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Migration and Agricultural Practices in the Peripheral Areas of Côte d'Ivoire State-Owned Forests

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Abstract: Côte d'Ivoire's rural areas adjacent to the state-owned areas of the southern half of the country, such as classified forests, are experiencing significant migratory flows due to their agricultural potential. The population movements in these rural areas have changed the rural landscape. The general objective of this study was to identify the peasant innovations implemented in these rural areas adjacent to the state's forest domains in a context of land saturation caused by migratory flows. This objective was elucidated from the case of the classified forest of Haut-Sassandra (CFHS). To achieve this, surveys were conducted in 11 villages on the periphery of the FCHS to determine the profile of planters and the main crops grown. Subsequently, floristic inventories were carried out on farms to analyse the diversity of associated species. Analyses showed that the rural populations of the CFHS are mainly composed of Allochthones (64%). Four innovative production systems were identified: a cashew-based production system, a cocoa-based production system, a coffee-based production system and a coffee- and cocoa-based production system. These farmer innovations based on agroforestry practices make it possible to restore impoverished lands and fight against climatic hazards. Consequently, these local practices deserve to be popularised in areas of strong land pressure as strategies to overcome the shortage of arable land and fluctuating prices of agricultural production.

Keywords: agroforestry; plantation economy; perennial crops; farmer innovations; Côte d'Ivoire

1. Introduction

In tropical regions, family farming is the main source of income for rural populations [1]. In Africa, this agriculture mobilises more than 70% of the population in rural areas and contributes 50–70% of the countries' gross domestic product [2,3]. Particularly in Côte d'Ivoire, agriculture is one of the main pillars of economic development. Indeed, before independence, Côte d'Ivoire focused its economic development on agriculture, mainly coffee and then cocoa. After independence, public policies contributed to farmers' preference for cocoa, which became the main source of agricultural income for both the Ivorian population and the State. There, agriculture, which is mainly dominated by cocoa cultivation (or cocoa farming), has caused a major change in the Ivorian forest landscape and social fabric since the early 1960s [4,5]. Indeed, cocoa farming is still manual and subject to the availability of forests, leading to massive deforestation in Côte d'Ivoire. This decrease in forest cover, combined with the ageing of orchards and the proliferation of cocoa swollen shoot viruses, is causing the cocoa economy to shift from the southeast to the southwest through the central-west, depending on the availability of forests in these regions. This shift in the cocoa economy has exacerbated pressures on arable land and remaining forests [6]. The migratory flow generated by the displacement of the cocoa economy also increased during the decade of politico-military crisis of 2002–2011 in the central-west region [7] and would have led to a saturation of rural areas [8].

Faced with ageing orchards, the proliferation of cocoa swollen shoot viruses and land saturation in rural areas, many producers have infiltrated most protected areas and converted large areas into cropland [7]. This is the case of the classified forest of Haut-Sassandra (CFHS) in central-western Côte d'Ivoire, which lost more than 70% of its forest area during the politico-military crisis [9].

To confront these constraints (ageing orchards, proliferation of cocoa shoot viruses and land saturation), what adaptation or bypass strategies do farmers use to recover or capture forest rents? Similarly, is there a link between these current innovations and the recent or old origin of farmers?

In order to address these concerns, the overall objective of this study was to identify farmer innovations in rural areas of protected forest areas, in a context of land saturation as a result of migration flows, based on a case study of the CFHS. Thus, understanding these farmer innovations will ensure sustainable agriculture in Côte d'Ivoire.

2. Methodology

2.1. Study Site

Côte d'Ivoire is located in West Africa in the humid intertropical zone. It is bordered to the east by Ghana, to the north by Burkina Faso and Mali and to the west by Guinea and Liberia. It is bordered to the south by the Gulf of Guinea. The soils found there are ferralitic soils, ferruginous soils (lateritic armour) occupying tropical climate zones and hydromorphic soils in swampy formations and some river plains. While the forest occupied 24% of the country's surface area in 1960, it has now fallen below 11% in favour of farms dominated by cocoa cultivation. Côte d'Ivoire is the world's largest producer of cocoa beans, with more than 2 billion t per year. Apart from cocoa, Côte d'Ivoire is the leading producer of cashew nuts, with 700,000 t, and the third largest coffee producer in the world, with more than 120,000 t. Authors have noted that most of Côte d'Ivoire's cocoa production comes from protected areas [9,10].

