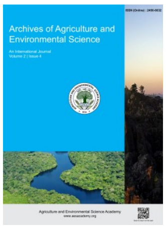
Archives of Agriculture and Environmental Science 11(2): 150-159 (2026)
https://doi.org/10.26832/24566632.2026.110201

e-ISSN: 2456-6632

This content is available online at AESA

Archives of Agriculture and Environmental Science

Journal homepage: journals.aesacademy.org/index.php/aaes



ORIGINAL RESEARCH ARTICLE

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Homegardens of Guinean Savannah Highlands of Adamawa in Vina, Cameroon: Woody floristic diversity and climate change mitigation potential

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ARTICLE HISTORY

Received: 09 January 2026
Revised received: 08 June 2026
Accepted: 17 June 2026

Keywords

Carbon stock
Floristic diversity
Homegardens
Stand structure

ABSTRACT

Homegardens stock carbon is crucial for climate mitigation. The aim of this study was to evaluate woody floristic diversity and climate change mitigation potential of homegardens in the Guinean Savannah highlands of Adamawa in Vina, Cameroon. For this, a household survey was conducted among 150 farmers in six villages. Botanical inventories were carried out in each village and the collected data was analysed in various ways. The results showed that the farmers populations have good understanding of climate change and have developed local mitigation strategies. In the homegardens of Vina, 1299 individuals were recorded, belonging to 39 species, 28 genera and 20 families. Tello locality had a greater number of individuals, species, genera and families than the other localities, with 309, 25, 22 and 19, respectively. The Shannon index of different locality was 1.92 in Malang and 2.42 in Bakari-bata. The homegardens in the Bakari-bata locality stored more carbon (175.38±136.96 tC/ha) and CO_2 equivalent (643.67±502.66tCO_2/ha) than other localities. According the age of homegardens, mature homegardens (between 30 and 40 years old) store a significant amount of carbon (175.16±93.49 tC/ha) and consequently CO_2 equivalent (642.84±343.12 tCO_2/ha). Thus, the results indicated the effectiveness of homegardens in mitigating climate change and contributed to the development of a database on REDD+ mechanisms in Adamawa region of Cameroon.

Citation of this article: Bintou, G., Zephirin, O. H., Guidawa, F., Youhana, D., & Marie, M. P. (2026). Homegardens of Guinean Savannah Highlands of Adamawa in Vina, Cameroon : Woody floristic diversity and climate change mitigation potential. *Archives of Agriculture and Environmental Science*, *11*(2), 150-159, https://dx.doi.org/10.26832/24566632.2026.110201

INTRODUCTION

Climate change is a concern for the national and international scientific community and many countries because of its impact on the environment. The effects of climate change include frequent droughts, floods, and wildfires (IPCC, 2022). Cameroon is no exception and is particularly vulnerable due to the overexploitation of its natural resources. Soil and hydrological cycle disturbances, air quality problems, biodiversity loss are already the effects of climate change (IPCC, 2007; Jama & Zeila, 2005). Despite the effects of climate change, adaptation and mitigation measures exist, among which is agroforestry (Awazi *et al*., 2019). Agroforestry is the production of trees and non-tree crops or animals on the same piece of land (Motis, 2007). It is an integrated land use that can directly enhance plant diversity while reducing habitat loss and fragmentation. In agroforestry systems, there are both ecological and economic interactions between the different components (Nair, 1993; Garrett, 1997). It provides ecosystem services, environmental benefits and economic products within multifunctional landscapes (Jose, 2009). Agroforestry can help reduce atmospheric CO_2 levels through three main mechanisms : carbon sequestration, carbon conservation and carbon substitution (Kaye *et al.*, 2000 ; Kürsten, 2000; Montagnini & Nair, 2004).

In the Guinean Savannah highlands of Cameroon, there are homegardens, which are agroforestry practice less diverse than agroforests in forest zones. Homegardens are flexible multilayered agroforestry practice found around houses that combine trees of socio-economic interest with crops and/or domestic animals (Nair, 1993). Several studies have shown that homegardens, like many agroforestry practices, can be considered as a viable land use option to help reduce biodiversity loss (Seid *et al.*, 2022; Kassa *et al.*, 2023; Tebkew *et al.*, 2023), offering a wide range of benefits such as food, fibre, fuelwood, construction materials, medicine, decoration, shade and fencing (Galluzzi *et al.*, 2010; Galhena *et al.*, 2013; Caballero-Serrano *et al.*, 2016). Moreover, homegardens combat also soil erosion, increase soil fertility and store carbon (Piponiot *et al.*, 2025; Humnessa, 2020; Eyzaguirre & Bailey, 2007; Kumar & Nair, 2004). Unfortunately, these agroforestry practices are fragmented, reducing their surface area, even though their multifunctionality benefits humans and is legitimately in line with the principles of sustainable development. In tropical areas around the world, several studies have focused on homegardens, particularly management methods, floristic diversity, the ethnobotany of associated species, the structure of woody stands and carbon stocks (Piponiot *et al.*, 2025; Luo *et al.*, 2024; Beyene *et al.*, 2024; Kassa *et al.*, 2023; Maryo *et al.*, 2023; Tebkew *et al.*, 2023; Hu *et al.*, 2023; Seid *et al.*, 2022; Yinebeb *et al.*, 2022; Manaye *et al.*, 2021; Abayneh & Mesele, 2021; Shao *et al.*, 2021). In addition, numerous studies have been conducted on the homegardens in the Guinean Savannah highlands of Cameroon (Zigro, 2005). Despite the abundance of research on homegardens in this agroecological zone, no studies have focused on woody carbon stock, even though carbon is a greenhouse gas that destroys the ozone layer. Through photosynthesis, trees fix carbon dioxide and convert it into biomass (ADEME, 2015). The sequestration of this gas provides many ecosystem services, including plant production, erosion control and water retention (Minasny *et al.*, 2013). It is therefore important to conduct a study on the floristic diversity and woody carbon stock of the homegardens in the Guinean Savannah highlands of Cameroon.

The objective of this work was to evaluate woody floristic diversity and climate change mitigation potential of homegardens in Vina Division and more specifically, to assess the biophysical characteristics of homegardens and evaluate their floristic composition and carbon stock.

MATERIALS AND METHODS

Study site

The work was carried out in the Guinean Savannah highlands of Adamawa, Cameroon, specifically in Vina Division. This Department is located between 12.82725° and 14.76536° East longitude and 6.52270° and 7.99075° North latitude. It has a Guinean climate with a rainy season (April–October) and a dry season (November–March) (Suchel, 1987). Average annual rainfall is 1500 mm with relative humidity of 70% and an average annual temperature of 23°C (Figure 1). The soil is ferralitic, red in colour, developed on old basalts, and weakly ferralitic modal soils developed on granitic rocks (Humbel, 1971). The vegetation in the area is shrubby savannah dominated by *Lophira lanceolata* and *Daniellia oliveri* (Letouzey, 1968). The investigations are being carried out in six localities in the Division, at a rate of two villages per district: the district of Ngaoundéré III with the villages of Malang (13.4116°N and 7.4188°E) and Darang (7.38521°E and 13.50713°N); the district of Bélel with the villages of Tello (7.17559°E and 14.18346°E) and Bakari bata (6.92881°E and 14.59994°N) and the District of Nyambaka with the village of Mboulaï (6.84283°E and 14.15466°N) and Babongo (6.80727°E and 14.18135N). The localities were chosen because of the abundance of homegardens in these localities.

