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Women's preferences for associated species in cocoa-based agroforestry systems and their uses in the Kokumbo Sub-Prefecture (Côte d'Ivoire)

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Abstract

Due to their multiple uses, species associated with cocoa trees have an important socio-economic and environmental value for women in Central Côte d'Ivoire. Based on surveys followed by an inventory carried out in six villages of the Sous-Préfecture of Kokumbo, this study assesses women's preference for cocoa companion species using the pebble distribution method, in order to quantify the value accorded by the latter according to their various uses. A total of 79 plant species were identified, divided into 67 genera and 31 families. These species associated with cocoa trees have an explicit value for women, as they meet the vital needs of farming households, such as self-consumption (43.32%), sale (35.21%), shade (7.53%), timber and firewood (7.15%). Using the pebble distribution method, we have highlighted the most important species associated with cocoa trees for women. For self-consumption, we have *Dioscorea spp* with 29.47% and *Musa paradisiaca* (18%). They attribute a high commercial value to *Musa paradisiaca* (25%) and *Persea americana* (21%). They also prefer species that provide good shade for cocoa trees, such as *Ceiba pentandra* (19.74%) and *Milicia excelsa* (11.30%). Those that provide good firewood and energy, such as *Milicia excelsa* (28%) and *Albizia zygia* (19%). Domestication of the tree and shrub species most appreciated by farmers could stimulate their regeneration. The marketing of products from cocoa agroforests could enable women to acquire financial autonomy in order to improve the living conditions of their households in general and those of their children in particular.

Keywords: Cocoa agroforests; Women; Perception; Associated species; Côte d'Ivoire

1. Introduction

Introduced to West and Central Africa more than a century ago (Champaud, 1973), the cocoa tree was first introduced to Côte d'Ivoire in the south-east of the country towards the end of the 19th century (Burle, 1961). Today, cocoa occupies an important place in the Ivorian economy. Indeed, Côte d'Ivoire produces 42% of the world's cocoa (ICCO, 2016) with an annual value of over 10 billion USD (World Cocoa Foundation, 2012). As such, cocoa is the main source of foreign currency inflows to Côte d'Ivoire, and to date it remains the country's largest agricultural foreign trade product (Kossonou et al., 2024A). Cocoa production also contributes to the fight against poverty in rural areas (Jagoret, 2011). The economic performance of the cocoa filière is the work of small-scale producers, with small farms averaging 2.5 ha (Assiri et al., 2009).

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Cocoa production areas in Côte d'Ivoire are largely based on agroforestry cocoa plantations, which remain the source of income and food security for many farms (Kossonou et al, 2024B). In central Côte d'Ivoire, particularly in the Toumodi Department, the presence of cocoa-based agroforestry systems has been highlighted by Kpangui et al. (2015). The presence of associated species in cocoa-based agroforests in Côte d'Ivoire serves to meet needs related both to the plantation and to Man (Sonwa et al., 2001). The uses made of the plants relate to needs, sometimes specific, for the cocoa tree and for man (Mollet et al., 2000). The use made of associated species in coffee and cocoa plantations in the south of V-Baoulé in Côte d'Ivoire were discussed by Herzog & Bachmann (1992). In this area, the practices implemented, the uses made of species associated with cocoa trees and the perceptions that local communities (men in particular) have of the plants they use in traditional agroforestry systems have been documented (Adou Yao et al., 2015; Adou Yao et al., 2016). The economic profitability of these systems has also been studied (Kouadio et al., 2018), as has the role of women in these systems (Kossonou, 2020), their role in the use of associated products (Kossonou et al., 2024A) and the importance of the species in the food security of bean-producing households (Kossonou et al., 2024B). However, in Côte d'Ivoire, the world's leading producer country, few studies locate women's preference for and use of associated species in cocoa-based agroforestry systems.

The aim of the present study, carried out in six localities of the Kokumbo Sub-Prefecture in central Côte d'Ivoire, was to shed light on what is known about women's preferences for associated plant species in cocoa-based agroforests and the different types of use they make of them.

2. Material and methods

2.1. Study area

The study was conducted in the Toumodi department located in central Côte d'Ivoire. The work was carried out in six (6) villages hosting cocoa-based agroforestry systems identified by Kpangui et al. (2015). These were: Niamkey-Konankro, Langossou, Kassékro, N'Dakro, Bonikro and Kimoukro (Figure 1). The interest of the study area lies in the fact that it is part of one of the former large production zones commonly known as the cocoa loops (Central West loop) in Côte d'Ivoire. It is also an ecological zone of forest-savanna transition, where cocoa production is carried out in the form of agroforests to cope with unfavorable environmental conditions for cocoa production. There are three types of agroforestry system (Kpangui et al., 2015): simple FAS, complex FAS and young complex FAS (mixed). The relief of the study area, consisting of low plateaus and a low-lying system of ripples and hills, belongs to “the Baoulé chain” (Adou Yao et al., 2016). This system known as ''la chaîne baoulé'' stretches from Mount Kokumbo in the southwest to Fétékro in the northeast. Altitudes range from 100 m to 550 m, and the main peaks include Kokumbo-Boka (505 m) and Orumbo-Boka (527 m). The equatorial climate is characterized by two seasons. There is a rainy season starting in February and ending in October, and a dry season from November to January. Average annual rainfall is 1176 mm, while annual temperatures vary between 26.5°C and 28°C (Kouadio, 2019). According to Guillaumet and Adjonohoun (1971), the vegetation consists of a mosaic of Guinean savannahs and semi-deciduous dense rainforests with *Celtis spp* (Ulmaceae) and *Triplochiton scleroxylon* (Malvaceae). All these species, participate in the good development of cocoa trees by circumventing the natural conditions of this area which are considered unfavorable to cocoa cultivation (Kpangui et al., 2015).