This current work was carried out in the CFHS rural area of central-west Côte d'Ivoire between 6°50 and 7°24 north latitude and 6°51 and 7°05 west longitude (Figure 1). Located in the second cocoa production area of Côte d'Ivoire, the vegetation belongs to the semideciduous dense rainforest domain characterised by *Celtis* spp. and *Triplochiton scleroxylon* (K. Schum) [11]. The CFHS is an area managed for satisfying the purpose of timber production. In this protected area, hunting, animal capture, and destruction as well as collection of plants are prohibited, except for scientific reasons or for the need of management.

The population bordering the CFHS is composed of indigenous people (belonging to the Niédéboua, Niaboua and Gouro ethnic groups); Allochtones, dominated by the Baoulé ethnic group, who came mainly from the central region; and Allogenes from the hinterland countries neighbouring Côte d'Ivoire, mainly Burkina Faso [12]. The relief is largely made up of a plateau with many valleys. Soils of ferralitic composition are suitable for agriculture. These natural conditions suitable for agriculture have resulted in a strong settlement of populations in this region practicing perennial crops, such as cocoa, coffee, rubber, cashew nuts and so forth, and food crops.

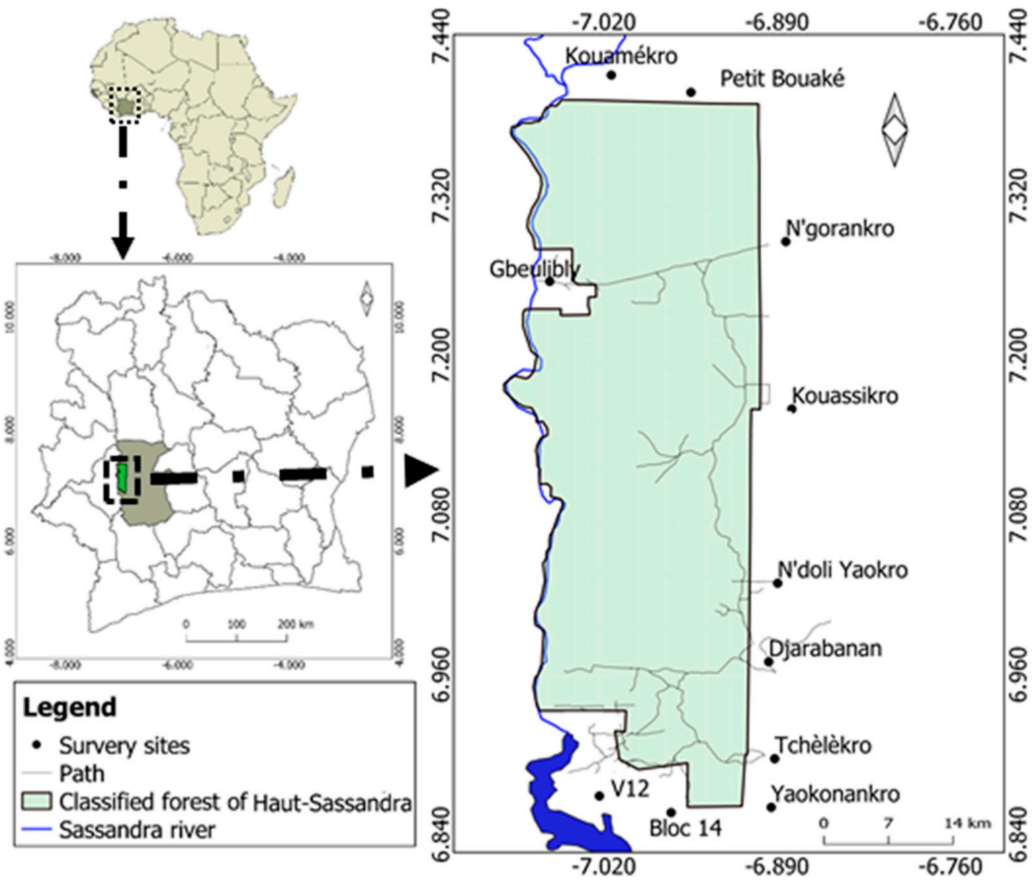

Figure 1. Location of the classified forest of Haut-Sassandra and the villages surveyed in the central-west region of Côte d'Ivoire.

2.2. Method of Collecting Data in the Field

Two methods were used to collect data in the study area: socio-agronomic surveys and floristic inventories in plantations. The surveys were carried out among peasant heads of households in the 11 villages bordering the CFHS using a questionnaire. These individual surveys focused on the sociodemographic characteristics of farmers (age of the farmer, level of education, origin of planters and marital status) and the characteristics of agrosystems (crops grown, age of crops and associated tree species).

