International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print); 2222-5234 (Online)
Website: https://www.innspub.net
Email contact: info@innspub.net
Vol. 28, Issue: 4, p. 23-32, 2026

RESEARCH PAPER

OPEN ACCESS

Structural characteristics of populations of *Vitellaria paradoxa, Parkia biglobosa* and *Anacardium occidentale* in rice-growing areas of the Tioroniaradougou subprefecture (Northern Côte d'Ivoire)

Dofoungo Koné*[1,2], Sibirina Soro[2], Seguena Fofana[1], Zana Silue[1], Doudjo Noufou Ouattara[3,4], Eboua Narcisse Wandan[2]

[1]*Institute of Agropastoral Management, Peleforo Gon Coulibaly University, Korhogo, Côte d'Ivoire*
[2]*Laboratory of Science, Society and Environment, Félix Houphouët-Boigny National Polytechnic Institute, Yamoussoukro, Côte d'Ivoire*
[3]*Laboratory of Botany and Plant Diversity Valorization, Faculty of Natural Sciences, Nangui Abrogoua University, Abidjan, Côte d'Ivoire*
[4]*Swiss Center for Scientific Research in Côte d'Ivoire, Abidjan, Côte d'Ivoire*

Key words: Trees outside forests, Vegetation structure, *Vitellaria paradoxa*, *Parkia biglobosa*, *Anacardium occidentale*, Tioroniaradougou

Received: March 18, 2026 **Accepted:** April 01, 2026 **Published:** April 06, 2026

DOI: https://dx.doi.org/10.12692/ijb/28.4.23-32

ABSTRACT

In Côte d'Ivoire, trees outside forests are either planted or are remnants of the past that are maintained on agricultural farms. However, in rice-growing areas in the north of the country, few studies have been conducted on these species. This study aims to determine the demographic structure of *Vitellaria paradoxa, Parkia biglobosa*, and *Anacardium occidentale* in rice-based agrosystems in the subprefecture of Tioroniaradougou. Data were collected through floristic surveys conducted on 78 rice farms spread across three villages. The demographic structure of the studied species was determined based on the average tree density, the relative frequency of species, the diameter structure, and the basal area of the stand. The average plant density for the three species studied was 14.27 plants/ha in Fégboho and 9.79 plants/ha in Kaforo and Nambekaha. *Vitellaria paradoxa* was the species with the highest average plant density regardless of the location (6.72 plants/ha in Fégboho, 6.14 plants/ha in Nambekaha, and 5.76 plants/ha in Kaforo). *Vitellaria paradoxa* was also the most common species (found on 97.44% of farms), followed by *Parkia biglobosa* (93.59% of farms) and *Anacardium occidentale* (46.15% of farms). The diameter structure of the plants was bell-shaped for *Parkia biglobosa* and *Vitellaria paradoxa*, whereas it was "inverted J"-shaped for *Anacardium occidentale*. The *Vitellaria paradoxa* stand had the largest basal area (0.76 m^2/ha), followed by those of *Parkia biglobosa* (0.24 m^2/ha) and *Anacardium occidentale* (0.04 m^2/ha). Thus, the population structure of *Vitellaria paradoxa, Parkia biglobosa*, and *Anacardium occidentale* in rice-growing areas of the Tioroniaradougou subprefecture was determined.

***Corresponding author:** Dofoungo Koné ✉ asd41dof@gmail.com
https://orcid.org/0009-0000-2629-4906

Co-authors:

Doudjo N. Ouattara: https://orcid.org/0000-0003-1379-317X

Wandan E. Narcisse: https://orcid.org/0000-0002-2833-5369

INTRODUCTION

Plant diversity is recognized as a vital heritage shared by all of humanity (Manfo *et al.*, 2015). Studies of tree vegetation have long focused on forests at the expense of other tree-dominated ecosystems. However, with the issue of climate change, trees outside forests are becoming an increasingly critical factor for the sustainable management of natural resources and the preservation of biodiversity.

Trees outside forests are woody plants found on land that does not fall into the category of forest land (or forests) and other wooded areas (Bellefontaine *et al.*, 2001). Trees outside forests include woody plants found along roads, in stands smaller than 0.5 hectares, on grasslands, in grazing areas, on farms, in urban and suburban areas, or standing alone in the landscape (Bellefontaine *et al.*, 2001).

The important role that trees outside forests play for rural communities in terms of food, medicine, the economy, and the environment has been shown in several studies (Assogba *et al.*, 2017; Garba *et al.*, 2020; Chucha *et al.*, 2022; Murhula *et al.*, 2023; Rasmane *et al.*, 2023; Keita *et al.*, 2024). In terms of food, medicine, and the economy, trees outside forests are sources of food products, medicines, timber, fuelwood, and fodder. The collection and sale of these products constitute a source of income for rural populations. Thus, in rural areas, trees outside forests meet several of the population's needs and are integrated into their strategies for production, consumption, and income generation. Ecologically, trees outside forests contribute to soil protection against erosion, the preservation of biodiversity, carbon sequestration through increased biomass, and the resilience of ecosystems to climate change (Putra *et al.*, 2020; Tirkey *et al.*, 2024; Kolman *et al.*, 2025; Kouamé *et al.*, 2026; Pierre *et al.*, 2026).

