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Bamboo Species in Agroforestry Systems of Dibrugarh District, Assam, India

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Abstract

Agroforestry improves productivity, ecological stability and rural livelihoods by mixing trees with crops. Bamboo, with its speedy growth and high biomass, is a vital component of climate-resilient farming in Assam. The present study was conducted in 11 sites of Dibrugarh district of Assam, documenting 14 bamboo species and five genera. The genera *Bambusa* was found the most dominant in this study. Species were strategically integrated into home gardens, tea-agroforestry interfaces, riparian zones and forest–agriculture transitions, serving roles as windbreaks, fences, and soil stabilizers. Findings highlight bamboo's ecological versatility and contribution to rural livelihoods, carbon sequestration, and renewable bioenergy. Bamboo-based agroforestry thus signifies a sustainable pathway for ecological restoration and rural development in Upper Assam..

Keywords: *Bamboo Distribution, Agroforestry Systems, Tea-Agroforestry Interfaces, Dibrugarh District.*

Introduction

Agroforestry is a sustainable land-use system that provides high land productivity, ecological sustainability and social and economic benefits to farmers and rural communities. Agroforestry is a widespread farming system that maintains soil fertility, reduces pollution and ensures income security. Agroforestry plays a key role in increasing agricultural productivity, improving the rural livelihoods and contributing to ecosystem services in diversely farmed landscapes. In tropical and subtropical ecosystems, bamboo has become an important crop within many agroforestry systems, because of its fast growth rate, numerous uses and a wide tolerance of climate, thus providing a wide range of ecological and socio-economic benefits [1].

Bamboo is a fast-growing perennial grass belonging to the family Poaceae that is native to many countries in Asia and is commonly found in traditional farming systems. Due to its quick growth rate and its immense biomass production, bamboo is of great ecological and economic value. Bamboo can easily be integrated into an agroforestry system such as on the borders of farmlands, homestead gardens or within a mixed cropping system. Therefore, bamboo-based farming systems can lead to more efficient land use, higher soil conservation and higher income diversification for small-scale farmers [2].In the North Eastern region of India, mainly Assam, bamboo plays a very dominant role in the rural agroforestry systems. The farmers in Assam grow bamboos within their agricultural landscapes along with crops like paddy, vegetables and fruit trees and use the bamboo products regularly and also generate income for their livelihood. Thereby, the bamboo-based agroforestry systems in Assam provides the local requirements, building materials, crafts and fuel and also contributes to soil conservation, carbon sequestration and the stabilization of fragile ecosystems while also supporting rural livelihoods [2],[3].

In recent years, bamboo agroforestry throughout Northeast India moved from an informal and unregulated pattern to an organized tool for rural livelihood transformation and climate resilience. With over 60% of India's bamboo growing stock found in this region, local practices are very diverse at the state level ranging from multi-layered food forests in Manipur to state-sponsored agroforestry expansion zones in Tripura [4].
In the state of Assam, particularly in the Dibrugarh district, bamboo farming is practiced at a wider scale. Large tracts of land of Assam are being used for planting bamboo in homesteads and as a boundary crop in farmlands.

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Bamboo has therefore the potential to enhance land productivity and to provide long-term ecological services and to improve the livelihood of people in rural areas [3]. Bamboo shoots, locally known as Khorisa can be eaten fresh, fermented, or canned. They are nutritious because they contain proteins, carbohydrates, minerals, and fiber, while being low in fat and sugar. This makes bamboo shoots a healthy food with good future potential [5].

The primary objective of this study is to assess the diversity and distribution of bamboo species in agroforestry systems of Dibrugarh district, Assam. By utilizing a flexible, extensive random-sampling approach across 11 different field sites, this paper establishes how spatial distribution and diversity of bamboo are direct results of how they are intercropped within different farming layouts.

Materials and Methods

The study was conducted in Dibrugarh district of Assam (Fig.1), North Eastern India (27°05′–27°42′ N; 94°33′–95°29′ E), which has a humid subtropical climate with heavy monsoon rainfall, moderate temperatures and fertile alluvial soils ranging from sandy loam to clayey loam. These conditions are highly favorable for bamboo cultivation.

Field surveys were carried out across 11 sites representing diverse ecological settings such as home gardens (Lahoal, Banipur, Boiragimoth, Mohanbari), tea ecosystem interfaces (Bongalgaon, Hatiali, Chabua), riverine floodplains (Rohmoria, Bogibeel), and southern agro-industrial landscapes (Naharkatia, Namrup). Random walking transits through farming grids enabled documentation of bamboo species.

Data collection involved measuring culm girth at breast height with a flexible tape, photographing clumps with a GPS-enabled camera, and recording morphological traits and associated crops in a field notebook. GPS coordinates were processed in QGIS to prepare digital maps of study sites. Photographs captured clump architecture, nodal rings, branching patterns, and culm sheaths, while associated crops and spatial arrangements were noted to understand bamboo-based agroforestry systems.