Six villages were selected to carry out botanical inventories on the farms of the populations previously surveyed. The combination of surface exploration and itinerant prospecting was used for floristic inventories. The area surveys consisted of arranging 625 m^2 (25 × 25 m) plots in the various agrosystems [13]. A total of 156 plots were placed in 91 agricultural plantations on the periphery of the CFHS. All plant species found in the plots were identified. Then, all individuals of perennial agricultural species and associated non-agricultural woody species were counted in each plot to assess the horizontal structure (density) of the plots. Subsequently, mobile surveys were carried out to establish the general floristic list. These surveys consisted of browsing the plantations visited in different directions and identifying all plant species not inventoried in the plots, without considering their abundance or size [14,15]. In addition, information on the use of species associated with perennial crops was provided to plantation owners.

2.3. Analysis of Sociodemographic Characteristics and Species Diversity Associated with Cultures

The collected data were entered and encoded using Sphinx 2.5 and Excel 2016 software. The cross-referencing of the information received during these surveys made it possible to highlight the frequencies of the variables of the sociodemographic characteristics of the farmers.

The classification of plant species used was that of Angiosperm Phylogeny Group III (APG III) [16]. Agro-biodiversity was assessed by calculating specific wealth and the Shannon diversity index [17], and the distribution of associated species in different environments was assessed on the basis of the Piélou equitability index [18]. Species richness is the number of plant species present on a site. The Shannon diversity index reflects the diversity of the species that make up stands in an environment. It establishes a link between the number of species and the number of individuals in the same ecosystem or community. The Pielou equitability index makes it possible to measure the even distribution of the species in the stand in relation to an equal theoretical distribution for all species. It varies from 0 to 1. Structural diversity was determined from the calculation of the density of cultivated and associated species. Similarly, the relative frequency (F), expressed as a percentage, was determined for a given species in order to determine the most represented species in the plantations (Table 1).

Table 1. Mathematical formulas of the calculated floristic and structural indices.

Indices	Equations
Relative frequency (%)	F = (n_i/N)*100
Shannon index (H)	$H = -\sum (n\_iN) * \ln(n\_iN)$
Pielou equitability index (E)	$E = \frac{H}{\ln S}$
Individual density (d) indiv/ha	$d = \frac{N}{s}$

n_i: number of individuals of a species i; N: total number of individuals; S: total number of species of a biotope; d: density of individuals; s: area in hectares.

To compare the different categories of plantations, analysis of variance (ANOVA) tests with a factor were carried out on the floristic parameters (richness, composition and diversity indices) and the structural parameters (density) calculated. When a significant difference was observed between the means for a given parameter, Tukey's test was performed to identify homogeneous classes. The R software was used for all statistical tests.

2.4. Identification of Agricultural Production Systems Adopted by Farmers

To understand the relationships between the origin of planters and agricultural practices, a multiple factor analysis (MFA) coupled with a hierarchical ascending classification (HAC) was conducted. This analysis is recommended to evaluate the relationships between several contingency tables with common lines [19]. The descriptive variables considered were, on the one hand, qualitative parameters such as the origin of the populations and the culture practiced, and on the other hand, quantitative parameters such as the age and density of the cultures practiced and the species associated (i.e., richness and species diversity). For each of the variables, a multiple comparative test was performed between the mean values of each group and the overall mean to identify those which best characterised the group. All these analyses were carried out using the FactoMine Package of the R software [20].

3. Results

3.1. Profile of Producers and Characteristics of the Plantations Located in the Area

The surveys conducted made it possible to interview 264 heads of households on the periphery of the CFHS. The respondents were 64% Allochthones, 27% Aboriginal and 9% Allogenes. The age of the respondents varied from 18 to 85 years. Most of the growers surveyed were adults (56.82%) aged between 35 and 59 years. Regarding the level of education of farmers, 48% of respondents were illiterate. The people who attended school mainly had primary (27%) or secondary (23%) education. Only 1% of people had completed higher and Koranic education level. The educational level of the heads of households interviewed was very low.

The perennial crops grown on the periphery are mainly cocoa trees, which occupy 41% of the land, followed by coffee trees (34%) and cashew (25%). Considering the average age of the crops, the analyses indicated that on the periphery, cocoa and coffee farms are the oldest, with an average age of 22 years for each. Cashew is a recent crop, with an average age of 3 years (Table 2).

Table 2. Summary of variables of sociodemographic characteristics of actors and main cultures practiced.

