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Full Length Research

Woody species composition and diversity of Jessu Woodland, Gombe State, Nigeria

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ABSTRACT: Jessu Woodland is an important Sudan savanna ecosystem supporting woody biodiversity and local livelihoods, but increasing anthropogenic pressure threatens its ecological integrity. This study aims to assess the woody species composition and diversity of Jessu Woodland, Gombe State, Nigeria, between June and September 2021. Vegetation sampling was conducted using the Point-Centered Quarter (PCQ) method, while field observations, structured questionnaires and Focus Group Discussions (FGDs) were used to evaluate socio-ecological influences. A total of 36 woody species belonging to 18 families and 32 genera were recorded, comprising 30 tree species and six shrub species. *Maranthes polyandra* recorded the highest Importance Value Index (IVI) (50.89%), followed by *Ficus thonningii* (34.66%) and *Detarium microcarpum* (27.27%), while *Ficus polita* (1.10%) and *Vitex doniana* (2.02%) had the lowest values. Diversity indices indicated moderate diversity for trees (Simpson's index = 0.40; Shannon–Wiener index = 2.8) and low diversity for shrubs (Simpson's index = 0.28; Shannon–Wiener index = 1.2). Socio-ecological findings revealed that fuelwood harvesting, farming expansion, and grazing are major drivers of woodland degradation. The study concludes that anthropogenic activities significantly influence species distribution and diversity. This study recommended that reforestation, community-based conservation, and environmental awareness programs would enhance sustainable woodland management.

Keywords: Focus group discussion, importance value index, point-centred, quarter, questionnaire, woody species.

INTRODUCTION

Savanna woodlands constitute one of the most extensive vegetation types in sub-Saharan Africa and play a critical role in ecological stability, biodiversity conservation, and rural livelihoods. In semi-arid regions of Nigeria, particularly the Sudan savanna zone of Northern Nigeria, woodlands play a significant role in sustaining rural livelihoods through the provision of fuelwood, fodder, medicinal plants, and timber (FAO, 2020; IPBES, 2022).

Woody vegetation regulates microclimate, controls soil erosion, enhances nutrient cycling, and provides essential ecosystem goods such as construction materials and wild fruits (Hutchinson and Dalziel, 1954–1972; FAO, 2020). These woodlands also function as important carbon sinks, contributing to climate change mitigation in semi-arid landscapes.

However, increasing anthropogenic activities such as agriculture, fuelwood harvesting, overgrazing, charcoal production, recurrent bush burning and settlement expansion have resulted in loss of species diversity, habitat degradation, and declining woodland productivity, habitat fragmentation, reduction in woody species richness, altered species dominance, and poor regeneration of economically valuable species (Mueller-Dombois and Ellenberg, 1974; Kent, 2012; IPBES, 2022). In North-Eastern Nigeria, these pressures are further intensified by climate variability, prolonged dry seasons, and increasing human population density.

Gombe State lies within a fragile ecological transition zone between the Sudan and Sahel savannas. Woodland ecosystems in the state are increasingly exploited to meet domestic energy demands and agricultural needs. Jessu Woodland, located in Balanga Local Government Area, represents a remnant natural woodland that supports both biodiversity and local livelihoods. Field reconnaissance revealed extensive signs of human disturbance, including tree stumps from selective logging, browsing pressure on regenerating seedlings, farmland encroachment, and seasonal grazing routes. These disturbances are likely to influence species composition, structural characteristics, and dominance patterns within the woodland.

Quantitative vegetation assessment provides an objective means of evaluating the ecological status of woodland ecosystems. Indices such as species diversity and Importance Value Index (IVI) are widely used to describe floristic composition, dominance, and ecological significance of woody species (Cottam and Curtis, 1956; Mueller-Dombois and Ellenberg, 1974). IVI integrates relative density, frequency, and dominance, making it particularly useful for identifying ecologically important species and assessing disturbance effects. However, ecological data alone are insufficient to explain vegetation dynamics without considering human activities driving change.

Despite previous studies in Gombe State and adjoining savanna regions having focused mainly on forest reserves and protected areas, with limited attention given to community-managed or open access woodlands such as Jessu Woodland. Moreover, few studies have integrated field-based vegetation data with socio-ecological observations to explain patterns of dominance, scarcity, and regeneration failure. Despite its significance, little is known about the floristic composition, diversity status, and human interactions. Understanding the woody species composition and diversity, alongside community perceptions, is crucial for sustainable management, restoration, and policy intervention.

Therefore, this study aims to assess woody species composition and diversity, and to examine the influence of anthropogenic activities.

MATERIALS AND METHODS

Description of the study area

Jessu Woodland is located in Balanga Local Government Area, Gombe State, northeastern Nigeria. It lies along latitude 9°44′0″ N and Longitude 11°50′0″ E, with an altitude of 565m (Figure 1). The area experiences a Sudan Savanna climate, characterised by a distinct wet season (May–October) and dry season (November–April). Mean annual rainfall ranges from 850 to 1,200 mm, while mean annual temperature varies between 25 and 32°C. The vegetation consists mainly of scattered trees interspersed with shrubs and grasses. Farming, grazing, fuelwood collection, and hunting are the dominant land-use activities.

