

Estimating the Level of Carbon Dioxide Sequestration by Selected Trees at the Rajshahi University Campus, Bangladesh

Sana Ansari, Ayesha Akter, Abida Anzum, Ataur Rahman and Md. Hasanur Rahman*



Department of Botany, University of Rajshahi,
Rajshahi-6205, Bangladesh

***Correspondence:**

Email: hasanur7@yahoo.com

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Abstract

The carbon dioxide (CO₂) sequestration efficiency of five selected tree species- *Swietenia macrophylla* (Mahogany), *Acacia auriculiformis* (Akashmoni), *Tectona grandis* (Shegun), *Ficus benghalensis* (Banyan tree) and *Borassus flabellifer* (Tal palm) was estimated using a non-destructive method. Tree height and trunk diameter were measured at breast height (4 ft) and above breast height (6 ft) to assess CO₂ sequestration potential. At a trunk height of 4 ft, the highest CO₂ sequestration was recorded in *F. benghalensis*, with an estimated 198,070.59 kg, whereas the lowest was observed in *B. flabellifer*, with 13,425.46 kg. Similarly, at 6 ft trunk height, *F. benghalensis* exhibited the maximum CO₂ sequestration (233,812.999 kg), while *B. flabellifer* showed the minimum (9,992.96 kg). These results indicate that *F. benghalensis* is the most effective species for CO₂ sequestration among the studied trees, likely due to its large trunk diameter, extensive biomass and wide canopy structure, which contribute to greater carbon storage capacity.

Keywords: Carbon dioxide sequestration, Estimation, Selected trees.



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Introduction

Carbon dioxide (CO₂) sequestration is the process of capturing, securing, and storing carbon dioxide from the atmosphere. Green plants absorb CO₂ as they grow and bind it into biomass. These biological stores function as carbon sinks. Terrestrial carbon sequestration refers to the transformation of atmospheric CO₂ into components of biomass through the process of photosynthesis. This involves the assimilation of biomass into the soil as humus, effectively storing atmospheric CO₂ within these components. According to the IPCC (2003) and Gorte (2009), increased photosynthesis enhances the conversion of atmospheric CO₂ into biomass, thereby reducing the concentration of carbon dioxide in the atmosphere. During the growth of various plant parts, carbon is sequestered in both above and below-ground tissues (Chavan and Rasal 2010). It is well known that global CO₂ emissions have risen significantly in recent decades. The natural use of atmospheric CO₂ through photosynthetic processes provides an essential sink for this excess carbon. This natural process helps reduce the concentration of greenhouse gases in the atmosphere, thereby contributing to climate change mitigation and limiting the impact of global warming. The capacity of trees to sequester carbon varies significantly depending on species, age, growth rate, wood density, and environmental conditions (Pan et al. 2011). Carbon dioxide sequestration also has a positive impact on soil ecology. It enhances microbial diversity, improves nutrient cycling, and supports soil fauna (Ray et al. 2025). Increased soil organic carbon provides energy for microorganisms, fostering a more diverse and active microbial community that facilitates decomposition and nutrient availability. This, in turn, supports beneficial soil organisms such as earthworms and fungi, which improve soil aeration and structure. However, improper sequestration practices such as excessive biochar application or afforestation with invasive plant species can disrupt microbial

balance, alter soil pH, and negatively affect native ecosystems (Ezepue et al. 2019). Thus, while CO₂ sequestration strengthens soil ecology by promoting biodiversity and resilience, it requires careful management to avoid unintended ecological consequences. Carbon dioxide sequestration has attracted significant attention in current climate research. However, accurately measuring the sequestration potential of trees is challenging without precise biomass assessment. Therefore, the objective of this study was to estimate the CO₂ sequestration potential of five selected tree species grown in the Rajshahi University campus.

Materials and Methods

Plant species: The present investigation was carried out at Rajshahi University campus, Bangladesh. This sampling site was selected due to its extensive green coverage and low levels of carbon emissions from anthropogenic activities. The selected tree species were *Swietenia macrophylla*, *Acacia auriculiformis*, *Tectona grandis*, *Ficus benghalensis* and *Borassus flabellifer*.