Figure 1 Overview of study area locations

3. Methodology

3.1. Data collection was carried out in three phases.

3.1.1. Surveys of women

The first phase involved semi-direct interviews with women involved in cocoa agroforestry in the study area. This method is designed to assess precise and desired parameters (Mbolo et al., 2002). To this end, an interview guide was designed. It included not only questions with suggested answers, but also questions to which the respondent was free to reply. The interview was non-binding, and in the event of refusal to participate, the questionnaire was administered to another person. For each interview, the questionnaire aimed to establish the profile of the interviewees (age, level of education, number of children, number of family members). The interviews also focused on the women's preferences for the different plant species in their cocoa groves, according to the various possible uses of these species.

3.1.2. Itinerant and surface surveys

Following the surveys carried out, botanical surface and itinerant inventories were carried out. During these inventories, all woody plant species present in the cocoa plantation and all crops present in the field and their usefulness were recorded. In the cocoa agroforests visited, an itinerant surface inventory (25 m x 25 m) was carried out and the number of species per cocoa plantation was recorded in the presence of the woman holding the plantation. The itinerant inventory method involves walking through the area, noting all the plant species encountered (Aké-Assi, 1984).

The aim of this inventory was to record all woody plant species present in the cocoa plantation and all annual crops associated with cocoa plantations. The origin of each species (spontaneous and preserved or planted) and its various uses were recorded. Species identification was based on vernacular names in Baoulé, the local language of the study area. Whenever necessary, species not mentioned by the women during the interviews but encountered in their plantations were added. Species mentioned by the women but absent from their plantations were removed. It should be noted that the species removed were felled between the time the interviews were carried out and the time of the inventory.

3.1.3. Estimating the use value of species

The second phase consisted in determining the choices or preferences of women farmers concerning the species associated with their cocoa crops. It then provided information on the reasons for these choices, the use these women make of the species they keep in their plantations, and the functions of each of these species. To do this, the Pebble Distribution Method (PDM) was applied to show the interest (use) that these women accord to these species. This technique (PDM) is based on women's quantification of relative importance, and assumes that local people are best placed to estimate what is important to them (Sheil et al., 2004). Each time, the farmer was presented with a sheet of paper showing a table with the Baoulé vernacular names of the species inventoried in her cocoa field on the abscissa and the potential uses of the species on the ordinate. The farmer was then given 100 units (in our case, palm seeds) and asked to divide them up on the table according to the value attributed to each species according to its use(s) (Figure 2). Thus, the number of units placed in a cell of the table could be zero if, for the use concerned, the species had no value for the farmer. Otherwise, the number could vary from 1 to 100, and as a numerical value expressed as a percentage (%), was considered to correspond to the relative value of a species or

Figure 2 Pebble distribution method (PDM) exercise

use for the farmer. The notion of importance is specific to each individual, so there is variability in estimates depending on the farmer, but the method allows an overall estimate of the preference of the women surveyed. To assist and follow the respondent's reasoning, the question asked is: "Why is such and such an individual of such and such a species kept or introduced? On the x-axis, the values attributed to the species were used to rank them in order of importance, all uses taken together. On the y-axis, the values attributed to uses have been used to rank them, all species taken together, and to draw up a use profile for agroforestry cocoa farms. It is essential to note the farmer's justifications, as they provide a glimpse into the production logic and management style of the plot (Wagler, 2007). In addition, we had to ensure that the farmer expressed the importance attributed to each species present in the plot and then the value attributed in general to its use(s). The results of the PDM were used to calculate the overall importance attributed to each species, but also to each of the species' functions. The interview was conducted in the presence of a guide-interpreter.

3.2. Data analysis

Descriptive statistics were used to analyze the data. These included numbers, frequencies and percentages.

4. Results

4.1. socio-economic characteristics of respondents

The socio-economic characteristics of respondents in the study area are presented in Table 1. A total of 268 women were interviewed in the five villages visited. Of all the women farmers interviewed during the study, 31.34% were female cocoa farm owners, and 68.66% were involved in cocoa farming through their husbands (bean farmer's wives). Nearly 85% of the women surveyed were married, compared with 15% who were single.