Data collection

Vegetation sampling

Woody vegetation was sampled using the Point-Centered Quarter (PCQ) method (Cottam and Curtis, 1956). A total of 10 transects were laid systematically across the study area at 100 m intervals. At each point, the area was divided into four quadrants, and the nearest trees (DBH ≥ 10 cm) and shrubs (DBH ≥ 5 cm) were measured at breast height (1.3 m) in each quadrant was identified and measured. Species identification followed Hutchinson and Dalziel (1954–1972) and Burkill (1985). Voucher specimens were confirmed at the Gombe State University Herbarium. Relative density, relative frequency and relative dominance were computed to derive the Importance Value Index (IVI) using quantitative phytosociological methods as described by Cottam and Curtis (1956), Dix (1971), Mueller-Dombois and Ellenberg (1974) and Kent (2012). Diversity indices (Shannon–Wiener and Simpson's) were calculated following Magurran (2004).

Diversity indices

Biodiversity indices were computed as follows:

"Species diversity was assessed using Simpson's Diversity Index (Simpson, 1949) and the Shannon-Wiener Diversity Index (Shannon, 1948), as applied in Ojo (1996) to determine richness and evenness of woody species in the study area."

- Shannon–Wiener Diversity Index (H′):
- Simpson's Index of Diversity (1 – D):
- Species Richness (S): total number of species recorded.

These indices were calculated using PAST (Paleontological Statistics) software version 4.0 (Hammer et al., 2001) and Microsoft Excel.

Socio-ecological data collection

Prior to the survey, an Introductory Letter was obtained from the Department of Plant Sciences, and informed verbal/written consent was collected from all participants. Socio-ecological data were then obtained using structured questionnaires, Focus Group Discussions (FGDs), and direct field observation. A total of 150 respondents were selected using stratified random sampling, guided by the Yamane (1967) sampling formula. FGDs involved farmers, herders, women, youth, and traditional leaders selected through purposive sampling to capture diverse perspectives (Etikan *et al.*, 2016). In addition to floristic data, anthropogenic influences were evaluated through participatory rural appraisal (PRA) techniques including

