Determinants of Cattle Farmers' Perception of Climate Change in the Dry and Sub-humid Tropical Zones of Benin (West Africa)

Yaya Idrissou, Alassan Seidou Assani, Mohamed Nasser Baco, and Ibrahim Alkoiret Traoré

Contents

Abstract

Understanding the factors influencing the perception of climate change can help improve policies for strengthening the adaptive capacity of pastoralists with regard to climate change. Despite this importance, few studies have focused on this issue,

Y. Idrissou (✉) · A. S. Assani · I. Alkoiret Traoré
Laboratoire d'Ecologie, Santé et Production Animales (LESPA), Faculté d'Agronomie, Université de Parakou, Parakou, République du Bénin
e-mail: yayaidriss2617@gmail.com; alassanassani@gmail.com; alkouarit@gmail.com

M. N. Baco
Laboratoire Société-Environnement (LaSEn), Faculté d'Agronomie, Université de Parakou, Parakou, République du Bénin
e-mail: nasserbaco@yahoo.fr

W. Leal Filho et al. (eds.), *African Handbook of Climate Change Adaptation*,
https://doi.org/10.1007/978-3-030-42091-8_16-1

especially among cattle farmers. In order to attempt filling this gap, this study analyzed the determinants of the perception of climate change by cattle farmers distributed in the dry and sub-humid tropical zones of Benin as well as the current adaptation strategies developed by these farmers. For this purpose, surveys were carried out through group discussions and an individual questionnaire administered to 360 cattle farmers in the two climatic zones. The data collected related to the sociodemographic characteristics of cattle farmers and their perception of climate change and adaptation strategies. A binary logit model has identified the factors that influence cattle farmers' perceptions of climate change. The results of the study showed that cattle farmers perceive a drop in rain (at least 77%), an increase in temperature (at least 80%), and violent winds (at least 60%). Breeding experience, level of education of the farmer, household size, membership of a breeders' organization, and cattle herd size determine these perceptions. Four major groups of adaptation strategies have been developed by farmers to cope with climate change. These are production adjustment strategies, activity diversification strategies, livestock management strategies, and selection strategies. The political implication of this study is that government and development partners should integrate these factors into projects and programs related to climate change.

Keywords

Animal · Climatic zone · Climate change · Adaptation strategies · West Africa

Introduction

Climate change is currently an increasingly visible threat to the viability of the rural population of sub-Saharan Africa, where communities depend mainly on the exploitation of natural resources (Kaboré et al. 2019; Adimassu and Kessler 2016). Livestock rearing is one of the main economic activities on which the poorest people in sub-Saharan Africa depend as a source of food and income. Despite its importance, livestock is currently threatened by climate change (Apata et al. 2009; Deressa et al. 2009) because of its high dependence on natural resources specifically fodder and water (Idrissou et al. 2019; IUCN 2010). The impacts of climate change in the livestock sector are felt in the production and quality of forage crops (Polley et al. 2013; Chapman et al. 2012), water availability, animal growth, milk production, reproduction, and disease (Henry et al. 2012). Faced with this situation, the challenge for the scientific community is to produce knowledge enabling farmers to anticipate the effects of climate change on their system and to develop methods and tools to adapt to it (Sautier 2013). To achieve this, it is necessary to understand how pastoralists perceive climate change (Deressa et al. 2011), as this influences the way they manage climate-related risks and opportunities, as well as the strategies put in place to adapt (Mamba 2016). In developing countries, numerous studies have dealt with the perception and adaptation strategies of pastoralists in the face of climate change (Idrissou et al. 2020; Sanou et al. 2018; Ayanlade et al. 2017). In Benin, for example, several studies show that pastoralists perceive climate change through the drop in rain, irregular rainfall, and late start and early end of the rainy season (Idrissou et al. 2020; Dossa et al. 2017; Zakari et al. 2015). Pastoralists in Burkina Faso have unanimously discerned some changes in precipitation and temperature (Sanfo et al. 2015). They saw a decrease in annual precipitation, an increase in the intensity of precipitation, and the frequency of flooding. In Kenya, pastoralists have reported changes in the amount and distribution of precipitation, fog, temperature, and wind over the past 20 to 30 years (Cuni-Sanchez et al. 2019). To cope with the harmful effects of climate change, pastoralists in developing countries have developed several strategies such as herd mobility, storage of crop residues, and integration of livestock rearing with crop farming, among others (Idrissou et al. 2019).

These studies, although they allow apprehending the perceptions and adaptation strategies of cattle farmers, are still insufficient. Indeed, information on the factors that determine the perceptions of pastoralists has not often been analyzed. Knowledge of this aspect is important for science and will allow better targeting of policies to support the adaptation of pastoralists to climate change in developing countries.

Benin, a small country in West Africa, has three climatic zones, the most vulnerable to climate change being the dry and sub-humid tropical zones (Gnanglè et al. 2011; MEHU 2011). It is in these most vulnerable areas that more than 85% of the country's cattle farms are concentrated (Alkoiret et al. 2011). These cattle farms will be severely affected by the effects of climate change, resulting in reduced productivity (Nardone et al. 2010). Pastoralists in these zones are thus exposed to risks of food insecurity and increasing poverty. A study analyzing the perception and adaptation strategies of pastoralists in these areas in the face of climate change is timely as it can help improve policies aimed at supporting these pastoralists to adapt sustainably to climate change (Folefack and Tenikue 2015; Mabe et al. 2014). The aims of this study are therefore to (i) analyze the determinants of the perception of climate change by cattle farmers in the dry and sub-humid tropical zones of Benin and (ii) identify the current adaptation strategies developed by these farmers.