In rural areas of Côte d'Ivoire, trees outside forests are generally integrated into agricultural farms (Kouadio *et al.*, 2021; Kolman *et al.*, 2025; Piba *et al.*, 2025; Soumah *et al.*, 2025; Kouadio *et al.*, 2026). Some trees outside forests are planted, while others are remnants of the past that have been preserved on farms (Bellefontaine *et al.*, 2001; Murhula *et al.*, 2023).

According to Azenge and Meniko (2020), the conservation of trees outside forests in agrosystems is linked to the goods and services they provide to farmers and, more generally, to rural populations. This is the case for *Vitellaria paradoxa, Parkia biglobosa,* and *Anacardium occidentale* in northern Côte d'Ivoire (Soro *et al.*, 2011; Ruf *et al.*, 2019; Appia *et al.*, 2023). However, few studies have been conducted on these species in rice-growing areas in the north of the country. The aim of this study was to determine the demographic structure of *Vitellaria paradoxa, Parkia biglobosa*, and *Anacardium occidentale* plants in rice-based agrosystems in the subprefecture of Tioroniaradougou.

MATERIALS AND METHODS

Study area

The study was conducted in the Tioroniaradougou Subprefecture (Fig. 1). This subprefecture is located in northern Côte d'Ivoire, an area influenced by a Sudanese tropical climate characterized by a rainy season lasting five months from June to October, with peak rainfall in August, and a seven-month dry season extending from November to May (Eldin, 1971).

According to Ndabalishye (1995), the average annual rainfall in this area is 1,277 mm, and the average annual temperature is 26.6 °C. The Tioroniaradougou Subprefecture belongs to the subsudanian phytogeographic sector of Côte d'Ivoire (Guillaumet and Adjanohoun, 1971). The vegetation types found in this area include dense dry forests, open forests, wooded savannas, and shrubby savannas (Kouamé, 2010).

Materials

Conducting this study required the use of biological and technical materials. The biological materials used in this study consisted of *Vitellaria paradoxa, Parkia biglobosa*, and *Anacardium occidentale* plants found on rice farms. The technical materials included a measuring tape for measuring tree circumference and floristic survey forms for recording observations and measurements.