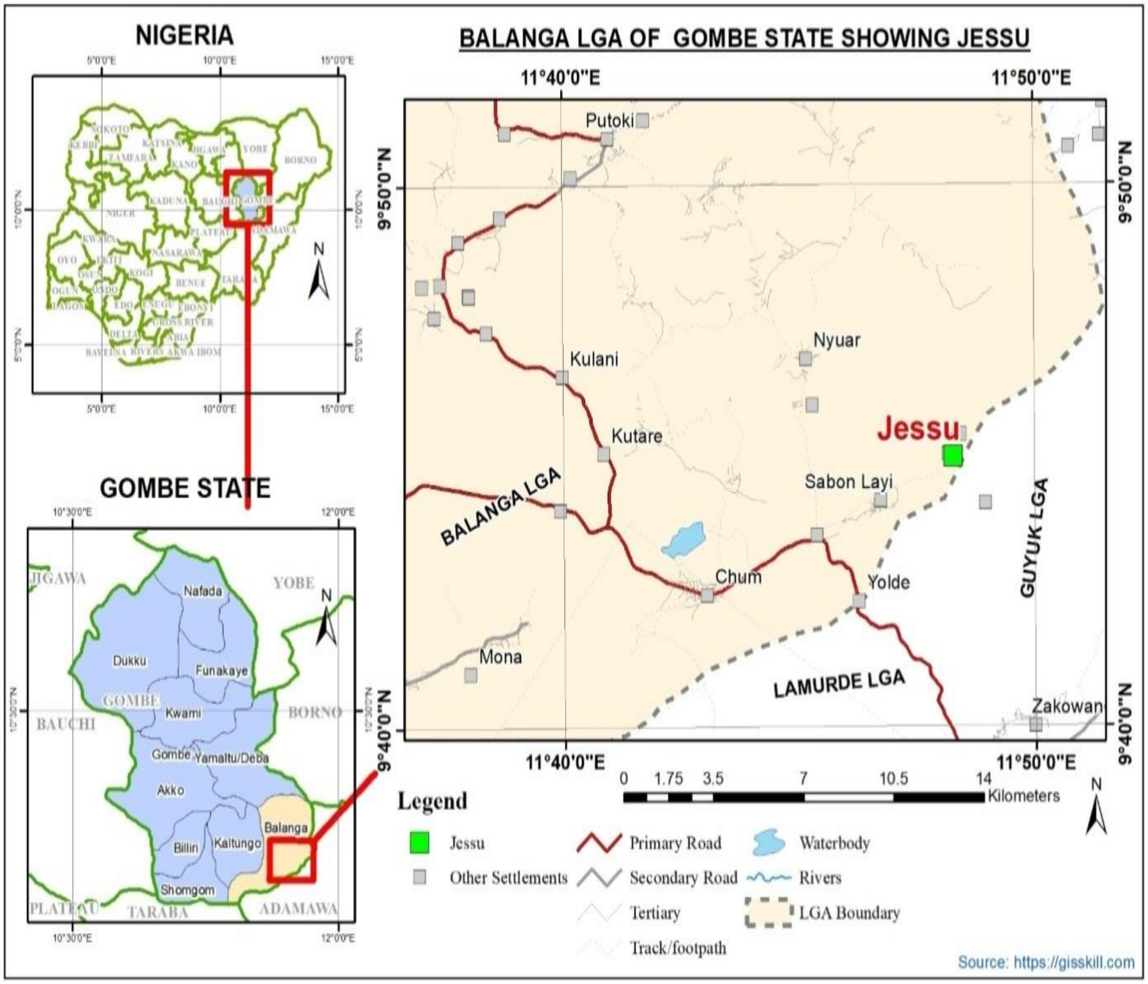

Figure 1. Map of the study site of data collection.

direct observation, focus group discussions, and questionnaire surveys. These methods provided qualitative insight into local land-use patterns and their perceived impacts on woody vegetation.

Sampling method and community segmentation

The choice of different segments of the community for Focus Group Discussions (FGDs) and key informant interviews was guided by a purposive sampling strategy**.** This method was employed to ensure that participants represented a cross-section of stakeholders directly or indirectly involved with the use, management, or degradation of the Jessu woodland. These segments included farmers, herders, traditional leaders, fuelwood collectors, and women**,** who were identified based on their direct dependence on the woodland for livelihood, local ecological knowledge, or community leadership roles.

This approach was chosen because purposive sampling is particularly effective in ecological and ethnobotanical studies where the aim is to gain deep insights from knowledgeable individuals (Etikan *et al.*, 2016). By targeting specific groups, the study was able to capture diverse perspectives on the anthropogenic drivers of vegetation change and the socio-cultural dynamics influencing conservation practices.

Participants were identified through community leaders and local extension agents**,** who helped in pinpointing individuals with direct interactions with the forest ecosystem. This ensured that the data collected reflected both ecological realities and socio-economic contexts. This approach provides a balanced view of local interactions with the woodland ecosystem. This sample size is considered adequate for capturing varied perceptions and traditional knowledge about the forest and its vegetation.

Direct field observation

Direct field observation was conducted systematically along the established transects and around sampling points to document visible anthropogenic disturbances. Particular attention was given to evidence of farming expansion, tree cutting, fuelwood collection, grazing, browsing, charcoal production, tree stumps, farmland encroachment and damage to natural regeneration. Observations were recorded using standardised field notes and subsequently compared with questionnaire and Focus Group Discussion responses to cross-check information obtained from community members. Direct observation is useful for verifying reported land-use activities and improving the reliability of socio-ecological information (FAO, 2004; USAID, 1996).

Questionnaire administration

150 Structured questionnaires were administered to randomly selected households in communities surrounding Jessu Woodland. The questionnaire captured demographic information, woodland uses (fuelwood, fodder, medicinal plants, and timber), perceived threats, and local conservation practices, following guidelines of Newing (2011) for socio-ecological research.

Focus group discussions (FGDs)

FGDs were conducted with farmers, herders, women, youth, and traditional leaders. Each group consisted of 8–12 participants. Discussions focused on historical changes in the woodland, drivers of degradation, and community-based conservation strategies. Responses were recorded, transcribed, and coded thematically (Bryman, 2016; Braun and Clarke, 2006).

Statistical analysis

Data analysis

Ecological parameters such as density, frequency, basal area, relative density, relative frequency, relative dominance, and Importance Value Index (IVI) were computed following Mueller-Dombois and Ellenberg (1974) and Kent (2012). Species diversity was assessed using Simpson's Index of Diversity (1–D) and Shannon–Wiener Index (H′). Data analyses were conducted using PAST software version 4.0 (Hammer *et al.*, 2001) and Microsoft Excel.

Questionnaire data were coded and analysed using SPSS version 25. Descriptive statistics (frequencies, means, and percentages) were generated. The Chi-square (χ^2) test was used to examine associations between categorical variables, particularly between respondents' demographic characteristics and woodland utilisation patterns, due to its suitability for analysing relationships among nominal data. Statistical significance was determined at a threshold of $p<0.05$. Thematic content analysis of Focus Group Discussion (FGD) responses followed Braun and Clarke (2006). The formulas are stated below:

Absolute density and Relative density by species

$$\text{Absolute density of a species} = \frac{\text{Relative density of a species}}{\text{Total density}}\ x \times 100$$

$$\text{Relative density of a species} = \frac{\text{Relative density of a species}}{\text{Total number of Individuals of all species}} \times 100$$

Frequency and Relative Frequency of a species

$$\text{Frequency} = \frac{\text{Number of point at which a species occurs}}{\text{Total number of points sampled}} \times 100$$

$$\text{Relative Frequency} = \frac{\text{Frequency of a species}}{\text{Total frequencies of all species}} \times 100$$

Basal area

Basal area, absolute and relative dominance by species

The Diameter at Breast Height (DBH) measured was converted into basal area by the formula

b = (d/2)2 x π),

Where: b = basal area, π = 3.1416, and d = diameter.