Variables	Modality	Proportion (%)
Origin	Aboriginal people	29.55
	Allochtone	60.98
	Allogenic	9.47
Age	<35 years	23.86
	[35–59] years	56.82
	≥60 years	19.32
Educational level	Illiterate	48
	Primary school	27
	Secondary school	23
	Superior	1
	Koranic school	1
Main crops practiced	Cocoa	41
	Coffee	34
	Cashew	25
Average age of crops	Cocoa	22
	Coffee	22
	Cashew	3

3.2. *Specific and Structural Diversity of Cocoa Plantations*

The inventories carried out made it possible to identify 148 plant species introduced or conserved in the plantations. They are divided into 88 genera and 38 plant families. Of these species, six are represented in almost all plots with a frequency of occurrence greater than 30%. This is *Elaeis guineensis* which was found in all plots with a rate of 100%. In contrast, *Citrus sinensis, Mangifera indica, Persea americana, Psidium guajava, Ficus exasperata*, were found in 59%, 53%, 47%, 38%, 33% of the plots respectively (Figure 2).

The diversity of the flora present in the plantations varies according to the origin of the owners of the plots (Table 3). Thus, 70 species were recorded in native plantations, 68 species in Allochtones and 66 species in Allogenes. Regarding the average specific richness, the highest average was observed in plantations held by nonindigenous and indigenous people, with eight and seven species, respectively. For the Shannon index, the calculated average values were very low. They varied from 1.22 to 1.42 in the Allochtone and Allogen plantations, respectively. No significant difference was observed between the value of the Shannon index at the level of farms in the different communities. The average value of the equity index was very relevant in the plantations of the different communities. The different equity indices calculated revealed that species are equitably spread across plantations in the three communities. It varied from 0.81 to 0.87, with the highest value in Allochtone plantations. However, there was no statistical difference between these values. Crop density was found to vary according to speculation and the origin of producers. At the level of cocoa farms, the density varies from 678 to 913 individuals per hectare. The highest average density of cocoa stems was observed among indigenous peoples. In coffee plantations, the average stem density varies from 280 to 709 individuals per hectare. The average density of coffee stems is high in Allogenic plantations, with an average of 709 individuals per hectare. In cashew plantations, the average stem density varies from 68 to 220 individuals per hectare. The highest average stem density was observed in Allochtones.

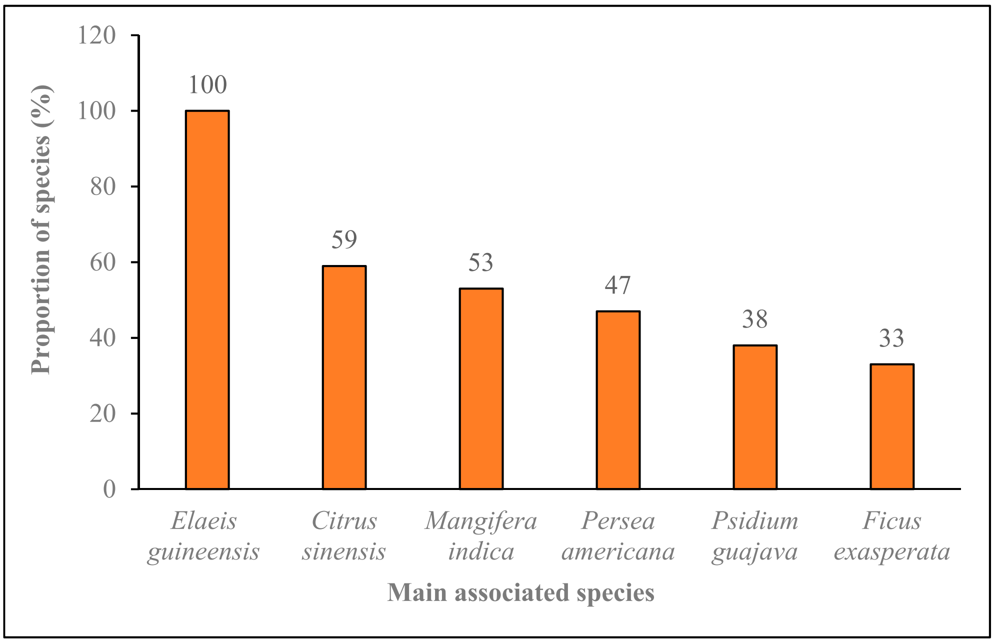

Figure 2. Distribution of the most common species found in plantations.

Table 3. Diversity indices calculated in the plots according to the origin of the producers.