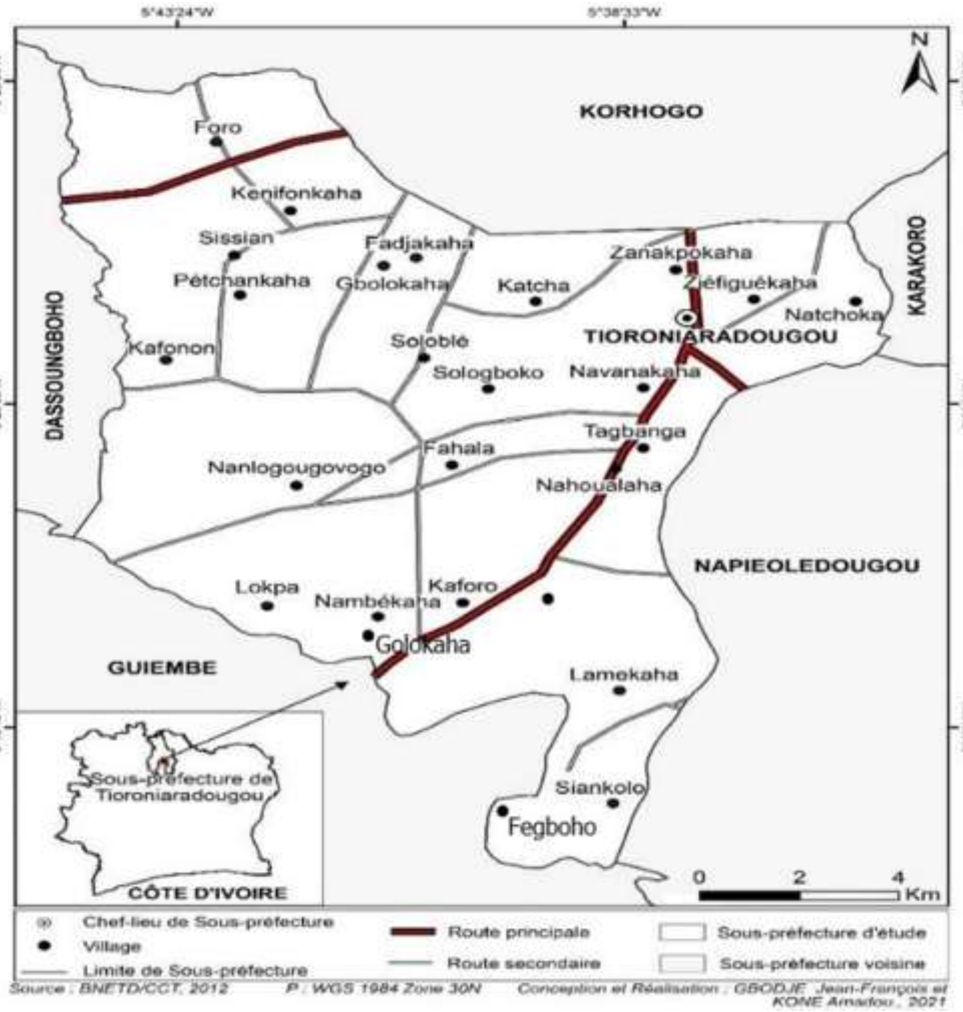

Fig. 1. Location of the Tioroniaradougou subprefecture

Data collection

The data were collected through floristic surveys conducted on 78 rice farms, including 30 in Nambekaha, 24 in Fégboho, and 24 in Kaforo in the subprefecture of Tioroniaradougou. The villages were selected based on the presence of rice farms in their areas and their easy accessibility. In each locality, farms were selected based on the producers' consent to participate in the study. On each rice farm, all Vitellaria paradoxa, Parkia biglobosa, and Anacardium occidentale trees were inventoried. The circumference at 1.30 m above ground level of each tree was measured to determine the diameter at breast height (DBH) at a later stage.

Data treatment

The floristic survey forms were analyzed manually. The resulting data were entered into an Excel 2016 spreadsheet. Dynamic cross-tabulation reports were used to provide information on the population structure of *Vitellaria paradoxa, Parkia biglobosa*, and *Anacardium occidentale*.

Data analysis

The demographic structure of the studied species was determined using the average density of woody plants (N), the relative frequency of species (FrR), the diameter structure of the stand, the basal area of the species (gi), and the basal area of the stands (G).

The average tree density (D) of a species is the ratio of the total number of its individuals to the total inventoried area (in ha). The average tree density (N) was calculated using the formula:

$$N = \frac{n}{S} \qquad (1)$$

where n is the total number of woody individuals recorded and S is the total area surveyed (in hectares).

The relative frequency of a species is the ratio of the number of farms where it is present to the total number of farms. This parameter measures the evenness of a species' distribution within an ecosystem. The relative frequency of species (FrR) was determined using the following formula :

$$F_rR = \left(\frac{f_i}{F}\right) \times 100 \qquad (2)$$

where f_i is the number of farms with species i and F is the total number of farms.

To determine the diameter structure of the stand, the diameter at breast height (DBH) of each tree was calculated using the following formula:

$$DBH = \frac{C}{\pi} \qquad (3)$$

where C is the circumference of the woody plant and π is equal to 3.14.

Next, the woody plants were divided into ten diameter classes, each spanning a range of 10 cm.

The basal area of a species (g) corresponds to the surface area (m²) occupied by the cross-sections of its woody individuals at a height of 1.30 m above the ground. The basal area of each species was calculated using the formula :

$$g = \sum \pi \frac{d_i^2}{4} \qquad (4)$$

where g is the basal area (in m²) of the species; d_i is the diameter at breast height (in meters) of tree i ; and π is equal to 3.14.

The basal area of a stand (G) is the sum of the basal areas (gi) of its woody individuals divided by the total surveyed area (S). In other terms, it is the ratio of the area (m²) occupied by the cross-sections of its woody individuals at 1.30 m above the ground to the total surveyed area (in ha). The basal area of the stand was calculated using the following formula:

$$G = \frac{1}{S} \times \sum g_i = \frac{1}{S} x \frac{\sum \pi d_i^2}{4} \qquad (5)$$

where g_i is the basal area (in m²) of tree i; d_i is the diameter at breast height (in meters) of tree i ; S is the total inventoried area (in hectares) ; and π is equal to 3.14.

RESULTS

Average plant density

When considering all plants of the three species studied, the highest average density (14.27 plants/ha) was recorded at Fégboho (Fig. 2). The plots at the other two sites had the same average density (9.79 plants/ha).

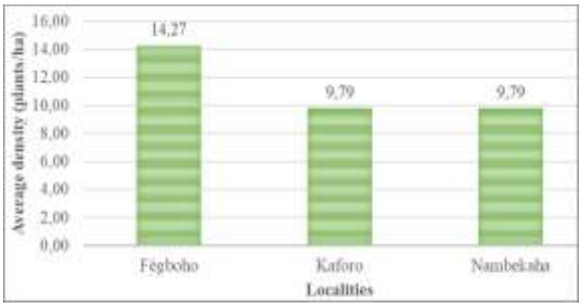

Fig. 2. Average plant density in different localities

The average plant density by species and location is shown in Fig. 3. Analysis of this parameter showed that *Vitellaria paradoxa* was the species with the highest number of individuals per unit area regardless of the location considered (6.72 plants/ha in Fégboho, 6.14 plants/ha in Nambekaha, and 5.76 plants/ha in Kaforo). In Fégboho, *Vitellaria paradoxa* was followed by *Anacardium occidentale* with an average density of 4.16 plants/ha. *Parkia biglobosa* was the species with the lowest average density (3.39 plants/ha) in Fégboho. However, in the plots at Kaforo and Nambekaha, *Vitellaria paradoxa* was followed by *Parkia biglobosa* with average densities of 2.87 plants/ha and 1.89 plants/ha, respectively. *Anacardium occidentale* was the species with the lowest average densities in these two locations (1.76 plants/ha in Nambekaha and 1.16 plants/ha in Kaforo).