Material and Methods

Study Areas

This study was carried out in two of the three climatic zones of Benin (located 6° and 12° 50′N and 1° and 3° 40′ E). These are the dry tropical zone between 9° 45′ and 12° 25′ N and the sub-humid tropical zone located between 7° 30′ and 9° 45′ N (Fig. 1). The choice of these zones is based on the fact that climate forecasts indicate that they are the most vulnerable to rainfall deficit and high sunshine (Gnanglè et al. 2011; MEHU 2011), yet more than 85% of the Beninese cattle herd is concentrated in these zones (Alkoiret et al. 2011).

In each zone, two (2) municipalities were chosen based on the large number of cattle farmers and preliminary interviews with technicians from the "Agences Territoriales pour le Développement Agricole" (ATDA). Thus, the municipalities

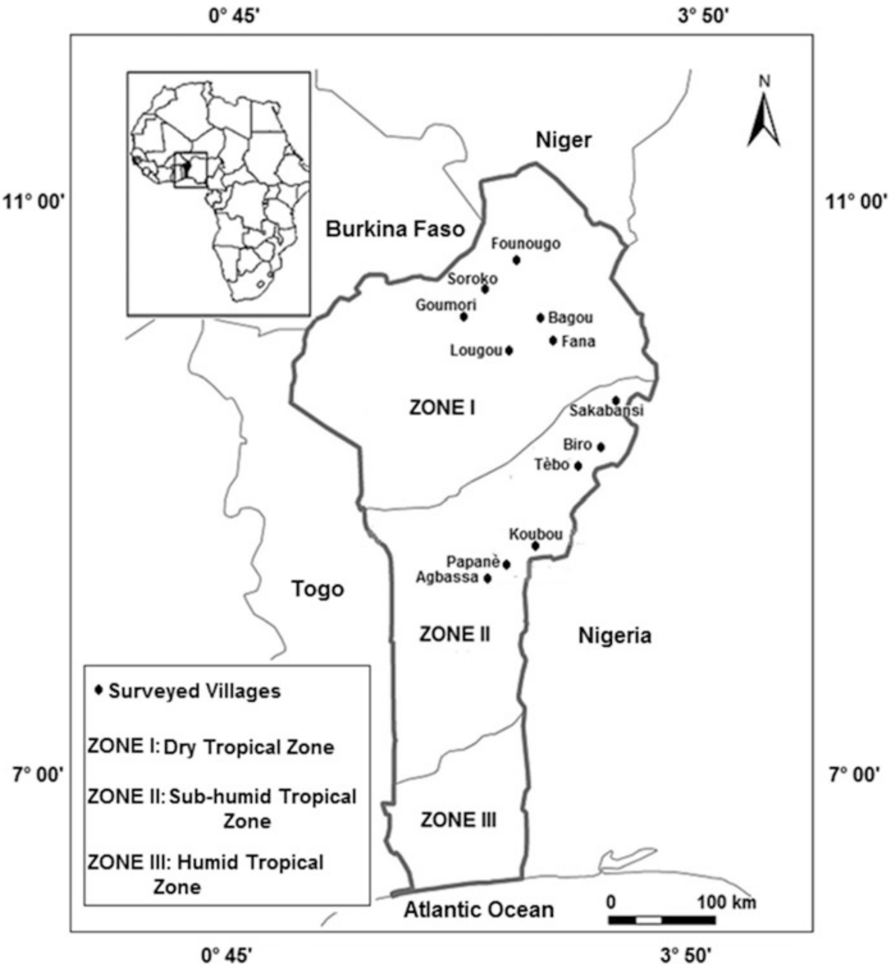

Fig. 1 Location of the villages surveyed in Benin

of Tchaourou and Nikki were selected in the sub-humid tropical zone and those of Gogounou and Banikoara in the dry tropical zone. Within each municipality, three villages have been selected (Fig. 1). In the dry tropical zone, which includes the municipalities of Gogounou and Banikoara, the mean annual rainfall is often less than 1000 mm, and the relative humidity varies from 18 to 99% (highest in August). The temperature varies from 24 °C to 31 °C. The soils in this zone are hydromorphic, well-drained soils, and lithosols. The vegetation of this zone is mainly composed of savannas with trees of smaller size. The sub-humid tropical zone, made up of the municipalities of Tchaourou and Nikki, is characterized by unimodal precipitation, from May to October, and lasts about 113 days with an annual mean rainfall varying between 900 and 1110 mm. The annual temperature ranges from 25 °C to 29 °C and the relative humidity from 31% to 98%. Soils in this zone are ferruginous with variable fertility. The vegetation of the sub-humid tropical zone is characterized by a mosaic of woodland, dry dense forests, tree and shrub savannas, and gallery forests.

Data Collection

Data collection was carried out from November 2018 to April 2019 in two stages that include the exploratory study and in-depth interviews.

