of males used for sale	1.85	0.36	1.31	0.53	0.96	0.53	0.7	0.85	3.12	0.54	2.28	0.97	0.93	0.62	3.29	0.92	1.81	0.74	1.35	0.63	**NS**
Total of born males	2.97	0.43	3.73	0.63	3.21	0.63	0.94	1	3.09	0.64	0.72	1.15	2.44	0.74	2.82	1.09	1.86	0.88	2.25	0.74	**NS**
Total of purchased males	1.12	0.14	1.02	0.21	0.46	0.2	0	0.33	0.88	0.21	0.68	0.38	0.27	0.24	2.39	0.36	0.16	0.29	0.3	0.25	***
Total number of males by year end	17.78	1.93	15.46	2.83	10.38	2.82	11.91	4.49	22.46	2.85	16	5.16	9.91	3.3	22.82	4.88	23.16	3.93	10.85	3.33	**
Total of females one year ago	49.64	4.55	35.4	6.67	20.75	6.33	33.18	10.58	38.72	6.71	19.68	12.15	26.38	7.78	25.93	11.48	43.34	9.27	49.18	7.85	**
Total dead females	7.81	1.58	2.9	2.31	2.75	2.3	5.27	3.66	4.49	2.32	4.08	4.21	3.61	2.7	1	3.98	5.63	3.21	3.13	2.72	**NS**
Number of females used for consumption	0.15	0.05	0.06	0.07	0.02	0.07	0	0.11	0.23	0.07	0.04	0.12	0	0.08	0.07	0.12	0.16	0.09	0.07	0.08	**NS**
Number of females used for ceremony	1.35	0.38	0.13	0.56	0.13	0.56	0.03	0.89	0.28	0.56	0.12	1.01	0.16	0.65	0.29	0.96	0.02	0.78	0.15	0.66	**NS**
Number of females used for sale	2.42	0.2	1.27	0.29	0.64	0.29	1.24	0.47	1.98	0.3	1.76	0.54	0.85	0.34	1.07	0.51	2.33	0.41	1.27	0.35	***
Total of born females	7.74	0.94	9.11	1.38	6.51	1.37	1.79	2.19	4.93	1.39	2.28	2.52	10.23	1.63	4.46	2.38	5.51	1.92	3.5	1.62	**
Total of purchased females	2.01	0.3	1.73	0.44	1.35	0.44	0	0.7	1.06	0.44	0.88	0.8	0.33	0.51	1.71	0.75	0.37	0.61	1.25	0.51	*
Total number of females by year end	46.01	4.43	33.37	0.49	20.79	6.45	28.39	10.29	37.82	6.53	17.36	11.82	21.3	7.57	27.61	11.17	39.35	9.01	39.3	7.63	*

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

In the current study, the cattle farms were characterized by the presence of various cattle species and other animal species. The diversity of bovine animals in farms found in this study confirms the observations of Hounkpèvi (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).

Impact of climate change on agricultural production in Banikoara

Almost all farmers (97 to 100%) encountered in this study recognize a very significant impact of climate change on agricultural production in general and livestock production in particular (table 3). 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 (95-100% of cases) compared to other study areas (79 to 85% of cases). 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 3. Impact of climate change on agricultural production reported by cattle breeders.

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	Frequent 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	*
	Excessive 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	***
	Frequent 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) 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 IPCC (2007), the average temperature at the Earth's surface had risen by 0.74 °C between 1906 and 2005 and the sea level has risen of 1.8 mm per year

between 1961 and 2003. These changes have negative impacts on natural resources and all sectors of life, including food security, human and animal health (IPCC, 2001; Orgeval, 2008). These predictions of the IPCC (2001) and Orgeval (2008) 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 resources water, 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 Rubio *et al.* (2009) which states 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 (Nozieres *et al.*, 2011).

Adaptation means used by cattle breeders to reduce the effect of climate change on agricultural production in Banikoara

The adaptation means used by cattle breeders to reduce the effect of climate change on agricultural production are variable and include transhumance, enhancement of crop residues, strengthening of the committees of transhumance corridors management, creation of watering holes and installation of fodder reserves, introduction of new breeds, animal selection, vaccination, deworming, vitamino prevention and antibiotic (table 4).

Table 4. Adaptation means used by cattle breeders to reduce the effect of climate change.