Most women (74.25%) involved in cocoa farming are young and under 50, while the remaining 25.75% are over 50. Thus, the proportion of women with schooling is 34.7% of all those surveyed, equivalent to 65.3% who are illiterate. Among women with schooling, those who said they had attended up to primary school were the most numerous (29.85%). Women with secondary education, on the other hand, are poorly represented, accounting for 4.85% of all educated women surveyed.

Table 1 Summary of information on women farmers in the Bélier

Variables	Description	% rate	Total
Level of education	No schooling	65.3	175
	Primary	29.85	80
	Secondary	4.85	13
Age groups	Under 50	74.25	199
	Over 50	25.75	69
Marital status	Married	84.33	226
	Single	15.67	42
Farm manager	Owner Non-owner	31.34 68.66	84 68.66

4.2. Floristic composition and diversity of cocoa-based agroforestry systems managed by women in the study area

During the establishment of a cocoa plantation, several species (exotic introduced or indigenous) may be associated with the clearing of the plot for several reasons. The synthesis of survey data and direct observations has enabled us to draw up a list of 79 plant species divided into 67 genera and 31 families. The most represented genera are *Solanum* (4), *Citrus* (4) and *Cola* (3). The Malvaceae (13 species), Solanaceae (7 species) and Fabaceae (6 species) families are the most diverse. The others make up a group of 22 families that have been encountered less than three (3) times (Figure 3).

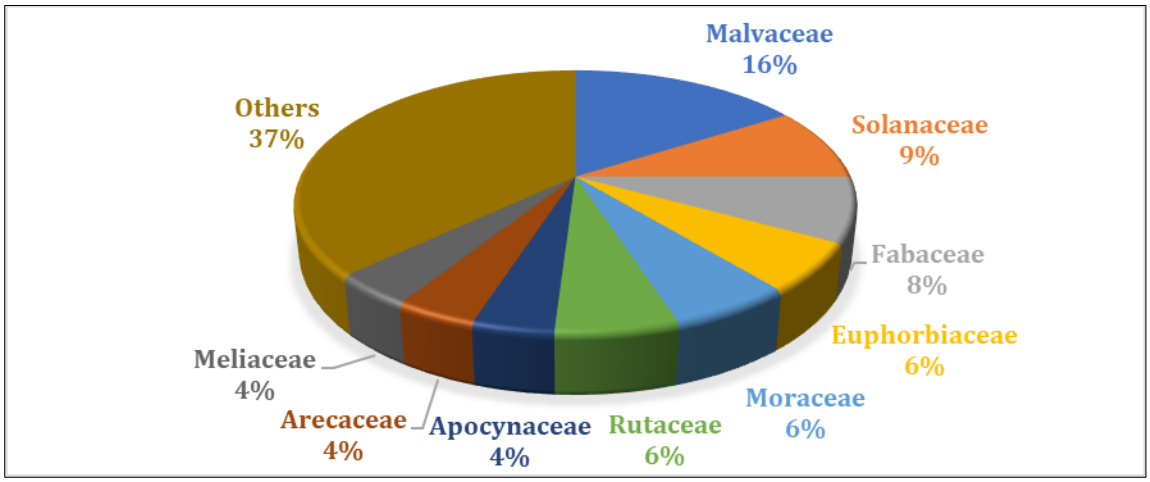

Figure 3 Spectrum of families of species in the study area

Four (4) phytogeographical types were determined, namely species belonging to the Guinéo-Congolaise region (GC), the Soudano-Zambézienne region (SZ), species belonging to both regions at the same time (GC-SZ) and introduced exotic species (i). Species from the Guinéo-Congolese region are the most numerous, at 42%. Next come introduced species with a proportion of 29%. Finally, species belonging to both the Guinéo-Congolese and Sudano-Zambézian regions account for 28% (Figure 4).

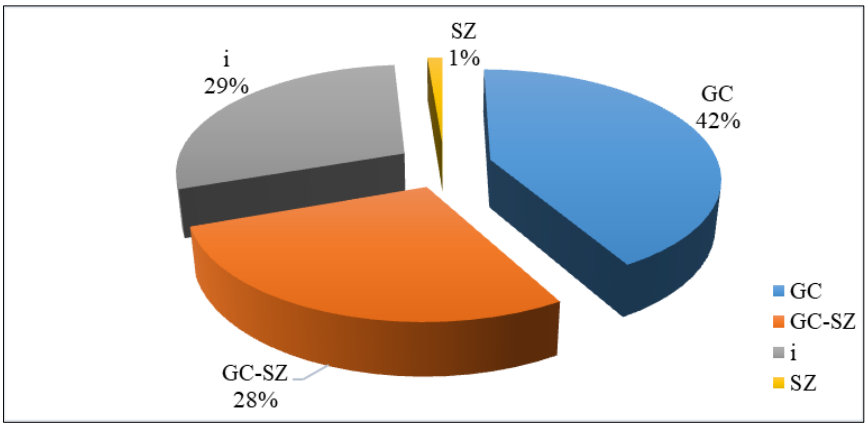

Figure 4 Spectrum of phytogeographic types of study area

The species in the study area belong to seven (7) biological types, including megaphanerophytes (MP), microphanerophytes (mp), mesophanerophytes (mP), nanophanerophytes (np), geophytes (G), therophytes (Th) and hemicryptophytes (H). In this analysis, mesophanerophyte species are the most numerous with a proportion of 32%, followed by microphanerophytes (28%), while megaphanerophyte species are the smallest minority. Their rate is 19% compared with the other biological types (Figure 5).

