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PERCEPTIONS AND ADAPTATIONS OF BEEKEEPERS AND HONEY HUNTERS TO CLIMATE CHANGE: THE CASE OF THE COMMUNES OF NATITINGOU AND TANGUIETA IN NORTHWEST OF BENIN

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ABSTRACT

The effects of climate change are a major threat to the environment and sustainable development of most sub-Saharan African countries. The perceptions and adaptation strategies of beekeepers and other operators in the honey sector (i.e. honey hunters) to climate change are, however, not adequately explored. The objective of this study was to evaluate the perceptions of beekeepers and honey hunters towards climate change and strategies of adaptation in north-west Benin. In that respect, a survey was conducted among 120 beekeepers in the Communes of Tanguiéta and Natitingou, northwest of Benin. Both beekeepers and honey hunters adopted several coping strategies such as: farming of other bee species, changing of beekeeping techniques, amendment of periods of beekeeping operations, displacement of the apiary, reduction or increase in number of hives and prayers. In a last resort, beekeepers that are severely affected by climate change had no other choice than abandoned beekeeping for honey hunting which, unfortunately, increased the pressure on the biodiversity of the bees.

Key Words: Apiary, biodiversity, beekeeping strategies

RÉSUMÉ

Les effets des changements climatiques constituent aujourd'hui une menace majeure pour l'environnement et le développement durable de plusieurs pays de l'Afrique sub-saharienne. Cependant, l'effet perceptions et stratégies d'adaptation que développent les apiculteurs et les opérateurs du miel (ex. chasseurs de miel) face aux changements climatiques ne sont pas suffisamment explorés. L'objectif de la présente étude effectuée dans le Nord Ouest du Bénin visait à analyser les perceptions des apiculteurs et des exploitants du miel sur les changements climatiques à travers leurs stratégies d'adaptation. A cet effet, une enquête a été conduite auprès de 120 exploitants du miel des Communes de Tanguiéta et de Natitingou, au Nord-ouest du Bénin. Il ressort de cette étude qu'aussi bien les apiculteurs que les chasseurs de miel adoptent plusieurs stratégies d'adaptation telles que: l'élevage d'autres espèces d'abeilles, la modification des techniques apicoles, la modification des périodes des opérations apicoles, le déplacement du rucher, la réduction ou l'augmentation du nombre de ruches et les prières. En dernier recours, les apiculteurs les plus atteints par les effets des changements climatiques abandonnent simplement l'apiculture pour la chasse au miel, ce qui accentue la pression sur la diversité des abeilles.

Mots Clés: Rucher, biodiversité, techniques apicoles

INTRODUCTION

Many surveys have proven the reality of climate change throughout the world. According to FIDA (2008), climate change constitutes one of the most serious threats which affect the sustainability of natural resources for the 21st Century. In West Africa, a tendency to the decrease in the rainfall quantities has been observed starting from the end of the 1960s until now (Hubert *et al*., 1989; Bricquet *et al*., 1997; Servat *et al*., 1999; FAO, 2007). High levels of vulnerability of the African countries to climate change, due to the agricultural dependence and very limited capacity of adaptation were quoted (Hubert *et al*., 1989; Ominde and Juna, 1991; Bricquet *et al*., 1997; Servat *et al*., 1999; FAO 2007).

In Benin, a West African country, studies achieved in 2001 forecasted a reduction of about 20 to 30% of the rainfall at national level from the date of the study to the year 2025 (MEHU, 2001).

Agricultural sector is the human activity, mostly directly influenced by the climatic change (FIDA, 2008. However, the impacts of climate change are not just of environmental concern, but will impede efforts to tackle poverty and promote national development. According to Gbetibou (2009), many human development systems will be affected by these changes, particularly agriculture, water resources, industry and human health. Thus, the rural farmers whose livelihoods depend on the use of natural resources are likely to bear the brunt of adverse impacts.

The consequences of climate change on pollinators are very little explored in the northwestern Benin. Moreover, to our knowledge, no studies linking honeybees and honey production, and climate change have been conducted in the country. The economic importance of the bees as pollinators in world agriculture is established (Adam, 1985; Kokoye, 1991; DAPS, 1995; Muhammad *et al*., 2006). In Benin, beekeeping is a secondary activity for most of people involved. However, it is an activity of great importance; but benefits very little attention in the development of agricultural strategies and policies. According to Pouvreau (1984), beekeeping presents a great interest in many areas such as: agricultural, social, food, economic, industry and environment.

