Full Length Research Paper

Farming practices, diversity and utilizations of associated species of cocoa plantations in a forest-savannah transition zone, Center Côte d'Ivoire.

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In Côte d'Ivoire, cocoa is grown in full sun such as in several tropical African countries conducting to biodiversity depletion. Facing this unsustainable situation, agroforestry systems in cocoa production can offer a promising alternative, for instance smallholders' plantations where trees have long times been associated. In order to understand these systems for a sustainable production of cocoa, we conducted a study to analyse smallholders' farming practices in an ecological transition zone. In an ethno-botanical and zoological approach, we surveyed some farmers selected randomly to address the issues such as: what are the preferred associated species and for what purposes are they planted; what are the cultivation practices? In some of the farms, we surveyed and assess tree and fauna species richness and diversity. Uses of plant and animal species have been analysed ethnobiologically and discussed. We used chi-square tests to compare the proportions. The study showed that 176 plant species that were associated to cocoa trees were used (auto-consumption or marketed) by the farmers for firewood, medicinal and food purposes; and 13 mammal species were encountered and hunted in the farms. By containing several plant and animal species with high conservation value, the traditional agroforests of the study area play a relative important role in biodiversity conservation. Before disseminating these good practices, one should analyse their economic performances.

Key words: Traditional agroforestry, companion species of cocoa, mammal species, uses of species, Côte d'Ivoire

INTRODUCTION

Tropical rainforests are globally appreciated for their rich biodiversity, economic assets and their ability to store large amounts of carbon, thus mitigating global climate change. They are intimately connected to the livelihoods and culture of forest-dwelling communities, who very often depend on them for subsistence agriculture, hunting, timber, non-timber forest products, and cultural and religious purposes (Sheil et al., 2006). Despite these benefits, large scale logging, intensified agriculture, development, and mining have driven widespread
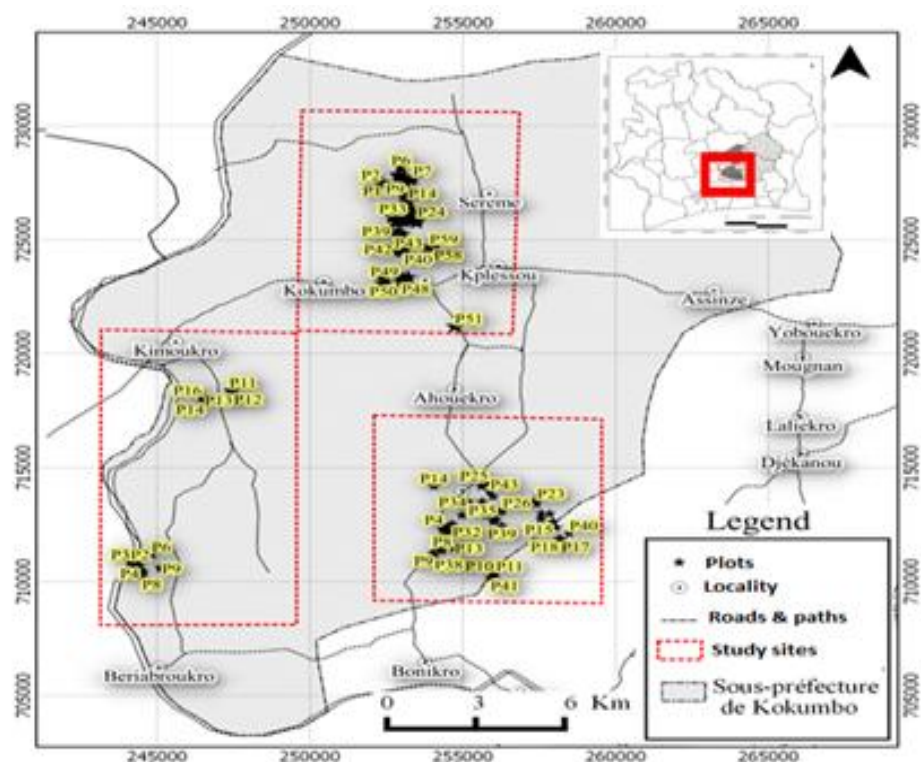
Figure 1: Location of the plots and the study site in the Centre Côte d'Ivoire

deforestation and degradation of tropical rainforests worldwide (Achard et al., 2002). International attention has been increasingly focused on conservation of these forests through sustainable forest management, designation of protected areas, and reduced deforestation. One such effort is the transition of farmers away from traditional systems of shifting cultivation, considered as one of the main causes of deforestation. This induced global warming, and towards more permanent agroforestry systems, which are thought to reduce deforestation and improve smallholder livelihoods (Garrity, 2004).