Floral and Structural Parameters		Allochtone	Aboriginal People	Allogenic	Total
Number of species	Total	68	70	66	152
	Average/625 m^2	5b	7a	8a	6
Diversity indices	Shannon's index	1.22a	1.28a	1.42a	1.36
	Piélou equitability	0.87a	0.81a	0.84a	0.85
	Density of cashew trees (indiv/ha)	94a	220b	68a	152
	Density of cocoa trees (indiv/ha)	913a	678a	867a	785
	Density of coffee trees (indiv/ha)	441a	280a	709b	411

indiv/ha: individual per hectare. For each line, the values followed by the same letter are not significantly different at the 5% threshold.

3.3. Use Values of Species Found in Cocoa Plantations

The plantation surveys identified six main types of use of the species (Figure 3): medicinal use (*A. boonei*, *G. kola*, etc.), food use (*P. americana*, *E. guineensis*, etc.), timber use (*T. superba*, *C. pentandra*, etc.), shading use (*M. excelsa*, *B. costatum*, etc.), soil fertility (*Albizia* sp., *L. nigritana*, etc.) and other uses (cultural, firewood, craft and support for the yams' stems). The list of species and their uses can be found in the supplementary document (Table S1).

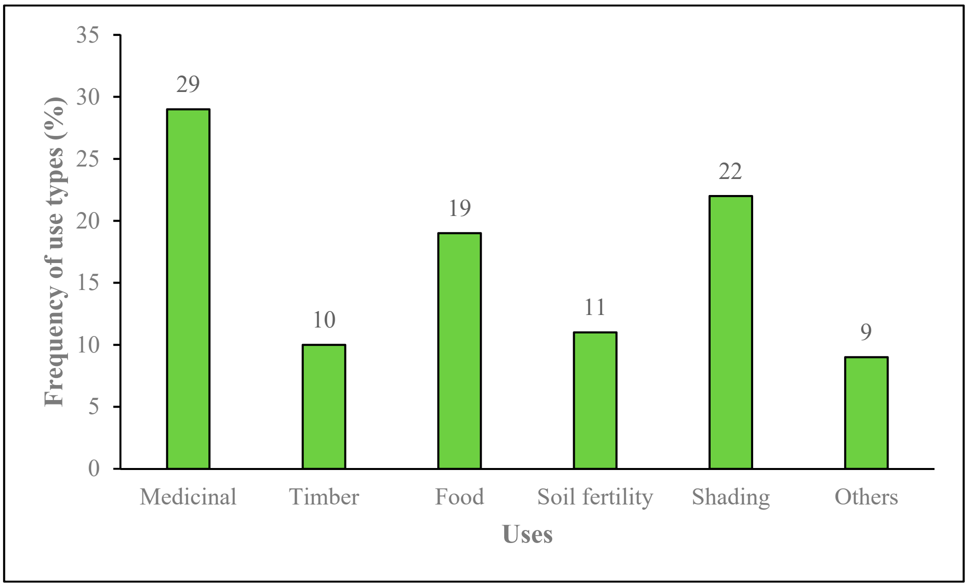

Figure 3. Distribution of uses of species associated with plantations.

3.4. Typology of Agroforestry Systems in the Rural Areas of the CFHS

The objective of creating a typology is to gather in the same group (class) plots with floral, structural and human similarities. This analysis allows for exploration of the relationships between the different variables collected in the plots. A data matrix was developed to describe the plots surveyed according to the different variables collected. Thus, four variables (age of cultivation, density of species and crops, plant diversity and origin of farmers) made it possible to define the typology of agroforestry systems according to communities. Four production systems have been identified (Figure 4).

The first system (G1) is represented by a cashew-based agroforestry system that is practiced mainly by Allochtones (38%). The average age of a cashew tree is 10 years, with an average density of 414 individuals per hectare. Farmers combine cocoa and coffee on the same plot. The average age of cocoa and coffee is 7 years. The average density of cocoa trees is 916 individuals per hectare and that of coffee is 258 individuals per hectare. The average density of associated species is 65 individuals per hectare. In this system, farmers first make cashew nuts, then introduce cocoa and coffee.

The second system (G2) is represented by a cocoa-based agroforestry system, held mainly by indigenous people (55.3%). The average age of a cocoa farm is 22 years, with an average density of 1086 individuals per hectare. The farmers combine coffee and cashew trees. The average age of coffee trees is 2 years and that of cashew trees is 1 year. The average density of coffee trees is 107 individuals per hectare and that of cashew trees is 100 individuals per hectare. The average density of associated species is low in this system, with a value of 79 individuals per hectare. This system corresponds to a conversion of old cocoa orchards into coffee and, recently, into cashew.