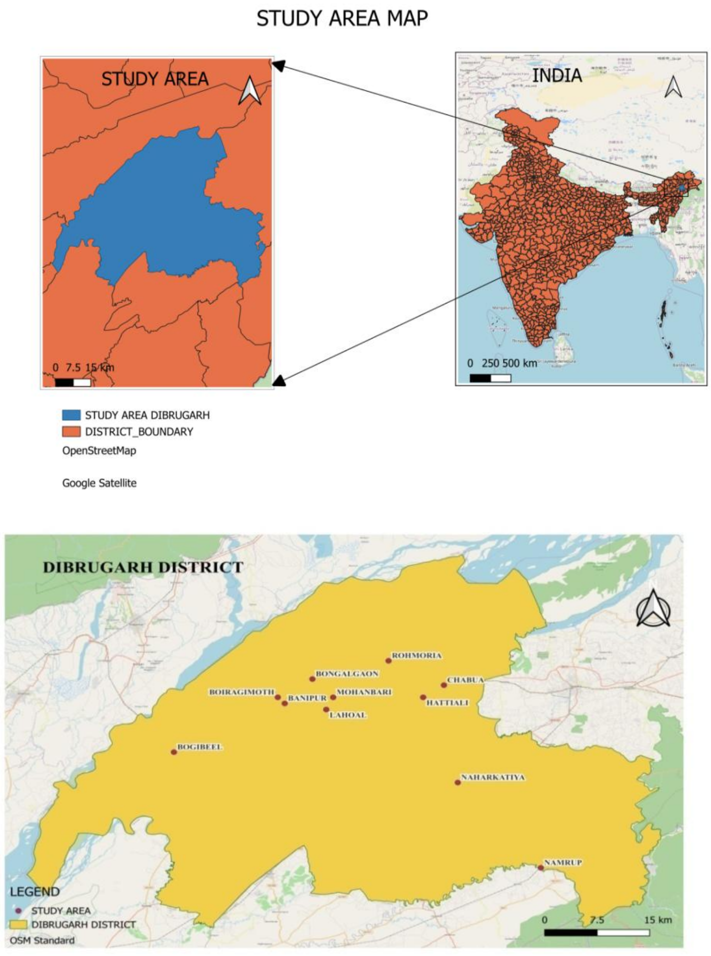

Fig 1: Study area map of Dibrugarh District of Assam

Results and Discussion

Bamboo Diversity and Intercropping Typologies

According to the random sampling field survey, it shows that 11 locations of Dibrugarh district contain 14 bamboo species under five genera such as *Bambusa*, *Dendrocalamus*, *Pseudosasa*, *Melocanna* and *Oxytenanthera*. The most diverse among them was the genus *Bambusa* which accounted for 10 out of 14 species recorded.

A key structural measure documented was the Culm Girth Circumference (in centimeter). Structural size differed greatly within the collection, with its highest being very robust *Dendrocalamus giganteus* (Girth Circumference=36 cm) down to the very slender, running *Pseudosasa japonica* (Girth Circumference=0.5cm).

The comprehensive list of recorded species by scientific name and local name, along with respective culm Girth Circumference, growth habits, field locations, and specific intercropped agroforestry configurations is presented in Table 1.

Table 1: Bamboo Diversity, their sizes and structures and Intercropping patterns

Sl. No.	Botanical name	Local/ Common Name (Assamese	Culm Girth (cm)	Growth Habit	Field Locations	Intercropped Agroforestry Pattern & Land-Use Type
1	*Bambusa tulda* Roxb.	Jati Bah	12.0	Sympodial (clump Forming)	Lahoal, Chabua, Rohmoria, Banipur, Namrup, Hatiali, Bogibeel	Intercropped directly with tea plantations, various crops, and along low-lying paddy field boundaries.
2	*Bambusa balcooa* Roxb	Bhaluka Bah	29.0	Sympodial (Dense, Heavy)	Chabua, Rohmoria, Hatiali	Integrated within traditional home gardens and intercropped with various agricultural food crops.
3	*Bambusa vulgaris* Schrad. ex J.C.Wendl	Beki Bah	17.0	Sympodial (Open Clump)	Banipur	Planted as structural boundary lines and overstory
4	*Bambusa assamica* Barooah & Borthakur	Saru Bijuli Bah	2.5	Sympodial (Slender Clump)	Banipur, Hatiali	Managed as a living protective fence around home gardens and intercropped with miscellaneous annual crops.
5	*Bambusa pallida* Munro	Bijuli Bah	7.0	Sympodial (Clump-forming)	Boiragimoth Kachari Gaon	Cultivated strictly as a dense living fence adjacent to traditional household home gardens (Bari
6	*Bambusa bambos* (L.) Voss	Kotoha Bah	11.0	Sympodial (Thorny, Dense)	Bongalgaon	Deployed as a protective barrier and boundary 7marker running near commercial tea ecosystems.
7	*Bambusa pseudopallida* Sheng & W.T.Lin.	Bijuli Bah	3.0	Sympodial (Clump-forming)	Hatiali	Intercropped as an understory vegetative layer within multi-tier traditional home gardens.