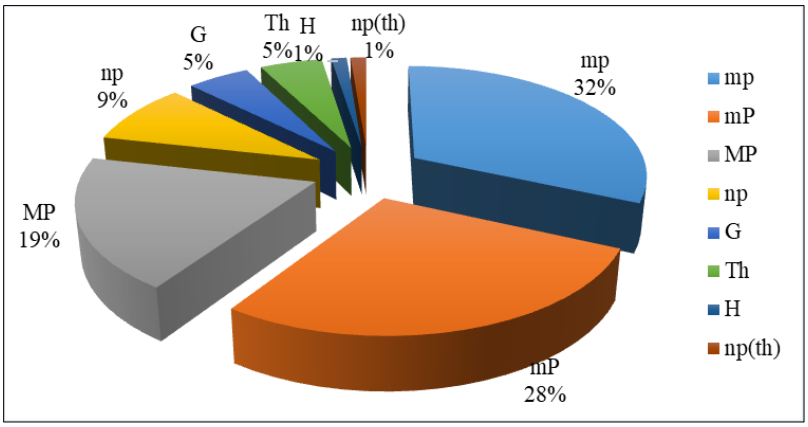

Figure 5 Spectrum of biological types in the study area

Based on the species inventoried, the study identified three (3) morphological types: trees (a), shrubs (b) and herbs (h). Figure 6 illustrates the dominance of trees (65%), followed by herbaceous plants (19%) and shrubs (16%).

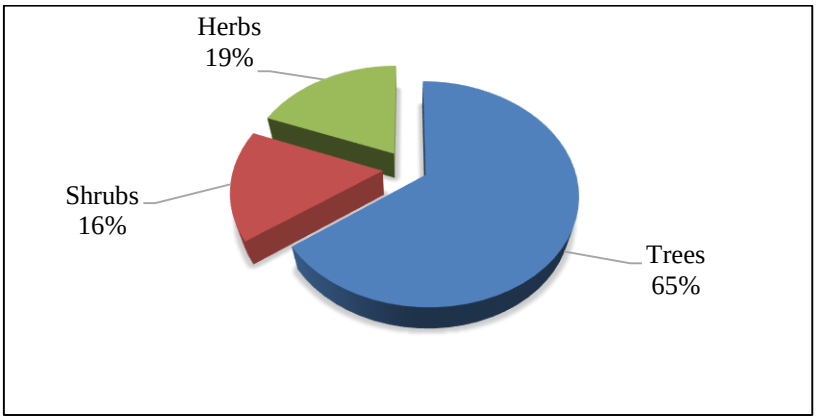

Figure 6 Spectrum of morphological types in the study area

In the study area, there are 50 conserved species versus 29 introduced species (Figure 7). It can be seen that farmers' wives (13.92%) and married owners (22.78%) save more species when clearing the plot to be cultivated. This is not the case for single owners. In this group, introduced species are in the majority (17.72%).

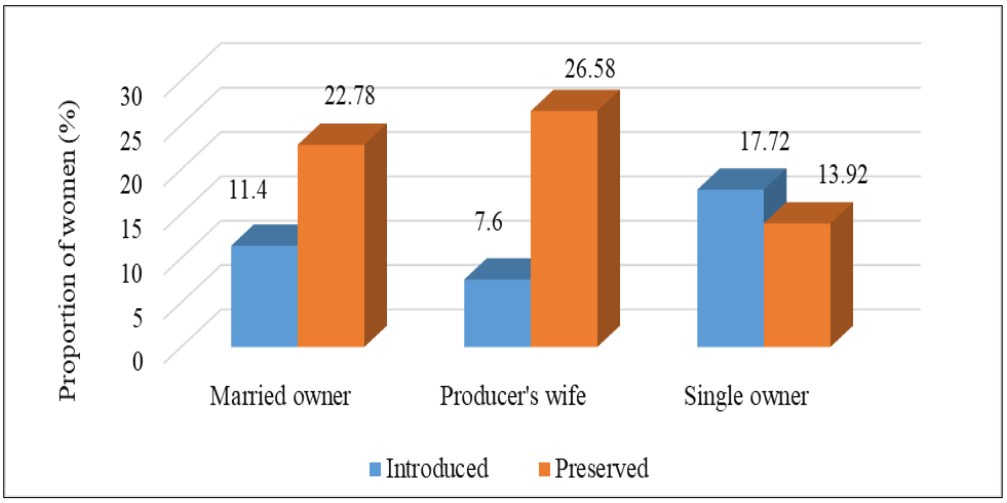

Figure 7 Spatial distribution of associated species in cocoa plantations in the study area by category of women

4.3. Importance accorded to the functions of associated species by women in cocoa-based agroforestry systems

Our surveys revealed that women in the study area attribute seven main functions to cocoa-associated species: self-consumption, sale, fertilization, pharmacopoeia, shade, timber and firewood, and a social aspect. Women are more interested in plant species associated with cocoa trees for self-consumption, with a proportion of 43.32%. On the other hand, they are less interested in the social aspect (0.56%), as shown in figure 8.