The practice of this activity provides a degree of financial autonomy and thereby, contributes to the household's incomes. As a result, beekeeping is one of the strategies of diversification of farmers' income (Pouvreau, 1984; DAPS, 1995).

The objective of the present study is to determine the perceptions and adaptations strategies developed by beekeepers and honey-hunters in response to climate change for the conservation of bee diversity in the municipalities of Natitingou and Tanguiéta, in Northwestern Benin.

MATERIALS AND METHODS

The data used for the study were collected from honey operators represented by beekeepers, honey hunters and those doing both activities in the Communes of Natitingou and Tanguiéta. The city of Natitingou lies between 10 ° 18' 46 " latitude north, and 1 ° 23' 19" longitude east and covers an area of 3,045 Km² (Afrique Conseil, 2006a). The Commune of Natitingou is characterised by the chain of Atacora from which it takes its hilly terrain, consisting mainly of plateaus and hills with generally high slope valleys.

The climate is of the Sudano-Guinean type, linked with the Atacorien relief with two distinct seasons: a dry one which covers the period from mid-October to mid-April, and a rainy season that extends from mid-April to mid-October. It is characterised by rainfall ranging between 1,000 to 1,400 mm, with the highest records in the months of August and September. Trees, shrub Savannah and clear forests make up the vegetation of the Commune.

The Commune of Tanguiéta is located at 10 ° 37' 0 " latitude north, and 1 ° 16' 0" longitude east. Tanguiéta covers an area of 5,456 Km² (AfriqueConseil, 2006b). The climate of the Communes of Tanguiéta is Sudano-Sahelian, with a rainy season from the end of May to November and a dry season from November to May. It is characterised by an annual rainfall ranging between 800 and 1,100 mm, with the highest values recorded during the months of August and September. The vegetation of the Commune

of Tanguiéta includes forests and shrubby savannahs.

The observation units were the honey operators of the Communes of Natitingou and Tanguiéta. Beekeepers, honey hunters and people doing both activities were considered as honey operators. In these two Communes, a total of 120 operators were randomly selected and surveyed individually. An individual inquiry questionnaire was used to collect socio-demographic characteristics of respondents, their perceptions of climate change and strategies of adaptations. Semi-structured interviews and "focus group discussions" were organised to understand the role of beekeeping in the localities. Observations and triangulation of information were used to ensure the veracity of the collected information.

Quantitative analysis of the data was conducted through the calculation of descriptive statistics (tables of frequencies, mean and standard deviations), means comparison using Chi-square tests ($\chi 2$) and logistic regressions. The statistical software SPSS Version 16 was used for this purpose.

Content analysis was also used to explore qualitative data such as the stories and the views of respondents. According to Bardin (1977), content analysis is an effort of interpretation, that balances between two poles, on the one hand, the rigour of the objectivity and on the other hand, the maturity of the subjectivity. As proposed by Wanlin (2007), content analysis is organised around three consecutive phases that are: (i) look ahead, (ii) exploitation of the materials and (iii) the processing of the results, and the inference and the interpretation.

The study focused on the determinants of the ability of honey operators to cope with climate changes. To do this, a logistic regression model was estimated. A LOGIT model was used for this purpose (Hassan and Nhemachena, 2008). Table 1 presents the variables introduced in the different models.

The model is presented as follows:

$X_i = \alpha_0 + \alpha_1 EXP + \alpha_2 SMAT + \alpha_3 STAT + \alpha_4 ETHN + \alpha_5 NSCO + \alpha_6 NALP + \alpha_7 MIGR + \alpha_8 TAIL +$

TABLE 1. Codes and terms of the variables used in the regression model

Names of the variables	Code	Nature	Modalities	Expectedsigns
Experience	EXP	Continue	-	+
Marital status	SMAT	Discontinue	Not maried = 0 ; Maried=1	±
Position in household	STAT	Discontinue	Non-household head= 0 ; Household head =1	±
Ethnic group	ETHN	Discontinue	Ditamari=1, Wama=2, Gourmanché=4, Boulba=5	±
Schooling	NSCO	Discontinue	No = 0 ; Yes = 1	+
Litteracy	NALP	Discontinue	No = 0 ; Yes = 1	+
Stranger	MIGR	Discontinue	No = 0 ; yes = 1	±
Familymembers	TAIL	Continue	-	+
Number of farm hands	ACTI	Continue	-	±
Training in beekeeping	FORM	Discontinue	No = 0 ; Yes = 1	±
Creditavability	CRED	Discontinue	No = 0 ; Yes= 1	±
Beekeepers	API	Discontinue	No= 0 ; Yes= 1	±
Honey hunters	CHAS	Discontinue	No = 0 ; Yes = 1	±

