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RESEARCH ARTICLE

FARMERS' PERCEPTION OF THE EFFECTS OF SOME PRESERVED TREE SPECIES IN THE COFFEE AND COCOA AGROFORESTS IN TOGO (WEST AFRICA)

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ABSTRACT

A survey conducted in the forest zone of Togo with 317 coffee and cocoa farmers, made it possible to identify the species appreciated or detested by the farmers in the coffee and cacao orchards. It also helped to know the reasons why these species are preserved or not. In the coffee plantations, the first most appreciated and suitable species to be preserved were *Erythrophleum suaveolens (76.2%), Khaya grandifoliola (76.1%), Albizia adianthifolia (72.3%), Milicia excelsa (68.4%), Albizia zygia (56.1%), Terminalia ivoiriensis (40.1%)* and *Terminalia superba (40.1%)*. In the cocoa plantations, the farmers preferred *Milicia excelsa (65.2%), Albizia adianthifolia (56.5%), Terminalia ivoiriensis (52.2%), Terminalia superba (52.2%)* and *Khaya grandifoliola (39.1%)*.The mains reasons why these farmers prefer these species were related to the quality of the shading they provided (95%), the improvement of the soil fertility and preservation under their feet (93%) and the supply of quality timber (92%).The most detested forest tree species in coffee agroforests were *Cola chlamydantha (89%), Cola nitida (89%), Ceiba pentadra (88%), Milicia excelsa (86%), Bombax costatum (79%) and Mangifera indica (77%),* while in cocoa plantations, *Bombax costatum (93%), Cola nitida (91%), Anogeisus leicarpus (88%), Cola chlamydantha (87%) and Glyricidia sepium (80%) were preferred,* because they were impoverishing and hardening the soil (89%), providing a bad shading (78%) and invading the orchards (75%). Lots of information was collected for a better orientation of the preservation and dissemination strategies of the plant genetic resources in the production area for enhancing sustainable coffee and cocoa cropping in Togo.

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INTRODUCTION

The dense forests of the sub-humid mountainous zone of Togo (Ecological Zone IV) form part of the places where the floristic diversity was particularly high in sub-Saharan Africa (Ferla *et al.*,2001).They also formed part of the areas of extreme endemism in West Africa (Beentje *et al.*,1994), mainly because of the particular paleoclimatic and ecological, humidity and fog conditions, which favored certain plant species (Rossi 1984, Wieringa and Porter 2004).These forests embodied important genetic resources of community interest. Indeed, these ecosystems and biodiversity associated with them provided important services to human communities. These ecosystem services involved among others lumber, service wood (posts and poles), energy wood (firewood and charcoal), Non Timber Forest Products (NTFPs) from plant origin (medicinal plants, fruits, seeds and leaves, liana, traditional mats, toothpicks, brooms, trays, cages, baskets and fans, fodders, etc.) and NTFPs from animal origin (insect fauna, herpetological fauna, avifauna, mammalian fauna and fish resources, etc.), which were in general used in food for the direct consumption and marketing. Despite these benefits offered by these dense humid forests ecosystems in this part of Togo, the preservation of these forests is now possible thanks to the agroforests which consisted of the combination of cash crops including coffee and cocoa plants under tree cover. This practice has helped for long time to save many trees with economic and ecological value in these agroforest parks. For production purposes, the coffee and cocoa plantations need an