The third system (G3) is an agroforestry system based on coffee, set up mainly by Allochtones (60.5%). The average age of coffee trees is 28 years, with an average density of 726 individuals per hectare. The associated crops are cocoa and cashew. The average density of cocoa trees is 228 individuals per hectare and that of cashew trees is 54 individuals per hectare. The average age of cocoa is 11 years and that of cashew is 1 year. The density of associated species is low, with 83 individuals per hectare. Originally, this system corresponded to a conversion of old coffee orchards into cocoa trees, but recently, farmers have introduced cashew.

The fourth system (G4) is mainly represented by a cocoa–coffee-based agroforestry system led by Allogenes (48.1%) and indigenous peoples (44.4%). The average age of cocoa is 16 years and that of coffee is 12 years, with an average density of 940 individuals per hectare for cocoa and 679 individuals per hectare for coffee. There are also young cashew trees with an average age of 2 years. The average density of associated species is very high, with 288 individuals per hectare (Table 4). This system corresponds to a diversification of crops.

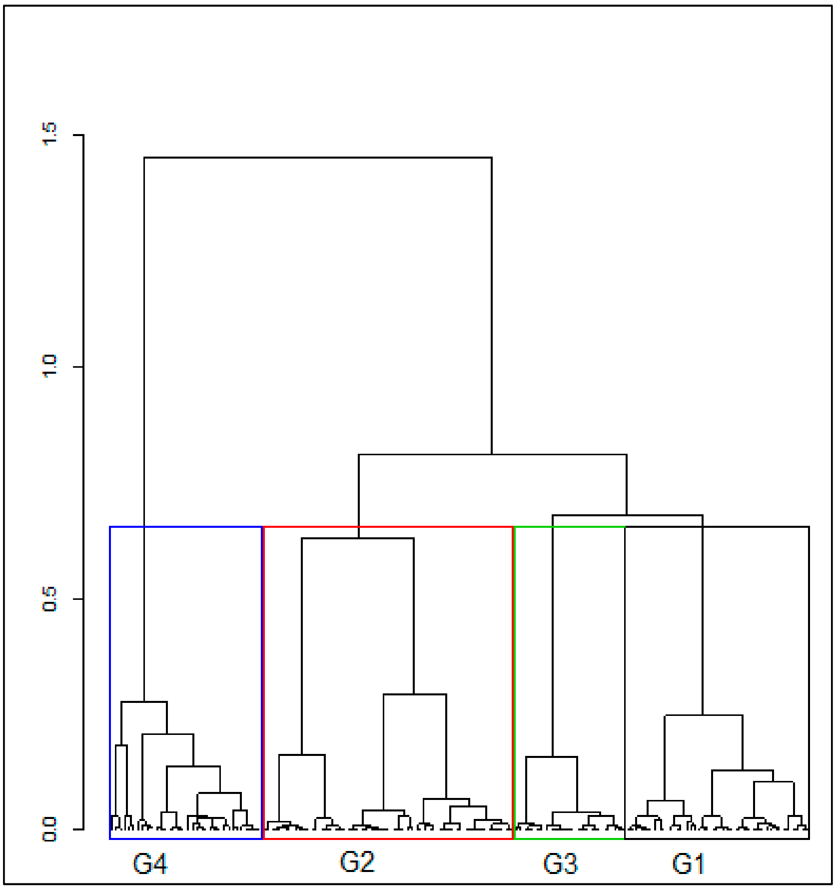

Figure 4. Ascending hierarchical classification of the 156 plots studied.

Table 4. Summary of qualitative and quantitative variables from the CFHS ascending hierarchical classification in rural areas.

Variables	Category	G1	G2	G3	G4	Test Statistics
Origin	Allochtone	83.30	42	60.50	7.40	56.62 ***
	Allogenic	13.90	6	20.90	48.10	
	Aboriginal people	2.80	52	18.60	44.40	
Age	Cocoa	7a	22c	11ab	16bc	0.18 ***
	Coffee	7a	3a	28c	12b	0.53 ***
	Cashew	10b	1a	1a	2a	0.49 ***
Density (indiv/ha)	Cocoa	916b	1086b	228a	940b	0.34 ***
	Coffee	258a	107a	726b	679b	0.37 ***
	Cashew	414b	100a	54a	56a	0.32 ***
	Associated species	65a	79a	83a	288b	0.53 ***
Floral diversity	Shannon's Index	1.08a	1.31b	1.28b	1.95c	0.45 ***
	Equitability Index	0.89b	0.86b	0.88b	0.75a	0.15 **
	Specific Richness	3.92a	4.94a	4.81a	13.89b	0.65 ***

indiv/ha: individuals per hectare. For each line, the values followed by the same letter (a, b, c) are not significantly different at the 5% threshold; significance level of the Fisher's tests: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