Absolute dominance (per unit area) of a species = Absolute density of a species × mean basal area of a species.

$$\text{Relative Dominance of a Species} = \frac{\text{Absolute Dominance of a species}}{\text{Total number of Absolute Dominance of all species}} \times 100$$

Importance Value Index (IVI) and relative importance value (RIV) for each species

Adopting the method of Dix (1961) in Abba *et al.* (2022), the IVI from the woodland data will be calculated by summing relative frequency, density and dominance values for each species.

IVI = Relative Density + Relative Dominance + Relative Frequency

$$\text{Relative importance value} = \frac{\text{Relative Density} + \text{Relative Frequecny} + \text{Relative Dominance}}{3}$$

Species diversity index

Measurement of alpha diversity. Two common approaches for measuring alpha diversity are species richness and evenness/ heterogeneity (Adopting the method of Ojo (1996); Simpson (1949); Shannon (1948), in Abba *et al.,* 2022).

Simpson's diversity index

The formula used for calculating D is:

$$D = \frac{\Sigma\, n(n-1)}{N(N-1)}$$

Where: D = diversity index, N = Total number of organisms of all species found, n = number of individuals of a particular species.

The value of D ranges between 0 and 1.

Shannon-Wiener index

The Shannon index was used to calculate the community diversity using the formula:

H' =sΣ i =1 pi (pi)

Where H= the Shannon –Wiener index and pi = the proportion of individuals of the total sample belonging to the i_{th} species. Σ = Sum

Socio-ecological data

Questionnaire data were coded and analysed using SPSS version 25. Descriptive statistics (frequencies, means, and percentages) were generated. Chi-square tests examined associations between demographic variables and woodland utilisation patterns. Thematic content analysis of FGD responses followed Braun and Clarke (2006).

RESULTS AND DISCUSSION

Woody species composition

A total of 36 woody species, belonging to 18 families and 32 genera, were recorded in Jessu Woodland. Of these, 30 species (83.3%) were trees, while six species (16.7%) were shrubs (Table 1). The dominance of tree species reflects the typical structure of Sudan savanna woodlands, where woody trees form the main vegetation layer with an understory of shrubs and grasses. In Jessu Woodland, it indicates moderate floristic richness for a Sudan savanna ecosystem. Comparable species richness has been reported in other savanna woodlands of northeastern Nigeria, including Kanawa Forest Reserve (Abba *et al.*, 2015) and Wawa-Zange Forest Reserve (Abba *et al.,* 2022), where species numbers ranged between 35 and 51. The similarity in species composition across these sites reflects shared climatic conditions, soil characteristics, and land-use history typical of the Sudan savanna zone.

The dominance of Fabaceae, Combretaceae, and Moraceae observed in Jessu Woodland aligns with findings by Abdullahi (2010) and Amonum *et al.* (2019), who reported these families as ecologically important across Nigerian savannas due to their drought tolerance, nitrogen-fixing ability, and adaptability to recurrent disturbances such as fire and grazing. This pattern is characteristic of savanna ecosystems across northern Nigeria. Their prevalence suggests that Jessu Woodland retains core savanna structural characteristics despite increasing anthropogenic pressure.

Among shrubs, six species belonging to five families were identified. The families Anacardiaceae and Fabaceae exhibited the highest representation of shrubs. These families are recognised as native and dominant components of savanna-woodland vegetation across the Sahelian zone, where they play essential ecological roles in soil stabilisation, nutrient cycling, and resilience to grazing pressure. Comparable results were reported by Abba *et al*. (2015) in Kanawa Forest Reserve and by Amonum *et al.* (2019), who also identified Fabaceae as the dominant family.

Importance Value Index (IVI) for trees in Jessu Woodland

The high IVI recorded for *Maranthes polyandra* (50.89%) indicates strong ecological dominance. Similar dominance of a few species has been reported in disturbed savanna woodlands of northern Nigeria (Abba *et al*., 2015; Abdullahi, 2010), where selective exploitation favours disturbance-tolerant species. The limited exploitation of *Maranthes polyandra* observed in the field mirrors findings by Kent (2012), who noted that species with low economic value often attain higher dominance under human pressure. The other high IVI values of *Ficus thonningii* (34.16%) and *Detarium microcarpum* (27.27%) are consistent with reports by Burkill (1985), who highlighted their socio-cultural importance, particularly as shade trees and sources of edible fruits. Studies by Abdullahi and Mohammed (2017) showed that such culturally valued species are often selectively preserved around settlements,

Table 1. Woody species (trees and shrubs) composition at Jessu Woodland.