α_9ACTI + α_{10}FORM + α_{11}CRED + α_{12}API + α_{13}CHAS + e_1 ..... (1)

Where Xi = the adaptation strategy I; e_1= error term; α_0= constant term; α_i= parameters to estimate. As "Ethnic groups" was not a qualitative dichotomous silent variable, the software treated each of their modality as such and calculates the coefficients. However, to simplify the reading of the results, each of these terms was regarded as a variable and was introduced in the regression model.

RESULTS AND DISCUSSION

Socio-demographic characteristics of respondents. Table 2 presents the main socio-demographic characteristics of respondents. It is clear that exploitation of honey is exclusively men's activity, as all the respondents were men at both study sites.

Furthermore, most of the respondents were married and head of households. Four ethnic groups were identified in the sample, namely, the Ditamari in Natitingou, the Wama, the

TABLE 2. Socio-demographic characteristics of beekeepers and honey hunters in northwestern Benin

Variables (%)	Variables	Natitingou	Tanguiéta	Study zone
Sex	Male (M)	100	100	100
	Female (F)	0	0	0
status	Not maried	7.1	32.1	233
	Maried	92.9	67.9	76.7
Position in household	Householdhead	92.9	70.5	78.3
	Dependant	7.1	29.5	21.7
Ethnic groups	Ditamari	97.6	0	34.2
	Wama	0	61.5	40
	Gourmanché	0	17.9	11.7
	Boulba	2.4	20.5	14.2
Religion	Animism	50	34.6	40
	Christian	42.9	53.8	50
	Muslim	7.1	11.5	10
Level of schooling	Yes	45.2	29.5	35
	No	54.8	70.5	65.0
Level of literacy	Yes	35.7	25.6	29.2
	No	64.3	74.4	70.8
Beekeeping as principal activity	Yes	0	0	0
	No	100	100	100
Migrant	Yes	46.3	53.8	51.3
	No	53.7	46.2	48.7
Training in Beekeeping	Yes	11.9	28.2	22.5
	No	88.1	71.8	77.5

Gourmanché inTangiéta and the Bulba in the two study sites. More than half of respondents were Christians, while others were Animists and Muslims.

Concerning formal education, more than half of the respondents never went to school. The finding was similar in the two Communes, where only 23% of respondents in Natitingou and 24.2% of the respondents in Tanguiéta were literate. For all the respondents, beekeeping was a secondary activity. Our results showed that only 8% of the respondents had access to agricultural credit during the 2009-2010 agricultural campaign. On the other hand, the age of respondents varied between 20 and 67 years, with an average of 34 years (± 11.09).

Beekeepers and honey hunters' perceptions of climate change. The study indicated that 57.5% of honey operators in the two communes felt the effects of climate change. Indeed, the independence test showed no relationship between the municipality and the perception of the effects of climate change (χ^2 = 0.223, ddl = 1; P = 0.152).

Honey operators, could be ranged in three main categories; honey hunters (46.7%), beekeepers (41.7%) and beekeepers-honey hunters (11.6%); and the ability to perceive climate change varied with the category of operator. About 57.5% of honey operators claimed to feel the effects of climate change, accounting for 50% of beekeepers, 55.4% of honey hunters and 92.95% of beekeepers-honey hunters. The independence test (χ^2 of Pearson) also revealed that the perception of climate change effects depended on the category of the operator at the significance level of 10% (χ^2 = 5.411; ddl = 2; P = 0. 067). Honey hunters were most likely to feel the effects of climate change. Indeed, this category of operators used two different forms of honey exploitation and, as such, they were more likely to be sensitive to climate change effects.

The results of the logistic model (Table 3) showed that, variables in the regression model explained 23.3 to 31.3% of the choice made by producers to exploit the honey. The unexplained variables were attributable to some hardly measurable factors, which were not included into this model, such as climatic conditions and the welfare of households. The model was also globally significant at 1% probability level.

The respondents' experience and their category were the main determinants of their ability to perceive the effects of climate change on their activities. Experience had a positive and significant effect at 10% level on the ability of the operator to discern the effects of climate change. In other words, the older the respondents, the more they were able to perceive the effects of climate change. These results tally with the observations by Maddison (2006), who reported that the more experienced farmers were the more they perceived better the effects of climate change.

