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Estimation of Biomass Carbon in Different Bamboo Species in the Bambusetum of Rain Forest Research Institute (RFRI), Jorhat, Assam, India

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Abstract

This study evaluates the above-ground biomass (AGB), carbon stock, and CO_2 sequestration potential of seven bamboo species cultivated in the Bambusetum of RFRI, Jorhat, Assam. Using species-specific allometric equations based on diameter at breast height (DBH) and culm height, the study found that *Bambusa balcooa* exhibited the highest biomass (195.24 Mg/ha), carbon stock (97.62 Mg/ha), and CO_2 equivalent (358.27 Mg/ha), followed by *B. vulgaris* and *B. cacharensis*. *Schizostachyum dullooa* and *Melocanna baccifera* recorded the lowest values. These findings underscore the role of bamboo in carbon sequestration and its relevance to climate change mitigation.

Keywords: *Biomass, Carbon sequestration, Above-ground biomass, Climate change mitigation*

Introduction

Bamboo, a versatile and fast-growing member of the Poaceae family, has garnered global attention for its ecological, economic, and environmental significance. Distributed widely across tropical and subtropical regions, bamboo plays a vital role in rural livelihoods, construction, paper production, and handicrafts. Beyond its utilitarian value, bamboo is increasingly recognized for its remarkable potential in climate change mitigation due to its rapid growth rate, high biomass productivity, and efficient carbon sequestration capabilities (Lobovikov et al., 2009; Yiping et al., 2010).

Unlike conventional timber species, bamboo can reach maturity within 3–5 years, making it a renewable resource with a short rotation cycle. Its extensive root system contributes to soil stabilization and erosion control, while its dense canopy aids in microclimate regulation. These attributes position bamboo as a

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strategic species for afforestation, reforestation, and ecological restoration programs, especially in degraded landscapes.

One of the most compelling attributes of bamboo is its ability to sequester atmospheric carbon dioxide (CO_2) through photosynthesis and store it in its biomass. Studies have shown that certain bamboo species can rival or even surpass traditional forest species in terms of carbon storage per unit area (Kaushal et al., 2022; Camargo García et al., 2024). This makes bamboo an ideal candidate for inclusion in carbon offset initiatives and REDD+ (Reducing Emissions from Deforestation and Forest Degradation) programs.

Accurate estimation of biomass and carbon stock is essential for quantifying the ecological benefits of bamboo and integrating it into climate policy frameworks. Traditional destructive sampling methods, while precise, are labor-intensive and impractical for large-scale assessments. In contrast, non-destructive techniques using species-specific allometric equations—based on measurable parameters such as diameter at breast height (DBH) and culm height—offer a reliable and scalable alternative (Chave et al., 2005; Devi et al., 2023).

The Rain Forest Research Institute (RFRI), under the Indian Council of Forestry Research and Education (ICFRE), has established a Bambusetum in Jorhat, Assam, which serves as an ex-situ conservation site for diverse bamboo species. This facility provides a unique opportunity to study the biomass carbon potential of different bamboo taxa under controlled conditions. The primary objective of this study is to estimate the above-ground biomass (AGB) carbon of selected bamboo species cultivated in the Bambusetum of ICFRE-RFRI, Jorhat, Assam. By applying species-specific allometric models, the study aims to identify bamboo species with high carbon sequestration potential, thereby contributing to sustainable forestry practices and climate change mitigation strategies.

Materials and Methods

Study Area

The study was conducted at the Rain Forest Research Institute (RFRI), Jorhat, Assam, located between 26°46′N–27°10′N latitude and 93°0′E–94°0′E longitude, with an elevation of 116 m. The region experiences a humid subtropical climate with annual rainfall of 2000–2500 mm and temperatures ranging from 7°C to 36°C. The Bambusetum conserves 39 bamboo species from 13 genera, supporting research in biodiversity, silviculture, and agroforestry.