S/N	Family	Scientific Names	Genera	Habit	Common Names	Hausa Names
1	Anacardiaceae	*Mangifera indica* L.	*Mangifera*	Tree	Mango tree	Mangoro
		Haematostaphis barteri	*Haematostaphis*	Shrub	Blood plum	Bashau
		Lannea velutina A. Rich.	*Lannea*	Tree	Goat fat	Faru
2	Annonaceae	*Annona squamosa* L.	*Annona*	Tree	Custard apple	Gwandan daji
		Holarrhena floribunda (G.Don) T. Durand & Schinz	*Holarrhena*	Tree	False rubber	Gamon sauwa
3	Apocynaceae	*Adenium obesum* (Forssk.)	*Adenium*	Shrub	Desert rose	Kariya
4	Arecaceae	*Borassus aethiopum*	*Borassus*	Tree	Elephant palm	Giginya
5	Bombacaceae	*Bombax costatum* Pellegr. & Vuillet	*Bombax*	Tree	Red kapok tree	Kuriya
		Adansonia digitata L.	*Adansonia*	Tree	Baobab tree	Kuka
6	Burseraceae	*Boswellia dalzielii* Hutch.	*Boswellia*	Tree	Frankincense	Cibdii
7	Combretaceae	*Combretum hypopilinum* Diels	*Combretum*	Tree	White denehi	Janginye
		Combretum collinum Fresen.	*Combretum*	Tree	–	–
		Anogeissus leiocarpus (DC.) Guill. & Perr.	*Anogeissus*	Tree	African birch	Marke
8	Chrysobalanaceae	*Parinari curatellifolia* Planch. ex Benth	*Parinari*	Tree	Mmupudu	Gwanja kusa
		Maranthes polyandra Benth.	*Maranthes*	Tree	Manding-bambaratudu	Gwanja kusa
9	Ebenaceae	*Diospyros mespiliformis* Hochst. ex A. Rich.	*Diospyros*	Tree	West African ebony	Kanya
10	Fabaceae	*Detarium microcarpum* Guill. & Perr.	*Detarium*	Tree	Tallow tree	Tauraa
		Piliostigma reticulatum (DC.) Hochst.	*Piliostigma*	Shrub	Camel's foot	Kargo
		Tamarindus indica L.	*Tamarindus*	Tree	Tamarind	Tsamiya
		Parkia biglobosa (Jacq.) R.Br. ex G.Don	*Parkia*	Tree	African locust bean	Dorawa
		Tetrapleura tetraptera	*Tetrapleura*	Tree	Prekese	Dawo
		Cassia sieberiana DC.	*Cassia*	Tree	Drumstick tree	Marga
		Acacia sieberiana DC.	*Acacia*	Tree	White thorn	Farar kaya
		Cassia singueana Del.	*Cassia*	Shrub	Winter cassia	Runfa
11	Meliaceae	*Azadirachta indica* A. Juss.	*Azadirachta*	Tree	Neem	Dogonyaro
		Khaya senegalensis (Desr.) A. Juss.	*Khaya*	Tree	Senegal mahogany	Madaci
12	Moraceae	*Ficus polita* Vahl	*Ficus*	Tree	Heart-leaved fig	Durumi
		Ficus platyphylla Del.	*Ficus*	Tree	Flake rubber	Gamji
		Ficus thonningii	*Ficus*	Tree	Strangler fig	Ceediya
13	Rubiaceae	*Nauclea latifolia* Sm.	*Nauclea*	Tree	African peach	Tafashiya
14	Rutaceae	*Vepris heterophylla* (Engl.)	*Vepris*	Shrub	Kinkeliba	–
15	Sapotaceae	*Vitellaria paradoxa* Gaertn. f.	*Vitellaria*	Tree	Shea butter tree	Kadanya
		Malacantha alnifolia (Bak.) Pierre	*Malacantha*	Shrub	Fogny	Bauchi kurmi
16	Sterculiaceae	*Sterculia setigera* Del.	*Sterculia*	Tree	Karaya gum	Kukuki
17	Simaroubaceae	*Hannoa undulata* (Guill. & Perr.)	*Hannoa*	Tree	–	–
18	Verbenaceae	*Vitex doniana* Sweet	*Vitex*	Tree	Black plum	Dinya

Source: Field Study (2021).

settlements, explaining their high ecological importance even in degraded landscapes.

Conversely, species such as *Vitex doniana* (2.02%) and *Ficus polita* (1.10%), which recorded very low IVI values, have been reported as declining in several savanna ecosystems due to overexploitation for fuelwood and medicinal purposes (Abba *et al*., 2015; FAO, 2020). The near absence of seedlings observed for these species in Jessu Woodland supports earlier findings that intensive harvesting disrupts regeneration dynamics in open-access woodlands. (Table 2).