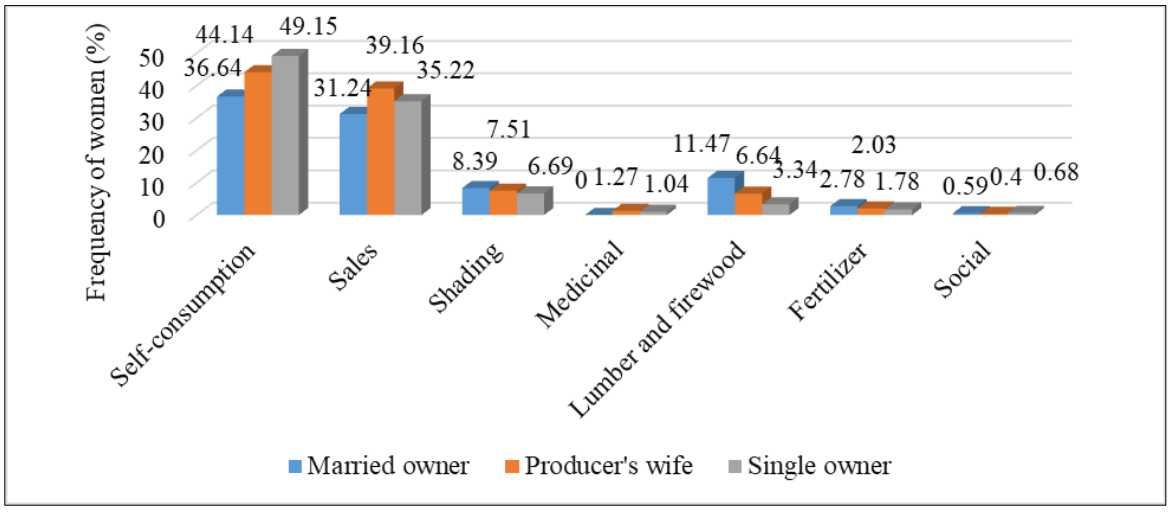

Figure 8 Importance of Women's Positions in SAFc

Self-consumption (43.32%) is the primary function taken into account by women. For women, the trees in cocoa farms are not preserved or introduced at random. It's the result of eating habits that are the guiding principle. For them, these species help provide foodstuffs such as leaves (Figure 9), condiments, wine, fruit and edible mushrooms (Figure 10).

Figure 9 View of *Solanum nigrum* leaves used to make the sauce called Saturday

Figure 10 View of harvested mushrooms used as sauce ingredients

During the course of the survey, the women made it clear that the main objective, and even the goal, of setting up cocoa farms was to earn money through the sale of cocoa. Following the drastic fall in the purchase price of merchantable cocoa from producers in general, the introduction of fruit trees very quickly helped to increase income. The highly representative value attributed in this case to the sales function (35.21%) expresses the women's strategy of diversifying sources of income and even living comfortably.

Shading (7.53%) ranks third in terms of function in the women's plantations surveyed. As the study area is an ecological zone unfavorable to cocoa cultivation, the species associated with it help to deflect unfavorable environmental conditions, in addition to the many other services they offer. The species present in cocoa-based agroforestry systems provide important environmental services, including soil, watercourse and watershed protection, fauna and flora conservation, carbon sequestration and storage, all of which contribute to the protection of cocoa trees and their healthy production.

Timber or firewood (7.15%) is the fourth most important function performed by women on cocoa farms. Wood fuel, which essentially comprises firewood and charcoal, is crucial to the survival and well-being of rural populations, enabling them to cook food so that it tastes better and is safe to eat.

Cocoa agroforests offer better access to the fuel essential for cooking. This is the case of *Albizia zygia* which, according to the women, has branches or a trunk that produce good, long-lasting fire.

Medicine (2.92%) is ranked sixth by women. For women, the agroforest is a rich environment for medicinal products. There are also plants for the treatment of certain ailments. Such is the case of *Newbouldia laevis*, whose bark is used to

treat kidney ailments. The bark of *Entandrophragma angolense, Alstonia boonei, Ricinodendron heudelotii* and *Celtis zenkeri* is crushed and the decoction given to women who have just given birth as an antibiotic.

Carapa procera grains are used to make traditional black soap, which is used for personal hygiene to ward off evil spirits. The bark and kernels of *R. heudelotii* are used to treat infertility in women and prevent miscarriage. The leaves are also an excellent remedy for boils, and the bark treats coughs and rheumatism. Leaves, bark (Figure 11), roots and fruit are all used to treat illnesses. Women's mastery of this diversified pharmacopoeia limits their presence in hospitals.