Methodology

The methodological approach of this work was carried out in two phases : a phase of household surveys and floristic inventories.

Household surveys

Household surveys were conducted through semi-structured individual interviews using a pre-developed questionnaire (Mapongmetsem *et al.*, 2016). A total of 150 households were surveyed, with 25 people per locality. The topics of the questionnaire focused on farmer perceptions of climate change (manifestations of climate change, local strategies to lessen climate change) and the biophysical characteristics of homegardens (in particular the size, types and layout of these gardens in relation to the household) (Figure 2). The surveys also made it possible to identify the ages of homegardens (< 20 years, [20-30] years, [30-40] years and > 40 years) which are used to assess the temporal dynamics of carbon stocks.

Floristic inventory

Floristic inventories are carried out in 25 homegardens per locality. Each homegarden is surveyed using transects of varying sizes. In the transects, all trees are identified and their dendrometric characteristics are recorded.

Diameter at breast height

Each homegarden is thoroughly inspected in order to list all the individuals present. Plants are identified in the field. Unknown plants are sampled for later identification at the Laboratory of Biodiversity and Sustainable Development at the University of Ngaoundéré. The botanical nomenclature used is that adopted by Lebrun & Stork (1991-1997). The circumference at breast height was measured on all woody individuals at 1.30 m above the ground on specimens taller than 1.5 m using a tape measure.

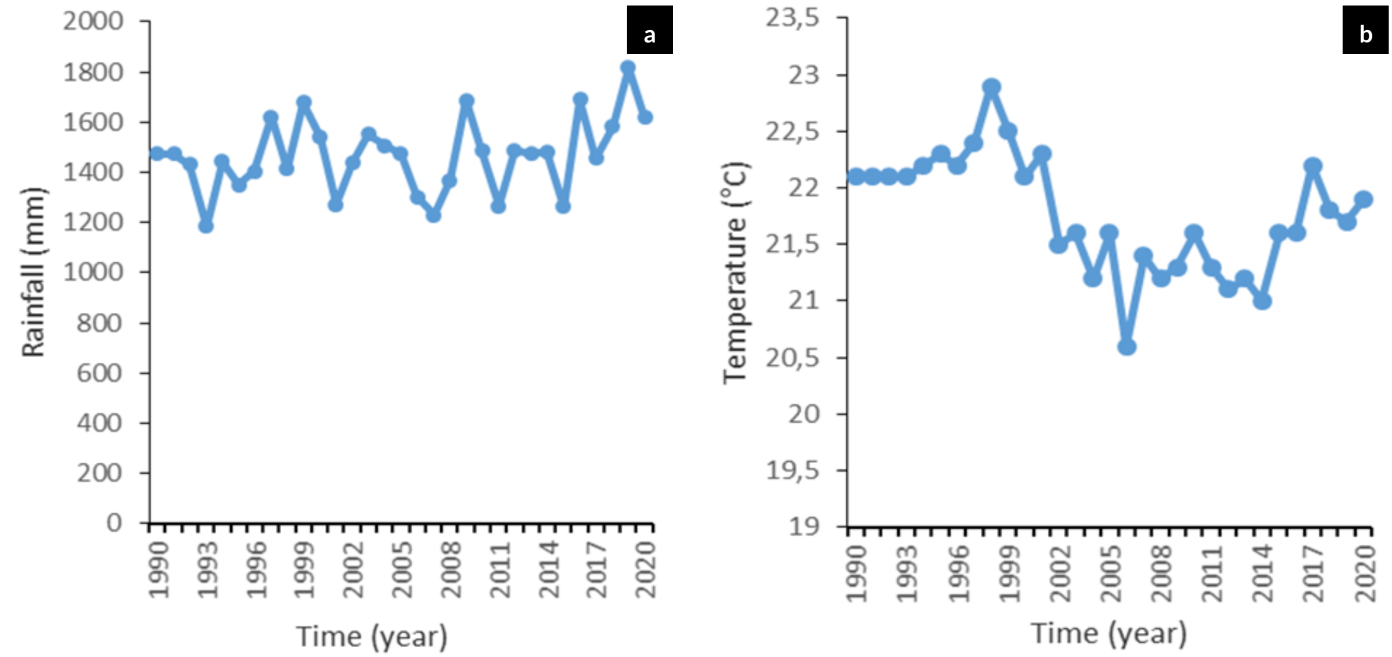

Figure 1. *Variations in rainfall (a) and temperature (b) in Vina Division from 1990 to 2020. Source : Ngaoundéré Airport Meteoroogical station (2020).*