Exploratory Study

During this phase, interviews were carried out with technicians from the ATDA in order to identify the villages and cattle farmers to be surveyed. On the basis of the defined criteria, with the local technicians, the villages of Koubou, Papanè, and Agbassa were identified in the municipality of Tchaourou; the villages Tèbo, Biro, and Sakabansi in the municipality of Nikki; the villages of Bagou, Fana, and Lougou in the municipality of Gogounou; and finally those of Founougo, Goumori, and Soroko in the municipality of Banikoara (Fig. 1).

After identifying the villages, focus groups of staff varying from 6 to 15 people were carried out (one focus group per village). During the focus groups, the questions were open and made it possible to record the maximum of responses on the perceptions and adaptation strategies of cattle farmers. At the end of these focus groups, a list of climatic parameters cited by cattle farmers was drawn up. These climatic parameters have been broken down into different indicators of their manifestations as cited by farmers. A global synthesis was made to constitute the content of the questionnaire for in-depth interviews.

The interviews carried out during the exploratory study made it possible to randomly select 30 cattle farmers per village to whom questions were addressed individually for the continuation of the study. Thus, a total of 360 cattle farmers were surveyed during this study. The criteria for choosing cattle farmers were having cattle breeding as their main activity and being at least 50 years old. The choice of breeding as the main activity to discriminate the respondents is justified by the fact that several studies focus on agro-pastoralists and generalize the results obtained both to agro-pastoralists and to pastoralists. However, these socio-professional categories face different socioeconomic problems (Zampaligré et al. 2014). The age barrier (50 years) is explained by the fact that climate change is very slow and elderly people are needed to have reliable historical information (Kaboré et al. 2019; Bambara et al. 2016).

In-Depth Interviews

The in-depth interview consisted of collecting data through semi-structured interviews with the 360 cattle farmers identified during the exploratory study. For data collection, local investigators were recruited and trained. The training of local investigators was undertaken for a week and piloted before the start of interviews with cattle farmers. The aim of the training was to minimize bias and errors in data collection. The interviewers used to conduct the interviews with the cattle farmers were selected from each study village and understood the local language of the village. The data were collected using a questionnaire. A first series of questions related to the sociodemographic characteristics of the cattle farmers (sex, age, breeding experience, ethnic group, household size, number of agricultural assets, level of education, contact with agricultural extension services, membership of a breeders' organization, etc.) and a second series of questions concerned the perception of climate change indicators as well as the adaptation strategies developed. The questions posed to farmers on their perception of climate change are consistent with the indices of the Expert Team on Climate Change Detection Monitoring and Indices (ETCCDMI) (Zhang and Yang 2004). Climate change indicators are meteorological parameters whose evolution over time reflects climate change. These indicators are total annual precipitation, rainfall intensity, daily maximum, and minimum temperatures. Other parameters were also taken into account including "rainless days" or pockets of drought, vortex, and strong winds (Bambara et al. 2016; Salack et al. 2012).

Statistical Analysis

The data from the surveys were processed using the Statistical Package for Social Sciences (SPSS) version 17. Frequencies of responses were reported and compared with chi-square ($\chi 2$) test. The quantitative variables describing the cattle farmers surveyed were presented as means $\pm$ standard deviations and compared between climatic zones using the Mann-Whitney U nonparametric test (McDonald 2009).

The determinants that influence cattle farmers' perception of climate change have been analyzed by binary logistic regression (Kaboré et al. 2019; Uddin et al. 2017). The equation of the binary model is as follows:

$$\mathrm{Yi} = \mathrm{Xi}\,\beta + \varepsilon\mathrm{i} \tag{1}$$

where Yi is the variable which takes the value 1 if the farmer perceives a climate change indicator and 0 if he does not perceive it; Xi is the set of explanatory variables indicating the factors that influence the cattle farmers' perception of climate change; and εi is the standard error.

Before estimating the logistic regression model, the explanatory variables were checked to determine the existence of multi-colinearity, using the contingency coefficient test (Uddin et al. 2017). A collinearity was observed between the breeding experience and age; between the number of agricultural assets and household size; and between membership of a breeders' organization and contact with extension services. Consequently, age, number of agricultural assets, and contact with extension services were omitted from the logistic regression model after the multi-colinearity test. The explanatory variables used for the regressions are sex, breeding experience, ethnic group, level of education, location (climatic zone), membership to a breeders' organization, household size, and herd size.

Results and Discussion

Sociodemographic Characteristics of the Cattle Farmers Surveyed

The sociodemographic characteristics of the cattle farmers surveyed are summarized in Table 1. The majority of the cattle farmers surveyed are of the Fulani sociocultural group (80.83%) and of the male sex (92.5%). They are relatively old (56.43 ± 5.88 years) and have an average experience of 30 years in cattle breeding. Cattle farmers in the sub-humid tropical zone were older and more experienced ($p < 0.05$) than those in the dry tropical zone. Very few cattle farmers have been educated (5%). The household size of the cattle farmers surveyed was on average 11 people, and the cattle herd size was on average 64 heads. A large number of cattle farmers are members of an organization (90.92%) and are also in contact with agricultural extension services (66.21%). It is specified that the number of cattle farmers in contact with agricultural extension services in the dry tropical zone is significantly high ($p < 0.05$) compared to that of the sub-humid tropical zone. This could be explained by the fact that historically the dry zone is an area purely dedicated to animal husbandry, which leads technicians leaving agricultural college and university to settle more in this zone. Additionally, the first livestock extension structures were created in the dry zone.