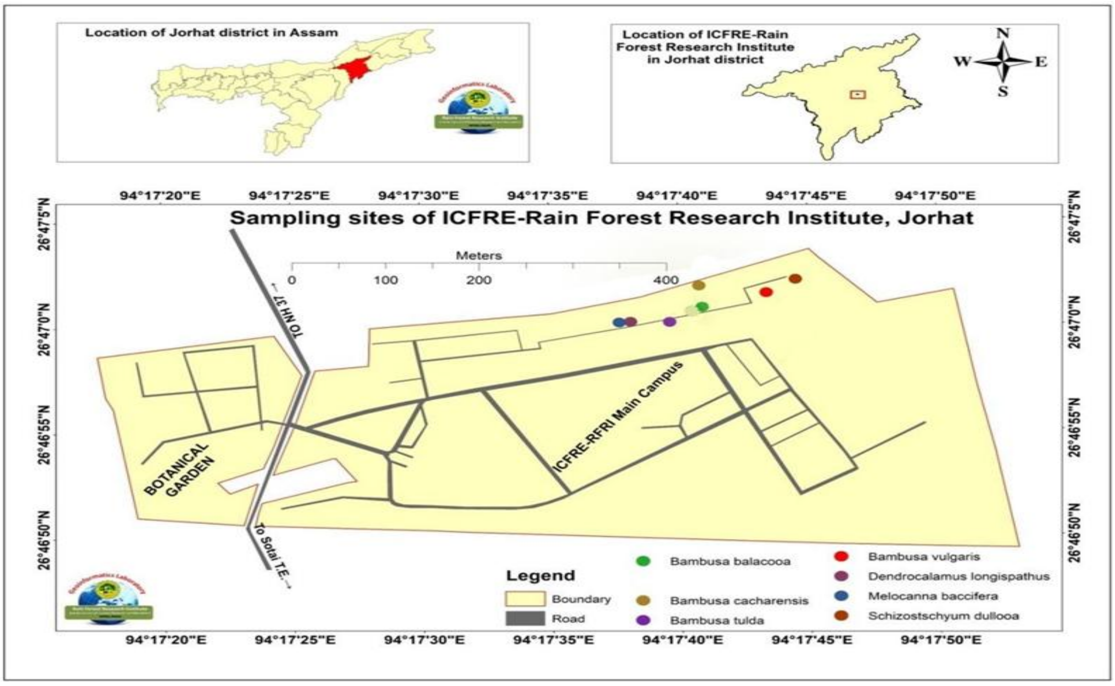

Fig. 1: Map of study area

Table 1: Selected bamboo species of Bambusetum for biomass carbon study

Sl. No.	Species Name	Local Name
1	*Bambusa tulda* Roxb.	Jati banh
2	*Dendrocalamus longispathus* (Kurz) Kurz	Bor bhuluka banh
3	*Melocanna baccifera* (Roxb.) Kurz	Torai
4	*Schizostachyum dullooa* (Gamble) Majumder	Dolo banh
5	*Bambusa cacharensis* R.B. Majumdar	Betua banh
6	*Bambusa vulgaris* Schrad.	Tansti banh
7	*Bambusa balcooa* Roxb.	Bhaluka banh

Field Equipment and Materials

During the field survey, a caliper was used to measure the diameter at breast height (DBH) of bamboo culms, while a measuring tape assisted in determining plot dimensions; a range finder provided accurate culm height readings, a GPS camera documented geospatial coordinates and visual records of each clump, and all observations were meticulously recorded in a field notebook for subsequent analysis.

Data Collection and analyses

Species identification was carried out using standard taxonomic keys and verified through expert consultation at the Rain Forest Research Institute. Sample plot sizes varied depending on the species, ranging from 4×4 m to 10×10 m, and within each plot, five culms per clump were randomly selected to account for intra-clump variability. Culm height was measured using a range finder, while diameter at breast height (DBH) was recorded at 1.37 meters above ground level using a caliper.

Following field measurements, data analysis involved calculating the average culm biomass, which was then extrapolated to a per hectare basis. Biomass values expressed in kilograms per hectare (kg/ha) were converted to megagrams per hectare (Mg/ha), using the conversion factor of 1 Mg = 1000 kg. Carbon stock was estimated by assuming that 50% of the dry biomass constitutes carbon, and the CO_2 equivalent was derived by multiplying the carbon stock by a factor of 3.67, reflecting the molecular weight ratio between CO_2 and carbon.

Results and Discussion

The study revealed significant variation in above-ground biomass (AGB), carbon stock, and CO_2 sequestration potential among the seven bamboo species evaluated in the Bambusetum of ICFRE-RFRI, Jorhat. *Bambusa balcooa* emerged as the most efficient species in terms of biomass accumulation, recording an AGB of 195.24 Mg/ha, which translated to a carbon stock of 97.62 Mg/ha and a CO_2 equivalent of 358.27 Mg/ha. This aligns with previous findings that highlight *B. balcooa* as a high-yielding species with robust culm structure and growth rate (Das et al., 2017).

Following closely, *Bambusa vulgaris* and *Bambusa cacharensis* demonstrated substantial carbon sequestration capacities, with AGB values of 169.74 Mg/ha and 134.92 Mg/ha respectively. Their CO_2 equivalents were 311.47 Mg/ha and 247.57 Mg/ha, reinforcing their suitability for afforestation and carbon offset programs (Kaam et al., 2023; Kaushal et al., 2022).

Dendrocalamus longispathus showed moderate biomass potential (106.75 Mg/ha), while *Melocanna baccifera* and *Bambusa tulda* recorded lower values, yet still contributed meaningfully to carbon storage due to their rapid growth and ecological adaptability (Devi et al., 2023). *Schizostachyum dullooa* had the lowest biomass and carbon values, with an AGB of 40.19 Mg/ha and CO_2 equivalent of 73.75 Mg/ha, though its ecological role in biodiversity conservation remains important.

These results underscore the species-specific differences in carbon sequestration potential and highlight the importance of selecting appropriate bamboo taxa for climate mitigation strategies.

Table 2: Above-Ground Biomass, Carbon Stock, and CO_2 Equivalent of Selected Bamboo Species

Sl. No	Species	AGB (Mg/ha)	Carbon (Mg/ha)	CO_2 Equivalent (Mg/ha)
1	*Bambusa balcooa*	195.24	97.62	358.27
2	*Bambusa vulgaris*	169.74	84.87	311.47
3	*Bambusa cacharensis*	134.92	67.46	247.57
4	*Dendrocalamus longispathus*	106.75	53.38	195.89
5	*Melocanna baccifera*	90.77	45.39	166.56
6	*Bambusa tulda*	83.54	41.77	153.29
7	*Schizostachyum dullooa*	40.19	20.09	73.75

Carbon sequestration varied significantly among species, primarily due to differences in culm diameter and height. *Bambusa balcooa*, *B. vulgaris*, and *B. cacharensis* demonstrated superior carbon storage, making them suitable for afforestation and carbon offset initiatives. Although *M. baccifera* and *S. dullooa* showed lower biomass, their rapid growth and ecological roles remain valuable.

Conclusion

The study confirms that bamboo species vary in their biomass carbon potential. *Bambusa balcooa* is the most effective for carbon capture, followed by *B. vulgaris* and *B. cacharensis*. Even species with lower biomass contribute meaningfully to ecological restoration. Bamboo cultivation should be prioritized in climate mitigation strategies.

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Declarations

Conflict of interest: The authors declare that they have no conflict of interest

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