Importance Value Index (IVI) for shrubs in Jessu Woodland

For shrubs, *Haematostaphis barteri* recorded the highest IVI (7.73%) in Jessu Woodland (Table 3). Its dominance can be linked to its adaptability and effective seed dispersal strategies. Conversely, *Piliostigma reticulatum* had the lowest IVI (0.72%)**,** likely due to intense anthropogenic exploitation for medicinal purposes and fuelwood**.** A comparable trend was observed by Idris *et al.* (2017), who also noted lower IVI values for *H. barteri* under

Table 2. Importance Value Index (IVI) for Trees in Jessu Woodland

S/N	Scientific names	R.F (%)	R.D (%)	R.DOM (%)	IVI (%)
1	*Acacia sieberiana* DC.	0.67	0.67	0.01	1.35
2	*Adansonia digitata* L.	1.33	1.33	0.20	2.86
3	*Annona squamosa* L.	0.67	0.66	0.13	1.46
4	*Anogeissus leiocarpus* (DC.) Guill. & Perr.	1.00	1.00	0.29	2.29
5	*Azadirachta indica* A. Juss.	4.00	4.00	2.48	10.48
6	*Borassus aethiopium* Mart.	2.67	0.66	1.60	4.93
7	*Bombax costatum* Pellegr. & Vuill.	2.00	2.00	1.74	5.74
8	*Boswellia dalzielii* Hutch.	3.67	3.66	2.77	10.10
9	*Cassia sieberiana* DC.	2.67	2.66	0.58	5.91
10	*Combretum collinum* Fresen.	5.00	4.99	4.65	14.64
11	*Combretum hypopilinum* Diels	2.00	2.00	0.58	4.58
12	*Detarium microcarpum* Guill. & Perr.	7.67	7.66	11.94	27.27
13	*Diospyros mespiliformis* Hochst. ex A. Rich.	3.00	4.66	1.60	9.26
14	*Ficus platyphylla* Del.	2.33	2.33	0.87	5.53
15	*Ficus polita* Vahl	0.33	0.33	0.44	1.10
16	*Ficus thonningii* Blume	9.33	9.32	16.01	34.66
17	*Hannoa undulata* Guill. & Perr.	2.67	2.66	2.32	7.65
18	*Holarrhena floribunda* (G. Don) T. Durand & Schinz	0.33	0.33	1.66	2.32
19	*Khaya senegalensis* (Desr.) A. Juss.	1.00	1.00	0.72	2.72
20	*Lannea velutina* A. Rich.	4.00	3.99	3.20	11.19
21	*Mangifera indica* L.	0.69	0.69	1.45	2.83
22	*Maranthes polyandra* Benth.	11.33	11.31	28.25	50.89
23	*Nauclea latifolia* Sm.	1.33	1.33	0.28	2.94
24	*Parinari curatellifolia* Planch. ex Benth.	2.00	2.00	0.06	4.06
25	*Parkia biglobosa* (Jacq.) R. Br. ex G. Don	2.00	2.99	1.89	6.88
26	*Sterculia setigera* Del.	3.00	2.99	1.89	7.88
27	*Tamarindus indica* L.	2.66	2.66	1.89	7.21
28	*Tetrapleura tetraptera* (Schum. & Thonn.)	6.67	4.66	6.12	17.45
29	*Vitellaria paradoxa* Gaertn. f.	4.33	4.33	3.20	11.86
30	*Vitex doniana* Sweet	1.00	1.00	0.02	2.02

Keys: RF = Relative frequency, RD = Relative density, R.DOM = Relative dominance, IVI= Importance value index (**Source:** Field Study, 2021).

Table 3. Importance Value Index (IVI) for Shrubs in Jessu Woodland

S/N	Scientific names	R.F (%)	R.D (%)	R.DOM (%)	IVI (%)
1	*Adenium obesum* (Forsk.) Roem. & Schult.	1.33	1.33	0.07	2.73
2	*Cassia singueana* Del.	2.67	2.66	0.01	5.34
3	*Haematostaphis barteri* Hook. f.	4.00	1.99	1.74	7.73
4	*Malacantha alnifolia* (Baker) Pierre	1.00	1.00	0.58	2.58
5	*Piliostigma reticulatum* (DC.) Hochst.	0.33	0.33	0.06	0.72
6	*Vepris heterophylla* (Engl.) Letouzey	1.33	1.33	0.04	2.70

Keys: RF = Relative frequency, RD = Relative density, R.DOM = Relative dominance, IVI= Importance value index (**Source:** Field Study, 2021).

different ecological settings. The presence of several species with low IVI values in the current study indicates that many woody species in Jessu woodland are rare or sparsely distributed, reflecting potential vulnerability to disturbance. Similar findings were reported by Narimisa and Narimisa (2018). who emphasised that a high proportion of species with low IVI values signals ecological fragility and the need for conservation measures.

