

# Role and Status of Plantain in Agroforestry Systems of South West Cameroon: which Pathways to Productive and Sustainable System?

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## Abstract

South West of Cameroon is usually cultivated with cocoa as cashcrop. The farmers incomes are affected by variations of the cocoa price and perturbations of the local economy. The two ways to survive are diversification of cocoa plantations with plantain and other varied foodcrops or extension of foodcrops by clearing and burning the forest. The high number of cropped species and technical practices means complexity. The main target is to identify the cropping systems which would be satisfactory on the agronomical, environmental and economical point of view. Twenty associations related to species composition are observed from 200 plots, within 15 villages, in 6 microregions. It shows a high number of cocoa-based associations with other perennials and mostly plantain as a main foodcrops. The historical analysis points out the status of plantain as the main crop after deforestation in association with perennials or food crops authorizing an adaptative strategy. His description first step focuses mainly on the types of associations then on the types of successions. It is a prior study for a sustainability analysis.

## INTRODUCTION

In most humid and semi-humid tropical areas, traditional cash crops have to face an important crisis due to an international market depreciation. The impact is dreadful for millions of small farmers (Anonymous, 2001). In South West Cameroon, the development of small family farms has been based on the extension of cocoa plantations on pioneer fronts. In the last ten years, both the drop of cocoa price and the devaluation of local money enhanced the development of foodcrops as a main strategy to compensate the income loss, especially for plantain which is the main valuable goods on the local urban market (Temple, 1995; Alary, 1996). Nevertheless, the market demand for plantain is still not fully and regularly satisfied and plantain remains an important opportunity as a diversification crop in cocoa-based systems (Temple and Chataigner, 1996). Consequently, areas allocated to cocoa plantations remains stable in small family farms. Whereas foodcrops and especially plantain areas increase through shifting cultivation to the detriment of forest (Békié et al., 2000).

In this context, the conception of sedentary cropping systems require the adoption of specific agricultural practices. However, classical production based on chemicals use do not appear to be economically competitive for plantain in the present context of Cameroon (Temple et al., 1996). Nowadays, a high diversity of cropping systems exists in S-W Cameroon, which could provide different appropriate ways to more sustainable cropping systems. The main objective of this study is to determine how a comprehensive analysis of existing cropping systems could provide key information on recent trends and help to conceive sustainable cropping systems.

## MATERIALS AND METHODS

The study was carried out in the South West Province of Cameroon in the main cocoa oriented region. Tombel, Ebonji, Bole, Owe, Muyengue and Malende are six microregions located North of Mount Cameroon and South of Kumba town with altitude between 50 and 600 m. Climate is humid tropical with 1800-3000 mm annual rainfall, and temperature ranging between 24.5 and 28.5°C (monthly means). Human population is around 50 hab/km<sup>2</sup>. Half this region has high density. A general pressure is exercised on the land. Forest reserves exist but are restricted. Farming systems are focused on cocoa plantation and foodcrops production from small family farms (Békié et al., 2000).

Our approach consisted in combining a characterization of present agricultural situations, together with historical approach of crop successions and intercrop structure, in order to understand the key determinants of cropping systems changes. Complex intercropping systems can be considered as agroforestry systems, although cocoa based systems are more commonly classified as plantations crops (Fujisaka et al., 1996). Intercropping systems with planted foodcrops after deforestation or fallow period can be characterized with reference to slash and burn cropping systems (Nair, 1993). Cropping systems were described from 209 plots within 101 identified farms in 15 villages (Temple et al., 1996).

The average surface of the studied farms is 6.75 ha but varies between 0.75 and 25 ha. Families are composed from 1 to 22 people. If family usually represents the main work force, it is completed occasionally from 'outside', 30% of farms have salaried employees especially those with more than 10 ha. Ninety three percent of farms cultivates the cashcrops. Autoconsumption is general relatively to the farm and family sizes. The total surface of the observed plots is 579 ha with an average of 2.9 ha per plot.

The collected data consist in both oral surveys and observations on farmers fields :

- indicators of the cultivated biodiversity (inventory of species and respective densities, agronomical performances of main crops),
- history of successions (date and modality of clearing, previous crops, cover type at planting time, fallow length in case of use, etc.),
- main agricultural practices during the current cropping cycle.