Table 1 Sociodemographic characteristics of cattle farmers

Variables	Climatic zones		Total
	STZ	DTZ	
Percentage (%)			
Sex			
Male	95.00[a]	90.00[a]	92.50
Female	5.00[a]	10.00[a]	7.50
Ethnic group			
Fulani	80.00[a]	81.67[a]	80.83
Bariba	20.00[a]	18.33[a]	19.17
Level of education			
Educated	6.67[a]	3.33[a]	5.00
Non-educated	93.33[a]	96.67[a]	95.00
Membership in an organization	88.33[a]	93.50[a]	90.92
Contact with the extension	60.67[a]	71.75[b]	66.21
Mean ± standard deviation			
Age	57.95 ± 6.52[a]	54.91 ± 4.7[b]	56.43 ± 5.88
Breeding experience	34.37 ± 10.95[a]	25.75 ± 8.4[b]	30.05 ± 10.63
Number of agricultural assets	8.55 ± 3.64[a]	7.16 ± 3.25[a]	7.85 ± 3.50
Household size	11.70 ± 4.64[a]	11.71 ± 4.81[a]	11.70 ± 4.71
Cattle herd size	61.28 ± 41.59[a]	67.72 ± 35. 46[a]	64.50 ± 38.62

STZ sub-humid tropical zone, *DTZ* dry tropical zone

[a, b]The values of the same line indexed by different letters are significantly different at the 5% threshold

Cattle Farmers' Perception of Climate Change Indicators

Seventy-seven percent (77%) of cattle farmers in the sub-humid tropical zone and 82% in the dry tropical zone perceived a decrease in rainfall (Fig. 2a). The indicator "high intensity of rainfall" was perceived by 78% of the cattle farmers of the dry tropical zone against 52% of the cattle farmers of the sub-humid tropical zone. In the both zones, indicators of change in precipitation such as the duration of the drought pocket, the late onset, and the early cessation of the rains were perceived by more than 80% of the farmers interviewed. At least 50% of the farmers in both zones perceived an irregularity in the rains. These indicators of change in precipitation perceived by pastoralists could be explained by the fact that these indicators remain the most visible in the observation of rainfall pejoration in Africa (Bambara et al.

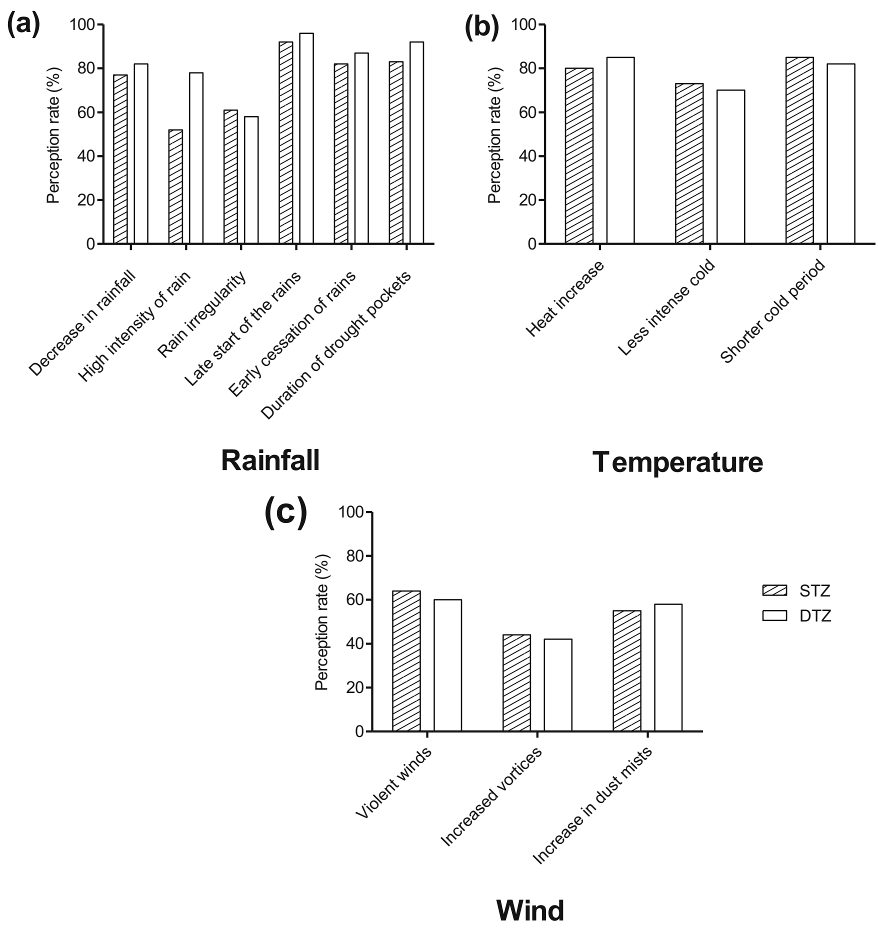

Fig. 2 Perception of indicators of changes in rainfall (**a**) in temperature (**b**) and wind (**c**) by cattle farmers in the dry (white) and sub-humid (black) tropical zones of Benin

2013). These results therefore confirm the work of several authors in Africa (Cuni-Sanchez et al. 2019; Opiyo et al. 2016).