Faced with the high cost of inputs, women producers are obliged to organize themselves and, better still, to adopt diversification strategies whose main role is to integrate bio-fertilizing trees into SAFc. It is therefore important for women growers to introduce and, better still, maintain fertilizing plants (3.31%) in cocoa farms during their installation and throughout the life cycle of the cocoa trees. This is the case with *Gliricidia sepium* (commonly known as fertilizer), whose leaves are cut and placed at the foot of the cocoa trees to fertilize the soil. Rural women find palm wine (Figure 12), fruit and many other useful products to welcome their guests.

Figure 11 View of the trunk of the anti-malarial *Alstonia boonei* skinned as a remedy

Figure 12 View of the BioValSE team's welcome with palm wine (sap from *Elaeis guineensis*) in Niamkey-Konankro

4.4. Women's perception of associated species in cocoa-based agroforestry systems

A hierarchical ranking of species by PDM, applied in the study area, shows that women attach importance to some species and not to others. The species for which they attach no importance are still present in their cocoa plantations, due to the lack of means to have them felled, and they avoid destroying their cocoa plantations when they fall. Table 2 shows the ten most important species for women, ranked in descending order.

Of all the species present in the study area, women value *Dioscorea sp*, *Musa paradisiaca*, *Xanthosoma mafaffa* and *Elaeis guineensis* with 29%, 18%, 12% and 7% respectively. Women find food satisfaction in these fruit species

In addition to cocoa trees (*Theobroma cacao*), women in the study area prefer plants (Figure 17) with a high commercial value, such as *Musa paradisiaca* (25%), *Persea americana* (21%), *Citrus sinensis* (12%) and *Manihot esculenta* (11%). The shows the hierarchical distribution of plants with preferential commercial value in the eyes of women.

Table 2 Species hierarchy for each use in the study

Self-consumption	**Sale**	**Shade**	**Medicinal**	**Lumber and firewood**	**Fertilizer**	**Social**
Dioscorea spp (29.47 %)	*Musa paradisiaca* (25 %)	*Ceiba pentandra* (19.74 %)	*Alstonia boonei* (21.64%)	*Milicia excelsa* (28 %)	*Ceiba pentandra* (41.19 %)	*Musa paradisiaca* (16.55 %)
Musa paradisiaca (18 %)	*Persea americana* (21 %)	*Milicia excelsa* (11.30 %)	*Alchornea cordifolia* (17 %)	*Albizia zygia* (19 %)	*Milicia excelsa* (18.91 %)	*Citrus sinensis* (14.76 %)
Xanthosoma mafaffa (12 %)	*Citrus sinensis* (12 %)	*Triplochyton scleroxylon* (8.86 %)	*Ricinodendron heudelotii* (14.08 %)	*Triplochyton scleroxylon* (14 %)	*Triplochyton scleroxylon* (9.74 %)	*Persea americana* (13.51%)
Manihot esculenta (7 %)	*Manihot esculenta* (11 %)	*Terminalia superba* (7.99 %)	*Entandrophragma angolense* (13.44%)	*Terminalia superba* (7 %)	*Zanthoxylum zanthoxyloides* (8.64 %)	*Elaeis guineensis* (11.89 %)
Elaeis guineensis (7 %)	*Xanthosoma mafaffa* (5 %)	*Alstonia boonei* (7.55 %)	*Morinda lucida* (4.53 %)	*Ceiba pentandra* (6 %)	*Gliricidia sepium* (8.26 %)	*Solanum melongena* (9.11 %)
Solanum melongena (4 %)	*Citrus reticulata* (4 %)	*Persea americana* (7. 03 %)	*Spondias mombin* (3.70%)	*Zanthoxylum zanthoxyloides* (4 %)	*Terminalia superba* (6.39 %)	*Musa sapientum* (6.44 %)
Mangifera indica (3 %)	*Ricinodendron heudelotii* (4 %)	*Cola gigantea* (4.30%)	*Psidium guayava* (3.68 %)	*Terminalia superba* (3 %)	*Bombax buonopozense* (4.01 %)	*Dioscorea spp* (3.77 %)
Abelmoschus esculentus (3 %)	*Elaeis guineensis* (3%)	*Zanthoxylum zanthoxyloides* (3.24 %)	*Cola gigantea* (3.03%)	*Pycnanthus angolensis* (3 %)	*Alstonia boonei* (3.06 %)	*Citrus reticulata* (3.48 %)
Solanum indicum (2 %)	*Solanum melongena* (3 %)	*Ricinodendron heudelotii* (2.93 %)	*Carapa procera* (3.03%)	*Bombax buonopozense* (2 %)	*Nesogordonia papaverifera* (0.4 %)	*Psidium guayava* (3.32 %)
Capsicum frutescens (2 %)	*Capsicum frutescens* (2 %)	*Mangifera indica* (2.33 %)	*Persea americana* (2.69%)	*Antiaris toxicaria* (2 %)	*Morinda lucida* (0,4 %)	*Garcinia kola* (2.98 %)
Others (14.53 %)	Others (10 %)	Others (27.66%)	Others (16.21 %)	Others (11 %)	Others (0%)	Others (14.19 %)

Analysis of the data collected during the survey shows that *Ceiba pentandra* (19.74%), *Milicia excelsa* (11.30%), *Triplochiton scleroxylon* (8.86%) and *Terminalia superba* (7.99%) are the trees that women believe provide good shade for cocoa trees.