In West and Central Africa, an increasing proportion of cocoa, primary national revenue, is grown in full sun. Here, the introduction of this cash crop has increased the forest depletion. In Côte d'Ivoire, the first world exporter of cocoa beans, the situation is similar to all the tropical Africa (Assiri et al., 2012). The farms result from primary or secondary forests conversion that conducts drastically to the decline of forest biodiversity and cocoa associated agrobiodiversity (Kpangui et al., 2015). The Adoption and the monopolization of the lands by the cultivation systems of this crop has led to a decrease in fallow length in traditional systems due to their life cycle varying between 30 and 50 years. However, all these practices do not mean loss of the biodiversity. Many studies showed that the traditional agroforestry systems (AFS) would participate in the conservation of the local diversity, and in the fight against the global warming (Bhagwat et al., 2008). These

agroforestry systems can bring in some economic and ecological benefits according to their highly diverse structural and compositional complexities (Deheuvels et al., 2012). They offer a diverse types of habitat on which depend directly the main crop, the associated plant species, and the populations for they survived. They also inhabited some animal species (Kouakou, 2015).

In order to understand these systems applied for longtime in the Country, we conducted study to analyze smallholders' farming practices of agroforestry systems, their diversity, and the environmental benefits of the associated tree species for famers and cocoa trees in the site of Kokoumbo.

MATERIALS AND METHODS

Study Area

The study was conducted in Kokoumbo (Figure 1) located in of the Centre of Côte d'Ivoire (6°25' N; 5°19'W): in three localities: Langossou, Kimoukro, and Niamkey-Konankro. This area is in a transition zone with mix forest-savannah vegetation (Chauveau, 1979). Local people of the study area were mainly made of ethnic group Baoulé arrived from successive migrations and some other populations (Chauveau, 1979). This area with several traditional agroforestry systems (Kpangui et al., 2015) is near ancient cocoa belt (Centre-west) in Cote

d'Ivoire. The study area is covered by the forest-savannah contact zone where climatic and ecological conditions were said inadequate for cocoa cultivation: low humidity, long dry season, relatively low fertility of soils (Yao-Kouamé, 2007). The rainy season goes from March to November with the highest precipitations in June and October. The mean annual temperature is about 27.1°C. The landscape of the zone, made of uplands and hills belonging to ''Baoulé chain'' The altitudes vary between 100 and 550 m a.s.l. with mount Kokoumbo-Boka the highest summit (550 m).

Data Collection and Analysis

The collection of local knowledge relied on individuals with a comprehensive knowledge of traditional agroforestry systems. The key informants, in three localities of Kokoumbo (Langossou, Kimoukro, and Niamkey-Konankro) held specific knowledge on the cocoa based agroforestry systems and management. We surveyed, through open-ended questions and participative field observations, the cocoa-based agroforest smallholders to determine their social perceptions by addressing issues like "what are the associated species and for what purposes are they planted?" what roles can play the agroforestry systems: utilizations in daily life? What animal species are encountered in the farms? This technique is central to the ethnological and anthropological fieldwork (Nabanonga, 2005). We were engaged in the daily farming activities of the villagers. We watched what farmers did and recorded what they said and asked questions about their own actions and the behavior of others (Vroh et al., 2014). The purpose of this technique was to produce comprehensive accounts of different practices and uses of forests units and their resources by local farmers.

Concomitantly with the surveys, a phyto-ecological approach, in some randomly selected farms was applied to make botanical inventories in 25 x 25 m^2 plots (Kpangui et al., 2015) to determine tree species richness, diversity, and to assess their provision of ecosystem services such as the utilizations of companion species in different life domains, of the associated plant.