The associations are defined by identification of dominant species through a frequency analysis completed by the characterization of the species densities. A multiple cropping index was calculated for perennials crops (not presented). Historical similarities on cropping successions help to define typical schemes.

## RESULTS AND DISCUSSION

Twenty third cropped species are observed in the studied plots. Fruit trees were 7 with mandarin tree (*Citrus reticula*), orange tree (*Citrus sinensis*), lime (*Citrus aurantifolia*), kola nut (*Cola anomala*), African pear (*Dacryodes edulis*), avocado (*Persea americana*) and mango (*Mangifera indica*) completed by pineapple (*Ananas comosus*) as non fruit tree. Cocoa (*Theobroma cacao*), coffee (*Coffea canephora*) and oil palm (*Elaeis guineensis*) were the three cash crops. Foodcrops are diverse: yam (*Dioscorea sp.*), banana (*Musa sp. sub group banana AAA cv Gros Michel*), plantain (*Musa sp. sub group plantain AAB*), cassava (*Manihot utilissima*), cocoyam (*Xanthosoma sagittifolium*), taro (*Colocasia antiquorum*), maize (*Zea mays*), groundnut (*Arachis hypogea*), melon (*Cucumerpsis manii*), okra (*Hibiscus esculentus*), sweet potato (*Ipomea batatas*) and chilli pepper (*Capsicum frutescens*).

### Crop Associations

Most plots include a high number of species intercropped (figure 1). Only 4% of observed plots are single cropped (in this case, cocoa or plantain), and 20% exceed 7 associated species. The more frequent lignous perennials crops (table 1) are cocoa (73% of the observed plots), fruit trees such as citrus (36%), coffee (30%). Most frequent annuals or semi-perennials (non lignous) are plantain (82% of the plots), cocoyam (66%), cassava (32%).

We notice a high frequency of mixed cropping systems (Table 1). Plantain and

cocoyam are observed (presence frequency) respectively on 84 and 71% of plots with cocoa, 98 and 83% of plots with coffee, 95 and 74% of plots with oil palm, and 89 and 61% of plots with fruit trees (Table 1). The percentages related to each species (relative association frequency) are similar to the general distribution. Nevertheless it is noticeable that in coffee plots, plantain and cocoyam are significantly more frequent. Cocoa, coffee, oil palm, fruit trees, and cocoyam are observed on 84, 98, 95, 89 and 74% respectively of the plantain plots.

Three systems may be single-cropped: cocoa (7% of the plots but 16% of the surface), oil palm (<0.5%) and plantain (>1%). It is possible to identify 17 types of associations related to the dominant species and their production stages (Table 2).

In a first group, perennials (mainly cocoa, coffee and fruit trees) and foodcrops (mainly plantain and cocoyam) are associated at productive stage (Table 2). The two main associations represent 42% of the total studied plots and 51% of the surface (Table 2). They are balanced between cocoa/fruit trees and cocoa/coffee. Cocoa is also associated on 17% of the plots (14% of the surface) with either plantain, or diverse crops and foodcrops.

In a second group (8% of the plots and 4.5% of the surface) plantain and other foodcrops (cocoyam, cassava, maize...) are associated with young cocoa trees (Table 2). Young coffee or oil palm trees are also associated with plantain. Density of cocoa (around 1000 plants/ha) in young cocoa plantations is similar to the plantain density (table 3). In productive plantations this cocoa density is nearly the same but associated plantain density has been divided by two. Plantain and food crops are sometimes present at low density with some oil palm and fruit trees even in specialised cocoa plantation (Table 3).

The third group of associations (13% of the plots and 9% of the surface) is with herbaceous crops: either plantain with cocoyam or yam, or yam- or cassava-based associations with short cycle foodcrops as maize, melon or groundnut but nearly always with presence of plantain.

Cocoa plantations are generally considered as agroforestry systems with no details on their diversity and their functioning (Nair, 1993). The increasing presence of plantain in cocoa plantations was noticed by Lachenaud (1987). Aulong et al. (2000) describe the floristic composition of the cocoa association with fruit trees. But as far as it is known, no classification of the different associations is proposed. This work identifies twenty different cropping systems. It is the first attempt to clarify the complexity of the different strategies developed by farmers, in order to adapt traditional cocoa-based cropping system to economical constraint and food demand.