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	
Feeding	Transhumance	89.61	4.48	93.55	5.28	85.71	7.48	70	15.64	90.91	6.22	80	15.68	87.5	8.23	76.92	15.89	93.33	7.46	76.92	10.57	***
	Enhancement of crop residues	72.55	6.56	50	10.76	66.67	10.08	100	0	40.91	10.64	100	0	50	12.45	42.86	18.67	42.86	14.79	30	11.50	*
	Strengthening of the committees of transhumance corridors management	72.55	6.56	50	10.76	66.67	10.08	100	0	40.91	10.64	100	0	50	12.45	42.86	18.67	42.86	14.79	30	11.50	*
	Creation of water dams and fodder reserves	19.61	5.83	25	9.32	16.67	7.97	0	0	36.36	10.41	0	0	30	11.41	28.57	17.04	14.29	10.46	20	10.04	***
Improvement of Zoo-technical performances	Introduction of new breeds	89.61	4.48	93.55	5.28	85.71	7.48	70	15.64	90.91	6.22	80	15.68	87.5	8.23	76.92	15.89	93.33	7.46	76.92	10.57	***
	Animal selection	72.55	6.56	50	10.76	66.67	10.08	100	0	40.91	10.64	100	0	50	12.45	42.86	18.67	42.86	14.79	30	11.50	***
Animal Heath	Vaccination	85.39	5.19	87.95	7.00	95.24	4.55	90.91	9.81	80.49	8.58	76.00	16.74	61.67	12.10	100	0	79.07	12.16	77.05	10.55	***
	Deworming	83.71	5.42	72.29	9.63	96.43	3.97	84.85	12.23	75.61	9.29	92.00	10.63	63.93	11.95	96.30	7.12	74.42	13.04	77.05	10.55	***
	Vitamino prevention	80.34	5.84	79.27	8.72	90.48	6.28	69.70	15.68	65.85	10.26	52.00	19.58	50	12.45	77.78	15.68	74.42	13.04	72.13	11.25	***
	Antibiotic	80.79	5.79	77.50	8.98	78.57	8.78	69.70	15.68	75.61	9.29	92.00	10.63	56.67	12.33	70.37	17.22	79.07	12.16	72.13	11.25	*
	Others medical follow up	29.94	6.73	26.25	9.47	19.05	8.40	33.33	16.08	21.95	8.96	0	0	16.67	9.28	14.81	13.40	30.23	13.73	13.33	8.53	NS

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

In the adaptation means relating to the improvement of food supplying, the transhumance breeding system and the using of crop residues were the predominant means followed by the creation of watering holes and installation of fodder reserves.

These implement methods used by cattle breeders to reduce the effect of climate change on agricultural production is partially in accordance with the recommendations of FAO (2008). According to FAO (2008), most agricultural systems have a measure of

in-built adaptation capacity ("autonomous adaptation") but the current rapid rate of climate change will impose new and potentially overwhelming pressures on existing adaptation capacity. This is particularly true given that the secondary changes induced by climate change are expected to undermine the ability of people and ecosystems to cope with, and recover from, extreme climate events and other natural hazards. It is for this reason that the IPCC encourages "planned adaptation", that is deliberate steps aimed at creating the capacity to cope with climate change impacts (IPCC, 2007). Effective adaptation strategies and actions should aim to secure well-being in the face of climate variability, climate change and a wide variety of difficult to predict biophysical and social contingencies. In pursuing this aim, climate adaptation should focus on support for the decision-making and capacity building processes that shape social learning, technology transfer, innovation and development pathways. Adaptation is most relevant when it influences decisions that exist irrespective of climate change, but which have longer-term consequences (Stainforth *et al.*, 2007). A key component of climate adaptation involves building resilience, where resilience is the capacity of a system to tolerate disturbance without collapsing into a qualitatively different state that is controlled by a different set of processes: a resilient system can withstand shocks and rebuild itself when necessary. Over 60% of Africans remain directly dependent on agriculture and natural resources for their well-being (FAO, 2003). Agriculture is highly dependent on climate variability (Salinger *et al.*, 2005) which is why the threat of climate change is particularly urgent in Africa (Boko *et al*, 2007). This report confirms the current results found in the municipality of Banikoara in Benin.

Conclusion

The municipality of Banikoara in Benin is vulnerable to climate change because of their dependence on rainfed agriculture, high levels of poverty, low levels of human and physical capital, and poor infrastructure. 97 to 100% of cattle breeders encountered in this study in the municipality of Banikoara recognize a significant impact of climate change on agricultural production in general and livestock production in particular. The impact of climate changes is notable through frequent droughts, high winds, excessive heat, or the rare late rains and floods frequently observed during the rainy season. Frequent droughts are reported with a corollary to the decline of pastoral productivity, overgrazing, declining water resources, narrowing corridors and reduced masses of crop residues.

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