Sl. No.	Botanical name	Local/ Common Name (Assamese	Culm Girth (cm)	Growth Habit	Field Locations	Intercropped Agroforestry Pattern & Land-Use Type
8	*Bambusa barpatharica* Majumdar	Barpathar Bah	3.0	Sympodial (Clump-forming)	Hatiali	Maintained within the built agricultural matrix, growing directly inside a commercial tea factory compound
9	*Bambusa nana* Roxb.	Borosi- dang Bah/ Jupuri-Bah	1.0	Sympodial (Shrubby/ Dwarf)	Hatiali	Kept as a low-stature structural component within the inner rings of managed home gardens.
10	*Bambusa wamin* Brandis ex E.G.Camus	Kolosi Bah	5.0	Sympodial, Ornamental	Mohanbari	Integrated solely as an ornamental land-use feature along household gates and modern infrastructure interfaces
11	*Dendrocalamus giganteus* Munro	Mokal Bah	36.0	Sympodial (Massive Clump)	Banipur, Naharkatia	Established as a massive overstory landmark directly bordering lowland paddy fields
12	*Melocanna baccifera* (Roxb.) Kurz	Muli Bah	9.0	Diffuse Clump / Leptomorph	Hatiali	Occupying semi-managed forest areas and woodlots transitioning into active agricultural zones.
13	*Oxytenanthera parvifolia* Brandis ex Gamble	Pahariya Jati Bah	7.5	Sympodial (Clump-forming)	Hatiali	Distributed within localized forest fragments 14adjacent to managed agroforestry plots.
14	*Pseudosasa japonica* (Siebold & Zucc. ex Steud.) Makino	Kar Bah/ Arrow Bamboo	0.5	Monopodial (Running habit)	Banipur	Maintained in specialized, small-scale running matrices within the interior layout of private home gardens.

Intercropping Patterns and Agroforestry Integration

The spatial distribution of the documented species is heavily tied to how they are intercropped within the local agricultural landscape. Rather than growing wild, the recorded species serve specific functions within different farming layouts.

A. Widespread Cultivars and High-Plasticity Intercropping

Bambusa tulda (Girth 12·0 cm) and *Bambusa balcooa* (Girth 29·0 cm,) showed the widest distribution across the district. *Bambusa tulda* was commonly intercropped with tea bushes, vegetable plots, and paddy field bunds, highlighting its role as a fundamental multi-purpose component in local agroforestry systems. Its sympodial growth habit and moderate canopy allow coexistence with crops. In the same way, *Bambusa balcooa* is valued for its dense, thick-walled culms and makes it highly sought for structural purposes. Both the species also improve soil health by providing organic matter and nutrients from the decomposed fallen leaves back into the soil, helping nearby crops to grow better.

B. Spatial Distribution in Commercial Tea Matrices and Industry Interfaces

At tea cultivation sites like Hatiali, Chabua, Bongalgaon, the species selection is driven by microclimatic protection and spatial designs. *Bambusa vulgaris* (Girth 17.0 cm) and *Bambusa bambos* (Girth 11.0 cm) is found to be planted alongside tea rows functioning as windbreaks and shielding delicate leaves of *Camellia sinensis* from severe storm. *Bambusa barpatharica* (Girth 3.0cm) was recorded inside the premises of a tea factory area in Hatiali indicating bamboo use beyond agriculture for decorative (aesthetic), shade, or boundary purposes.

C. Canopy Stratification and Fencing in Home gardens (Bari)

In Lahoal, Banipur and Boiragimoth Kachari Gaon, *Bambusa assamica* (Girth 2.5 cm) and *Bambusa pallida* (Girth 7.0 cm) were directly used as living fences. Smaller bamboo species like *Bambusa pseudopallida* (Girth 3.0 cm), *Bambusa nana* (Girth 1.0 cm) and the running *Pseudosasa japonica* (Girth 0.5 cm) occupied small understory or specialized border spaces, under the partial shade of fruit or betel nut trees. It indicates how the multiple species can be arranged vertically without causing severe root or light competition. *Bambusa wamin* (Girth 5.0 cm) in Mohanbari was mainly maintained for decoration and landscape beauty, especially in areas developing near roads and infrastructure.

D. Lowland Margins and Forest-Agricultural Transitions

The distribution of the big sized recorded species, *Dendrocalamus giganteus* (Girth 36.0 cm) was recorded in Banipur and Naharkatia that illustrates a targeted land-use choice. Because this bamboo grows very large and thick, farmers plant it only in open border areas where there is enough space for it to grow properly. *Melocanna baccifera* (Girth 9.0 cm) and *Oxytenanthera parvifolia* (Girth 7.5 cm) were confined to the forest patches of Hatiali indicating the importance of forest-agriculture transition zones for bamboo diversity conservation.

Conclusion

The study demonstrates that Dibrugarh district maintains a rich diversity of bamboo documenting 14 species with five genera, with the genus *Bambusa* being the most dominant. These species are strategically integrated into various agroforestry systems, including multi-tier home gardens, commercial tea ecosystems, and riparian zones where they serve critical roles as windbreaks, living fences and structural materials. The research underscores bamboo's potential as a "green gold" resource for Upper Assam, contributing to rural livelihoods, soil conservation, and carbon sequestration, while also offering a viable feedstock for renewable bioenergy production.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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