### **Crop Successions**

The historical and technical analysis of the studied plots identifies 19 types of successions (results not presented). Six successions with perennials were generated by specialized cropping of cocoa or coffee generally set up on clearing without burning forest and going to diversification with low or no inputs. Maintaining specialized cropping systems with cocoa or oil palm alone need inputs: pesticides for the first one, fertilizers for the second one. In fact, cocoa plantations associated with plantain at young stages, followed by single-crop cocoa systems at production stage represent the traditional pattern. But, new diversified systems are now being developed. Mature cocoa plantations have been recently diversified by intercropping plantain or fruit trees. In the latter case, the system changes towards long-term agroforestry with no inputs except for the cocoa fruits. The cocoa successions with the main associations are synthesized on the upper part of the Figure 2.

New cocoa plantations are frequently delayed due to single crop plantain production in newly deforested areas. This plantain production (lower part of Figure 2) may be maintained with fallow rotation and intermediate intensive practices at low inputs. Such semi-intensive solutions are not observed for other foodcrops systems. Indeed this solution change towards cassava-based extensive systems with short fallows as yam/plantain association for instance (Figure 2). Such changes to cassava systems has been previously observed from yam-based system in Nigeria (Juo and Ezumah, 1992).

Other situations which include coffee or palm trees are not described but follow the same diversification pattern.

## CONCLUSIONS

This study describes the structure and functioning of current cropping systems in SW Cameroon. It allows a comprehensive understanding of the evolution of these systems in a market changing environment. Next step will consist in evaluating the different components of the sustainability of these systems. Long term maintenance of biological and chemical fertility (i.e. to ensure the agronomical performance of the system) still needs to be evaluated. **The capacity of plantain semi-intensive systems to combine commercial production and ecological sustainability remains to be confirmed.**

Agroforestry systems and plantain semi-intensive systems are two indigenous innovations that may be relevant pathways for the moving from traditional extensive itinerant systems to a progressive intensification and settling. **Are these systems sustainable or only relevant for short term adaptation?** Agronomical performance and ecological sustainability remain have to be evaluated before promoting the most suitable systems.

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## Tables

Table 1. Percentage of plots for a considered species related to the total number of studied plots (presence frequency) and related to the number of plots of one species in association (relative association frequency). The letters S and D in brackets mean that the relative frequency of association between the two species is similar (S) or distinct (D) from the percentage of presence.

Frequency	Cocoa	Coffee	Oil Palm	Fruit Trees	Plantain	Cassava	Yam	Cocoyam	Annual Foodcrops
% total plots	<b>73</b>	<b>30</b>	<b>11</b>	<b>36</b>	<b>82</b>	<b>32</b>	<b>4</b>	<b>66</b>	<b>43</b>
Cocoa	100	31 (S)	7 (S)	45 (S)	84 (S)	28 (S)	0 (D)	71 (S)	36 (D)
Coffee		100	24 (D)	39 (S)	98 (D)	54 (D)	0 (S)	83 (D)	61 (D)
Oil Palm			100	52 (S)	95 (S)	43 (S)	0 (S)	74 (S)	48 (S)
Fruit Trees				100	89 (S)	21 (D)	0 (S)	61 (S)	28 (D)
Plantain					100	33 (S)	5 (S)	74 (D)	44 (S)
Cassava						100	5 (S)	86 (D)	80 (D)
Yam							100	37 (D)	100 (D)
Cocoyam								100	54 (D)

Table 2. Frequency of the different associations characterized by dominant species related to the number of studied plots together the corresponding surface. The asterisk mentions the associations schematized on figure 2. The double line separates the associations dominated by lignous or herbaceous plants. The total number of studied plots is 201, within 15 villages, in 6 microregions in the South West Province of Cameroun.