The majority (at least 80%) of cattle farmers in the both zones recognize that the heat is getting stronger (Fig. 2b). These results reflect an increase in maximum and minimum daily temperatures observed throughout the year. Farmers also indicated that the cold season is warming up (70% and 73% of the cattle farmers in the dry and sub-humid tropical zones respectively) and tends to become shorter (82% in the dry zone and 85% in the sub-humid zone). As the temperature is a direct feeling, the farmers can easily see its increase through warmer days and nights. In addition, high temperatures cause animals to seek more shade and water (Idrissou et al. 2020). This behavior of animals observed by farmers could also explain their perception of the increase in temperature.

According to 60% of cattle farmers in the dry tropical zone and 64% of the farmers in the sub-humid tropical zone, the winds have become more and more violent (Fig. 2c). The increase in vortices was reported by at least 40% of cattle farmers in the both zones. In addition, more than 50% of the cattle farmers in the two zones perceived an increase in dust mists. Strong winds cause material damage such as destruction of roofs, erosion of cultivable land, uprooting of trees, etc. This damage noted by farmers could explain their perception. Similar perceptions have been reported by several authors in other parts of Africa (Limantol et al. 2016; Opiyo et al. 2016).

Determinants of Cattle Farmers' Perception of Climate Change

The analysis of binary logistic regression performed to determine the factors that influence the farmers' perception of the change in precipitation and temperature is summarized in Table 2. The variable "Breeding Experience" positively affects perceptions of reduced rainfall and late onset and early cessation of rains. This result indicates that farmers with longer years of cattle breeding experience were more likely to perceive climate change. In addition, experienced farmers observe changes over time and compare them to current climatic conditions, allowing them to quickly perceive climate change. This result is similar to those obtained by several authors (Sanogo et al. 2017; Uddin et al. 2017).

The level of education of the cattle farmers positively influences the perception of the late onset of the rains at the threshold of 10% (Table 2). The most educated farmers are more interested in calendar dates or the start of school holidays, which generally coincide with the start of winter (Kaboré et al. 2019). The less educated do not really make the difference between an early or late season.

Membership of a breeders' organization influences cattle farmers' perception of reduced rains and late onset and early cessation of rains. Breeders' organizations benefit from training from development partners through non-governmental organizations (NGOs), agricultural development projects, and programs. Through these different structures, cattle farmers are made aware of climate change as well as the present and future consequences on their livelihood. In addition to these sources of

Table 2 Determinants of cattle farmers' perception of change in precipitation and temperature

	Decrease in rainfall			Late start of the rains			Early cessation of rains			Heat increase		
Variables	β	$SE\ \beta$	p	β	$SE\ \beta$	p	β	$SE\ \beta$	p	β	$SE\ \beta$	p
Constant	0.224*	2.458	0.0927	7.020***	2.528	0.005	3.887*	2.329	0.095	4.956	3.346	0.139
Climatic zone	0.652	0.522	0.212	0.202	0.459	0.659	0.277	0.459	0.546	1.051	0.608	0.840
Breeding experience	0.077*	0.043	0.074	0.093**	0.039	0.018	0.077**	0.037	0.041	0.017	0.056	0.763
Sex	2.210	0.992	0.26	1.223	0.800	0.126	0.021	0.735	0.977	1.543	1.204	0.20
Ethnic group	0.020	0.543	0.97	0.782	0.502	0.12	−0.524	0.504	0.298	0.291	0.636	0.647
Education level	1.536	1.224	0.209	0.363*	0.930	0.0696	0.925	0.954	0.332	0.893	1.187	0.452
Household size	0.029	0.046	0.521	0.018	0.043	0.673	0.023	0.042	0.579	0.117**	0.056	0.039
Membership in an organization	0.351*	0.614	0.0568	−0.246*	0.571	0.0666	−0.426**	0.561	0.0447	0.091	0.751	0.903
Cattle herd size	0.004**	0.005	0.0382	0.061**	0.050	0.042	0.008*	0.005	0.0706	0.011*	0.006	0.087
Number of observations	360			360			360			360		
−2log likelihood	14.33			153.56			154.94			102.56		
Prob > Chi	0.009			0.019			0.025			0.000		

*significant value at 10% ($0.05 < p \leq 0.10$); **significant value at 5% ($0.01 < p \leq 0.05$); ***significant value at 1% ($p < 0.01$)

learning are the relationships that cattle farmers have with each other which serve as channels for sharing experiences.

Household size positively influenced the cattle farmers' perception of the increased heat. This finding indicates that with increasing household size, the likelihood that cattle farmers perceive climate change increases. Milk represents an essential constituent of the food ration of Fulani cattle farmers and also generates income for their households (Alkoiret et al. 2010). Climate change is causing a decrease in the milk production of animals (Henry et al. 2012). Large households are therefore no longer able to meet the milk demand of their large families. This is why cattle farmers can more easily detect climate change (Kosmowski et al. 2016).

Cattle herd size has also influenced cattle farmers' perception of the increase in heat, the decrease in rainfall, and the late onset and the early cessation of rains. This means that farmers with large numbers of cattle perceive climate change better than those with small numbers due to the high demand for water and forage. This result is similar to that obtained among Turkana cattle farmers in northwestern Kenya (Opiyo et al. 2016).