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enabling environment that requires the presence of the forest, whether artificial or natural (Adden *et al.,* 2016). However, in the 1970s, the Société Nationale de Rénovation de la Caféière et de la Cacaoyère / National Society for the Renovation of Coffee and Cocoa Plantation (SRCC) of Togo began introducing high yield heliophilous hybrid varieties of coffee and cocoa trees. For these new varieties, the technical recommendation was to grow in full sunlight to maximize the yield and production (SOFRECO, 2010). This farming technique with zero shading leads the populations to gradually eliminate the trees present in the coffee and cocoa cropping zone. The extinction of these forest ecosystems, as a result of human activities, drastically reduces the biological diversity in the area. In addition, the land belongs to local communities, making the Government powerless to take any action aiming at protecting the forests and their biodiversity in the area. In the absence of any action, these forests and their biological diversity will completely disappear by 2023 (Salazar *et al*., 2018). Meanwhile, among these trees, some would be the last representatives of the original moist forest of this area. Apart from these agronomic practices that led to the destruction of the forest species, other factors not the least worsened further the forests degradation in this part of Togo. Therefore, the ever-increasing number of people, the exploitation of wood for the needs of wood products and energy wood, the search for suitable land for agriculture and transhumance, threatened dangerously these forest stands and led therefore to their extinction (Ouôba, 2005; Lamien, 2006; Sulaiman *et al.*, 2017). All these forms of exploitation, although directly providing relatively high income to local populations, contributed to the loss of the biodiversity. The situation is currently very alarming in the sense that almost all the forests in the sub-humid mountainous area of Togo are degraded. The gallery forest that protected the water courses were also destroyed. The many botanical surveys in the area always helped to discover new species not yet referenced neither in the national and international data base nor in the collections of the National Herbarium of Togo. Therefore, recent studies revealed that more than 200 plants species still well preserved in the ecosystems of the area by the local communities (some of which are not yet in the flora of Togo), are endangered. (Adjonou, 2009). Faced with this situation, it urged to take initiatives aiming at safeguarding forest endangered species in forest area in Togo. The replanting of agroforests is today the most reassuring way for safeguarding the plant genetic resources necessary to the reconstitution of the forest, to the production of goods and services and the sustainability of the coffee and cocoa agroforests. In order to take corrective measures to these situations and to meet the international commitments undertaken by Togo, it was essential to know the species preferred or not by the farmers in the agroforests to promote them for better use and protection of the environment and especially endangered species. Therefore, this study aimed to (i) identifying the tree species preferred and detested by the farmers in the coffee and cocoa agroforests in Togo and the reasons why they are preserved or not, then (ii) detecting the endogenous viewpoints for a better preservation of these forest resources.

MATERIAL AND METHODS

The surveys were carried out in the eight districts of the coffee and cocoa production area in Togo (Agou, Kloto, Kpélé, Danyi, Amou, Akébou, Wawa and Blitta), in 18 village communities with the mobilization of 317 farmers distributed in 48 focus groups (25 focus groups growly essentially coffee and 23 focus groups growing essentially cocoa). The 48 focus groups are made up of socio-professional categories. The survey covered 11 groups of men under 30 years old, 17 groups of men over 30 years old, 6 groups of women under 30 years old and 14 groups of women over 30 years old (Table 1). The data collection was carried out in the first quarter of 2018 using a survey sheet developed and validated by the actors involved. The survey sheet included about ten questions that alternately covered (1) general information (date of survey, main crop, type of groups, location and geo-referenced coordinates), (2) information on tree species one would like to see in his/her plantation (vernacular name, French name and scientific name) with photo of each identified individual plant, (3) reasons for preferring these previously identified species, (4) ranking in order of importance according to the preferences of each group, (5) information on the trees species that one would not like to see in the plantation (vernacular name, French name and scientific name) with photo of each identified individual plant, (6) reasons for detesting these previously identified species, (7) how can we better preserve the identified species, all categories included ?, (8) reasons for non-combination of the agroforestry trees with coffee and cocoa orchards, (9) consequences observed in plantations after the cutting of agroforestry trees for some time, and (10) free opinions of farmers in terms of recommendations. The parameters analyzed covered (i) nature of the forest tree species that farmers prefer to see in their plantations and why (preferred species and reasons), (ii) ranking of species that they prefer to have in their plantation in order of importance, (iii) nature of the species that the farmers do not want to have in their plantations and why (detested species and reasons), (iv) endogenous view point for the better preservation of these forest plant resources (v) reason for refusing to associate trees with coffee and cocoa trees; and (vi) consequences observed in coffee and cocoa plantations after tree cutting. To calculate the preferential weight, preferential scores were given to each species identified according to the focus group and the dominance of each species identified according to its position was calculated. The same applies to the various enumerated reasons. All the calculations are expressed in percentage of groups of farmers preferring or detesting this or that species as well as the reasons provided.