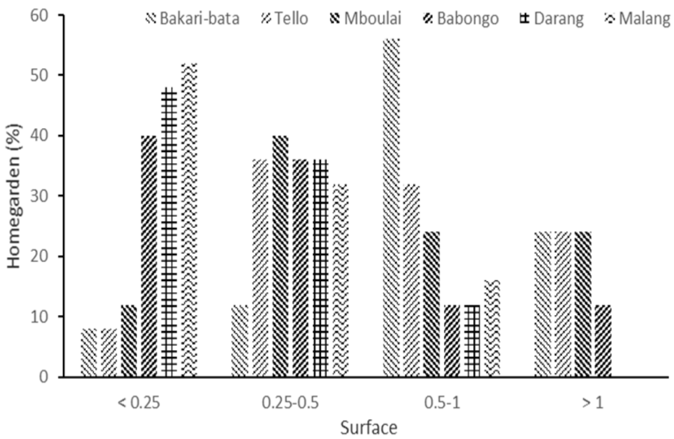

Figure 2. *Distribution of homegardens by surface area.*

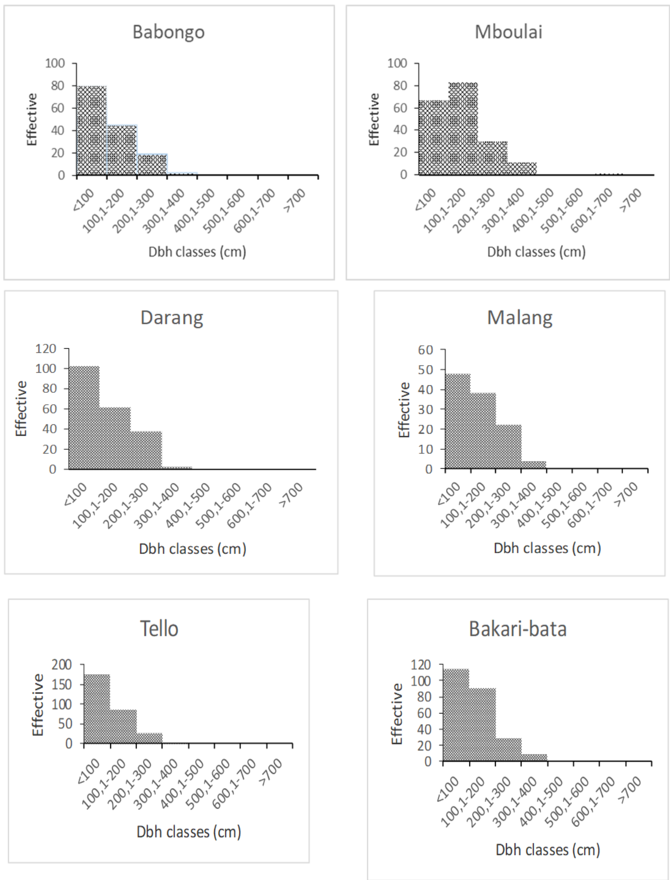

Figure 3. *Diameter class distribution in homegardens of the Guinean Savannah Highlands.*

(Beyene *et al.*, 2024; Tebkew *et al.*, 2023). The diameter at breast height (DBH) was obtained by dividing the circumference by 3.14. To establish the horizontal structure of the tree stands in the homegardens, the work was inspired by that of Dangai *et al.* (2021) and Gebru *et al.* (2020). The woody species were clustered into eight diameter classes of 100 cm intervals : < 100, 100-200, 200.1-300, 300.1-400, 400.1-500, 500.1-600, 600.1-700, >700 (Figure 3).

Structural variables

Structural variables like Basal area (BA), relative frequency, relative density and relative dominance were calculated and used for Importance Value Index (IVI) and Family Importance Value (FIV).

Basal area (BA): This is the surface area occupied by the trunk of the tree at the diameter at breast height. Basal area (m^2/ha) = $\pi D^2/4$ with D the diameter of the individual at 1.30m from the ground. This diameter was also used to establish the distribution of trees in diameter classes (Lejoly, 1993). The basal area was used to calculate relative dominance. The relative frequency, relative density and relative dominance were calculated according to the formula of Cottam & Curtis (1956) and Mori *et al.* (1983).

Relative density (ReDe): The relative density of a species or family is the ratio of the total number of individuals of a species or family to the total number of individuals in the sample multiplied by 100.

Relative density of a species (ReDe) = n/N × 100.

Relative density of a family (ReDef) = nf/N × 100.
Where n is the number of individuals of a species; nf the number of individuals of a family; N the total number of plots.

Relative dominance (ReDo): Relative dominance is the ratio of the basal area occupied by a species or family to the total basal area multiplied by 100.

Relative dominance of a species (ReDo) (%) = BA/BAT ×100.

Relative dominance of a family (ReDof) = BAf/BAT ×100.
Where BA is the basal area of a species; BAf the basal area of a family; BAT the total basal area in the sample.

Relative frequency (ReFr): Relative frequency is the ratio expressed as a percentage between the frequency of species and the total sum of all frequencies multiplied by 100.

ReFr (%) = (Frequency of species i)/ (Sum of all frequencies) ×100.

ReFrf (%) = (Frequency of family i)/ (Sum of all frequencies) ×100.

Ecological indices

Various ecological indices were determined, enabling the structure of the stands to be studied and a quantitative assessment of their diversity to be made. These included Shannon-Weaver indices, Pielou's Equitability, Importance Value Index (IVI) and Family Importance Value (FIV).

Shannon-Weaver index (ISH): ISH = - ∑((Ni/N)*ln(Ni/N)) where Ni= number of individuals of species i, N= total number of individuals. ISH is expressed in bits. It is the most widely used and recommended index in comparative stand studies, as it enables to assess the weight of the species in the land cover. The higher the number of species in the stand, the higher the ISH. For ISH ≤ 0.5 = very low diversity, ISH < 2.5 = low diversity; 2.5 ≤ ISH < 4 = medium diversity; ISH ≥ 4 = high diversity (Shannon, 1948).

Pielou's Equitability Index (EQ): EQ = ISH/lnN. Pielou's equitability index provides information on the distribution of trees among the different species in a stand. It correspond to the ratio between the observed diversity (ISH) and the maximum possible diversity of the number of species (N). It tends towards 0 when almost all the numbers are concentrated in one species and towards 1 when all the species have the same abundance. For EQ < 0.6 = low; 0.6 ≤ EQ ≤ 0.7 = medium; EQ ≥ 0.8 = high (Pielou, 1966).

Importance Value Index (IVI): It has enabled the characterisation of plant communities and the identification of dominant species (Kent & Coker, 2003).

IVI (%) = Relative frequency + Relative density + Relative dominance

Family Importance Value (FIV): It has enabled to appreciate the importance of families in a plant community. The family importance value was determined using the formula of Cottam & Curtis (1956).

FIV (%) = Relative frequency of families + Relative density of families + Relative dominance of families.

Carbon stock estimation and CO_2 equivalent

Carbon stock: To determine carbon stock, indirect methods are applied using allometric equations. To determine phytomass, the pantropical equation of Chave *et al.* (2014) was used.

Epigeal phytomass (PE): PE = exp [-1.803-0.976E + 0.976ln (Ω) + 2.673ln (Dbh) -0.0299 [ln (Dbh)] 2] with PE= epigeal phytomass ; E = (0.178*TS*0.938*CWD-6.61PS) *103 ; Ω = 0.413 is the specific density of wood in g/m^3; Dbh = diameter at breast height in cm.

Hypogeous phytomass (PH): For hypogeous phytomass, the equation of Cairns *et al.* (1997) was used. PH = exp (-1.0587 + 0.8856 × ln (PE)) with PH = Hypogeous phytomass (kg); PE = Epigeal phytomass.

Total phytomass: Total phytomass (TP) = Epigeal phytomass + Hypogeous phytomass.

According to the IPCC (2003), biomass is converted into carbon using the following formula: Carbon stock (tC/ha) = Total phytomass × 0.5

CO_2 equivalent: According to the IPCC (2003), it is recognised that the atomic mass of Carbon is equal to 12 and that of oxygen is 16. The molecular mass of CO_2 is 44. Thus, the CO_2/C ratio is 3.67. The stock of equivalent atmospheric CO_2 was estimated by multiplying the carbon stock from biomass by 3.67. CO_2eq = QCt × 3.67, where QCt is the amount of carbon sequestered by the plant.

Data analysis

Farmer perceptions of climate change and biophysical characteristics in particular the size and typology of homegardens, were presented as percentages. Concerning, carbon stocks, one-factor analysis of variance was performed according to village and age of the home gardens (< 20 years, [20-30] years, [30-40] years and > 40 years). The carbon stocks were presented as mean ± standard deviation. Significant means are separated by the Duncan Multiple Range Test. The software used was Statgraphic 5.0. Microsoft Office Excel was used to draw the graphs.

