SUMMARY

Faced with declines in profits and labor productivity of cocoa in the past decade, the majority of smallholder cocoa farmers in southern Cameroon are diversifying their income generation and food production activities. Farmers are enriching their cocoa plantations by increasingly integrating forest species, fruit trees, and annuals. This study characterizes the vegetation structure and composition of this evolving agroforestry system and identifies the species preferentially planted by farmers within the Forest Margins Benchmark area in southern Cameroon.

The cocoa plantations around Yaoundé (an area with a relatively high population density and related land scarcity) contain nearly twice as many trees that provide consumable products but only half as many timber species as plantations in the sparsely populated southern sections of the benchmark area. Of the five most important fruit tree species planted, only one is indigenous. Of the five most important non-fruit tree species planted, three have a high timber value and are regularly exported. Fruit and non-fruit trees planted in cocoa agroforests generate additional income for households and provide shade for the cocoa stand.

INTRODUCTION

In southern Cameroon, cocoa agroforest are issued from the slow modification of the forest and introduction of cocoa trees. The Cameroon forest is one of the main parts of the Congo Basin, the second largest humid forest after the amazon.

The management of cocoa plantation in southern Cameroon had been heavily influenced by some macroeconomics and institutional decisions: The international cocoa prices have drop; the CFA currency has been devaluated and the cocoa sector has been liberalised in Cameroon. Faced with declines in profits and labour productivity of cocoa in the past decade, the majority of smallholder cocoa farmers in southern Cameroon are increasingly diversifying their income generation and food production activities. Farmers are enriching their cocoa plantations by increasingly integrating forest species, fruit trees, and annuals. Few studies have tried to investigate the impact of the changing policy environment on the management of cocoa agroforest. The objective of this study is to characterise the vegetation structure and composition of this evolving agroforestry system and identify the species

preferentially planted by farmers within the Forest Margins Benchmark area in southern Cameroon.

METHODOLOGY

Study area: The Humid Forest Zone of Southern Cameroon.

The Humid Forest lowland is characterised by the presence of both evergreen and deciduous rainforest formations; a length of growing period of 271-365 days and a daily mean temperature during the growing season of above 20^{o}c (FAO et IITA, 2000). Such conditions are found in many countries of west and Central Africa. The Cameroon Humid Forest zone is about 16% of the Central African humid forest and its most biodiverse area. Deforestation is a major problem and is closely related to agricultural practices. In 1987, the most recent year which reasonable statistics were available, the HFZ had 4.7 millions of people, of whom 2.2 millions (47.5%) lived in rural areas (Ndoye et Kaimowitz, 2000). Cocoa production systems in Cameroon are mainly found in the unimodal zone of the Southwest and Littoral Provinces and in the bimodal zone of the Center and South Provinces. Approximatively 300 000 to 400 000 ha are covered by cocoa production systems (Kotto-Same et al. 2000) in Southern Cameroon. In this study, we will focus mainly on bimodal area

where a benchmark has been defined to study the management of natural resources. This benchmark area is the research site of the ASB program for the Congo Basin (Kotto-Same et al. 2000) and for the Humid Forest Zone of the EHPTA program in West and Central Africa (Brader, 2000).

The benchmark, covers an area of 1.5 millions ha along a forest margins exhibiting a gradient of population pressure and agricultural intensification increasing from the south to north (figure 1). Three blocks of the benchmark are distinguished and are ranked (high to low) with respect to intensity of resource use as follows: the Yaoundé Block, The Mbalmayo Block and The Ebolowa Block. Rural Population density is low in the south (5 people/km2) and high in the north (80 people/km2). Road infrastructure is poor around Ebolowa and good in Yaoundé area. The Yaoundé Block is characterised by good accessibility to urban markets

Across the benchmark, 24.8% of the total land area is estimated to be in some agricultural use (including fallow fields) (Gockowski et al. 1998). Cocoa agroforest, which were the predominant productive land use system, account for 3.8% of total area and represent 48% of total productive agricultural land use area.

Vegetation survey.

Vegetation data have been collected in 60 plantations throughout the benchmark area. The survey covered 12 villages. 5 cocoa plantations were recorded per village. The surface retained for survey was 25% of the cocoa farm, using an elementary plot of 25mX25m in each plantation. All the trees (cocoa and non cocoa) with a diameter at breast height (dbh: diameter at 1.3m) > 2.5cm, were recorded for all the plots. For each tree, the height was estimated and the species identified using the work of Vivien et Faure (1985&1995), Letounzey (1982) and by the comparison with the specimen of the National Herbarium, Yaoundé. The main uses of the tree species were also noted through interaction with key informants. The species were then grouped into one of the following classes: consumable, medicinal, timber and others. Each tree was also classified into one of the following height strata: 0-5m, 5-10m, 10-20m and >20m. For each strata, the density of non-cocoa tree were calculated.

Household Survey

A Household survey was undertaken with 300 farmers in 21 villages of the benchmark area. A structured questionnaire was used as the survey instrument. Amongst other information each farmer was asked to give the five most important fruit tree and the five most important non-fruit tree species planted to intensify and diversify their cocoa plantations after the cocoa price crisis and the devaluation of the CFA currency.