Cattle Farmers' Adaptation Strategies to Climate Change

To adapt to climate change, cattle farmers in the dry and sub-humid tropical zones of Benin have developed several strategies (Table 3). These strategies can be grouped

Table 3 Adaptation strategies of cattle farmers in the dry and sub-humid tropical zones of Benin in the face of climate change

Adaptation strategies			Climatic zones			
Strategy group	Type of strategy	Total	DTZ	STZ	X^2	p-Value
Production adjustment strategies	Forage cropping	31.1	10[a]	52.2[b]	72.9	<0.0001
	Storage of crop residues	76.1	82.2[a]	70[b]	6.7	0.009
	Making hay	18.9	19.4[a]	18.3[a]	0.01	0.89
	Night grazing	14.4	13.9[a]	15[a]	0.02	0.88
	Use concentrated feed	72.8	77.8[a]	67.8[b]	4.05	0.04
Activities diversification strategies	Integration livestock-crop	83.9	95[a]	72.8[b]	31.2	<0.0001
	Fattening	15.3	11.1[a]	19.4[a]	3.68	0.051
	Off-farm activities	25.6	15[a]	36.1[b]	19.9	<0.0001
Livestock management strategies	Herds destocking	70	77.8[a]	62.2[b]	9.6	0.001
	Livestock diversification	58.9	92.8[a]	25[b]	167.9	<0.0001
	Pastoral mobility	96.1	100[a]	92.2[b]	12.5	0.0003
Selection strategies	Breeding local breeds	2.3	19.4[a]	21.1[a]	0.06	0.79
	Cross between local breed and breed adapted to heat	25.3	31.7[a]	18.9[b]	7.1	0.007

DTZ dry tropical zone, *STZ* sub-humid tropical zone
[a, b]The values of the same line indexed by different letters are significantly different at the 5% threshold

into four major groups of strategies, namely, production adjustment strategies, activities diversification strategies, livestock management strategies, and selection strategies. This classification is similar to that developed by Calvosa et al. (2010).

The production adjustment strategies consist of the storage of crop residues, use of concentrated feed, forage cropping, making hay, and night grazing. The adoption rates for the storage of crop residues (82.2%) and the use of feed concentrates (72.8%) were significantly higher ($p < 0.05$) in the dry tropical zone than in the sub-humid tropical zone. Conversely, forage cropping (52.2%) was more adopted ($p < 0.0001$) by cattle farmers in the sub-humid tropical zone. Indeed, the rainfall and the number of rainy days recorded in the sub-humid zone being higher than that obtained in the dry zone could favor the forage cropping in this zone. Also, as the climatic conditions are not conducive to the forage cropping in the dry zone, this leads cattle farmers in this zone to resort to other strategies such as the use of feed concentrates and the storage of crop residues to feed the animals.

Integration of livestock rearing and crop cultivation, fattening, and off-farm activities are the types of strategies contained in the activities under the diversification strategies category. The practice of fattening did not vary significantly ($p > 0.05$) from one climatic zone to another. On the other hand, the integration livestock and crop was more adopted ($p < 0.0001$) in the dry zone than in the sub-humid zone. This result means that pastoralists have moved to agro-pastoralism. Indeed, milk was the staple food for Fulani cattle farmers (Alkoiret et al. 2010), but with the fall in milk production due to climate change, the consumption of cereals has increased. To obtain these cereals, cattle farmers exchanged milk for these products with farmers. But today, given the decrease in crop yield and the strong demand due to the demographic surge, cereals are inaccessible because their prices have increased, making the exchange of products difficult. This may be the reason why cattle farmers integrate livestock and crop because they are convinced that livestock cannot be their only source of food. This result is similar to those obtained in Burkina Faso by Sanfo et al. (2015). Off-farm activities were more practiced by cattle farmers in the sub-humid tropical zone ($p < 0.0001$) than those in the dry zone. This could be explained by the fact that the sub-humid tropical zone is an area which abounds in urban centers of a commercial nature, which could facilitate trade. Thus, income from off-farm activities can be used by cattle farmers to increase the level of investment in inputs such as labor, feed concentrates, and veterinary products.

Herd destocking, livestock diversification, and pastoral mobility, all of which are livestock management strategies, were adopted more in the dry zone ($p \leq 0.001$) than in the sub-humid zone. Indeed, the insufficiency of forage due to the precariousness of the rains pushes the cattle farmers having a large number of cattle to practice the transhumance to reduce the risk of mortality (Kiema et al. 2013). In addition, other cattle farmers are forced to reduce the size of their herd (Kima et al. 2015; Oyekale 2014). Livestock diversification through the introduction of small ruminants into the breeding constitutes a real advantage for the farmers because of their low food needs, their larger feeding areas, and their higher reproduction rates (IUCN 2010).

Breeding local breeds adapted to local climatic conditions, and the crossing between local breeds and heat-resistant breeds were the two selection strategies implemented by the cattle farmers in both zones. The adoption rates for the first strategy were not significantly different ($p < 0.05$) in the two study zones. On the other hand, crossbreeding between local breeds and heat-resistant breeds as an adaptation strategy was more adopted in the dry zone ($p = 0.007$) than in the sub-humid zone. This could be explained by the fact that the dry zone is a pre-Sahelian zone where there is a high temperature, therefore requiring the breeding of heat-resistant animals.