In the study area, *Alstonia boonei* (21.63%), *Alchornea cordifolia* (17%), *Ricinodendron heudelotii* (14.08%) and *Entandrophragma angolense* (13.44%) are highly valued as medicinal plants by women in central Côte d'Ivoire to treat ailments.

For firewood and lumber, women said they preferred *Milicia excelsa* (28%), *Albizia zygia* (19%), *Triplochiton scleroxylon* (14%), and *Terminalia superba* (7%). Cocoa wood is used when cut or pruned by the grower. Branches are used for firewood.

Producers cited *Ceiba pentandra* (41.19%), *Milicia excelsa* (18.91%), *Triplochiton scleroxylon* (9.74%) and *Zanthoxylum zanthoxyloides* (8.64%) as plants that could fertilize the soil.

Species such as *Musa paradisiaca* (16.55%), *Citrus sinensis* (14.76%), *Persea americana* (13.51%) and *Elaeis guineensis* (11.90%) have very high social values and are likely to bring satisfaction to their guests.

5. Discussion

5.1. Composition and diversity of species associated with cocoa trees in the study area

The synthesis of survey data and direct observations yielded a list of 79 plant species associated with cocoa trees. This floristic richness is higher than that obtained by Jiofack et al. (2013) with 59 species; Laird et al. (2007) with 50 species; Oke and Odebiyi (2007), 45 plant species. In cocoa plantations in the same study area, Kpangui (2015) recorded 176 species, Kouadio (2019) recorded 65 species. Indeed, Kpangui worked in both sacred forests and cocoa agroforests in the said area. These results are similar to those of Kpangui et al. (2015) and Kossonou (2020), whose studies in the Central Cameroon region revealed significant species richness in SAFc. They found 204, 164 and 145 species respectively in cocoa plantations. These figures show the degree of pressure and anthropization in the forests and the forest-savanna transition zone. The study found that native species spared (50) outnumbered introduced species (29) in the SAFc controlled by women. Indeed, people prefer to leave certain plant species in place because of their knowledge of these species, or at least because of the influence that these species mostly have on the staple crop. When the farmer wants to establish his plantation, he clears the area, leaving a few local species in place, either to shade the young cocoa plants or for other purposes. However, the number of species spared is higher than that obtained by Kouadio (2019), who worked in the same area as ours.

5.2. Use values of species associated with cocoa trees in cocoa-based agroforestry systems in the study area

Self-consumption is the primary function taken into account by women. For them, the species present in cocoa plantations are not kept or introduced at random. It's the result of eating habits that are the guiding principle. For them, these species help to provide foodstuffs such as leaves, condiments, wine, fruit and edible mushrooms. Such observations are contrary to those obtained by Todem (2005), Morgane (2008) and Kwesseu (2010). For the latter, self-consumption would be ranked second to selling, which they favor. In addition, Kpangui (2015), in his work in the same study area, states that plants for food use rank third among the species used by populations. This may be due to the fact that these authors had interviewed more men than women, as men's perception of these species differs from that of women. Furthermore, our results are in line with those of ICRAF (2015) who ranked the food use of species associated with cocoa trees in first place with a rate of 49.2% and 51.38% respectively during their work on “Quelle diversification pour une production durable du cacao?”. Experience of the V4C project”. During the survey, women farmers told us that their main objective in setting up cocoa farms was to earn money by selling dried beans. Following the drastic drop in the purchase price of merchantable cocoa to male and female farmers, the introduction of fruit trees very quickly helped to increase income (Tano, 2012). The highly representative value attributed in this case to the sales function, expresses the actors' strategy to diversify sources of income and even to live easily.

The study revealed that shading was the third most important use cited by women in the Kokumbo zone. In this study, growers left trees in cocoa agroforestry systems to shade cocoa trees, and subsequently found the diversity of trees to be important. Paradoxically, the studies carried out by Todem (2005) and Morgane (2008) showed that this function was the main one for trees in cocoa farms. Traditional medicine for women ranks fifth as the use of species associated with cocoa trees in their plantations. For these women, the agroforest is a rich environment for medicinal products. Leaves, bark, roots and fruit are used to treat diseases. Similarly, Sanial (2015) describes cocoa plantations as a veritable pharmacy. Thus, women's mastery of this diversified pharmacopoeia limits their presence in hospitals. These assertions confirm those of Kwesseu (2010) and Jagoret et al. (2014). Women producers introduce and maintain fertilizing plants in their cocoa farms during their installation and during the life cycle of the cocoa trees. One example is *Gliricidia sepium*, whose leaves are used as a biofertilizer in the Central and cocoa-growing areas of Côte d'Ivoire. According to the latter, these plants often shade young cocoa trees, capture atmospheric nitrogen for assimilation and enrich the soil. These same results were obtained by Kouamé (2007) in west-central Côte d'Ivoire. The social aspect of species associated with cocoa comes seventh and last in the ranking. In cocoa agroforests, women find plants used for traditional rituals. Most

of these rites are performed during widowhood. In addition, fruit, palm wine and many other products from cocoa-based agroforestry systems are used to welcome guests according to African traditions.