Data were recorded in Microsoft Excel and analysis of variance was done using the program SAS. ANOVA procedure for student-Newman-Keuls test at 5% was used to compare blocks. Probabilities are presented in the tables.

RESULTS AND DISCUSSION

Density of cocoa and non-cocoa trees

The average density of cocoa is 1168 trees per hectare in the benchmark (Table 1). There is no significant difference in cocoa density among blocks.

The average density of non-cocoa trees was similar in the Ebolowa, Mbalmayo, and Yaoundé Blocks, i.e. 298, 358 and 308 trees per hectare, respectively.

Non-cocoa tree and Stratification

Tree canopies are mainly found in the 10-20m strata (129 trees per hectare), with only few trees being taller, i.e. 25 trees/ha on average (Table 2). In Yaoundé area, 142 trees per hectare have their canopy within the cocoa canopy (0-5m height), whereas around Ebolowa and Mbalmayo there are only 60 to 67 trees per hectare. In contrast, in 10-20m and >20m strata, the tree densities are significantly lower in the Yaoundé area.

The cocoa plantations around Yaounde contain nearly twice as many trees that provide consumable products but only half as many timber species as plantations in the southern section of the Benchmark area. The highest

densities of medicinal plant were found in the Ebolowa and Mbalmayo blocks, i.e. 19.7 and 37.8 trees per hectare, respectively.

Medicinal plants found inside cocoa plantations are very useful to farmers. Generally they rely on these species for the treatment of many common tropical diseases. Since the devaluation of the CFA, drugs have become more expensive and even more inaccessible to farmers.

Trees used for intensification and diversification

Use of fruit trees by cocoa farmers

Over twenty fruit tree species (24 specifically) are planted by farmers into cocoa agroforests (data not presented). Of these, 63% are exotic species and the rest indigenous. The ratio of exotic to indigenous increase from 2 in Ebolowa block to 2.5 in the Yaoundé block, indicating an increase use of exotic species under a more deforested and market-oriented environment. Overall of the five most important species used, *Dacryodes edulis, persea americana, Mangifera indica, Citrus sinensis and Citrus reticula*, only the first is indigenous. These species are used by 83, 77, 71, 57 and 27% of the cocoa farmer, respectively (Table 3).

These fruit trees are now seen by farmers as opportunities to earn cash and minimise the risk associated with the fluctuation of cocoa prices. The kilogram *of Dacdyodes edulis, Persea americana, Mangifera indica, Citrus sinensis* and *Citrus reticula* cost on average 515, 186, 107, 239 and 175 F CFA respectively in the Center Province of Cameroon (Temple, 2000). [1 US $ = 750 F CFA]

Use of non-fruit trees by cocoa farmers

The five most common species used are *Terminalia superba, Triplochiton scleroxylon, Chlorophora excelsa, Ceiba pentandra and Ficus mucuso* (Table 4). Amongst all the non-fruit tree species used for intensification and diversification, 15% are of high timber value, i.e. species being exported regularly based on information provided by ONADEF (local forest regeneration bureau).

CONCLUSION

Despite the fact that cocoa-agroforest were originally created for cocoa production, farmers are now managing non-cocoa trees inside these plantations to fulfil some household needs and provide shade to cocoa trees. The planting of fruit and non-fruit trees help in diversifying crops and promoting reforestation. They can generate an economic benefit through the sale of timber or fruit. They also help to minimize the risk associated with the fluctuation of cocoa prices.

Studies on cocoa system in the past were often concentrated on the production of cocoa. Self initiatives of farmers to manage other tree species inside cocoa plantations has made it necessary for researchers in horticulture and tree domestication to involve themselves in cocoa agroforest research and management. Furthermore, cocoa agroforests have become a repository of indigenous tree species in a rapidly changing landscape due to deforestation and intensified annual cropping systems.