RESULTS

Effects of the tree species identified in the coffee agroforests

In the coffee agroforests of the production zone in Togo, 17 tree species have been identified as preferred by the farmers (Figure 1). The agroforest species identified in the coffee orchards as the most popular species were *Erythrophleum suaveolens* (76.2%), *Khaya grandifoliola* (76.1%), *Albizia adianthifolia* (72.3%), *Milicia excelsa* (68.4%), *Albizia zygia* (56.1%), *Terminalia ivoiriensis* (40.1%) and *Terminalia superba* (40.1%). The main reasons why farmers preferred these species were related to the quality of the shading they provided (95%), the improvement of soil fertility and preservation under their feet (93 %) and the supply of quality timber (92%). Moreover, the farmers used them in traditional therapy (58%), in the fabrication of mortars (29%) and charcoal production (40%).These species also contributed to the preservation of soil moisture through their leaf cover (41%), termite hunting (38%), the plant protection against

Table 1. Survey villages with their focus groups

Zone	Village	Geo-localisation		Main crop	Focus group number				Focus group population			
		Longitude Nord	Latitude Est		M<30 yrs	M>30 yrs	F<30 yrs	F>30 yrs	M<30 yrs	M>30 yrs	F<30 yrs	F>30 yrs
Agou	Gadzawukpe	06°49,388	000°45,044	Cocoa	0	1	0	1	0	5	0	10
	Klonou	06°50,051	000°40,408	Cocoa	0	1	0	1	0	10	0	5
Akébou	Djon Djuire	07°75,025	000°78,254	Coffee	1	1	1	1	5	5	5	5
	Broumfou	07°73,296	000°68,116	Cocoa	1	1	1	1	5	5	5	5
Amou	Evou Apégamé	07°32,794	001°01,521	Cocoa	1	1	0	1	9	10	0	2
	Sodo Zion	07°19,222	000°51,078	Coffee	0	1	0	0	0	6	0	0
Blitta	Tchifama	08°11,111	000°48,322	Cocoa	1	1	1	1	4	7	3	5
	Assousso copé	08°15,527	000°45,534	Coffee	1	1	0	1	5	7	0	6
Danyi	Afougbadze	07°22,442	000°44,071	Coffee	0	1	1	0	0	17	4	0
	Yikpa Dzigbe	07°07,617	000°36,713	Cocoa	1	0	0	1	11	0	0	9
Kloto	Gbalave-Aveno	06°51,560	000°35,341	Cocoa	0	1	0	0	0	5	0	0
	Apoti	06°58,570	000°33,404	Coffee	0	1	0	1	0	5	0	5
Kpélé	Tsiko-Agagame	07°11,888	000°67,823	Cocoa	1	1	0	1	4	17	0	9
	Dzeyibo	07°23,052	000°92,605	Coffee	1	1	0	1	15	16	0	6
Wawa	Wobe	07°35,395	000°38,119	Cocoa	0	1	0	1	0	5	0	5
	Akloa	07°35,395	000°36,296	Cocoa	0	1	0	1	0	5	0	5
	Lomnava	07°36,240	000°44,018	Coffee	1	1	1	1	5	5	5	5
	Ave-Maria	07°36,382	000°48,649	Coffee	1	1	1	1	5	5	5	5
TOTAL				FG Coffee 25 FG Cocoa 23	10	17	6	15	68	135	27	87