RESULTS AND DISCUSSION

Farmer perceptions of climate change manifestations

Climate change, vary from one localitty to another. 73% of farmers interviewed in different localities underline that they have perfect knowledges on climate change and notice their effect. A few of them (27%), has no idea concerning climate variation. Populations of Babongo (80%) and Mboulaï (84%), anounce that they were confronted to unusual events such as violent winds which distroy houses and uproot trees ; dowpour and monstruous foods which destroy crops and carries away domestic properties from habitations. More, they face extreme temperature which are unbearable due to the precocity or lateness of rains. Populations of Malang (80%) and Darang (86%) notice climate change effects. These climate changes manifestations are characterized by a long period of coolness (November-January) and the increase of its instensity between years (February – April) in addition to devastating insects. The season duration become fickle. To these characteristics, degradation of land resources is added and they become improductive.

Local strategies to lessen climate change

According to local perceptions, the total amount of rainfall has been growing significantly and rainy days have been heavy in the past decades. The situation was particularly difficult from 2018 to 2020. The correlation between farmer perceptions and parameters as precipitattions were evident (Figure 1). Concerning temperature, they were high from 1990 to 2001 compared to other years. The consequences of climate change impacts the environment and the farmers live. This variation has been experienced the explored localities of the guinean savannah highlands. To mitigate them, farmers of the area developped local strategies. For one (42%) the solution is the reafforestation and the limitation of deforestation because trees are source of food and protect the environment. Trees conservation will help in the creation of microclimate, suitable during hot temperature. The use of organic maters instead of chemicals. This method is a lowcost one and without negative effect on environment. To palliate the increase of price in markets, farmers (64%) chose to produce what they need in homegardens. Agroforestry practices including homegardens, scattered trees on croplands, improved fallows, cocoa, coffee and banana agroforests constitute climate smart and sustainable adaptation options implemented by smallholder farmers across Africa and the tropics in the face of climate variability and change (Mandleni & Anim, 2011; Thorlakson & Neufeldt, 2012). Homegardens products needed are autoconsumed and the excess is commercialized. This pratice permit to fight against food insecurity and mal nutrition. Mapongmetsem *et al*. (2020) reported similar facts in the transitional savannah-forest ecozone of Cameroon. Another category of farmers (18%) opt for the agricultural farming calender concerning sowing and new cultural pratices were envisaged. Analogous pratices were reported in parklands of the sudano-sahelian zone of Cameroon (Dangai *et al*., 2021).

Biophysical characteristics of homegardens

Area of home gardens: Homegardens less than 0.25 ha are more numerous in the villages of Malang (52%), Babongo (40%) and Darang (42%). This situation can be explained by the fact that in peri-urban areas, houses are close together and homegardens are reduced to small size. These results are consistent with those of Mamah (2005). The 0.25-0.5 ha class is more abundant in the villages of Tello (36%) and Mboulaï (42%). Overall, this is the most abundant class (32%). The second most important class is the 0.5-1 ha, with an overall rate of 25.33%. Homegardens are more abundant in the villages of Bakari-Bata, Tello and Mboulaï. This is justified by the fact that these villages are in rural areas and therefore there is enough space to expand their area. The class with an area greater than 1 ha is poorly represented, with an overall rate of 14% (Figure 2). Furthermore, the maximum size of agroforestry practices in Kachibara district in Ethiopia is 1.43 ha (Abayneh & Mesele, 2021). Kassa *et al*. (2023) noted homegardens ranging in size from 0.016518 to 1.296 ha, with an average of 0.303271 ha. The size of homegardens varies from 0.015 to 0.5 ha in north-western Ethiopia (Yinebeb *et al*., 2022).

Typology of homegardens: Based on the different components of the systems, three types of homegardens were identified in the various villages explored. Homegardens consisting of livestock, trees and crops are included in agrosilvopastoral systems. This is the most common type in the villages of Malang (56%), Tello (60%) and Babongo (50%). The second type is agrisilviculture, which is common in the villages of Mboulaï (80%), Darang (56%) and Bakari-bata (56%). They consist of trees and crops. Silvopastoral homegardens consisting of trees and animals are less common (Table 1). Furthermore, in Indonesia, Nair (1993) identify agrosilvopastoral and agrisilviculture homegardens.

Layout of homegardens in relation to the house

There are specific layouts for each of the different components of homegardens. In some cases, trees are used as supports for climbing crops such as melons, beans, peppers, etc. These species can be arranged to the side or behind the house. Similar results are reported by Mapongmetsem *et al.* (2016) and Mapongmetsem *et al.* (2020) in homegardens in the same agroecological zone.

Table 1. Typology of homegardens.

Localities/Home gardens (%)	Bakari-bata	Tello	Malang	Darang	Babongo	Mboulaï
Silvopastoral	16	8	8	4	16	0
Agrosilvopastoral	56	32	36	56	28	80
Agrisilviculture	32	60	56	40	52	20

Table 2. Floristic composition of homegardens.

Localities/Ranks	Babongo	Mboulai	Darang	Malang	Tello	Bakari-bata	Total
Individuals	169	224	216	116	309	265	1299
Species	16	15	20	15	25	22	39
Genera	13	13	16	12	22	19	28
Families	11	12	16	10	19	16	20

Floristic composition of homegardens

Floristic richness: In the homegardens of Vina, 1299 individuals were recorded, belonging to 39 species, 28 genera and 20 families. The locality of Tello has a greater number of individuals, species, genera and families than the other localities, with 309, 25, 22 and 19 respectively (Table 2). In Ethiopia, a total of 59 plant species belonging to 56 genera and 36 families were recorded in homegardens, parkland and live fences (Abayneh & Mesele, 2021). 206 plant species were observed in the surveyed homegardens in southern and southwestern Ethiopia (Kassa *et al.*, 2023). In northern Ethiopia, 30 species, 24 genera, and 20 families were encountered in homegardens, whereas 11 species belonging to 9 genera and 8 families were recorded in natural forests (Gebru *et al.*, 2020). In the same area, 83 woody species belonging to 40 families and 47 genera were identified (Tebkew *et al.*, 2023). The present results are also comparable to those of Seid & Kebebew (2022) in southern Ethiopia, who recorded the total number of plant species from the sample homegardens as 74, belonging to 37 families, with an average of 14 plant species per homegarden. This observed difference could be due to different family needs, preferences and knowledge of species (Phondani *et al.*, 2020). It is most of all, based on food habit of the population.