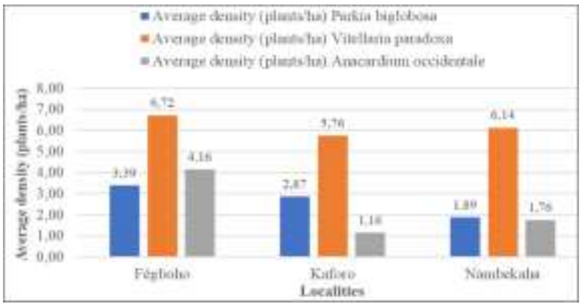

Fig. 3. Average plant density according to species and localities

Relative frequency of species

The relative frequency of each species across all study localities is shown in Fig. 4. The species *Vitellaria paradoxa*, found in 97.44% of the surveyed farms, showed the most regular distribution of individuals across the studied agrosystems. *Vitellaria paradoxa* was followed by *Parkia biglobosa*, whose individuals were recorded in 93.59% of the farms. *Anacardium occidentale* was the species with the lowest relative frequency, as its individuals were recorded in only 46.15% of the farms.

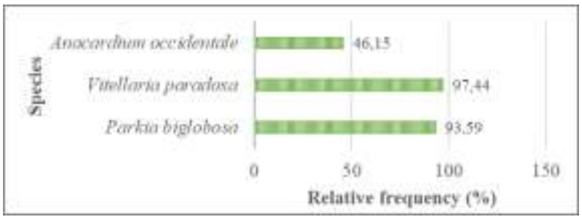

Fig. 4. Relative frequency of species for all localities

An analysis of the relative frequency of species by location (Fig. 5) revealed that *Vitellaria paradoxa* and *Parkia biglobosa* were the most common species in Kaforo. Indeed, individuals of these two species were recorded on all farms in Kaforo. In this locality, *Anacardium occidentale* was the least common species, as individuals of this species were present in only 33.33% of the farms. In the farms of Nambekaha and Fégboho, *Vitellaria paradoxa* was the most common species, with relative frequencies of 100% and 91.67%, respectively. *Vitellaria paradoxa* was followed by *Parkia biglobosa*, whose individuals were recorded in 96.67% of the farms in Nambekaha and 87.50% of those in Fégboho. In both of these localities, *Anacardium occidentale* was the least common species, with individuals present in 70.83% of the farms in Fégboho and 36.67% of those in Nambekaha.

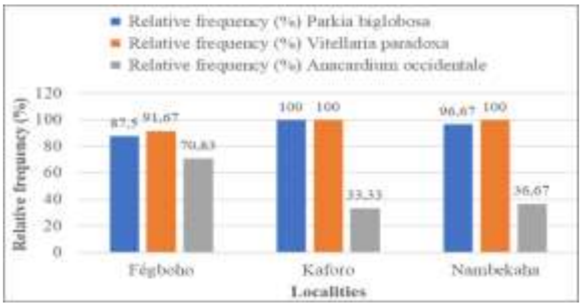

Fig. 5. Relative frequency of species in the different localities

Diametric structure of the stand

The distribution of plants across diameter classes followed a bell-shaped curve for *Parkia biglobosa* and *Vitellaria paradoxa* (Fig. 6 and 7). Indeed, for both species, plants with small diameters and those with large diameters were in the minority. The majority of plants belonged to the intermediate diameter classes. For *Parkia biglobosa*, the diameter class [20 cm; 30 [cm was the most abundant, with 80 plants (Fig. 6). The numbers of plants in the diameter classes decreased in an almost symmetrical pattern relative to the diameter class [20 cm; 30 cm [. For *Vitellaria paradoxa*, the most abundant diameter class, with 245 plants, was [30 cm ; 40 cm [(Fig. 7). The numbers of plants in the diameter classes decreased almost symmetrically relative to the diameter class [30 cm; 40 cm [.

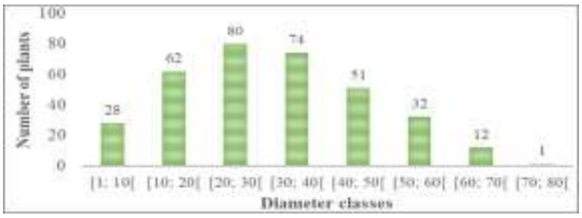

Fig. 6. Distribution of *Parkia biglobosa* plants in diameter classes

The distribution of *Anacardium occidentale* plants across diameter classes followed an "inverted J" shape (Fig. 8). The majority of plants belonged to the smaller diameter classes. In fact, the diameter classes with the highest number of plants were [1 cm; 10 cm [and [10 cm; 20 cm [, with 112 and 118 plants, respectively. Starting from the [10 cm; 20 cm [diameter class, the number of plants decreased steadily from the small-diameter classes to the large-diameter classes.