Conclusion

The manifestations of climate change are perceived by cattle farmers in the dry and sub-humid tropical zones of Benin. The changes in rainfall are felt through signs such as reduced rainfall and late start and early end of the rainy seasons. Changes in temperature and wind were felt through increased heat and violent winds. This study showed that the sociodemographic characteristics of cattle farmers such as the level of education and membership of an organization influence local perceptions of climate change.

Adaptation strategies implemented by cattle farmers can be grouped into four main groups. These are production adjustment strategies, activities diversification strategies, livestock management strategies, and selection strategies. These current developed strategies allow farmers to take advantage of their livelihood.

Based on the results of this study, there is a need to strengthen the adaptive capacities of farmers in both zones through their access to education and training on adaptation to climate change within breeders' organizations. These help to improve their perception of this phenomenon and help them to better develop adaptation strategies. Climate information is needed to enable them to increase production to achieve food security. In addition, endogenous climate change indicators should be further promoted, as they allow farmers to predict the course of the rainy season and guide them better in implementing their adaptation strategies to climate change.

Acknowledgments Yaya Idrissou thanks the International Foundation for Science for its financial assistance (IFS, B/6189-1). He also thanks the Intergovernmental Panel on Climate Change (IPCC) and the Prince Albert II of Monaco Foundation (FPAM) for their financial support. The contents of this document are solely the liability of Yaya Idrissou and under no circumstances may be considered as a reflection of the position of the Prince Albert II of Monaco Foundation and/or the IPCC.

References

Adimassu Z, Kessler A (2016) Factors affecting farmers' coping and adaptation strategies to perceived trends of declining rainfall and crop productivity in the central rift valley of Ethiopia. Environ Syst Res 5:13

Alkoiret IT, Awohouedji DYG, Gbangboche AB, Bosma RH (2010) Productivité des systèmes d'élevage bovin de la commune de Gogounou au nord-est du Bénin. Ann Sci Agron 14:145–163
Alkoiret TI, Radji M, Babatoundé S (2011) Typologie des élevages bovins installés dans la commune de Ouaké au nord-ouest du Bénin. Livest Res Rural Dev 23. http://www.lrrd.org/lrrd23/3/alko23050.htm
Apata TG, Samuel KD, Adeola AO (2009) Analysis of climate change perception and adaptation among arable food crop farmers in South Western Nigeria. Contributed paper prepared for presentation at the International Association of Agricultural Economists'2009 Conference, Beijing, 16–22 Aug 2009
Ayanlade A, Radeny M, Morton JF (2017) Comparing smallholder farmers' perception of climate change with meteorological data: a case study from southwestern Nigeria. Weather Clim Extrem 15:24–33
Bambara D, Bilgo A, Hien E, Masse D, Thiombiano A, Hien V (2013) Perceptions paysannes des changements climatiques et leurs conséquences socio environnementales à Tougou et Donsin, climats sahélien et sahélo-soudanien du Burkina Faso. Bull Rech Agron Bénin 74:8–16
Bambara D, Thiombiano A, Hien V (2016) Changements climatiques en zones nord-soudanienne et sub-sahelienne du Burkina Faso: comparaison entre savoirs paysans et connaissances scientifiques. Rev Décologie 71:35–58
Calvosa C, Chuluunbaatar D, Fara K (2010) Livestock and climate change. Livestock Thematic Papers
Chapman SC, Chakraborty S, Dreccer MF, Howden SM (2012) Plant adaptation to climate change—opportunities and priorities in breeding. Crop Pasture Sci 63:51–268
Cuni-Sanchez A, Omeny P, Pfeifer M, Olaka L, Mamo MB, Marchant R, Burgess ND (2019) Climate change and pastoralists: perceptions and adaptation in montane Kenya. Clim Dev 11:513–524
Deressa TT, Hassan RM, Ringler C, Alemu T, Yesuf M (2009) Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. Glob Environ Chang 19:248–255
Deressa TT, Hassan RM, Ringler C (2011) Perception of and adaptation to climate change by farmers in the Nile basin of Ethiopia. J Agric Sci 149:23–31
Dossa LH, Lesse DP, Houinato M, Sinsin B, Souberou F, Yabi I (2017) Vulnérabilité de l'élevage transhumant à la Variabilité hydro-climatique dans le nord-est de la République du Bénin. Rev CAMES 8:233–249
Folefack DP, Tenikue M (2015) Choice of coping strategies of producers facing the cotton crisis: a multinomial logit analysis in Cameroon. Int J Innov Appl Stud 11:77–89
Gnanglè CP, Glèlè Kakaï R, Assogbadjo AE, Vodounnon S, Afouda Yabi J, Sokpon N (2011) Tendances climatiques passées, modélisation, perceptions et adaptations locales au Bénin. Climatologie 8:27–40
Henry B, Charmley E, Eckard R, Gaughan JB, Hegarty R (2012) Livestock production in a changing climate: adaptation and mitigation research in Australia. Crop Pasture Sci 63:191–202
Idrissou Y, Assani AS, Toukourou Y, Worogo HSS, Assogba BGC, Azalou M, Adjassin JS, Alabi CDA, Yabi JA, Alkoiret IT (2019) Systèmes d'élevage pastoraux et changement climatique en Afrique de l'Ouest: Etat des lieux et perspectives. Livest Res Rural Dev 31. http://www.lrrd.org/lrrd31/8/yadris31118.html
Idrissou Y, Assani Seidou A, Tossou MF, Baco MN, Sanni Worogo HS, Adjassin JS, Assogba BGC, Alkoiret Traoré I (2020) Perception du changement climatique par les éleveurs de bovins des zones tropicales sèche et subhumide du Bénin: Comparaison avec les données météorologiques. Cah Agric 29:9. https://doi.org/10.1051/cagri/2019032
IUCN (2010) Building climate change resilience for African livestock in sub-Saharan Africa – World Initiative for Sustainable Pastoralism, (WISP): a program of IUCN – The International Union for Conservation of Nature, Eastern and Southern Africa Regional Office, Nairobi, Mar 2010