We coupled to this survey some questions about mammal diversity in the agroforests and their effects on cocoa pods and production. Then, some pedestrian prospections in the cocoa farms were conducted to give some overall idea of mammal diversity.

For the analysis, we combined the transcription of texts of interviews and participative observations of various activities in the cocoa farms. We analyzed ethnographically to interpret underlying ideas about the cocoa farms, management practices, the companion species and their management, and the uses of these species.

We determine species richness, floristic composition of species associated to cocoa that the local people use in the daily life. Statistical analyses were made. The chi-square test was used to compare proportions when the data were qualitative. All calculations were made with the R package.

RESULTS

Farmers Profile and Characteristics of Cocoa-based AFS

One hundred three (103) cocoa farmers were interviewed with mean age of 44 years. Eighty percent (80%) among them were indigenous, 10% Ivorian from other ethnic groups, and 10% West African nationals. On average, the farms were 3 ha, 34 years, with a yield of 1106.56 kg/farmer. Three cocoa varieties are cultivated generally. Three modes of access to land were used in the study sites and the main mode of access (more than 85%), according to the farmers was the inheritance. Donation was the second mode of access to land in Kokoumbo (about 9.65%). The last mentioned mode was the buying of land that is weakly represented.

The settlement of most of the farms visited started by slash and burn system. Anyway, some farms began by direct sawing of cocoa beans in cutting forest or in the understory of forest/savannah. Some other farmers used seedlings from cocoa beans nurseries. At first ages cocoa was intercropped with several plant species such as avocado, orange trees, bananas, yam, and cassava. But, peasants preferred, generally, to preserve or plant local species: fruit trees, medicinal species, food species and socio-cultural species. In the study areas, few full sun farms were found. Three (03) agroforestry systems were identified and characterized by the density of associated species (*Musa* spp, exotic and indigenous woody plants) and the variety of cocoa cultivated. The management of shade trees differed in these three systems.

Biodiversity of the Inventoried Agroforests (AFS)

Plant species and mammal diversity of the traditional agroforests

The botanical inventories allow recording 176 species in traditional cocoa-based agroforests of Kokoumbo. Sixteen (16%) were endemic species made of endemic to Ivorian territory (GCi), endemic to Upper Guinea Forest, and endemic to West African forests. Among the list of plant species, several rare and threatened species were identified (10%), (Table 1) such as *Milicia excelsa*, *Turraea heterophylla*, *Drypetes singroboensis*, *Gracinia kola*, and *Entandrophragma cylindricum*.

The interviews revealed 13 mammal species belonging to five (05) orders: *Rodentia, Lagomorpha, Artiodactyla, Carnivora,* and *Ungulata.* According to interviewers these animals caused several damages to the cocoa pods and associated species. Through the pedestrian prospections,

Table 1: Proportions of utilizations of the associated species in the three localities of Kokoumbo.

Types of uses	Kimoukro	Konankro	Langossou	Statistic of the test
Food	65.0	73.6	75.2	$\chi^2 = 0.3$
Fire wood	26.8	24.6	19.9	$\chi^2 = 1.8$
Medicinal	13.8	18.4	8.9	$\chi^2 = 10.2**$
Timber	7.8	10.2	3.4	$\chi^2 = 10.9**$
Other uses	8.9	19.5	16.2	$\chi^2 = 5.9*$

Figure 2: Some fruits of companion species harvested for being sold on local markets: on left *Garcinia kola*; on right, avocado (*Persea americana*)

nine hundreds eighteen (918) indices of presence were recorded, from direct (N = 12) and indirect (N = 906) observations. The analysis of these data revealed 13 Mammal species belonging to six (06) orders: *Rodentia, Lagomorpha, Carnivora, Artiodactyla, Ungulata*, and *Chiroptera*. Twelve among these species are listed as LC (e.g. *Cephalophus maxwelli)* and 2 LR (e.g. *Civettictis civetta*) by IUCN, 2014).

Utilizations of associated species in Cocoa based AF

In Kokoumbo, among the 176 species recorded in cocoa farms, 105 plant species (59.6%) were maintained, preserved or planted in the farms because they were benefits for farmers and their families. These companion species can be cataloged in five types of utilizations without taking into account their origin (exotic or indigenous species). Local communities used some of them as firewood, medicinal species, food (Figure 2), timber, and other purposes plants (ornamental, craft, traps or cultural purposes). The utilization as firewood appeared as the most important (Figure 3).