Trees and shrubs species diversity

The Simpson index of diversity (1–D) for trees in Jessu Woodland was 0.40, indicating moderate–low species diversity with pronounced dominance by a few species. This is markedly lower than values reported in comparable savanna ecosystems. For instance, Abba *et al.* (2015) recorded a value of 0.946 in Kanawa Forest Reserve, Gombe State; Abdullahi (2010) reported 0.984 in Yankari National Park, Bauchi State; Giliba *et al.* (2011) reported 0.957 in the Miombo woodland of Bereku Forest Reserve, Tanzania; while Wakawa *et al.* (2017) obtained 0.80 in Gashu'a, Yobe State, Nigeria. Although these sites fall within the broader savanna biome, differences in climatic conditions, disturbance intensity, and site history likely explain the variation in diversity indices. Climate has long been recognised as a key determinant of vegetation growth, distribution, and resilience (Zakaluk and Ranjan, 2008; Aregheore, 2009).

The Shannon–Wiener index for tree species diversity in Jessu Woodland was 2.8**,** which is considerably lower than the 4.43 reported by Abba *et al.* (2015) for Kanawa Forest Reserve. Such relatively low values suggest the influence of anthropogenic disturbances, particularly deforestation, which has simplified community structure and reduced opportunities for species interactions. Higher Shannon index values generally reflect older, more stable, and structurally complex ecosystems with greater ecological resilience (Magurran, 2013).

For shrubs, the Simpson index of diversity was 0.28**,** again lower than values documented in other savanna landscapes. Abba *et al.* (2015) reported 0.998**,** while Abdullahi (2010) and Wakawa *et al.* (2017) recorded similarly higher values. The Shannon–Wiener index for shrubs in Jessu was 1.20**,** in contrast to 4.26 reported by Kumar *et al.* (2006) in the tropical forests of Garo Hills, India. The relatively low diversity in Jessu could be attributed to land-use pressures, moisture limitations, and smaller sample sizes compared to more humid tropical environments (Chao *et al.,* 2020). Such low values are consistent with findings in disturbed woodland systems across Sub-Saharan Africa, where grazing, fuelwood collection, and agricultural expansion significantly reduce species richness and evenness (Newbold *et al.*, 2020).

Impact of anthropogenic activities on woody species composition and diversity

The demographic profile of respondents revealed a predominance of middle-aged and older individuals, particularly males, engaged in activities such as farming, firewood collection, and livestock rearing. This observation aligns with Jiren *et al.* (2020) and Azare *et al.* (2021), who emphasised that middle-aged rural dwellers, especially men, are the primary actors in land-use and natural resource extraction due to their socio-economic responsi-bilities. Farming emerged as the dominant occupation (66%), underscoring the reliance of local livelihoods on land and vegetation resources, a trend similarly documented by Ouedraogo *et al.* (2014) in West Africa.

Nearly all respondents (99%) engaged in farming, and 86% in firewood collection, highlighting intense anthropogenic pressure on Jessu Woodland. This mirrors findings by Hosonuma *et al.* (2012), who identified agriculture and fuelwood extraction as the leading drivers of deforestation in Africa. Respondents further reported the decline of key species such as *Holarhena floribunda*, *Acacia sieberiana*, and *Vitex doniana*—species that are economically valuable and ecologically sensitive, and thus more vulnerable to disturbance (Newbold *et al.*, 2020).

Environmental impacts were equally severe: 94% of respondents observed declining soil fertility and reduced water availability, which corroborates studies linking deforestation with soil degradation and reduced hydrological balance in semi-arid zones (Ouedraogo *et al.*, 2014; Azare *et al.*, 2021). Wildlife responses were mixed; while generalist species such as rodents and birds remained relatively abundant, specialist taxa appeared to decline, reflecting ecosystem simplification. This pattern is consistent with Bobo *et al.* (2014), who observed that adaptable generalists persist longer in modified habitats, though long-term ecological integrity remains threatened.

Focus Group Discussions (FGDs) reinforced these findings, identifying agricultural expansion and overgrazing as major drivers of biodiversity loss. Selective declines of species such as *Piliostigma reticulatum* and *Ficus polita* highlight pressures on species with high ecological or economic value, echoing the observations of Curtis *et al.* (2018) and Harris *et al.* (2021). A critical challenge remains the low conservation awareness: although 92% of respondents expressed willingness to participate in conservation, over half (56%) were unaware of ongoing efforts, and one-third (33%) had no knowledge of relevant policies. This governance gap undermines conservation effectiveness, reinforcing Pelz *et al.* (2021), who stressed the need for participatory engagement and community-based stewardship in communal lands.