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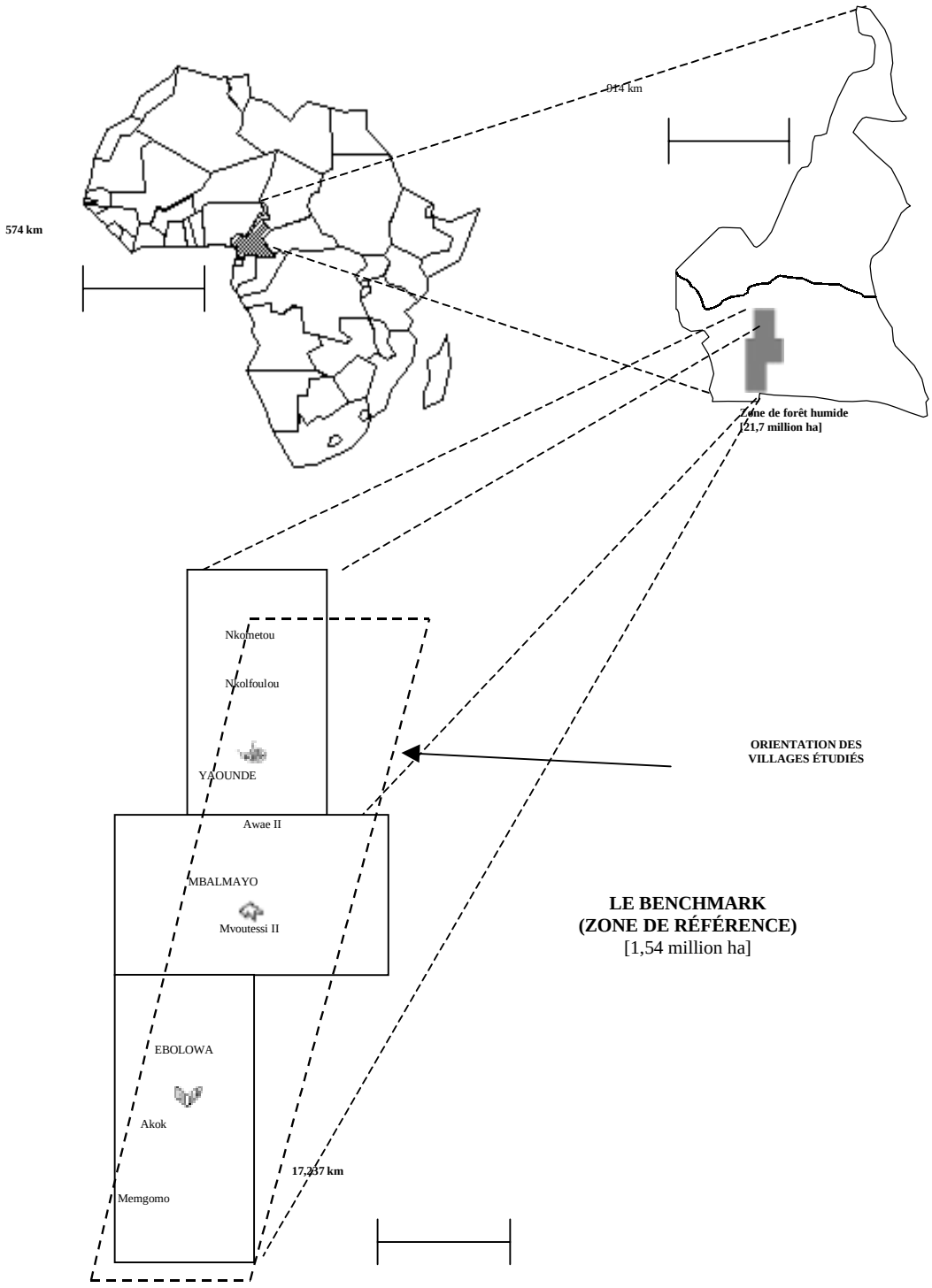

Figure 1: Study area: The Forest margins Benchmark area in Southern Cameroon

Table 1: Density of cocoa and non-cocoa trees by dominant use (density per hectare)

	Cocoa trees	Non Cocoa trees				
		Consumable	Medicinal	Timber	Others	Total
Ebolowa area	1048 a	104 b	20 a b	103 a	71 a	298 a
Mbalmayo area	1283 a	92 b	38 a	130 a	96 b	358 a
Yaoundé area	1172 a	192 a	12 b	49 b	53 b	308 a
Humid Forest Zone	1168	130	23	94	73	321
P-Value	0.2228	0.0021	0.0318	0.0012	0.0019	0.3948

Table 2: Density of non-cocoa trees in cocoa plantations by height strata (density per hectare)

	Strata			
	0-5m	5-10m	10-20m	>20m
Ebolowa area	67 b	59 a	138 a	34 a
Mbalmayo area	60 b	108 a	161 a	28 a
Yaoundé area	142 a	63 a	89 b	13 b
Humid Forest Zone	90	77	129	25
P-Value	0.0026	0.0405	0.0062	0.0132

Table 3: The five fruits tree species most commonly planted by farmers for the intensification and diversification of cocoa agroforest (in percent of farmers)

	Yaoundé	Mbalmayo	Ebolowa	HFZ	P-Value
Dacryodes edulis	80 a	80 a	91 a	83 a	0.3564
Persea americana	75 a	74 a	83 a b	77 a	0.5659
Mangifera indica	71 a	65 a b	78 a b	71 a	0.2615
Citrus sinensis	57 ab	47 b	65 b	57 b	0.4296
Citrus reticula	37 b	15 c	29 c	27 c	0.1297
P-value	0.0082	<0.0001	<0.0001	<0.0001	

Table 4: The five non-fruits tree species most commonly planted by farmers for the intensification and diversification of cocoa agroforest (in percent of farmers)

	Yaoundé	Mbalmayo	Ebolowa	HFZ	P-Value
Terminalia superba	28 a	32 a	35 a	32 a	0.8331
Triplochiton scleroxylon	28 a	31 a	35 a	31 a	0.8099
Chlorophora excelsa	37 a	32 a	5 b	25 a b	0.0024
Ceiba pentandra	22 a	16 a	16 b	18 a b	0.7411
Ficus mucuso	20 a	18 a	6 b	14 b	0.2286
P-value	0.6205	0.2214	<0.0001	0.0114	