Floristic diversity: Vegetation parameters are assessed using diversity indices. Shannon Index and Piélou's Equitability Index. The Shannon Indices for the different villages vary between 1.92 bits (Malang) and 2.42 bits (Bakari-bata). These values are 1.98, 1.97, 2.06 and 2.04 bits respectively for Tello, Mboulaï, Babongo and Darang. These low Shannon Index values indicate that homegardens are less diverse. The Pielou Equitability Index values for the different villages range from 0.35 in Tello to 0.43 in Bakari-bata. These values are 0.41, 0.36, 0.41 and 0.38 respectively for Malang, Mboulaï, Babongo and Darang. These low values suggest that a few species have high numbers of individuals. Contrary to the present observations, Mapongmetsem *et al.* (2020) noted high Pielou's Equitability Index values for most of the agroforestry sites studied. Indeed, agroforests are denser and more diverse agroforestry practices than homegardens. Similarly, Abebe (2005) and Hamawa (2005) report high diversity in homegardens of southern Ethiopia and Galim-tignère, respectively. In the locality of Kachabira in Ethiopia, the Shannon indices of homegardens are low compared to that of the present study (1.62, 1.57 and 1.75 bits) and the Pielou equitability indices are higher than those obtained in this study (0.82, 0.79 and 0.83) (Abayneh & Mesele, 2021). These results are comparable to those of Kassa *et al.* (2023). These authors found Shannon indices ranging from 1.04 to 1.55 bits and Piélou equitabilities ranging from 0.47 to 0.60. The same trend is observed in the homegardens of in southern Ethiopia, with a Shannon index of 2.82 and a Pielou equitability index of 0.876. The variation may be attributed to differences in farmers' management intensity and environmental conditions. Farmers' shade management intensity includes species selection, spacing, pollarding, lopping, and thinning.

Diameter class distribution of woody species

The diameter class distribution of woody species was determined based on the density of the Dbh of the species in the homegardens. The homegardens in the localities studied show an L-shaped distribution (Figure 3). The results show that the number of individuals decreases as the Dbh of the individual increases. This trend fitting has the L- look (Mapongmetsem *et al.*, 2011). This structure indicates active renewal of woody individuals in homegardens by farmers. A similar analysis was conducted by Maryo *et al.* (2023) in homegardens in northern Ethiopia.

Family importance value index

Among ecologically important families, Rutaceae ranks first with a Family Importance Value (FIV) of 65.18%. Next come Lauraceae (59.32%), Anacardiaceae (58.57%), Myrtaceae (57.66%), Caricaceae (54.62%) and Burseraceae (51.70%) (Table 3). The Rutaceae family is the most diverse with four species, including *Citrus sinensis*, *Citrus limon*, *Citrus grandis* and *Citrus reticulata*. This diversity can be explained by the socio-economic, nutritional and medicinal importance of these citrus fruits, including their fruits, leaves, bark and roots (Mapongmetsem *et al.*, 2020).

Ecological importance value index

Among the species present in homegardens, some play an important ecological role. Species with the highest Importance Value Index (IVI) are *Persea americana* (93.50%), *Mangifera indica* (87.36%), *Carica papaya* (67.98%), *Psidium guajava* (64.22%), *Citrus sinensis* (60.07%) and *Citrus limon* (35.10%) (Table 4). These fruit species form the floristic basis of homegardens (Mapongmetsem *et al.*, 2009). They justify the purpose of these agrosystems, whose production is intended for self-consumption and commercialisation. In the locality of Kachabira in Ethiopia, *Cordia africana* (39.8%) was the most important woody species in homegardens, followed by *Coffea arabica* (26.9%), *Persea americana* (18.8%) and *Mangifera indica* (4.9%). In the homegardens of the Wondo Genet landscape in southern Ethiopia, *Ensete ventricosum* (55.4%) was the most significant plant, followed by *Coffea arabica* (35.3%), *Cordia africana* (27.1%), *Persea americana* (24.8%), *Eucalyptus camaldulensis*

Table 3. Ecological importance value indices of families.

Localities/Family	Tello	Bakari-bata	Malang	Darang	Mboulaï	Babongo	FIV
Rutaceae	68.75	60.49	71.36	46.96	80.55	62.97	65.18
Burseraceae	58.33	45.66	44.43	26.76	77.77	57.26	51.70
Anacardiaceae	60.41	55.13	44.43	53.53	77.77	60.11	58.57
Moringaceae	29.16	37.33	0	26.76	0	0	18.65
Lauraceae	58.33	49.77	59.24	53.53	77.77	57.26	59.32
Myrtaceae	60.41	49.77	59.24	55.80	77.77	42.94	57.66
Moraceae	29.16	26.66	29.62	26.76	25	14.31	25.25
Caricaceae	58.33	49.77	44.43	40.15	77.77	57.26	54.62
Euphorbiaceae	29.16	0	0	29.04	0	14.31	12.08
Malvaceae	29.16	26.67	0	0	19.44	14.31	14.93
Nyctaginaceae	14.58	0	0	0	0	0	2.91
Bixaceae	14.58	24.88	0	0	0	0	6.57
Rubiaceae	14.58	12.44	0	0	0	0	4.50
Fabaceae	14.58	28.46	14.81	46.96	19.44	14.31	23.09
Asteraceae	14.58	0	0	0	19.44	0	5.67
Primulaceae	0	0	0	0	19.44	0	3.24
Rhamnaceae	0	0	0	13.38	0	0	2.23
Lamiaceae	0	0	0	26.76	0	0	4.46
Arecaceae	0	24.88	14.81	0	0	14.31	9.00
Lythraceae	0	0	14.81	0	0	0	2.46
Combretaceae	0	0	0	0	24.88	0	4.14

Table 4. Importance Value Index of woody species.

Localities/Species	Tello	Bakari-bata	Malang	Darang	Mboulaï	Babongo	IVI
Persea americana	99.18	77.91	70.48	102.25	139.53	71.66	93.50
Mangifera indica	61.14	85.94	81.25	94.90	135.78	65.15	87.36
Psidium guajava	59.18	36.18	41.38	78.72	130.01	39.84	64.22
Commiphora kerstingii	55.57	23.52	43.82	39.11	133.18	54.50	58.28
Citrus sinensis	55.57	31.01	37.66	57.45	129.58	49.17	60.07
Citrus limon	26.962	42.08	36.90	58.92	32.28	13.47	35.10
Manihot sp.	13.48	0	0	0	0	11.70	4.19
Vernonia amygdalina	13.15	0	0	0	32.43	0	7.59
Moringa oleifera	25.98	24.79	0	57.45	0	0	18.04
Bougainvillea spectabilis	13.15	0	0	0	0	0	2.19
Citrus reticulata	0	27.50	12.04	0	0	11.70	8.54
Euphorbia pulcherima	12.82	0	0	18.82	0	0	5.27
Pinus sp.	13.15	0	0	0	0	0	2.19
Citrus grandis	25.98	10.83	12.04	18.82	0	0	11.27
Pachira insignis	12.82	0	0	18.82	0	0	5.27
Carica papaya	41.43	57.54	53.55	69.70	130.59	55.09	67.98
Coffea robusta	12.82	12.07	0	37.64	0	0	10.42
Bixa orelana	12.82	35.59	0	0	0	0	8.07
Ficus sycomorus	12.82	12.07	0	0	0	0	4.14
Syzygium guineense	13.15	0	0	0	0	0	2.19
Annacardium occidentale	12.82	21.67	0	0	12.04	11.70	9.70
Acacia albida	12.82	0	0	0	0	0	2.13
Ceiba pentandra	12.82	10.83	0	0	32.28	0	9.32
Piliostigma thonningii	0	10.83	0	0	32.28	0	7.18
Ficus thonningii	0	0	0	18.82	32.43	11.05	10.38
Tamaridus indica	0	38.06	0	37.64	32.43	0	18.02
Maesa lanceolata	0	0	0	0	32.28	0	5.38
Gmelina arborea	0	0	0	0	38.13	0	6.35
Euphorbia cotinifolia	0	0	0	0	37.64	0	6.27
Senna spectabilis	0	0	12.04	0	18.82	0	5.14
Senna siamea	0	0	0	0	37.64	0	6.27
Ziziphus mauritiana	0	0	0	0	37.64	0	6.27
Punica granatum	0	0	0	0	12.04	0	2
Elaeis guineensis	0	21.67	0	0	12.04	11.7	7.56
Borassus aethiopum	0	11.7	0	0	0	11.7	3.9
Terminalia mantali	0	10.83	0	0	0	0	1.8
Spondias mombin	0	15.19	0	0	0	0	2.53
Adansonia digitata	0	21.67	0	0	0	0	3.61
Daniellia oliveri	0	30.62	0	0	0	0	5.1