Association	Number of plots (% total inquired plots)	Surface (% total inquired surface)
Young Cocoa / Plantain *	4	2.5
Young Cocoa / Diverse Crops	2.5	1.2
Young Coffee / Plantain	1	0.2
Young Oil Palm / Plantain	0.5	0.7
Cocoa *	7.2	15.9
Cocoa / Fruit trees *	19.5	27.4
Cocoa / Plantain *	6.2	7.6
Cocoa / Diverse Crops	6.7	3.7
Cocoa / Coffee	23.1	23.9
Cocoa / Foodcrops	4.6	2.6
Coffee / Diverse Crops	6.7	5.0
Oil palm	0.5	0.3
Mixed Perennials	1.5	0.1
Plantain	1.5	1.2
Plantain / Foodcrops *	3.1	2.3
Yam / Plantain *	3.1	2.0
Yam / Cassava	2	1.4
Cassava / Plantain	2	0.5
Cassava / Foodcrops *	4.6	1.5
Mixed Foodcrops	1.5	0.4

Table 3. Average density of the main species observed in the associations with perennials. The range of densities is mentioned into brackets. The letters A, B, C with the average density of cocoa refer to statistically distinct groups. The asterisk mentions the associations schematized on figure 2.

Association	Cocoa	Coffee	Plantain	Cocoyam	Cassava	Oil Palm	Fruit Trees
Young Cocoa:/ Plantain*	1100 <sup>A</sup> (1000-1600)		900 (500-1100)	< 2000	-	-	<10
Young Cocoa / Diverse Crops	1100 <sup>A</sup> (900-1600)	-	570 (50-1000)	2500 (0-7000)	50 (0-250)	5 (0-15)	6 (0-15)
Young Coffee / Plantain	-	1100 (-)	900 (800-1000)	possible	possible		
Young Oil Palm / Plantain	-	-	550	possible	possible	130	-
Cocoa*	1170 <sup>A</sup> (800-1600)	-	40 (0-150)	300 (0-1000)	-	2 (0-5)	2 (0-5)
Cocoa / Fruit Trees*	1240 <sup>A</sup> (800-1700)	-	50 (0-150)	440 (0-2000)	30 (0-100)	4 (0-15)	30 (10-75)
Cocoa / Diverse Crops	1090 <sup>AB</sup> (400-800)	-	380 (200-700)	1500 (200-4000)	470 (0-1000)	17 (0-50)	25 (10-30)
Cocoa / Plantain*	880 <sup>B</sup> (500-1100)	-	410 (200-800)	1163 (0-2000)	200 (0-600)	19 (0-50)	11 (0-25)
Cocoa / Foodcrops	530 <sup>C</sup> (200-700)	-	180 (0-330)	1800 (100-7000)	800 (0-5000)	2 (0-20)	11 (0-20)
Cocoa / Coffee	480 <sup>C</sup> (200-700)	195 (100-300)	150 (50-300)	1250 (0-4000)	360 (0-1000)	6 (0-20)	9 (0-30)
Coffee / Diverse Crops	-	770 (500-1000)	200 (100-250)	300 (0-500)	1250 (0-4000)	13 (0-30)	5 (0-15)
Oil Palm	-	-	-	-	-	120	-

## Figures

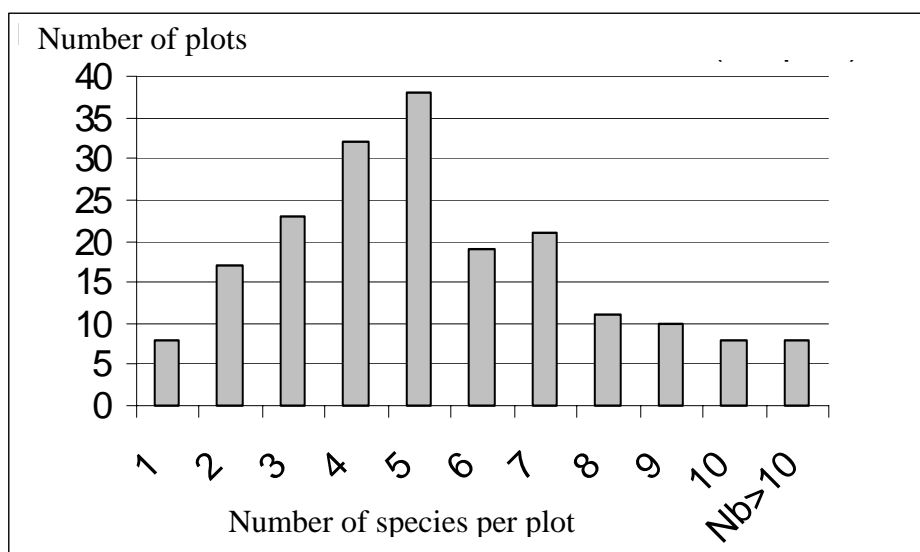


Fig. 1. Distribution of plots related to the number of species inter cropped on a same plot. The total number of studied plots is 198, within 15 villages, in 6 microregions in the South West Province of Cameroun. The data are collected by inventory of the cultivated species on each plot.

