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## **Diversity and diversification in cocoa agroforestry systems and household food security: Case study of central and southeastern Côte d'Ivoire**

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### **Abstract**

Côte d'Ivoire is a country with a strong agricultural vocation. The global market is increasingly demanding beans from sustainable production systems, encouraging cultivation methods better adapted to climate change while contributing to the food security of local families. For resilient cocoa production, some farmers in Côte d'Ivoire have adopted agroforestry systems for several generations. To better appreciate the viability of these systems, this study proposes to analyse their diversification and diversity, and their effects on the lives of households in two contrasting production zones of Côte d'Ivoire (central and southeast), and on their food security. The research involved ethnobotanical and socio-economic surveys of 70 producers and 2,568 women involved in the production of products from cocoa-based agrosystems. It was carried out through botanical inventories and direct observations in 329 cocoa plantations. Analysis of the data showed that in both zones, plantations managed by women were rich in 91 associated species, including 57 in the central zone and 52 in the southern zone. Comparing the diversity of species conserved in the two zones, we can see that the number of non-native species conserved by women is much higher than that of men in the Central zone. In the South-East zone, medicinal use is the main use made by the population, with 56.3% of the species cited. On the other hand, in the Centre zone, food use is the most common, with a frequency of 32%. Furthermore, in the South-East, of the 62 plant species inventoried in cocoa plantations, 54 species are spared to create shade, while in the centre of the country, five functions of the species inventoried were identified. Of the 60 species, 36 are useful for shading cocoa trees, and 15 (25%) for self-consumption and sale at the same time.

**Keywords:** Agroforestry systems, Côte d'Ivoire, diversification, food security, uses, women

## Introduction

As the world's leading cocoa producer, Côte d'Ivoire is subject to severe and gradual biodiversity erosion due to extensive farming practices. To maintain this position, farmers have long promoted shade-less production systems, which have virtually wiped-out traditional agroforests across almost the entire southern half of the country (Assiri, 2010). Today, with the scarcity of forest lands and evidence of seasonal variability, these unshaded systems are showing their limitations and raising questions about their sustainability. The growing demand for cocoa from sustainable production systems provides an opportunity to promote farming practices that are more sustainable and better adapted to climate change, while contributing to the food security of local families. To better assess the viability of traditional agroforestry systems, this study aimed to determine the role of these systems in the lives of households in the Kokumbo sub-prefecture (central Côte d'Ivoire) and the La Mé region (South-east). Specifically, the aim was to determine the diversity of trees associated with cocoa trees, their impact on the livelihoods of producers and the food security of households in two contrasting production areas of Côte d'Ivoire, namely the Centre and the South-east.

## Methodology

To achieve the objectives of this study, botanical studies were carried out in cocoa agroforestry systems to assess the plant diversity and diversification in the two study zones. Ethnobotanic and socioeconomic surveys of 327 farmers were also conducted to determine the use value of cocoa-related species (Adou Yao et al. 2016) and the level of household self-sufficiency and food security.

## Results and discussion

### *Diversity and diversification in cocoa agroforestry systems*

A total of 154 plant species associated with cocoa trees were recorded in both zones. The Southeast recorded the greatest diversity of associated trees with 113 species. The average number of individual trees in the plantations ranged from 3.82 (Centre) to 40.36 (Southeast). The average richness was  $1.25 \pm 1.02$  species in the Centre compared to  $3.42 \pm 3.46$  species in the Southeast (Table 1). In addition to cocoa, farmers grow other perennial and annual food crops on the same cocoa farm. Cashew nuts and coffee are intercropped with cocoa, especially in the Centre region for regeneration of old cocoa farms. Annual crops such as *Colocasia esculenta* (taro), *Manihot esculenta* (cassava), *Zea mays* (maize), *Musa spp* (banana), *Capsicum annuum* (chilli), are also found in young or old cocoa farms in both regions.

Table 1: Floristic diversity parameters of the two study areas Variable

		Centre	South-East	Grand total
Floristic richness	All farms	65	115	180
	Mean by farm	3.63	18.92	5.95
Origin	Exotic (non-native)	21	2	23
	Local (Native)	44	113	157
Type of trees	Fruit plants (Consume)	24	11	35
	Non-fruit trees	41	104	143

There are 27 plant species common to both areas, 88 species unique to the south and 38 species unique to the centre. The most common species are *Irvingia gabonensis*, *Garcinia kola*, *Cola nitida* (Figure1), and *Artocarpus communis*.

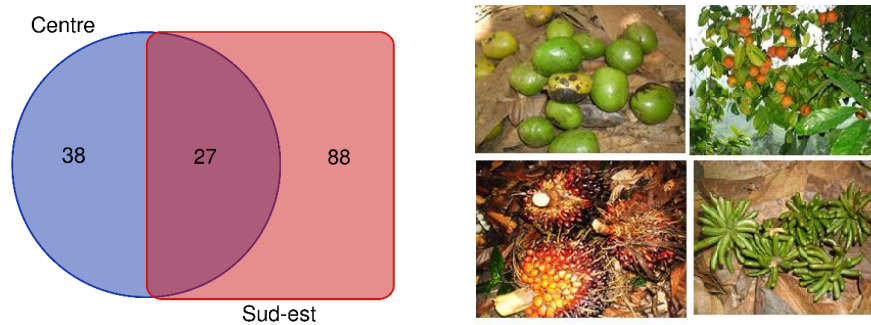
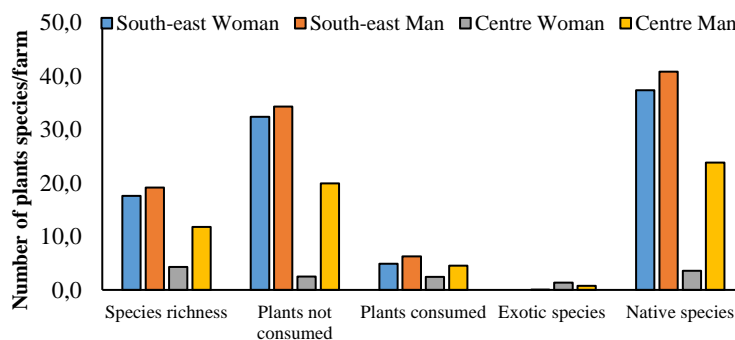