Figures 2 & 3

When considering the three localities of the study site, the number of species used by farmers varies from one to another (Table 1). According to the origin of the species (indigenous or exotic) there was also a variation in the number of these species (Table 2).

For animal species uses, the interviews showed that populations hunted in their farms with guns, chemicals, and traps. The captured species were used as a source of protein for many farmers, and for some it was a special treat. For example, as an old man said by "the soup of a roasted fruit bat was highly sought after". Once killed, the meat was often smoked, dried, or salted and considered a treat to some, a main food source to others. They had been consuming for years.

DISCUSSION

Cocoa Based AFS and Biodiversity Conservation

Unlike the national majority 56.4% of illiterates in the cocoa cultivation (Assri et al., 2009), more than half (58.8pc) smallholders in the study area were educated (primary school for most of them). This could be explained either by the return of school youth or, in recent years, with the return of officials and retirees who invest in cocoa production. This constitutes a major asset in the assimilation of cultural techniques taught by the support agencies through certification. This certification is designed to teach farmers, good cultural practices to both serve the environmental objectives (agroforestry mostly) and improve yields and quality of cocoa in a general context of aging orchards (Ruf et al., 2013). But all the practices and knowledge implemented, here, in the study area were not due to national agencies. Most of these

Table 2: Repartition of the associated species of cocoa used by local people

	Origin	Food	Fire wood	Medicinal	Timber	Other uses	Total
Species richness	Native forest species	11	41	25	19	6	68
	Transition native species	5	12	12	4	0	24
	Exotic species	12	3	1	1	0	13
Number of individuals	Native forest species	38.9	56.2	17.2	5.9	28.3	29.3
	Transition native species	28.6	51.2	48.8	29.8	0.0	31.7
	Exotic species	99.9	1.7	1.8	0.1	0.0	20.7
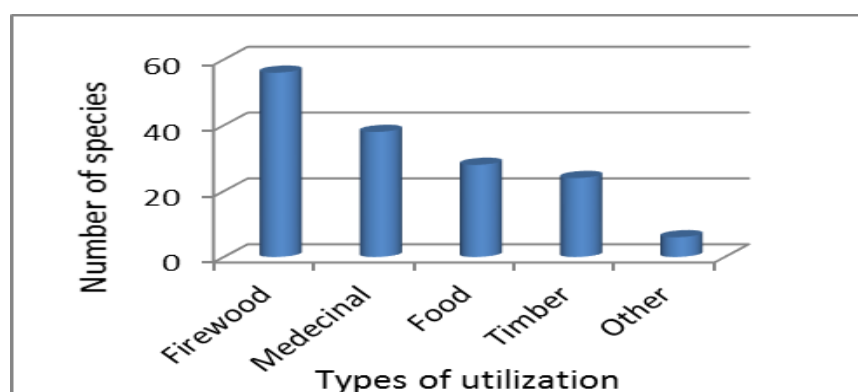
Figure 3: Number of companion species used by local farmers in the five main categories of utilizations defined.

farmers have acquired for long time the knowledge and know-how with the introduction of cocoa in this region or in their original regions where farmers cultivated before cocoa their settlement in Kokoumbo. Regarding the low productivity of orchards, it is nevertheless comparable to the national average (395 kg / ha) mentioned by some authors as Aguilar et al. (2003) but less than that found in forest areas (Varlet and Kouamé, 2013), around Taï National Park (455 Kg/ha). The study showed that the traditional agroforests (AF) of Kokoumbo were relatively diversified (species richness, endemic, rare and threatened species number).They appear relatively species-rich compared to cocoa-based and coffee-based agroforests elsewhere in tropical Africa (Correia et al., 2009). Anyway, cultivation techniques used could justify these observations; analyzes showed that the species removed, during the settlement and maintenance of plantations, were lianas, shrubs and herbaceous. These morphological types include, however, the majority of high conservation value species. The shifting cultivation would result in a depletion of endemic or rare and threatened species (Adou Yao 2010). It has been observed that the majority of endangered species are generally cited as excellent logging wood or fruit plants with high economic value. That was the case of timber like *Milicia regia* (Moraceae), *Khaya grandifoliola* (Meliaceae), vulnerable species on the red list of IUCN (2015). Among them, species with high economic value