Other variables such as marital status, status in the household, ethnic group, level of school enrolment and literacy, size of the household, number of farm assets, access to credit and training in beekeeping did not determine the ability of operators to recognise the effects of climate change. This can be explained by the fact that they had no direct contacts with the variables

TABLE 3. Results of the logistic model for the identification of the determinants of the perception of climate change by honey operators in northwestern Benin

Variables	Coefficients	Signification
EXP	0.073***	0.096
SMAT	0.525	0.750
STAT	0.526	0.759
ETHN (Ditamari)	1.266	0.431
ETHN (Wama)	-0.061	0.969
ETHN (Gourmantché)	1.750	0.299
ETHN (Boulba)	-0.119	0.942
NSCO	0.161	0.778
NALP	0.063	0.911
MIGR	-0.387	0.447
TAIL	-0.473	0.334
ACTI	0.047	0.578
FORM	-0.156	0.860
CRED	-22.798	0.999
API	2.358**	0.041
CHAS	2.510**	0.034
Constant	-6.415	0.207

Summary of the model R^2 Cox and Snell = 0,233 ; R^2 Nagelkerke = 0,313; P = 0,013

*P<1% ; ** P<5%; *** P< 10%

typically used to measure climate change which were temperature and rainfall. For the interviewed people, climate change occurred primarily by variations in temperature and precipitation. These two parameters were also the most evoked by farmers in previous studies on climate change (Orindi and Murray, 2005; Hassan and Nhemachena, 2008; Gbetibouo, 2009).

All of the respondents acknowledged the manifestations of climate change through changes in temperature (Fig. 1); while 96% of beekeepers, 100% of honey hunters and 84.6 of beekeepers/hunters attributed it to changes in rainfall (Fig. 2).

The decrease in temperature is related to the period of Harmattan (mid-December to mid January), during which temperatures are lower than during the rainy season. Depending on the season in a year, the respondents recorded higher or lower temperatures than normal. However, temperature increase appeared to be the climate change effect most perceived by African farmers (Hassan and Nhemachena, 2008).

Concerning the rainfall (Fig. 2), the increasing trend of the amount of rain in the year is clear. The results of the study did not tally with the findings by Maddison (2006) and Gbetibouo (2009). According to the respondents, it rained less and over a very short time, during periods when the rains used to be abundant. The importance of rain and the disparity in its distribution were mentioned, in addition to this increase in precipitations, by18.8% of beekeepers, 5.55% of honey hunters and 25% honey-hunters.

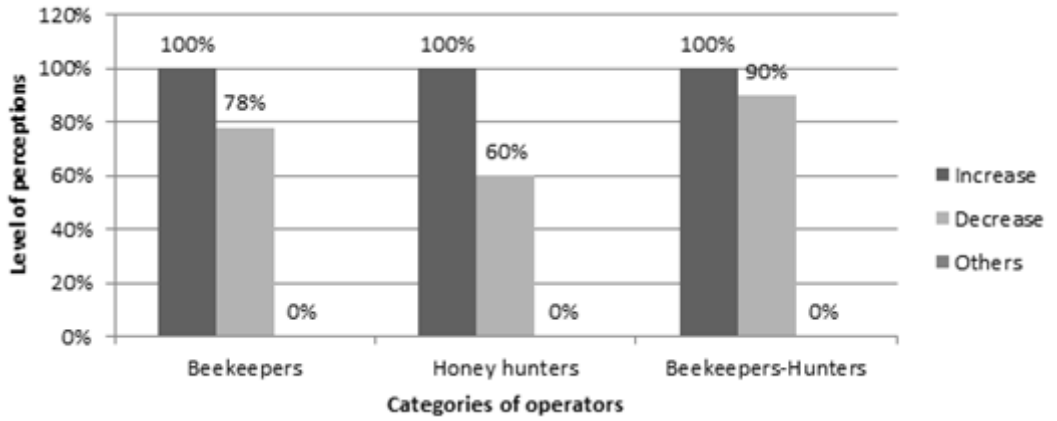

Figure 1. Respondents' perceptions of the changes in temperature by beekeepers and honey hunters in Benin.