Figure 1: Most common plants species conserve in cocoa farms in both two regions

**Gender influence in plants species diversification in cocoa agroforestry systems**

Regarding gender, 77% of plantations are managed by women against 23% by men. In both zones, the plantations managed by women have a total of 91 associated species, of which 57 in the central zone and 52 in the southern zone. Comparing the diversity of species kept in the two zones, the number of non-native species kept by women is much higher than that of men in Centre (Figure 2).



**Plants species composition in farm**

Figure 2: Composition of plant species on the cocoa farm in the study areas according to gender

**Plant Use value in cocoa agroforestry systems**

At the end of these surveys, it appears that local populations use plants associated with cocoa trees for six categories of use (Figure 3). Medicinal use constitutes in the south-east zone the main use made by the populations with proportions of 56.3% cited. On the other hand, in the centre it is the most practiced food use with a frequency of mention was 32%.

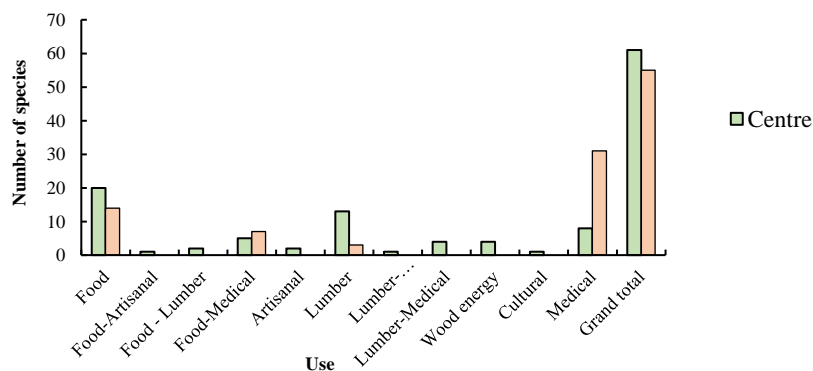


Figure 3: Species richness according to their use in the two areas studied

In the South-East, among the 62 species of plants inventoried in cocoa plantations, six (9.68%) are used for self-consumption, two species (3.23%) for self-consumption and 54 species

(87.09%) to create shading (Figure 1). On the other hand, in the centre of the country, five functions of the inventoried species have been identified. Thus 60 species, 36 species (60%) are useful for shading cocoa tree vines, 15 or 25% for self-consumption and sale at the same time, five (8.32%) for self-consumption and two species respectively for self-consumption. - shading and marketing with a score of 3.34% (Figure 4).

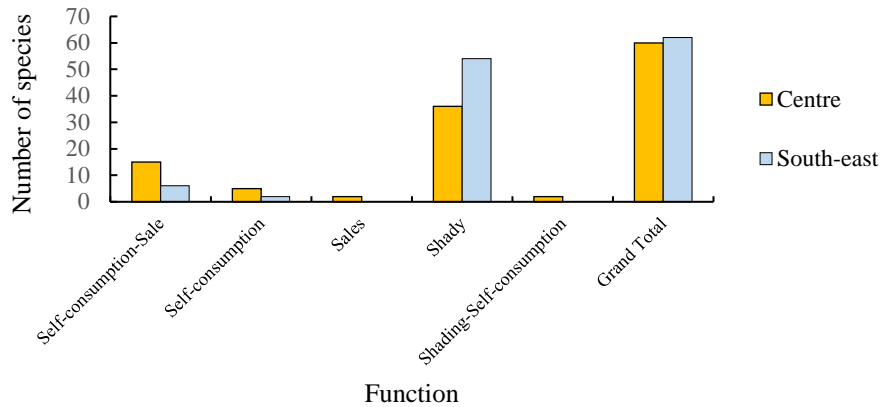


Figure 4: Distribution of species by type of use by the two study areas

### ***Cocoa agroforestry systems and food security***

In the Centre area, 88 % of the households interviewed were food secure, while 12% were food insecure (Figure 5).

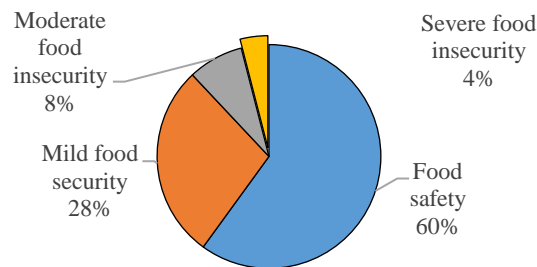


Figure 5: Prevalence of food insecurity, according to women in Centre area

### **Conclusion**

Cocoa-based agroforestry systems play a key role in the lives of rural households in Côte d'Ivoire. They are home to a high diversity of plants that provide a variety of services to populations, thus contributing to household food security. This diversity of sources of income increases with the complexity of the systems and contributes to the well-being of producers, hence the need to promote agroforestry in the current context of climate change and the food security of vulnerable households.

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