Table 5. Carbon stocks and CO_2 equivalent according to lmocality (a) Following locality and (b) age of homegardens.

(a) Following locality .

Localities	Carbone (tC/ha)	CO_2 equivalent (tCO_2/ha)
Babongo	61.13±35.83a	224.33±131.48a
Bakari-bata	175.38±136.96a	643.67±502.66a
Darang	102.18±56.65a	375.01±207.91a
Malang	83.59±56.67a	306.78±207.99a
Mboulai	157.68±125.99a	578.69±462.41a
Tello	87.08±55.06a	319.61±202.08a
Total	667.05	2448.09

Averages in the same row followed by identical letters are statistically identical at the 5% threshold.

(b) Age of homegardens.

Age groups	Carbone (tC/ha)	CO_2 equivalent (tCO_2/ha)
< 20	35.13±16.01a	128.91±58.74a
[20-30[	70.66±15.06a	259.32±55.26a
[30-40]	175.16±93.49b	642.84±343.12b
> 40	163.75±95.03b	600.98±348.74b
Total	444.71	1632.06

Averages in the same row followed by identical letters are statistically identical at the 5% threshold.

(20.0%), and *Grevillea robusta* (19.3%). Tebkew *et al.* (2023) reported that cash and fruit plants such as *C. Arabica*, *R. prinoides*, *M. indica* and *C. africana* have top IVI in their study sites in Northwest Ethiopia. Indeed, the introduction of species into homegardens depends on the socio-economic and even environmental objectives pursued by each farmer (Abayneh & Mesele, 2021). IVI is an important parameter that reveals the prioritisation of species for conservation (Berhanu *et al.*, 2016). Species with high IVI values need low priority for conservation efforts, whereas those with low IVI values need high conservation efforts (Gebru *et al.*, 2020). Thus, it is essential to prioritise conservation for species that have a low IVI (10%) value (Tebkew *et al.*, 2023).

Carbon stock and CO_2 equivalent

The homegardens of Bakari-bata store more carbon (175.38±136.96 tC/ha) and CO_2 equivalent (643.67±502.66 tCO_2/ha) than other localities (Table 5a). The analysis of variance reveals no significant difference despite the variations observed for the two parameters (0.4041>0.05). With regard to the dynamics according to the age of the homegardens, the carbon stock and CO_2 equivalent of adult homlegardens (between 30-40 years) stored more carbon (175.16±93.49 tC/ha) and consequently CO_2 equivalent (642.84±343.12 tCO_2/ha) than homegardens of other ages classes (Table 5b). Analysis of variance indicates a significant difference between age classes for both ecological parameters (0.0036≤0.01). This difference is attributable to variation in tree density, Dbh of trees, site characteristics (soil, garden age, and composition), management type (Maryo *et al.*, 2023). The amounts of carbon and CO_2 equivalent are higher than those reported by Beyene *et al.* (2024) in the homegardens of Wondo Genet Woreda, Southern Ethiopia; they quantified 33.32 Mg $C.ha^{-1}$ and 122.31 Mg $CO_2eq.ha^{-1}$. Indeed, these authors assert that there was a significant positive relationship between plant density, diameter, and basal area and above-ground and below-ground biomass carbon. Furthermore, the estimated carbon quantities are comparable to those of homegardens in northern Ethiopia, which are 7.79 Mg $C.ha^{-1}$ (Manaye *et al.*, 2021). In Asia, agroforestry systems with the lowest total carbon stocks were crop and fallow systems, with an average of 108 Mg $C.ha^{-1}$; the agroforestry systems with the highest total carbon stocks were forest gardens, with an average of 213 Mg $C.ha^{-1}$, followed by homegardens, with an average of 171 Mg $C.ha^{-1}$ (Piponiot *et al.*, 2025). Carbon stocks also vary depending on agroforestry practices and the allometric equations used to estimate biomass. The size and density of trees in agroforestry practices play a significant role (Bisht *et al.*, 2022).

Conclusion

This study assessed the biophysical characteristics of homegardens, to assess the floristic diversity and role of homegardens in carbon sequestration under the ecological conditions of the guinean Savannah highlands of Cameroon. The populations have good understanding of climate change and have developed local mitigation strategies. The size of homegardens differs from one village to another. Homegardens smaller than 0.25 ha were more numerous in the villages of Malang (52%), Babongo (40%) and Darang (42%). The floristic composition of the homegardens showed 1299 individuals belonging to 39 species, 28 genera and 20 families. The locality of Tello has a greater number of individuals, species, genera and families than the other localities, with 309, 25, 22 and 19, respectively. Homegardens of the guinean savannah highlands were less diversified and the homegardens in the localities studied show L-shaped distribution. The household gardens in Bakari-bata stored more carbon

(175.38±136.96 tC/ha) and CO_2 equivalent (643.67±502.66tCO_2/ha) than the other localities. In terms of dynamics according to the age of homegardens, the carbon stock and CO_2 equivalent of adult-aged homegardens (30-40 years old) store a significant amount of carbon (175.16±93.49 tC/ha) and consequently CO_2 equivalent (642.84±343.12 tCO_2/ha). Further, a more in-depth research is required on functioning of homegardens and assessing the carbon stock of herbaceous species, litter, dead trees and soil, and determining the carbon flow in village gardens.

DECLARATIONS

Authors contribution statement: Conceptualization, methology: G.B., Z.O.H. and Y.D.; Software, validation: Z.O.H. and G.B.; Investigation: G.B.; Data curation: Z.O.H.; Writing -original draft preparation: Z.O.H.; Writing-review and editing: G.F. and P.M.M.; Supervision: P.M.M. All authors have read and agreed to the published version of the manuscript.