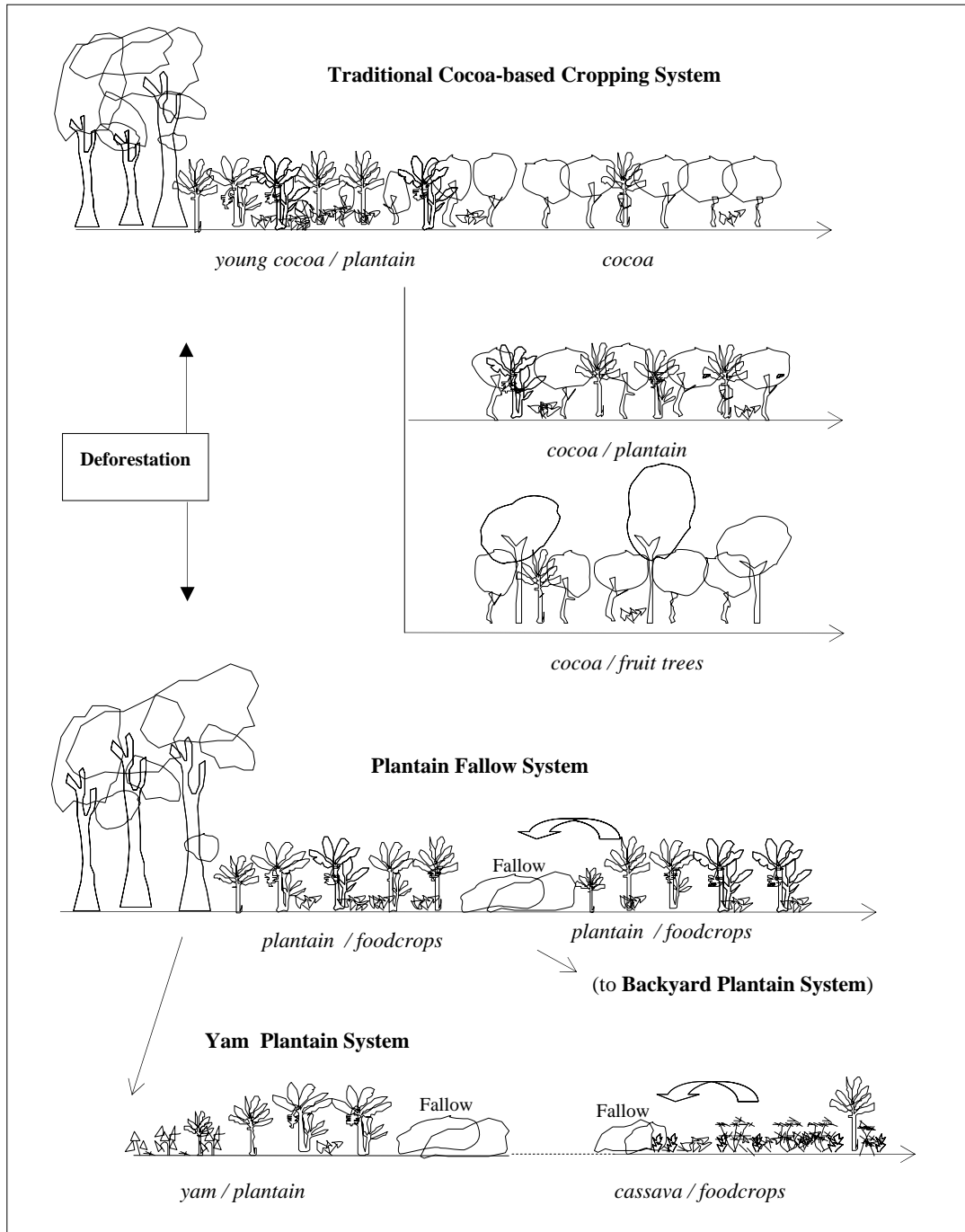


Fig. 2. Synthetic evolution of the main cocoa- and plantain-based cropping systems after deforestation. The study is from 201 plots within 15 villages in 6 microregions of South West Cameroon.