such as *Garcinia kola* (Clusiaceae) and *Irvingia gabonensis* (Euphorbiaceae) are used by local people for various purposes (Vroh et al., 2014). Cocoa based AF by hosting them become thus, real reservoirs of the protection of those species outside Protected Areas (Bhagwat et al., 2008). The situation seemed the same when considering some mammals in the AF. Indeed, 14 species belonging to 6 orders among which 12 had high conservation value by being listed on IUCN (2015) redlist. In definitive, the cocoa base agroforests of Kokoumbo region present relatively high conservation value.

Uses of the Species Associated to Cocoa Trees

Agroforestry can meet different needs of rural people: firewood, food and medicinal plants. Agroforestry systems provide in addition to cocoa production, many goods and services to rural populations (Herzog, 1992; 1994; Sonwa et al., 2001; 2002; Bhagwat et al., 2008). Beyond the inability of farmers to cut down most large trees (Adou Yao and N'Guessan, 2006), and the new introduction of species, their maintenance obeys to what complementary products could them give to the farmer and his family. They so maintain them for their use and the rest are only a matter of daily management. The results show, in fact, that, the species preserved in the plantations, used for various purposes in addition to their primary function, is to serve as shade for cocoa. Their

main use domains are firewood, medicinal, timber, and food. This situation, similar to that observed by Herzog (1994) in neighboring localities, could be explained by the fact that in the villages, wood is the main source of energy for households. They are also an important source of income for young people that make the collection a firewood their principal activity. Indeed, the species are mainly harvested in forests whose development requires that women travel some long distances. The large uses of medicinal plants demonstrate that farmers have good knowledge of their virtues. Their importance in plantations could be justified by the fact that farmers are turning to traditional medicine to cover their health needs to tackle poverty. Indeed, conventional structures (health centers) are relatively expensive compared to their purchasing power. Thus they collect in their fields, medicinal plants known to cure certain ills. This is the case of *Alstonia booneei* (Apocynaceae), recognized for its effectiveness in the treatment of malaria (Vroh et al., 2014). The variety of plants used as food by local people in the study zone could allow populations to ensure their food security and additional income especially women and children (Herzog, 1992; 1994; Mollet et al., 2000; Sonwa et al., 2001). Indeed, Herzog (1992) showed that the diet of the populations of the '' V Baoulé '' is based on starchy foods (yam and banana), vegetables (leaves *Ceiba pentandra*), fruits (avocado), and beverages (palm wine). He argues that the nutritional value of certain species *Elaeis guineensis* (Arecaceae) and *Ricinodendron heudelotii* (Euphorbiaceae), allowed populations to cover their need for energy and vitamins. The financial importance of food species was evaluated by Kouassi (2014) in two localities (Langossou and Niamkey-Konankro). According to his study the average annual income of the population in relation with associated species of cocoa is 22,013 FCFA. The species used as timber and ornamental are valuable resources in traditional agroforests because they are used by farmers either for the construction or to be marketed. Their low representation in plantations could be attributed to their incompatibility with cocoa culture according to farmers.

The interviews showed that the animals in the farms were hunted. The first reason advanced by these farmers to justify hunting is the fight against predators of cocoa crops or associated crops (Béné et al., 2013a&b). But the game is used for consumption and for sale. This activity according to farmers contributed a lot to their household incomes and supplied to their need of protein, for its taste and because they lacked means to buy meat like (beef, ship…) on market. That activity was important; the sale of bush meat from cocoa farms generated an income equivalent to that obtained by selling cocoa. According to Schulte-Herbrüggen (2011) Bush meat accounts for 75% of income obtained through the sale of NTFPs. Since 2013, with the Ebola has frightened away consumers and customers.