4. Discussion

4.1. Profile of Farmers in the Rural Areas of the CFHS

The surveys revealed a high proportion of Allochthones in rural areas. This proportion was caused by the displacement of the pioneer front from the central-eastern region to the central-western part of Côte d'Ivoire. Indeed, this pioneering front caused a significant movement of populations, mainly from the central region of the country, which led to the foundation of many villages and camps on the periphery of the CFHS. The analyses also showed that most cocoa farmers are adults. The dominance of adults in plantations is attributable to the fact that when family land is shared, the beneficiaries of arable land are exclusively adults [21]. According to the respondents, the young people serve as labour and will not be able to take possession of a plot until they are judged to be adults or they inherit the plantation after their father's death. These same findings have been observed in other regions of Côte d'Ivoire [21,22]. Moreover, research has already shown that young workers were the most numerous during the migration of the pioneer front from the centre-east to the centre-west of Côte d'Ivoire [6].

4.2. Variety of Species Knowledge Associated with Cocoa Plantations

Field investigations have shown that at the time of planting, farmers associate or preserve exotic or local fruit species such as *P. americana* (avocado), *C. sinensis* (orange), *M. indica* (mango), *P. guajava* (guava), *E. guineensis* (oil palm) and so forth. These species enable farmers to diversify their source of income and ensure their food security during the lean season. During this period, the fruits of these species are either consumed directly in the field or sold to traders or villagers who do not have any in their immediate environment. This work is similar to that of [23] in the long-term analysis and evaluation of complex agroforestry systems in central Cameroon. This researcher showed that, in addition to providing shade for cocoa, the related species provide farmers with a multitude of products (fruits, wood, leaves, bark, etc.), whether or not they are commercialised, contributing to self-sufficiency in food and household balance. The results also showed that the presence of a species in a plantation depends on the importance that the farmer attaches to it. Indeed, farmers preserve species that have symbolic or social value for them. This same observation was observed by [24] in the Bamiké countries. This author argues that the presence of a species in a plot or forest technical systems or its dynamics depends on the farmer's technical choices. Thus, the choice and number of species to be conserved depend on the farmer's origin. This situation has been observed in the savannah forest transition zone of Central Côte d'Ivoire [25] and in the semideciduous dense forest zone of central-west Côte d'Ivoire [21]. These authors argue that these preserved species are used for food, fuelwood and traditional medicine. According to them, this approach strongly influences the floristic composition of farms according to the origin of the communities [21]. Thus, our analyses have shown that Allogen and Aboriginal plantations are the most diversified. This high diversity of species in the plantations held by the Aboriginals could be explained by the fact that, being native to the study area, they have better control over the local flora. As a result, when they set up their farms, they spare several local species that are useful to them, as already pointed out in [21]. On the other hand, the high density of species observed in the plantations maintained by Allogenes is because they generally share the same plot with their Aboriginal guardian. In addition to the local species conserved by the natives on the plot, Allogenes prefer to add exotic species or adopt species from their area of origin instead.

The analyses also showed that the species preserved in the plantations are used for a variety of purposes, including medicine, food, timber, soil fertility and shade. Medicinal use is the most important, as already pointed out [26] in the Sudanese zone of Côte d'Ivoire and [27] in the humid forest zone in southern Cameroon. These authors demonstrate the perfect use of medicinal species by local populations. In addition to medicinal use, there is also food use. Species for food use occupy a special place. Indeed, when setting up the planting or selection of fruit species, farmers only retain species that are part of their diet or that can generate additional income.

4.3. Reconstruction of Traditional Agroforestry Systems by Communities

The typology of production systems has shown that the farming practices of populations differ according to both their origin and location. The production systems identified are characterised by the combination of three perennial crops (cocoa, cashew and coffee) in the same area. Four production systems have been identified, taking into account the various floristic and structural characteristics of perennial plantations in relation to the origins of populations. There are cashew-based production systems (G1), cocoa-based production systems (G2), coffee-based production systems (G3) and commercial polycultures (G4). Our results are similar to those obtained by [28] in traditional Mexican coffee systems. These authors identified in their work monocultures and commercial polycultures. These results reflect an evolution in cocoa replanting techniques in former production areas [29]. Using a similar analytical method, four agroforestry systems had been identified in Central Côte d'Ivoire [13]. Compared with these authors, coffee-based production systems and commercial polycultures are present in our work. The differences could be due to the fact that these authors carried out inventories in plantations maintained only by Allochtones.