M=Male ; F= Female ; yrs = years ; FG=Focus Group

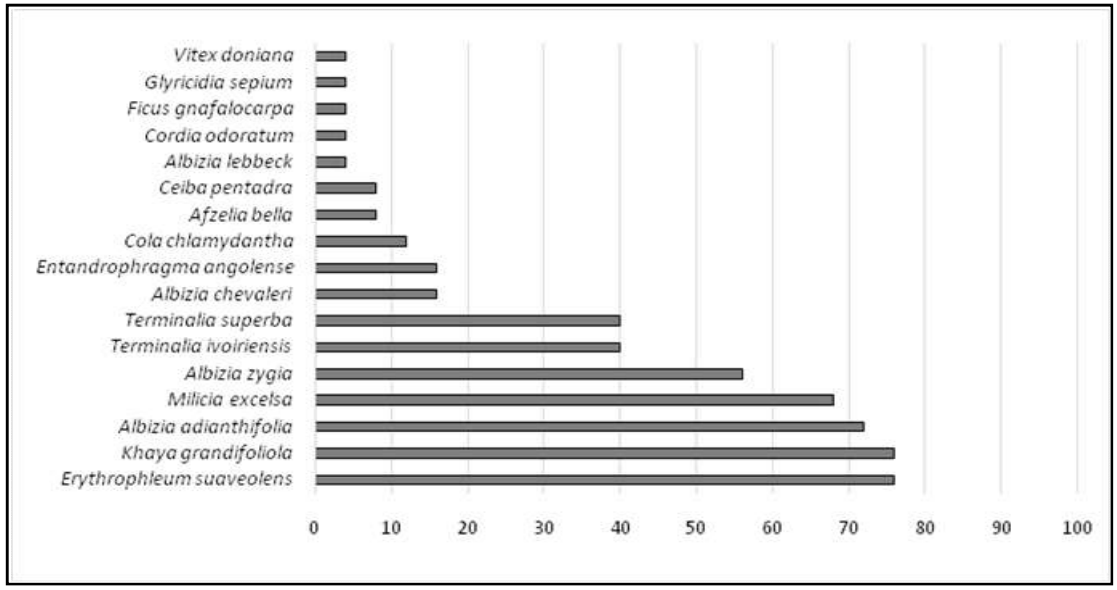

Figure 1. Preferred trees species in coffee agroforests in Togo, %

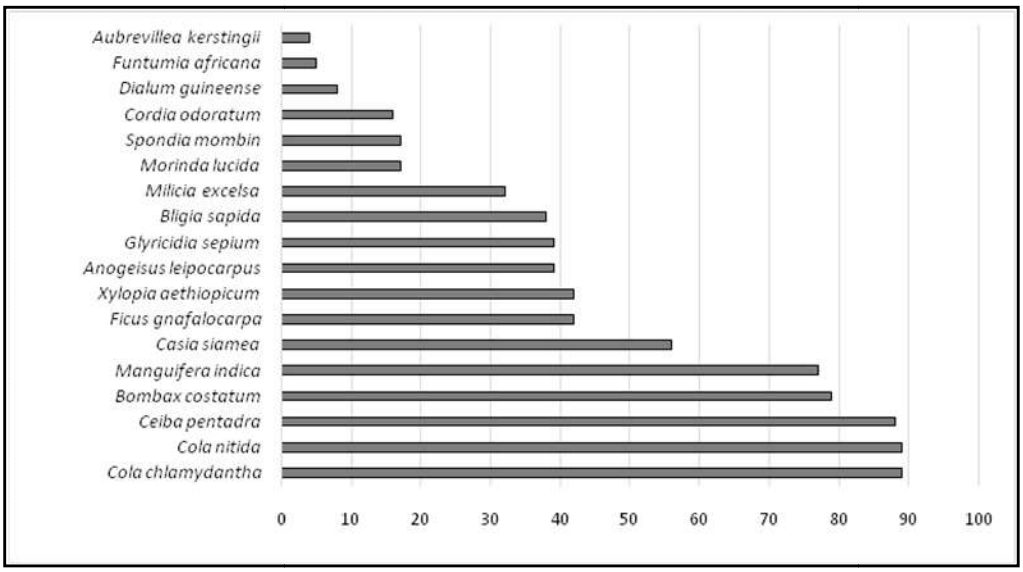

Figure 2. Detested trees species in coffee agroforests in Togo, %

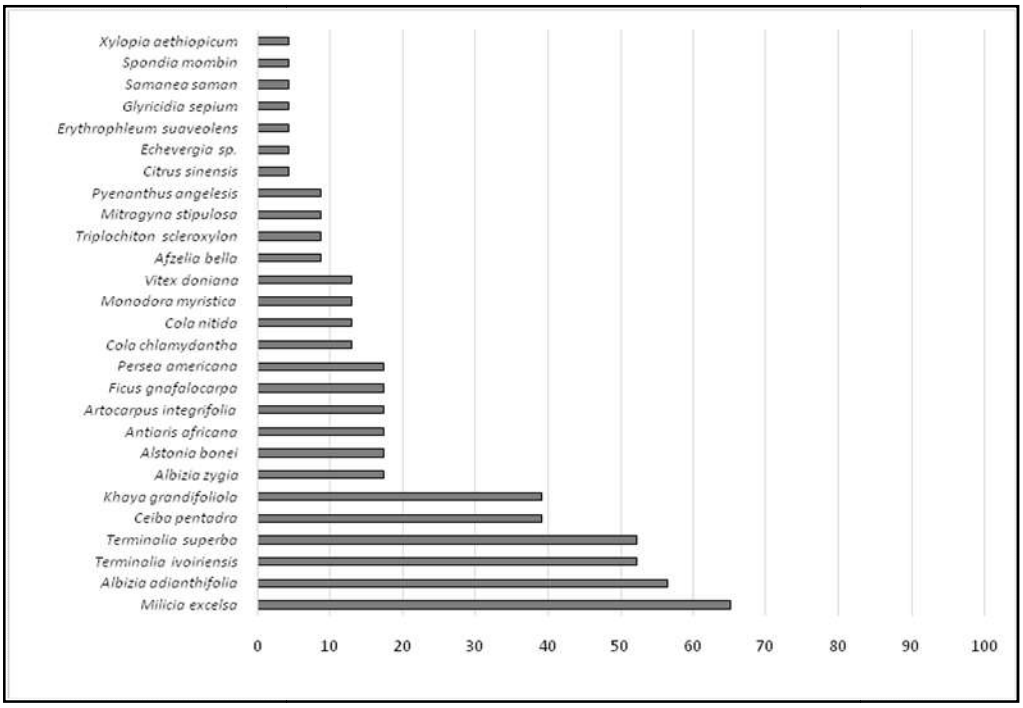

Figure 3. Preferred trees species in cocoa agroforests in Togo, %

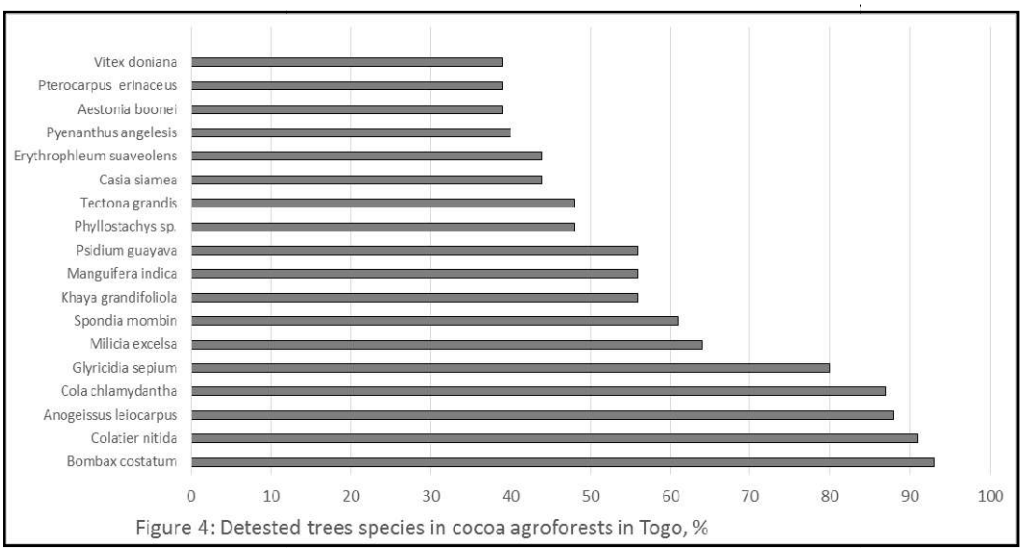

Figure 4. Detested trees species in cocoa agroforests in Togo, %

were *Bombax costatum* (93%), *Cola nitida* (91%), *Anogeisus leicarpus* (88%), *Cola chlamydantha* (87%) and *Glyricidia sepium* (80%), because they were impoverishing and hardening the soil (89 %), providing bad shading (78%) and invading the orchards (75%). In addition, 60% of the surveyed population estimated that these species would consume too much water, would prevent the penetration of water into the soil as the leaves mulch very slowly (58%), would result in uncontrolled cuts without compensation to the farmers because of the economic value of these trees (54%), would host pests such as ants, termites, mirids, etc. which invaded the plantations (51%), with roots that are harmful to the cocoa orchards (42%), branches that are easily broken and destroyed the cocoa trees (39%), would favor wild land fire with countless dry leaves left on the ground (33%) and would host the Swollen Shoot virus (21%).