Conflicts of interest: The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

Ethics approval: This study was conducted in view of the institutional ethical guidelines and does not harm the human participants.

Consent for publication: All co-authors gave their consent to publish this paper in AAES.

Data availability: The data that support the findings of this study are available on request from the corresponding author.

Supplementary data: No supplementary data is available for the paper.

Funding statement: No external funding was received for this study.

Additional information: No additional information is available for this paper.

Publisher's Note: Agro Environ Media (AESA) remains neutral with regard to jurisdictional claims in published maps, figures and institutional affiliations.

REFERENCES

Abayneh, L., & Negash, M. (2021). Species diversity, composition, structure and management in agroforestry systems: The case of Kachabira district, Southern Ethiopia. *Heliyon*, *7*, e06477. https://doi.org/10.1016/j.heliyon.2021.e06477

Abebe, T. (2005). *Diversity in homegarden agroforestry systems of Southern Ethiopia* (Doctoral dissertation, Wageningen University). Wageningen University.

ADEME. (2015). *L'agroforesterie, un outil « carbone » pour les PCET : Mettre en place une démarche d'agroforesterie sur le territoire d'un PCET*. http://www.pcetademe.fr/domainesactions/agriculture/contexte-et-enjeux

Awazi, N. P., Tchamba, N. M., & Tientcheu, M. I. (2019). Climate change resiliency choices of small-scale farmers in Cameroon: Determinants and policy implications. *Journal of Environmental Management*, *250*, 109560.

Berhanu, A., Demissew, S., Woldu, Z., & Didita, M. (2016). Woody species composition and structure of Kuandisha afromontane forest fragment in northwestern Ethiopia. *Journal of Forestry Research*, *28*, 343–355.

Beyene Teklu Mellisse, Tolera, M., & Derese, A. (2024). Traditional homegardens change to perennial monocropping of khat (*Catha edulis*) reduced woody species and enset conservation and climate change mitigation potentials of the Wondo Genet landscape of southern Ethiopia. *Heliyon*, *10*, e23631.

Bisht, S., Bargali, S. S., Bargali, K., Rawat, G. S., Rawat, Y. S., & Fartyal, A. (2022). Influence of anthropogenic activities on forest carbon stocks: A case study from Gori valley, Western Himalaya. *Sustainability*, *14*(24), 16918. https://doi.org/10.3390/su142416918

Caballero-Serrano, V., et al. (2016). Plant diversity and ecosystem services in Amazonian homegardens of Ecuador. *Agriculture, Ecosystems & Environment*, *225*, 116–125. https://doi.org/10.1016/j.agee.2016.04.005

Cairns, M. A., Brown, S., Helmer, E. H., & Baumgardner, G. A. (1997). Root biomass allocation in the world's upland forests. *Oecologia*, *111*, 1–11.

Chave, J., Réjou-Méchain, M., Búrquez, A., Chidumayo, E., Colgan, M. S., Delitti, W. B. C., Duque, A., Eid, T., Fearnside, P. M., Goodman, R. C., Henry, M., Martínez-Yrízar, A., Mugasha, W. A., Muller-Landau, H. C., Mencuccini, M., Nelson, B. W., Ngomanda, A., Nogueira, E. M., Ortiz-Malavassi, E., Pélissier, R., Ploton, P., Ryan, C. M., Saldarriaga, J. G., & Vieilledent, G. (2014). Improved allometric models to estimate the aboveground biomass of tropical trees. *Global Change Biology*, *20*, 3177–3190.

Cottam, G., & Curtis, J. T. (1956). The use of distance measurements in phytosociological sampling. *Ecology*, *37*, 451–460.

Dangai, Y., Hamawa, Y., Tsobou, R., Oumarou, H. Z., & Mapongmetsem, P. M. (2021). Carbon stocks in *Daniellia oliveri* agroforestry parklands in the Sudano-Sahelian zone of Cameroon. *Environmental Challenges*, *5*, 100397.

Eyzaguirre, P., & Bailey, A. (2007). International case studies and tropical homegardens projects: Offering lessons for a new research agenda in Europe. In A. Bailey, P. Eyzaguirre, & L. Maggioni (Eds.), *Crop genetic resources in European homegardens* (Proceedings of a workshop, 3–4 October 2007). European Cooperative Programme for Plant Genetic Resources (ECPGR).

Galhena, D. H., Freed, R., & Maredia, K. M. (2013). Home gardens: A promising approach to enhance household food security and wellbeing. *Agriculture & Food Security*, *2*, 8. https://doi.org/10.1186/2048-7010-2-8

Garrett, H. E. G. (1997). *Agroforestry: An integrated land-use management system for production and farmland conservation*. United States Department of Agriculture, Soil Conservation Service.

Galluzzi, G., Eyzaguirre, P., & Negri, V. (2010). Home gardens: Neglected hotspots of agro-biodiversity and cultural diversity. *Biodiversity and Conservation*, *19*(13), 3635–3654. https://doi.org/10.1007/s10531-010-9919-5

Gebru, E., Tolera, M., & Negash, M. (2020). Woody species composition, structure, and diversity of homegarden agroforestry systems in southern Tigray, Northern Ethiopia. *Heliyon*, *6*(12), e05500.

Hamawa, Y. (2005). *Caractérisations biophysiques des jardins de case chez les populations de Niza'a (Adamaoua, Cameroun)* (Mémoire de DEA). Université de Yaoundé I.

Hu, R., Xu, C., Nong, Y., & Luo, B. (2023). Changes in homegardens in relocation villages: A case study in the Baiku Yao area in Southern China. *Journal of Ethnobiology and Ethnomedicine*, *19*, 7. https://doi.org/10.1186/s13002-023-00578-4

Humbel, F. H. (1971). *Carte pédologique de Ngaoundéré 1:50 000*. ORSTOM.

Humnessa, T. (2020). Woody species diversity and composition of homegarden agroforestry practice in Dandi district, Central Ethiopia. *International Journal of Engineering and Science Computing*, *10*(11), 27483–27488.

IPCC. (2003). *Good practice guidance for land use, land-use change and forestry*. Institute for Global Environmental Strategies.

IPCC. (2022). *Climate change 2022: Impacts, adaptation and vulnerability*. Cambridge University Press. https://doi.org/10.1017/9781009325844

Jama, B., & Zeila, A. (2005). Agroforestry in the drylands of eastern Africa: A call to action. World Agroforestry Centre.

Jose, S. (2009). Agroforestry for ecosystem services and environmental benefits: An overview. *Agroforestry Systems*, *76*, 1–10.

Kassa, G., Bekele, T., Demissew, S., & Abebe, T. (2023). Plant species diversity, plant use, and classification of agroforestry homegardens in southern and southwestern Ethiopia. *Heliyon*, *9*(6), e16341.