Considering the age of perennial crops in these systems, it is thought that some may be a conversion from old to new crops or a diversification of crops. Indeed, in the first system (G1) held by Allochtones, cashew trees are the oldest, with a low density of associated species. This low density of associated species observed could be due to the fact that these are old rehabilitated plantations in which cashew is used as shade for young cocoa plants. Indeed, according to the Allochtone populations interviewed, cashew is a crop that is more resistant to drought and helps to protect young cocoa plants from climatic hazards.

The analyses also show that in the second and third systems (G2 and G3), maintained by the indigenous and Allochtone peoples respectively, there are cashew and coffee seedlings for the second system (G2) and cocoa and cashew seedlings for the third system (G3). This is explained by the fact that in the second system (G2), farmers convert cocoa trees into coffee trees, then recently, into cashew. Similarly, for the third production system (G3), old coffee plants are being converted into cocoa trees, and recently, farmers have been introducing cashew. However, the conversion of old cocoa and coffee orchards into cashew observed in production systems G2 and G3 is not occurring simultaneously, as Ruf [30] pointed out in Côte d'Ivoire. According to this author, in addition to protecting cocoa and coffee plants from climate change, this conversion is intended to combat swollen shoot disease. In systems G2 and G3, the average density of associated species is also low. This low average density of associated species is the result of the ageing of cocoa and coffee plantations. Indeed, the gradual decrease in the diversity of species associated with the ageing of orchards observed in these systems (G2 and G3) is explained by the fact that farmers select the species they consider useful when the plantation is in production. This same observation was noted in southern Cameroon [31,32] and in the classified Monogaga forest in southern Côte d'Ivoire [33]. These authors pointed out that reducing species density with the increasing age of cocoa plantations is a process common to tropical agroforestry systems to increase the production of young cocoa and coffee plants.

In the last system (G4), which is a mixture of coffee and cocoa seedlings and is mainly held by Allogenic and indigenous people, cashew seedlings with a high density of associated species appear. There are two possible reasons for the appearance of cashew seedlings. The first would concern the introduction of cashew used by farmers to restore soil fertility and control cocoa swollen shoot virus. The presence of cashew seedlings would also be a way for farmers to diversify their farms and sources of income, as had already been mentioned in Côte d'Ivoire [30]. In addition, the diversification of cocoa and coffee farms by the cashew tree would also be a response to climatic hazards and low yields [30].

All these cultural practices based on the association of perennial crops are the consequences of the depletion of forest reserves, as some authors had pointed out in the department of Oumé, in the central-western part of Côte d'Ivoire [34]. According to Ruf [30], in addition to the decline in forest rents, the practice of diversification or reconversion is a response of populations to droughts, fire risks and the difficulties of replanting cocoa. The introduction of the cashew tree is, therefore, an agroforestry innovation in response to these constraints.

5. Conclusions

The results obtained in this study made it possible to identify the peasant innovations implemented in the rural space of protected forests, in a context of land saturation caused by migratory flows. These innovations have been linked to the different indigenous, Allochtone and Allogenic origins of farmers. The analyses indicate that the different communities associate species with their exploitation and that the diversity of these species varies according to the communities.

This study also showed that these different communities have implemented innovative agricultural strategies based on the introduction of cashew nut cultivation, normally adapted to savannah areas, used by farmers in the southern forest as an alternative crop to restore impoverished land. These innovations are represented by four production systems, namely: cashew nut-based production system, aged cocoa-based production system, aged coffee-based production system and young coffee and cocoa-based production system. In addition, cashew cultivation is not only a total conversion of old cocoa or coffee orchards but also serves, in addition to restoring soil fertility, on the one hand, as shading useful to juvenile cocoa trees for their growth and development and, on the other hand, as a barrier to the spread of the cocoa swollen shoot virus and diversification of farmers' sources of income.

Finally, these peasant innovations need to be improved and promoted. It is therefore useful to integrate them into various agricultural development plans in order to ensure sustainable agriculture in Côte d'Ivoire in response to the increasing pressure on arable land.

Supplementary Materials: The following are available online at http://www.mdpi.com/2071-1050/11/22/6378/s1, Table S1: List of species and uses (a species can have several types of uses).

Author Contributions: The four coauthors contributed substantially to the study. They all participated in the field data collection and various analyses. The writing was done by Z.G.G. All authors read and approved the final manuscript.

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