Reasons for refusing the agroforestry and their consequences in coffee and cocoa plantations

With all the endogenous knowledge developed by the farmers on the forest trees, it was difficult to understand how they could not apply them themselves. Also, it tried to understand the reasons that motivated their refusal to associate the forest trees, yet well-known by them with their coffee and cocoa farms. In the orchards, the farmers estimated that (i) the constant anarchy cut discouraged the tenants (80%) to even plant trees in the orchards (refusal to keep the seedlings from seeds fallen under the trees), (ii) it was especially the landowners who cut the trees on the farms without the knowledge of their tenants who did not have any benefit (78%), (iii) they had difficulty in managing trees in orchards which often had too shading (77%) and therefore the production decreased even the death of coffee or cocoa plants, (iv) they cut trees to produce charcoal (75 %), (v) the trees hosted the rodents (squirrels), the diseases (pod rot) and pests (mirids) for their plantations especially the cocoa trees (71%), (vi) there was a lack of land (arable land) to shelter food crops and tubers ; therefore the trees were to be replaced by food crops in the orchards, (vii) they were lack of means for the forest plants to be planted (46%), (viii) it was by sheer ignorance (38%) of the benefits of trees associated with orchards (lack of knowledge of the species adapted to their farms) and (ix) they needed to sell the trees to solve financial problems (22%, especially land owners).

And yet the refusal to associate the agroforest trees with the coffee orchards had noticeable consequences on the future of the plantations. The farmers noted themselves that the absence of trees in the orchards for some time resulted in the following: (i) a very high mortality rate of coffee plants, (ii) hardening of the soil under the orchards, (iii) poor resistance of the coffee trees seedlings to sunshine, (iv) destruction of the coffee plant after cutting because of the sun exposure (sky-light), (v) rapid surge of water sprout and excessive sodding of the orchards, (vi) reduced rainfall, and (vii) decline in coffee production. In the cocoa farms, the effects were not beneficial either. The absence of tree species in cocoa orchards led to the following: (i) rapid surge water sprout which were innumerable, (ii) excessive sodding of plantations, (iii) yellowing of the leaves and fall of flowers on the cocoa trees, (iv) exposition of the plantation to heavy winds, (v) severity of the drought, (vi) savannization of the plots with risk of wildfires, (vii) progressive death of cocoa feet even complete destruction of the farm, (viii) decrease in soil fertility and degradation, (ix) severe insect attack (mirids in sky-light), and (x) decline in the cocoa production. Some (26%) said that the feet of the cocoa trees that were resistant under the sun gave a good production, but many people (56%) found that the alleged resistant feet died very quickly after two or three years.

Endogenous viewpoints of a better preservation of the identified forest resources

Given the findings of the advanced degradation in the agroforests and enhanced deforestation in the coffee and cocoa production area in Togo, the curiosity was deepened to collect the endogenous data on a better management and preservation of the identified forest resources. In the coffee and cocoa orchards, the populations advised to (i) preserve the seedlings of the preferred and recognized species in farms during the tillage (converse and avoid destroying the species that grow naturally and hardly) (ii) collect seeds / beans / seedlings of these species (especially the endangered ones) and establish nurseries (especially for the species that hardly grow in their natural state) and produce the seedlings of these species, (iii) systematically reforest the farms (especially in the coffee and cocoa plantations) and the devastated areas (creating a conservation park for species identified as detested by the farmers), (iv) replace the cut trees, (v) avoid anarchic cuts in the plantations and sensitize people (especially young people) for non-anarchic exploitation of these species, (vi) preserve plantations and fallows against wildfires, (vii) decrease the charcoal production and use alternative sources of energy wood, (viii) treat these trees against insects and diseases, (ix) associate forester in the management of the forest species in the farms (the forest managers monitor the trees before giving cut permit) and (x) provide training assistance and supports to farmers to guide the technical choices for a better management of the forest resources.