Kaboré PN, Barbier B, Ouoba P, Kiema A, Some L, Ouedraogo A (2019) Perceptions du changement climatique, impacts environnementaux et stratégies endogènes d'adaptation par les producteurs du Centre-nord du Burkina Faso. VertigO- Rev Électronique En Sci Environ 19. https://doi.org/10.4000/vertigo.24637

Kiema A, Some L, Nacro BH, Compaore H, Kagone H, Kpoda CY, Bambara GT (2013) Stratégies d'adaptation des éleveurs de la zone Est du Burkina Faso aux effets des changements climatiques. Agron Afr 6:67–79

Kima SA, Okhimamhe AA, Kiema A, Zampaligre N, Sule I (2015) Adapting to the impacts of climate change in the sub-humid zone of Burkina Faso, West Africa: perceptions of agro-pastoralists. Pastoralism 5:16

Kosmowski F, Leblois A, Sultan B (2016) Perceptions of recent rainfall changes in Niger: a comparison between climate-sensitive and non-climate sensitive households. Clim Chang 135:227–241

Limantol AM, Keith BE, Azabre BA, Lennartz B (2016) Farmers' perception and adaptation practice to climate variability and change: a case study of the Vea catchment in Ghana. Springerplus 5:830

Mabe FN, Sienso G, Donkoh S (2014) Determinants of choice of climate change adaptation strategies in northern Ghana. Res Appl Econ 6:75–94

Mamba SF (2016) Factors influencing perception of climate variability and change among small-holder farmers in Swaziland. Indian J Nutr 3:138

McDonald JH (2009) Handbook of biological statistics. Sparky House Publishing, Baltimore

MEHU (2011) Deuxième Communication Nationale de la République du Bénin sur les Changements Climatiques. Cotonou Ministère L'Environnement L'Habitat L'Urbanisme

Nardone A, Ronchi B, Lacetera N, Ranieri MS, Bernabucci U (2010) Effects of climate changes on animal production and sustainability of livestock systems. Livest Sci 130:57–69. https://doi.org/10.1016/j.livsci.2010.02.011

Opiyo F, Wasonga OV, Nyangito MM, Mureithi SM, Obando J, Munang R (2016) Determinants of perceptions of climate change and adaptation among Turkana pastoralists in northwestern Kenya. Clim Dev 8:179–189

Oyekale AS (2014) Impacts of climate change on livestock husbandry and adaptation options in the arid Sahel belt of West Africa: evidence from a baseline survey. Asian J Anim Vet Adv 9:13–26

Polley HW, Briske DD, Morgan JA, Wolter K, Bailey DW, Brown JR (2013) Climate change and North American rangelands: trends, projections, and implications. Rangel Ecol Manag 66:493–511

Salack S, Muller B, Gaye AT, Hourdin F, Cisse N (2012) Multi-scale analyses of dry spells across Niger and Senegal. Sécheresse 23:3–13

Sanfo A, Sawadogo I, Kulo EA, Zampaligre N (2015) Perceptions and adaptation measures of crop farmers and agropastoralists in the eastern and plateau central regions of Burkina Faso, West Africa. FIRE J Sci Technol 3:286–298

Sanogo K, Binam J, Bayala J, Villamor GB, Kalinganire A, Dodiomon S (2017) Farmers' perceptions of climate change impacts on ecosystem services delivery of parklands in southern Mali. Agrofor Syst 91:345–361

Sanou CL, Tsado DN, Kiema A, Eichie JO, Okhimamhe AA (2018) Climate variability adaptation strategies: challenges to livestock mobility in south-eastern Burkina Faso. Open Access Libr J 5:1–17

Sautier M (2013) Outiller l'adaptation des élevages herbagers au changement climatique: de l'analyse de la vulnérabilité à la conception participative de systèmes d'élevage. Thèse de doctorat, Université de Toulouse

Uddin MN, Bokelmann W, Dunn ES (2017) Determinants of farmers' perception of climate change: a case study from the coastal region of Bangladesh. Am J Clim Chang 6:151

Zakari S, Tente BAH, Yabi I, Imorou IT, Tabou T, Afouda F, N'Bessa B (2015) Vulnérabilité des troupeaux transhumants aux mutations climatiques: analyse des perceptions et adaptations locales dans le bassin de la Sota à Malanville. Afr Sci Rev Int Sci Technol 11:211–228

Zampaligré N, Dossa LH, Schlecht E (2014) Climate change and variability: perception and adaptation strategies of pastoralists and agro-pastoralists across different zones of Burkina Faso. Reg Environ Chang 14:769–783
Zhang X, Yang F (2004) RClimDex 10 user manual climate research branch Environment Canada