Field observation and human activities in Jessu Woodland

Field observations revealed clear evidence of human disturbance, including farming as the most common human activity affecting Jessu Woodland, with 99% of respondents reporting participation, followed by firewood collection (86%), logging (29%), grazing (25%), and charcoal production (8%) (Figure 2). The predominance of farming and firewood collection suggests that the woodland is under substantial pressure from livelihood activities that require the conversion or removal of vegetation. Agricultural expansion is widely recognised as an important driver of deforestation and forest degradation in Nigeria, particularly where woodland resources are converted to cropland to support local livelihoods (Azare *et al*., 2021). Similarly, the extraction of fuelwood and timber can reduce woody biomass and alter vegetation structure when harvesting exceeds the natural capacity of the woodland to regenerate (FAO, 2020; Abba et al., 2022).

The reported logging and charcoal production, although practiced by fewer respondents, may have dispropor-

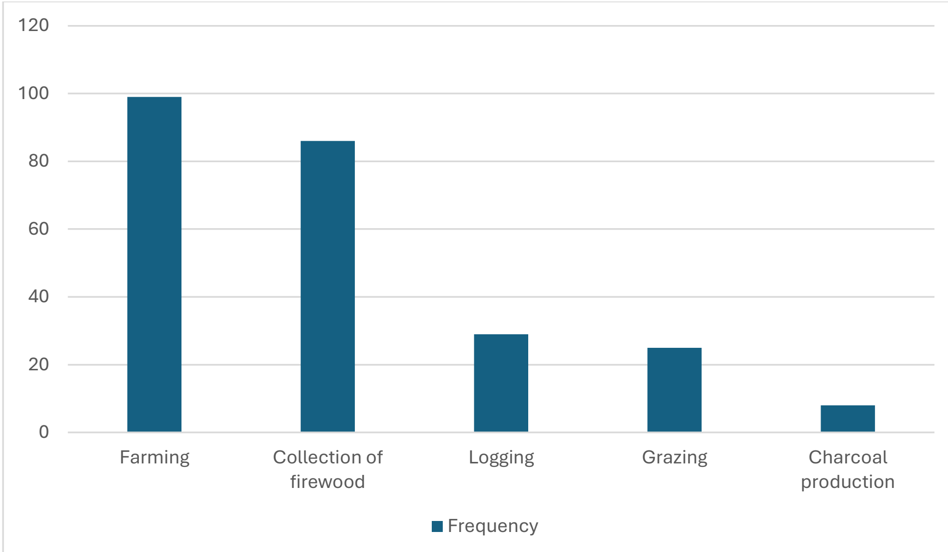

Figure 2. Bar Chart showing Human Activities in Jessu Community.

tionate effects because both activities involve the direct removal of woody species. Continuous extraction of trees and shrubs can reduce species abundance and diversity and contribute to changes in woodland structure, as observed in other Nigerian and West African woodland ecosystems (Abba et al., 2015; Wakawa et al., 2017). Grazing may also contribute to woodland degradation through browsing, trampling, and suppression of natural regeneration, while agricultural land-use changes can modify vegetation cover and ecosystem processes (Ouedraogo et al., 2014). More broadly, land-use activities are important drivers of biodiversity loss and can negatively affect ecosystem services and rural livelihoods (Newbold et al., 2016; IPBES, 2022). Therefore, the high prevalence of farming and firewood collection among respondents, together with logging, grazing, and charcoal production, indicates that human livelihood activities are major pressures on Jessu Woodland and may contribute to vegetation loss, reduced regeneration, and progressive land degradation if not properly managed.

Conclusion

The study documented 36 woody species across 32 genera and 18 families, of which 30 were trees and 6 were shrubs. The family Fabaceae contributed the highest number of species. Diversity indices indicated moderate tree diversity (Simpson’s 0.40; Shannon–Wiener 2.8) but lower shrub diversity (Simpson’s 0.28; Shannon–Wiener 1.20). Anthropogenic disturbances, particularly farming and firewood collection, emerged as the most significant threats to species composition and diversity.

Despite limited conservation awareness, community willingness to support conservation presents an opportunity for participatory woodland management. Sustainable strategies should integrate livelihood diversification, environmental education, and afforestation programs, particularly targeting species with low Importance Value Index (IVI) such as *Piliostigma reticulatum, Holarhena floribunda, Acacia sieberiana, Vitex doniana,* and *Ficus polita*

Recommendations

Based on the findings of the study, the following recommendations are proposed to improve the conservation and sustainable management of Jessu Woodland:

1. Conservation strategies should be developed and implemented in ways that reflect the ecological characteristics of Jessu Woodland and the socio-economic needs of surrounding communities.
2. Local communities should be actively involved in woodland management and conservation activities, supported by regular environmental education on the impacts of unsustainable farming, firewood collection, logging, grazing, and charcoal production.
3. Relevant environmental and forestry regulations should be effectively implemented and enforced, with emphasis on participatory monitoring, controlled resource extraction, sustainable farming practices, and appropriate land-use management.

These measures, consistent with recommended approaches to sustainable forest management, can reduce human pressure on Jessu Woodland, strengthen its ecological resilience, and support the long-term conservation of its biodiversity and ecosystem services.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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