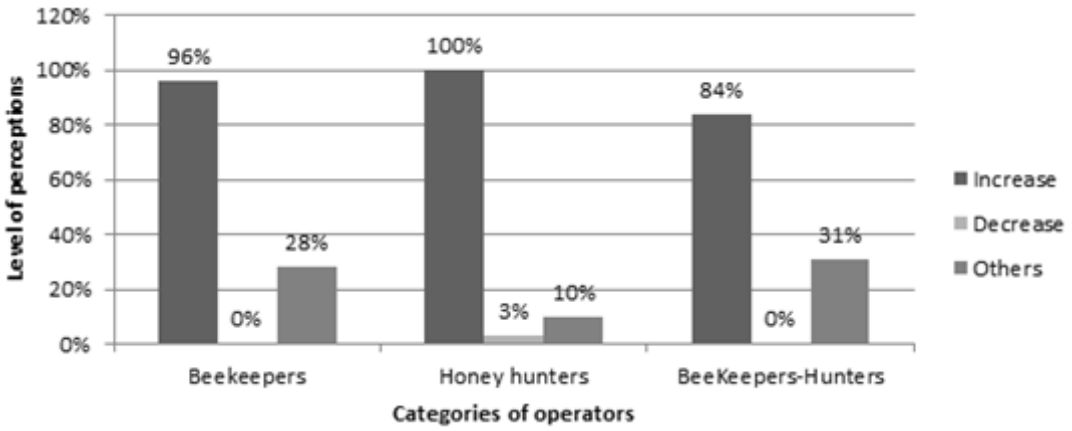

Figure 2. Respondents' perceptions of the changes in precipitations by beekeepers and honey hunters in north Benin.

Adaptation strategies

Strategies of beekeepers. Many strategies enable beekeepers to adapt to climate change (Fig. 3). These strategies included: beekeeping using other species (which implies the diversification of bees species), the change of the sites of the hives, the reduction or increase in the number of hives, the use of a particular type of hive (modern or traditional), the changing of apicultural techniques, the amendment of the periods of operations, the shift from beekeeping to honey hunting activity, praying activities or other strategies of adaptations. Among the beekeepers who perceived the effects of climate change, only 72% adopted one of the strategies of adaptation; thereby confirming the observation by Gbetibouo (2009) that although the producers perceived the effects of climate change, all of them did not adopt strategies of adaptation. According to the same author, approximately 67% of the producers who perceived the effects of climate change did not take any action to adapt to it because of poverty and lack of credit which constitute the barriers for adaptation climate change.

Not all the strategies of adaptations were adopted by beekeepers. Out of the 12 strategies previously listed, only six were actually adopted. Figure 3 shows the frequency of the adoption of strategies.

The changing of beekeeping techniques was the most used strategy to face climate change. This was followed by the prayer practices. The other strategies implied numerous techniques in relation with traditional beekeeping practices, such as changing the species of honeybees or using attractive substances as cow defecation. The observations made by several researchers (Heprun and Radloff, 1998; Paraïso *et al.*, 2011a) indicated that bee species in Northern Benin are *Apis mellifera* adansonii, with, at least, two different sub-species, namely, (i) the yellow and smaller type which is more productive and located in the forest areas; and (ii) the black and bigger type, subservient to the savannas and less productive in honey; and a third one, that occupies an intermediate position. The increase in the number of hives, the change in the location of installation of the hives and the use of a particular type of hive were strategies specific to the respondents.

Honey hunters strategies. Modern beekeeping is not well established everywhere in Benin, and subsequently, honey hunting is the most common interaction between humans and honey bees. Among the honey hunters, several potential strategies for adaptation to climate change were identified. They were: the amendment of the periods of hunting, change of the hunting grounds, reduction or increase in the frequency of hunting, change of the hunting techniques, transition from hunting to beekeeping, change of activity and prayer practices.

As with the beekeepers, honey hunters did not adapt to climate change. Indeed, among