In addition, to discourage robbers all-out, the farmers advised to (i) disseminate the low growing plants and that are compatible to the coffee and cocoa orchards to prevent early cuts, (ii) have an operator agreement between sharecroppers and landowners for the exploitation of timber, (iii) facilitate access to seed of the fertility species for use as village nurseries, (iv) encourage indigenous people to make available to immigrants some spaces for reforestation (because most farmers are immigrants in the area), (v) involve forest services in the preservation of non-tolerated or detested species,(vi) distribute the agroforest seedlings for better redensification of the orchards and forests, (vii) support the farmers in line planting with 25-30 mature agroforest trees per hectare and avoid wildfires by blocks and fire hall and then live hedges of pyrophyllous species, and (viii) establish a special program such as 1st June for agroforest trees in the coffee or cocoa orchards (month of the tree).

DISCUSSIONS

Togo is seeking to expand its cocoa and coffee production to meet the increased international demand. However, this effort faces economies of scale and ecological challenges due to numerous problem of lands use, forest degradation and deforestation. Full-sun cocoa and coffee farming are currently the most widespread cropping system in humid and sub-humid zone in West Africa (Tondoh *et al*, 2015; Gockowski and Sonwa, 2011), an area stretching from Guinea to Cameroon that has been identified 25 years ago as a global biodiversity

hotspot (Myers *et al*., 2000). But this cropping system could not support the sustainability of cocoa and coffee production. The suitable agro-ecological conditions for butter cocoa and coffee growing remains the forest zone (Sauvadet *et al*., 2019; Adden *et al*., 2016; Cerdan *et al*., 2012). The long-term conversion of forest to full-sun cocoa and coffee plantations might result in agro-ecological drawbacks such as forest degradation, biodiversity loss, soil quality depletion associated with low yield and food insecurity; and greenhouse gas emission as pointed out by several authors (Gockowski and Sonwa, 2011; Tscharntke *et al*., 2011; Lal, 2009; Asase *et al*., 2009). As found in this study, it was important to promote the reforestation in cocoa production area in order to restore a butter growing conditions to cocoa and coffee trees. This will permit to avoid the worse consequences noted by some authors in cocoa and coffee farming area and to gain environmental and economic values been in shaded trees and agroforestry use (Tondoh *et al*, 2015, Jezeer *et al*., 2017). Complex agroforests have been promoted as a potential solutions to address trade-offs between environmental conservation efforts and the need for increased agricultural productivity for smallholder farmers in the tropics (Wartenberg *et al*, 2017). To guarantee the protection of the shade trees suitable for reforestation and to preserve the biodiversity in cocoa and coffee production area in Togo, it was necessary to know the farmer's desire for better management of plant genetic resources. This study reveals the list of forest trees which were needed to be promoted in the rural community in order to face anarchic plant cutting and to restore the microclimate suitable for sustainable cocoa and coffee growing. By the way, it was possible to maintain some trees species as shade trees in cocoa and coffee orchards. For those trees whom were detested by producers, it was necessary to create the conservation park for their preservation. It was well-know that agroforestry was a widely advocated adaptation strategy for enhancing agricultural resilience to extreme climates (Gao *et al*., 2018). Based on the results, it was suitable to recommend the use of *Erythrophleum suaveolens, Albizia zygia, Terminalia superba, Terminalia ivoiriensis, Albizia adianthifolia, Milicia excelsa* and *Ceiba pentadra* as a native trees species for reforestation in cocoa and coffee farming area in Togo because they had more lucky to be preserved by farmers in their orchards if any treats regarding diseases or pests were not identified for these trees.

Conclusions

The survey carried out in the forest zone of Togo with the coffee and cocoa farmers helped to identify the preferred species (44 tree species in total) and detested (37 tree species in total) by the farmers in the coffee orchards (35 tree species identified) and cocoa plantations (46 tree species identified) then the reasons why they are preferred or not. The farmers explained why the association of the agroforest trees with coffee and cocoa orchards did not work. Yet endogenous strategies of these species preservation existed and could be applied by rural communities. Lots of information was collected for a better orientation of the preservation strategies and dissemination of plant genetic resources in the coffee and cocoa production area of Togo in order to guarantee the sustainability of the coffee and cocoa agroforests production as well as the biodiversity needed to maintain the ecosystem services.

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