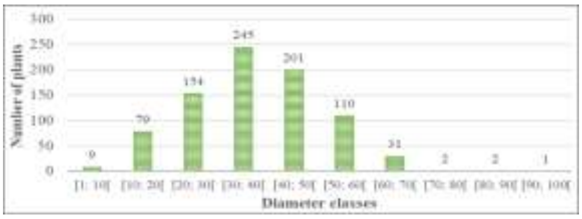

Fig. 7. Distribution of *Vitellaria paradoxa* plants in diameter classes

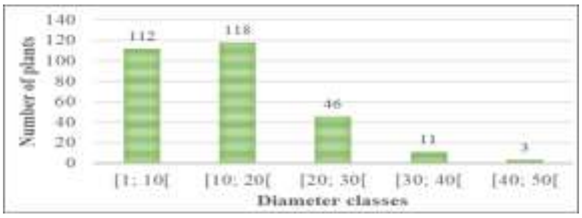

Fig. 8. Distribution of *Anacardium occidentale* plants in diameter classes

Basal area of species

The basal area of each species across all locations is shown in Fig. 9. The species *Vitellaria paradoxa* had the largest basal area (102.29 m²). *Vitellaria paradoxa* was followed by *Parkia biglobosa* with a basal area of 32.65 m². *Anacardium occidentale* was the species with the smallest basal area (5.84 m²).

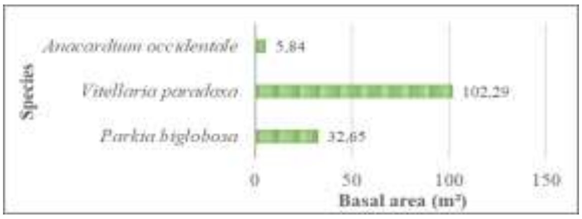

Fig. 9. Basal area of species for all localities

The basal area of the species by locality is shown in Fig. 10. Analysis of this parameter revealed that *Vitellaria paradoxa* had the largest basal area regardless of the locality (57.93 m² in Nambekaha, 25.64 m² in Kaforo, and 18.71 m² in Fégboho). At all three sites, *Vitellaria paradoxa* was followed by *Parkia biglobosa* (14.30 m² in Nambekaha, 10.60 m² in Kaforo, and 7.75 m² in Fégboho). *Anacardium occidentale* was the species with the smallest basal area in all three locations (2.74 m² in Nambekaha, 1.89 m² in Fégboho, and 1.21 m² in Kaforo).

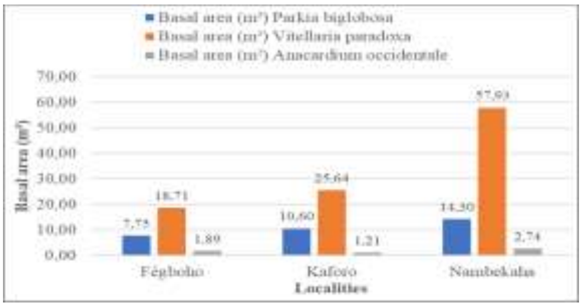

Fig. 10. Basal area of species according to localities

Basal area of stands

The basal area of the stands of each species for all localities is shown in Fig. 11. The *Vitellaria paradoxa* stand had the largest basal area (0.76 m²/ha). The *Vitellaria paradoxa* stand was followed by that of *Parkia biglobosa*, with a basal area of 0.24 m²/ha. The *Anacardium occidentale* stand had the smallest basal area (0.04 m²/ha).

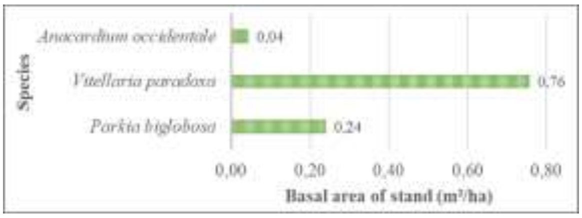

Fig. 11. Basal area of the stand for all localities

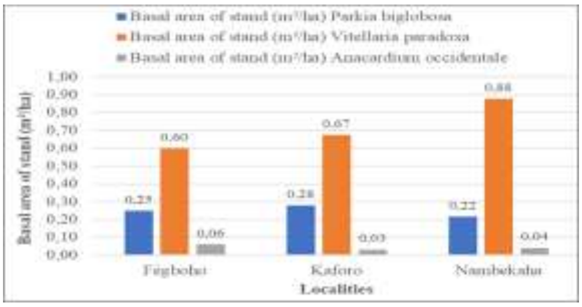

Fig. 12. Basal area of the stand according to species and localities

The basal area of the stands of each species by locality is shown in Fig. 12. Analysis of this parameter showed that the *Vitellaria paradoxa* stand had the largest basal area regardless of the site considered (0.88 m^2/ha in Nambekaha, 0.67 m^2/ha in Kaforo, and 0.60 m^2/ha in Fégboho). In all three locations, the *Vitellaria paradoxa* stand was followed by that of *Parkia biglobosa* (0.28 m^2/ha in Kaforo, 0.25 m^2/ha in Fégboho, and 0.22 m^2/ha in Nambekaha). The *Anacardium occidentale* stand had the smallest basal area in the three locations (0.06 m^2/ha in Fégboho, 0.04 m^2/ha in Nambekaha, and 0.03 m^2/ha in Kaforo).