CONCLUSION

In an ecological transition zone with less natural forest left, local farmers have managed to restore a forest cover with all its environmental benefits, thanks to their traditional cocoa-based agroforests**.** The relative high rate of endemic, rare and threatened species combined with the mammal diversity, and patrimonial consideration of the agroforests allowed us to assign them to high conservation value for biodiversity. The environmental services of these traditional cocoa-based agroforests showed a relatively high level provisioning services as complement of the primary product of their cocoa farms. The smallholders had important traditional ecological knowledge about ecosystems services when settled and managed their farms. This brings to light the importance of indigenous and local knowledge to the conservation and sustainable utilizations of ecosystems in rural transition area of cocoa production in the Centre of Côte d'Ivoire. For a sustainable cocoa production, the government authorities should disseminate such practices.

ACKNOWLEDGEMENTS

Abbreviation

AFS: agroforestry systems
GCi: endemic species to Ivorian territory
PASRES: Programme d'Appui Stratégique à la Recherche Scientifique
CORAF/WECARD: Conseil ouest et centre africain pour la recherche et le développement agricoles / West and central African Cuncil for Agricultural Research and Development
CSRS: Centre Suisse de Recherches Scientifiques en Côte d'Ivoire
ICRAF-CI: World Agroforestry Centre – Côte d'Ivoire
UFR: Unité de Formation et de Recherches
UFHB: University Félix Houphouët-Boigny, Abidjan
UJLoG: University Jean Lorougnon Guédé, Daloa
IUCN: International Union for Conservation of Nature

REFERENCES

Achard F, Eva HD, Stibig HJ, Mayaux P, Gallego J, Richards T, Malingreau JP (2002). Determination of deforestation rates of the world's humid tropical forests. Science. 297: 999-1002.
Adou Yao CY (2010). Pratiques paysannes, biodiversité en forêt de Monogaga, Côte d'Ivoire : impacts des pratiques de gestion des populations locales Wanne et Bakwe et de la Sodefor sur la forêt classée de Monogaga. Editions Universitaires Européennes. 232 pages.
Adou Yao CY, N'Guessan KE (2006). Diversité floristique spontanée des plantations de café et de cacao dans la forêt classée de Monogaga, Côte d'Ivoire. Schweiz. Z. Forstwes. 157(2): 31-36.

Aguilar P, Paulin D, Keho Y, N'Kamleu G, Raillard A, Deheuvels O, Petithuguenin P, Gockowski J (2003). L'évolution des vergers de cacaoyers en Côte d'Ivoire entre 1995 et 2002. Actes de la 14e conférence internationale sur la recherche cacaoyère. 18-23 octobre 2003. Accra, Ghana, pp. 1167-1175.

Assiri AA, Yoro GR, Deheuvels O, Kebe BI, Keli ZJ, Adiko A, Assa A (2009). Les caractéristiques agronomiques des vergers de cacaoyer (Theobroma cacao L.) en Côte d'Ivoire. Journal of Animal & Plant Sciences, 2 (1): 55 - 66.

Assiri AA, Kacou EA, Assi FA, Ekra KS, Dji KF, Couloud JY, Yapo AR (2012). Rentabilité économique des techniques de réhabilitation et de replantation des vieux vergers de cacaoyers (Theobroma cacao L.) en Côte d'Ivoire. Journal of Animal & Plant Sciences 14(2): 1939-1951.

Bene J-CK, Gamys J, Dufour S (2013a). The hunting practice in Northern Nimba County, Liberia. Global Advanced Research Journal of Environmental Science and Toxicology Vol. 2(1): 022-036.

Bene J-CK, Gamys J, Dufour S (2013b). Marketing channel of hunting products in northern Nimba County, Liberia. Livestock Research for Rural Development 25 (1) 2013.

Bhagwat SA, Willis KJ, Birks HJB, Whittaker R.J (2008). Agroforestry: a refuge for tropical biodiversity? Trends in Ecology and Evolution. 23: 261-267.

Chauveau J-P (1979). Les cadres socio-historiques de la production dans la région de Kokumbo (pays baoulé, Côte d'Ivoire). Cahier ORSTOM sciences humaine, Volume n°7, Bondy (France), 143 p.

Correia M, Diabaté M, Beavogui P, Guilavogui K, Lamanda N, Foresta H (2009). Tree structure and diversity of coffee-based agroforests and natural forest in Guinée Forestière (Guinea, West Africa). Poster presented to the Second World Congress of Agroforestry, Nairobi, August 2009.