5.3. Associated species preferred by women in SAFc

The results reveal that women in the study area initially have a high preference for *Dioscorea spp* (28.67%), *Musa paradisiaca* (17.51%) and *Xanthosoma mafaffa* (12.16%) for consumption. This choice of certain foods can be explained by the fact that the staple diet of the "V Baoulé" people is based on starchy foods (yams and bananas), vegetables (cheese leaves), fruits eaten raw (avocado) and beverages (palm wine). Our observations are similar to those of Herzog (1992) in the same study area. For this author, the staple diet of the "V Baoulé" people is based on the above-mentioned starches. According to this author, the nutritional value of certain species, including *Elaeis guineensis* and *Ricinodendron heudelotii*, enabled people to cover their energy and vitamin requirements. Cocoa agroforests are home to important varieties of fruit species with very high commercial value, such as *Musa paradisiaca*, *Persea americana*, *Citrus sinensis* and *Manihot esculenta*. Some of these species have been cited by Todem (2005) as species associated with cocoa plantations with very high commercial value. Indeed, the wide variety of cocoa agroforestry systems could provide rural populations with additional income, particularly women and children (Herzog, 1994 ; Mollet et al., 2000 ; Sonwa et al., 2001). Asare and David (2010) have also shown that in Ghana, farmers prefer to introduce plantain and manioc to their cocoa plantations. Throughout the study area, *Ceiba pentandra*, *Milicia excelsa* AND *Triplochiton scleroxylon* are trees that women consider to provide shade for cocoa trees. These results are in line with those presented by Legendre and Legendre (2008), who distinguish between plants providing weak shade, such as *Canarium schweinfurthii*, *Pterocarpus soyauxii* and *Elaeis guineensis*, and those providing strong shade, such as *Persea americana*, *Dacryodes edulis*, *Ceiba pentandra*, *Milicia excelsa* et *Ricinodendron heudelotii*. The women prefer *Albizia zygia*, *Triplochiton scleroxylon* and *Terminalia superba* as firewood. According to these women, these forest species provide highly incandescent fires for cooking household food. These findings are in line with those of Kwesseu (2010), who asserted that some of the above-mentioned species are appreciated by farmers for the excellent fires they provide in Central Cameroon. Cocoa wood is used when it is cut or when the producer prunes it. In this way, the branches are used for firewood. 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 household energy. They are also an important source of income for young people, who make collecting wood their main activity. Female growers said they preferred *Ceiba pentandra*, *Milicia excelsa*, *Triplochiton scleroxylon* and *Zanthoxylum zanthoxyloides* to *Ceiba pentandra* as fertilizer plants in cocoa plantations. The rapid decomposition of the leaves of these species enriches the soil, thereby increasing cocoa production. Some of these species are in line with the findings of Mbolo (2002).

6. Conclusion

In central Côte d'Ivoire, mainly in the Toumodi Department, this study was undertaken to assess the importance of species associated with cocoa trees for women in terms of function and use. The methodological approach adopted in this study demonstrated the importance of species associated with cocoa trees for women. The various surveys and analyses revealed that of the 268 women interviewed, 31.34% owned a cocoa farm, 84.33% were married and 69.03% were at least 50 years old. The majority of these women producers are of Ivorian origin (92.54%), dominated by Baoule natives (88.06%). In the area, 34.7% of the women surveyed had attended school. In addition, the results of surveys coupled with itinerant surveys enabled us to identify a total of 79 plant species, divided into 67 genera, seven (7) uses and 31 families. Among the species associated with cocoa trees, 29 are introduced species, compared with 50 that have been spared. In short, women attach a great deal of importance to associated species. However, they place more emphasis on self-consumption (43.32%) and sale (35.21%). This shows that far from diversifying cocoa-based agroforests, it would be important to focus on cocoa production and then diversify it with fruit (36) and forest (43) species of high consumption, high fertility, regular shade, firewood and timber, medicinal value and capable of sustainably satisfying women in the sale of products from species associated with cocoa trees. On the whole, women producers showed a preference for *Dioscorea spp* and *Musa paradisiaca* in terms of food. *Musa paradisiaca* and *Persea americana* are the most profitable for women producers. The economic value of the species associated with cocoa trees preferred by women needs to be determined so that they can be domesticated, valued and better perceived for their importance in the household economy and their contribution to the financial empowerment of rural women.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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