DISCUSSION

The average plant density of the three species studied was 14.27 plants/ha in Fégboho and 9.79 plants/ha in Kaforo and Nambekaha. The low density of these woody plants is likely due to the farmers' decision to maintain only a few individuals, thereby avoiding competition that would be detrimental to rice, which is the main component of the system. Indeed, the density of trees outside forests on agricultural land depends on the ecological requirements of the crop on the one hand, and on the farmers' perspectives and needs on the other (Yameogo *et al.*, 2019; Yoni *et al.*, 2023; Ouédraogo *et al.*, 2026). Farmers are therefore aware that a high density of woody plants on rice farms would cause excessive shading and lead to lower yields, as rice is a sun-loving plant.

Analysis of average plant density by species and localities showed that *Vitellaria paradoxa* was the species with the highest number of individuals per unit area regardless of the locality considered (6.72 plants/ha at Fégboho, 6.14 plants/ha at Nambekaha, and 5.76 plants/ha at Kaforo). *Vitellaria paradoxa* was followed by *Parkia biglobosa*, except at Fégboho. Analysis of the relative frequency of species for all localities revealed that *Vitellaria paradoxa* was the most common species (present in 97.44% of farms). *Vitellaria paradoxa* was followed by *Parkia biglobosa*, individuals of which were recorded in 93.59% of the farms. *Anacardium occidentale* was the species with the lowest relative frequency (individuals recorded in 46.15% of the farms).

The average plant densities and relative species frequencies obtained are thought to reflect their importance in rice farmers' production, consumption, and income-generating strategies.

Indeed, according to Koulaï and Kouakou (2024), *Vitellaria paradoxa* nuts, with an average annual production of 250,000 tons, represent the third-largest source of agricultural income in northern Côte d'Ivoire. As for *Parkia biglobosa*, the ripe fruits yield flour used for food on the one hand, and seeds that are processed into a natural seasoning product called "soumbara" on the other (Fatoumata *et al.*, 2016; Appia *et al.*, 2023). The marketing of these products by farmers represents a means of increasing and diversifying their income (Appia *et al.*, 2023). Regarding *Anacardium occidentale*, its fruits, known as cashews nuts, are one of Côte d'Ivoire's main export products and have contributed significantly to the country's socioeconomic development since the year 2000 (Ruf *et al.*, 2019). The low average plant densities and low relative frequencies of *Anacardium occidentale* compared to *Vitellaria paradoxa* and *Parkia biglobosa* could be explained by the existence of plantations dedicated to its cultivation.

The distribution of plants in diameter classes followed a bell-shaped curve for *Parkia biglobosa* and *Vitellaria paradoxa*. According to Kono *et al.* (2024), this type of distribution is characterized by a low proportion of both small-diameter and large-diameter plants. The low representation of small-diameter plants, which reflects low regeneration potential, is likely due to the suppression of young plants by rice farmers to avoid competition with rice.

The harvesting of fruits from these species and their export from the agrosystem by farmers also contributes to the low regeneration potential (Garba *et al.*, 2020). Indeed, because of fruit harvesting, the number of seeds remaining in the agrosystems is low, even though these are sexually reproducing species. The low abundance of large-diameter individuals is likely due to their exploitation by rice farmers for timber, firewood, and charcoal.

The distribution of *Anacardium occidentale* plants in diameter classes followed an "inverted J" pattern. In fact, the number of individuals was very high in the small-diameter classes and declined sharply as the diameter classes increased. As *Anacardium occidentale* is a species planted by farmers, this diameter structure would indicate that cashew trees were recently planted on most of the surveyed rice farms. Thus, the *Anacardium occidentale* stand would be dominated by young plants.

Analysis of the basal area of the stands of each species for all localities showed that the *Vitellaria paradoxa* stand had the largest basal area (0.76 m^2/ha). The *Vitellaria paradoxa* stand was followed by that of *Parkia biglobosa*, with a basal area of 0.24 m^2/ha. The *Anacardium occidentale* stand had the smallest basal area (0.04 m^2/ha). These low basal areas of the stands are likely the result of agricultural management practices that maintain a low tree density in order to optimize space and light for rice cultivation.

CONCLUSION

This study provided a comprehensive characterization of the populations of *Vitellaria paradoxa*, *Parkia biglobosa*, and *Anacardium occidentale* within rice-based agrosystems of the Tioroniaradougou subprefecture. Overall, the average plant density of the three species was low, reflecting values of 14.27 plants/ha in Fégboho and 9.79 plants/ha in both Kaforo and Nambekaha. Among the species studied, *Vitellaria paradoxa* exhibited the highest average density across all sites and was also the most widely distributed, occurring in 97.44% of farms, compared to *Parkia biglobosa* (93.59%) and *Anacardium occidentale* (46.15%).