Deheuvels O, Avelino J, Somarriba E, Malezieux E (2012). Vegetation structure and productivity in cocoa-based agroforestry systems in Talamanca, Costa Rica. Agriculture, Ecosystems and Environment. 149: 181-188.

Dupraz C, Liagré F (2008). Agroforesterie : des arbres et des cultures. Editions France Agricole, Paris, France. 415 p.

Garrity DP (2004). Agroforestry and the achievement of the Millennium Development Goals. Agroforestry Systems. 61(1-3): 5-17.

Herzog FM (1992). Étude biochimique et nutritionnelle des plantes alimentaires sauvages dans le sud du V-Baoulé, Côte d'Ivoire. Thèse de doctorat, École Polytechnique Fédérale Zurich , Suisse, 134 p.

Herzog FM (1994). Multipurpose shade trees in coffee and cocoa plantations in Cote d'Ivoire. Agroforestry systems. 27: 259-267.

IUCN (2015). IUCN Red List of Threatened Species. Version 2015.1. <www.iucnredlist.org>.[accessed 28.08.15]

Koukou C-V (2015). Diversité biologique de la faune mammalienne des agroforêts a cacaoyers dans la région de Toumodi (Centre de la Côte D'ivoire) : Implication dans la Conservation. Mémoire de Master des Sciences de Vie et de la Terre, UFR Agroforesterie, Université Jean Lorougnon Guédé, Daloa, Côte d'Ivoire. 47 p.

Kouassi DF (2014). Évaluation des performances agro-économiques des plantations agroforestières à base de cacao du Centre de la Côte d'Ivoire : Cas de la Sous-préfecture Mémoire de Master de Botanique, UFR Biosciences, Université Félix Houphouët-Boigny, Abidjan, Côte d'Ivoire. 50 p.

Kpangui KB, Kouamé D, Gone BZB, Vroh BTA, Koffi BJC, Adou Yao CY (2015). Typology of cocoa-based agroforestry systems in a forest-savannah transition zone: case study of Kokumbo (Centre, Côte d'Ivoire). International Journal of Agronomy and Agricultural Research (IJAAR). 6(3): 36-47.

Mollet M, Téré H, Herzog F (2000). Ligneux à usages multiples dans les systèmes agraires tropicaux: une étude de cas de Côte d'Ivoire. Schweiz. Z. Forstwes. 151 (10): 355-364.

Nabanonga KGN (2005). Transgressing boundaries: Gendered spaces, species, and indigenous forest management in Uganda. PhD Thesis, Wageningen University. Tropical Resource Management Papers 60. 227p.

Ruf FO, N'Dao Y, Lemeilleur S (2013). Certification du cacao, stratégie à hauts risques. Forun Inter-Réseaux développement rural. 7p.

Schulte-Herbrüggen B (2011) The importance of bushmeat in the livelihoods of cocoa farmers living in a wildlife depleted farm-forest landscape, SW Ghana PhD Thesis Department of Anthropology, University College London, 282 p.

Sheil D, Salim A, Chave J, Vanclay JK, Hawthorne WD (2006). Illumination-size relationships of 109 coexisting tropical forest trees. Journal of Ecology. 94: 494-507.

Sonwa DJ, Weise SF, Tchatat M, Nkongmeneck BA, Adesina AA, Ndoye O, Gockowski J (2001). Rôle des agroforêts à cacao dans la foresterie paysanne et communautaire au sud-Cameroun. Document RDFN, n°25 g (i), 12 p.

Varlet F, Kouamé G (2013). Étude de la production de cacao en zone riveraine du Parc National de Taï. Programme de Développement Économique en Milieu Rural (PRODEMIR), GIZ. 184p.

Vroh BTA, Ouattara D, Kpangui KB (2014). Disponibilité des espèces végétales spontanées à usage traditionnel dans la localité d'Agbaou, Centre-ouest de la Côte d'Ivoire. Journal of Applied Biosciences 76: 6386-6396.

Yao-Kouamé A (2007). Caractéristiques physiques des sols brunifiés dérivés des formations du complexe volcano-sédimentaire de kanhankro (Toumodi) en moyenne Côte d'Ivoire. Rev. CAMES-Série A, Vol. 05; 76-86