Kaye, J. P., Resh, S. C., Kaye, M. W., & Chimner, R. A. (2000). Nutrient and carbon dynamics in a replacement series of *Eucalyptus* and *Albizia* trees. *Ecology*, *81*, 3267–3273.

Kent, M., & Coker, P. (2003). *Vegetation description and analysis: A practical approach*. John Wiley & Sons.

Kumar, B. M., & Nair, P. K. R. (2004). The enigma of tropical homegardens. *Agroforestry Systems*, *61*, 135–152.

Kürsten, E. (2000). Fuelwood production in agroforestry systems for sustainable land use and CO_2 mitigation. *Ecological Engineering*, *16*, 69–72.

Lebrun, J. P., & Stork, A. L. (1991–1997). *Énumération des plantes à fleurs d'Afrique tropicale* (Vols. 1–4). Conservatoire et Jardin botaniques de la Ville de Genève.

Lejoly, J. (1993). *Méthodologie pour les inventaires forestiers (flore et végétation)*. AGRECO-CTFT.

Letouzey, R. (1968). *Phytogéographie du Cameroun*. Lechevalier.

Luo, J., Li, Q., He, J., Yan, J., Zhang, S., Chang, X., & Wu, T. (2024). Local knowledge of homegarden plants in Miao ethnic communities in Laershan region, Xiangxi area, China. *Journal of Ethnobiology and Ethnomedicine*, *20*, 37. https://doi.org/10.1186/s13002-024-00676-x

Mamah, M. (2005). *Contraintes, opportunités environnementales et développement du village Idool (Adamaoua–Cameroun)* (Mémoire de maîtrise). Université de Ngaoundéré.

Manaye, A., Tesfamariam, B., Tesfaye, M., Worku, A., & Guf, Y. (2021). Tree diversity and carbon stocks in agroforestry systems in northern Ethiopia. *Carbon Balance and Management*, *16*, 14. https://doi.org/10.1186/s13021-021-00174-7

Mapongmetsem, P. M., Etchiké, D., & Ngassoum, M. B. (2016). Conservation and enhancement of biodiversity in the agroforests of the peri-urban area of Bafia (Central Region, Cameroon). *Scientific and Technical Review Forest and Environment of the Congo Basin*, *6*, 60–69.

Mapongmetsem, P. M., Hamawa, Y., Baye-Niwah, C., Froumsia, M., Zigro, L., & Meiga, O. S. (2009). Conservation and enhancement of biodiversity in case agroforests in the Sudano-Guinean zone. In X. van der Burgt, J. van der Maesen, & J.-M. Onana (Eds.), *Systematics and conservation of African plants* (pp. 375–384). Royal Botanic Gardens, Kew.

Mapongmetsem, P. M., Ngassoum, M. B., & Etchiké, D. A. B. (2020). Potentialités des agroforêts contre les changements climatiques en zone d'écotone forêt-savane du Cameroun. *European Scientific Journal*, *16*(15), 319–350.

Mapongmetsem, P. M., Nkongmeneck, B. A., Rongoumi, G., Dongock, Nguemo, D., & Dongmo, B. (2011). Impact des systèmes d'utilisation des terres sur la conservation de *Vitellaria paradoxa* dans les savanes soudano-guinéennes. *International Journal of Environmental Studies*, *68*(6), 851–872.

Mandleni, B., & Anim, F. D. K. (2011). Climate change awareness and decision on adaptation measures by livestock farmers. In *Proceedings of the 85th Annual Conference of the Agricultural Economics Society* (18–20 April, Warwick University).

Maryo, M., Wolde, A., & Negash, M. (2023). Woody species diversity and carbon stock potentials in homegarden agroforestry and other land use systems, northern Ethiopia. *Heliyon*, *9*, e19243.

Minasny, B., McBratney, A. B., Malone, B. P., & Wheeler, I. (2013). Digital soil mapping of soil carbon. *Advances in Agronomy*, *118*, 1–47. https://doi.org/10.1016/B978-0-12-405942-9.00001-5

Montagnini, F., & Nair, P. K. R. (2004). Carbon sequestration: An underexploited environmental benefit of agroforestry systems. *Agroforestry Systems*, *61*, 281–295.

Mori, S. A., Boom, B. M., De Carvalho, A. M., & Dos Santos, T. S. (1983). Southern Bahian moist forests. *The Botanical Review*, *49*(2), 155–232.

Motis, T. (2007). *Agroforestry principles*. ECHO.

Nair, P. K. R. (1993). *An introduction to agroforestry*. Kluwer Academic Publishers.

Phondani, P. C., Maikhuri, R. K., Rawat, L. S., & Negi, V. S. (2020). Assessing farmers' perception on criteria and indicators for sustainable management of indigenous agroforestry systems in Uttarakhand, India. *Environmental and Sustainability Indicators*, *5*, 100018. https://doi.org/10.1016/j.indic.2019.100018

Pielou, E. C. (1966). The measurement of diversity in different types of biological collections. *Journal of Theoretical Biology*, *13*, 131–144. https://doi.org/10.1016/0022-5193(66)90013-0

Piponiot, C., Cogné, M., Freycon, V., Thoumazeau, A., Gusmão, M., & Peltier, R. (2025). Traditional agroforestry systems in Timor Leste can store large amounts of carbon in both soil and biomass. *Agroforestry Systems*, *99*, 138. https://doi.org/10.1007/s10457-025-01222-8

Seid, G., & Kebebew, Z. (2022). Homegarden and coffee agroforestry systems plant species diversity and composition in Yayu Biosphere Reserve, southwest Ethiopia. *Heliyon*, *8*(4), e09281. https://doi.org/10.1016/j.heliyon.2022.e09281

Shannon, C. E. (1948). A mathematical theory of communication. *Bell System Technical Journal*, *27*, 379–423, 623–656.

Shao, H., Hill, R., Xue, D., & Yang, J. (2021). In situ conservation of traditional vegetable diversity in Wa homegardens in southwestern Yunnan, China. *Journal of Ethnobiology and Ethnomedicine*, *17*, 54. https://doi.org/10.1186/s13002-021-00479-4

Suchel, J. B. (1987). *The climates of Cameroon* (Doctoral dissertation). University of Bordeaux III.

Tebkew, M., Asfaw, Z., & Worku, A. (2023). Management strategies and floristic diversity in agroforestry practices of northwestern Ethiopia. *Heliyon*, *9*(11), e20963.

Thorlakson, T., & Neufeldt, H. (2012). Reducing subsistence farmers' vulnerability to climate change: Evaluating the potential contributions of agroforestry in western Kenya. *Agriculture & Food Security*, *1*, 1–13.

Yinebeb, M., Lulekal, E., & Bekele, T. (2022). Composition of homegarden plants and cultural use in an indigenous community in Northwest Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, *18*, 47. https://doi.org/10.1186/s13002-022-00545-5

Zigro, L. (2005). *Home gardens and biodiversity conservation among the Gbaya, Fulbe and Vouté peoples (Adamawa, Cameroon)* (Master's thesis). University of Ngaoundéré.