The diameter class distributions revealed contrasting structural patterns, with *Vitellaria paradoxa* and *Parkia biglobosa* displaying bell-shaped structures, while *Anacardium occidentale* exhibited an inverted J-shaped distribution, indicative of a predominance of younger individuals. In addition, *Vitellaria paradoxa* showed the highest basal area (0.76 m^2/ha), followed by *Parkia biglobosa* (0.24 m^2/ha) and *Anacardium occidentale* (0.04 m^2/ha).

These structural characteristics highlight the strong influence of agricultural management practices, where farmers deliberately maintain low tree densities to reduce competition and optimize light and space for rice cultivation. Consequently, the observed population structures reflect both ecological dynamics and human-driven management strategies within these agrosystems.

ACKNOWLEDGEMENTS

The authors would like to thank the rice farmers in the villages of Fégboho, Golokaha, Kaforo, and Nambekaha for allowing us to conduct the floristic surveys on their rice farms.

REFERENCES

Appia VK, Zadou DA, Kouasii KH. 2023. Social value of the néré tree in the Gour cultural area in Ivory Coast. European Scientific Journal **19(17)**, 91-105. https://doi.org/10.19044/esj.2023.v19n17p91

Assogba GA, Fandohan AB, Salako VK, Assogbadjo AE. 2017. Uses of *Bombax costatum* (Malvaceae) in lands adjacent to the Pendjari Biosphere Reserve in the Republic of Benin. Bois et Forêts des Tropiques **333**, 17-29.

Azenge C, Meniko JPP. 2020. Species and uses of trees outside forests on agricultural land in the Kisangani region in Democratic Republic of Congo. Revue Marocaine des Sciences Agronomiques et Vétérinaires **8(2)**, 163-169.

Bellefontaine R, Petit S, Painorcet M, Deleporte P, Bertault J-G. 2001. Trees Outside Forests. Toward better recognition, FAO Conservation Paper 35. FAO. Rome, Italy, 231 p.

Chucha FA, More YH, Adane GW. 2022. Economic importance of smallholder farmers' agroforestry practices at Gombora District, Hadiya Zone, Southern Ethiopia. International Journal of Biosciences **20(6)**, 18-25. http://dx.doi.org/10.12692/ijb/20.6.18-25

Eldin M. 1971. The climate. In The natural environment of Côte d'Ivoire. ORSTOM. Paris, France. 73-108.

Fatoumata C, Soronikpoho S, Souleymane T, Kouakou B, Marcellin DK. 2016. Biochemical and microbiological characteristics of African mustards produced from fermented *Parkia biglobos*a seeds and fermented *Glycine max*, sold in Côte d'Ivoire. International Journal of Biological and Chemical Sciences **10(2)**, 506-518. http://dx.doi.org/10.4314/ijbcs.v10i2.5

Garba A, Amani A, Douma S, Sina AKS, Mahamane A. 2020. Demographical structure of the *Tamarindus indica* L. in southwest of Niger (north Soudan). International Journal of Biological and Chemical Sciences **14(1)**, 126-142. https://dx.doi.org/10.4314/ijbcs.v14i1.11

Guillaumet J-L, Adjanohoun E. 1971. The vegetation of Côte d'Ivoire. In The natural environment of Côte d'Ivoire. ORSTOM. Paris, France. 157-266.

Keita I, Yameogo J, Tyano A, Hien M, Somda I. 2024. Assessment of *Tamarindus indica* L. stands in the forest areas of Kuinima and Dindéresso in Western Burkina Faso. International Journal of Biological and Chemical Sciences **8(5),** 1701-1712. https://dx.doi.org/10.4314/ijbcs.v18i5.7

Kolman KT, Sanogo S, Eponon ECG. 2025. Floristic diversity and carbon sequestration of cocoa agroforestry systems in Nawa and Indénié Djuablin Regions, Côte d'Ivoire. International Journal of Plant and Soil Science **37(11)**, 412-427. https://doi.org/10.9734/ijpss/2025/v37i115855

Kono LD, Bindzi M-AM, Mebenga RLN, Koulbout D, Angoni H, Zock B. 2024. Analysis of floristic diversity and structure of woody vegetation on the periphery of Odzala-Kokoua National Park, Republic of Congo. Afrique Science **25(1)**, 117-130.

Kouadio CKN, Koulibaly A, Coulibaly S, Boko BB, Dramane KB, Diomandé VP-A, Kouadio YJ. 2021. Natural regeneration potential of associated woody species in traditional cocoa agrosystems in the rural area of Djekro (Daloa, Côte d'Ivoire). Agronomie Africaine **33(1),** 97-108.

Kouadio NKC, Koulibaly AV, Amon AD-E, Dramane KB. 2026. Medicinal phytodiversity in cocoa agroforestry systems and well being of local communities in Department of Daloa, Central West, Côte d'Ivoire. Journal of Advances in Biology and Biotechnology **29(1)**, 415-425.