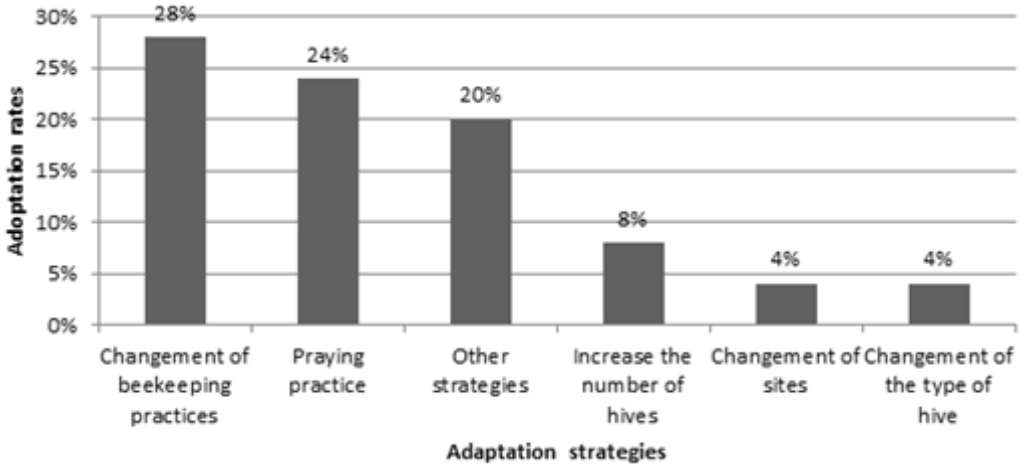

Figure 3. Adoption rates of the climate change adaptation strategies by beekeepers and honey hunters in north Benin.

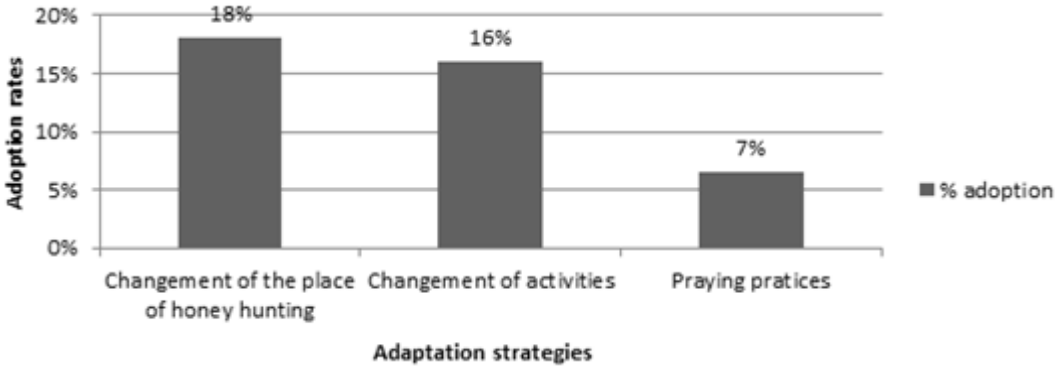

Figure 4. Rate of adoption of the strategies of adaptation to climate change.

beekeepers who perceived the effects of climate change, only 80.64% adopted at least a strategy of adaptation (Fig. 4). These results corroborate with those of Gbetibouo (2009). Moreover, not all adaptation strategies were adopted. Thus, out of the nine strategies previously listed, only three were actually adopted. Figure 4 shows the frequency of the adoption of their different strategies.

The change of the hunting grounds was the most used by hunters to compensate the adverse effects of climate change. This was followed by prayer and activity change. This last strategy was a sign of the impotence of the hunters facing climatic vagaries. In Benin and many others West African countries, more than 70% of honey producers relied on honey hunting and only 10 to 30 % were involved in modern beekeeping activities. Honey hunters, therefore, represented the most active people involved in honey collection (Heprun and Radloff, 1998; Paraïso *et al.*, 2011a; b).

African honeybees are exposed to several threats such as hunting and habitat loss (Hussein, 2000; Dietemann *et al*., 2009; Paraïso *et al.*, 2011b). Beekeeping in Africa at the moment relies on local bees, which therefore, need appropriate establishment of conservation policies destined to maintain nesting sites and ensure the persistence of a healthy wild population. Most of the adaptation strategies of the honey hunters, however, put a very serious pressure on bee populations and will lead to the destruction of their diversity, which constituted a serious threat to their conservation.

CONCLUSION

Climate change is also affecting beekeeping activities in Benin. The perception of beekeepers and honey hunters on climate change and of its effects on beekeeping activities, prove the various impacts of climate change on this very important agricultural sector in the country. Various strategies of adaptation developed by the respondents are quite specific either to the beekeepers or to honey hunters. Most of the adaptations strategies of the honey hunters lead to more destruction of wild colonies to compensate the economic shortfall because of the reduction of the honey production which is one of the consequences of climate change. Appropriate measures for the promotion of sustainable beekeeping practices are needed, for the preservation of bee diversity and a sustainable development of the agriculture in the study area as well as in the sub-region. The end result will be an improvement of the living conditions of beekeepers.

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