Kouamé KN, Coulibaly LF, Traoré MS, Koffi E-BZ, Diarrassouba N. 2026. Characterization of stands and evaluation of carbon sequestration capacity of shea parklands (*Vitellaria paradoxa* C. F. Gaertn., Sapotaceae) in the departments of Dabakala and Kong, Ivory Coast. International Journal of Biosciences **28(1)**, 1-15.

Kouamé NF. 2010. Phytogeographic regions. In Atlas of Biodiversity in West Africa-Volume III, Côte d'Ivoire. Main. Frankfurt, Germany. 132-139.

Koulaï A, Kouakou A. 2024. Socioeconomic determinants of the shea industry among rural women in the Niakaramandougou Subprefecture in Côte d'Ivoire. Revue Internationale de la Recherche Scientifique **2(4)**, 1866-1873.

Manfo DA, Tchindjang M, Youta HJ. 2015. Agroforestry systems and biodiversity conservation in a heavily human-impacted environment: the case of Obala. Revue Scientiique et Technique Forêt et Environnement du Bassin du Congo **5,** 22-34.

Murhula I, Iragi C, Bahati G, Asifiwe R, Zaluke FM, Mubalama L. 2023. Contribution of the "Exploitation and Conservation" approach of trees outside the forest to improving the fertility of agricultural soils on the edge of the KAHUZI BIEGA National Park in South Kivu, DRC. Afrique Science **22(4)**, 1-14.

Ndabalishye I. 1995. West African subsistence farming: the case of Côte d'Ivoire. Institut des Savanes. Abidjan, Côte d'Ivoire. 383 p.

Ouédraogo SA, Bazié HR, Koala J, Traoré A. 2026. Effect of tree densities on soil physical properties in agroforestry parkland systems dominated by shea trees in Burkina Faso. International Journal of Plant and Soil Science 38(2), 45-70. https://doi.org/10.9734/ijpss/2026/v38i25964

Piba SC, Karidioula TP, Missa K. 2025. Dendrometric parameters and carbon sequestration potential of coffee-based agroecosystems in the mountainous region of Côte d'Ivoire. Journal of Applied Biosciences **208**, 22026-22035. https://doi.org/10.35759/JABs.208.1

Pierre NK, Gizele ZG, Laurence KKA, Madeleine KAT, Abel NK, Sabas BYS. 2026. Evaluation of the impact of floristic diversity on the productivity of cocoa based agroforestry systems in the new cocoa production area: The case of the Biankouma department (Western Côte d'Ivoire). International Journal of Biosciences **28(1)**, 44-55. https://dx.doi.org/10.12692/ijb/28.1.44-55

Putra MU, Rujehan, Sarjono MA, Matius P, Ahyauddin. 2020. Land use with agroforestry system in North Kalimantan Province Indonesia State. International Journal of Biosciences **16(3)**, 183-195. http://dx.doi.org/10.12692/ijb/16.3.183-195

Rasmane NAK, Tano KD, Koffi JA, Yavo W, Koné MW. 2023. Ethnobotanical study of plants used in the treatment of malaria in Abengourou, Côte d'Ivoire. Afrique Science **23(3),** 65-77.

Ruf F, Kone S, Bebo B. 2019. Côte d'Ivoire's cashew nut boom: A social and ecological transition of the cotton and cocoa systems. Cahiers Agricultures **28(21)**, 1-12. https://doi.org/10.1051/cagri/2019019

Soro D, Traoré K, Kassi NJ. 2011. Variability in morphological characteristics of shea trees (*Vitellaria paradoxa*) in northern Côte d'Ivoire. International Journal of Biological and Chemical Sciences **5(3)**, 1201-1214.

Soumah M, Adahé LAN, Abrou E-JN, Adiko GAE, Kouadio G, Adou YCY. 2025. Diversity and carbon stocks in an agroforestry experimental zone in southeastern Côte d'Ivoire: The case of Agnéby program growers' plantations. International Journal of Biological and Chemical Sciences **19(5)**, 2018-2033. https://dx.doi.org/10.4314/ijbcs.v19i5.19

Tirkey AIP, Kumar R, Prasad RS, Malakar A. 2024. Agroforestry for carbon neutrality: an effective pathway to net zero. Journal of Advances in Biology and Biotechnology **27(11)**, 591-602. https://doi.org/10.9734/jabb/2024/v27i111643

Yameogo G, Ouedraogo H, Yelemou B. 2019. Biodiversity dynamic of Vipalogo agroforestry parklands in north soudanian zone of Burkina Faso. International Journal of Biological and Chemical Sciences **13(6)**, 2765-2776. https://dx.doi.org/10.4314/ijbcs.v13i6.27

Yoni M, Senou I, Yonli EY. 2023. Characterization of Agroforestry Parks with *Anarcadium occidentale* L. and Ecosystem Services in the Forêt Classée de Dindéresso in western Burkina Faso. European Scientific Journal **19(27)**, 203-234. https://doi.org/10.19044/esj.2023.v19n27p203