Methods:

Determination of carbon sequestration potential of tree species

The methods suggested by Chavan and Rasal (2010) are as follows:

Step 1: The total green weight of the tree

The total (green) weight of a tree is calculated as follows:

$$W_{\text{above-ground}} = 0.25 D^2 H \text{ (Diameter for trees } D < 11\text{")}$$

$$W_{\text{above-ground}} = 0.15 D^2 H \text{ (Diameter for trees } D > 11\text{")}$$

$$W_{\text{above-ground}} = \text{Above-ground weight in pounds}$$

$$D = \text{Diameter of the trunk in inches}$$

$$H = \text{Height of the tree in feet}$$

The root system weight is about 20% of the above-ground weight.

Therefore, to determining the total green weight of the tree, multiply the above-ground weight by 120% or 1.20:

$$W_{\text{total green weight}} = 1.2 \times W_{\text{above-ground}}$$

Step 2: The dry weight of the tree

The average tree is 72.5% dry matter and 27.5% moisture. Therefore, to determine the dry weight of the tree, multiply the total green weight of the tree by 72.5%.

$$W_{\text{dry weight}} = 0.725 \times W_{\text{total green weight}}$$

Step 3: The average weight of carbon in the tree

The average carbon content is generally 50% of the tree's dry weight total volume. Therefore, in determining the weight of carbon in the tree, multiply the dry weight of the tree by 50%.

$$W_{\text{carbon}} = 0.5 \times W_{\text{dry weight}}$$

Step 4: Carbon dioxide sequestration weight in the tree

CO₂ has one molecule of Carbon and 2 molecules of Oxygen. The atomic weight of Carbon is 12 and the atomic weight of Oxygen is 16. The weight of CO₂ in trees is determined by the ratio of CO₂ to C is 44/12 = 3.67. Therefore, to determine the weight of carbon dioxide sequestered in the tree, multiply the weight of carbon in the tree by 3.67.

$$W_{\text{carbon-dioxide}} = 3.67 \times W_{\text{carbon}}$$

Parameters

The parameters of this study were: 1) tree trunk diameter, 2) plant height, 3) total green weight (TGW), 4) dry weight of the tree (DWT), 5) carbon weight in the tree (CW), and 6) weight of CO₂ in the tree (CO₂W).

Results and Discussion

CO₂ sequestration measured at 4 ft tree-trunk height

The carbon dioxide (CO₂) sequestration efficiency of five tree species was assessed. The evaluation was conducted in two steps, as shown in Table 1. The results demonstrated that *Swietenia macrophylla* with a trunk diameter of 73.2 inches and an approximate height of 35 ft, sequestered 20,370.54 kg of CO₂. In comparison, *Acacia auriculiformis*, with a trunk diameter of 68.4 inches and an approximate height of 44 ft, sequestered 22,360.28 kg of CO₂. The CO₂ sequestration rate increased in *Tectona grandis*, which sequestered 32,033.53 kg of CO₂ with a trunk diameter of 76.8 inches and an approximate height of 50 ft. The highest CO₂ sequestration rate was recorded in *Ficus benghalensis*, sequestering 198,070.59 kg of CO₂ at an approximate height of 37 ft. In contrast, the lowest sequestration rate was observed in *Borassus flabellifer*, which sequestered 3,425.46 kg of CO₂ with a trunk diameter of 61.2 inches and an approximate height of 33 ft (Table 1). It is evident that *Ficus benghalensis* sequestered the highest amount of CO₂, while the lowest was recorded in *Borassus flabellifer*. A moderate rate of CO₂ sequestration was observed in *Swietenia macrophylla*, *Acacia auriculiformis* and *Tectona grandis* (Table 1).

Table 1: CO₂ sequestration measured at the level of 4 and 6 ft height tree-trunk.

Height tree-trunk	Name of the Trees	Data collection site of the trees at RU campus	Tree dia. (inch)	Plant height (ft)	Total green weight, (TGW) of the tree (pounds)	Dry weight, (DW) of the tree (pounds)	Weight of carbon, (CW) (pounds)	Weight of CO ₂ sequestered in the tree, (CO ₂ W) (pounds)	Weight of CO ₂ sequestered (CO ₂ W) (kg)
4 feet	Mahogany	Gymnasium	73.2	35	33756.91	2443.76	12236.88	44909.35	20370.54
	Akashmoni	Khaleda Zia Hall	68.4	44	37054.195	26864.29	13432.146	49295.97	22360.28
	Shegun	West Residential area	76.8	50	53084.16	38486.02	19243.01	70621.84	32033.53
	Banyan tree	Rokeya Hall	222	37	328231.44	237967.79	118983.89	436670.9	198070.59
	Tal palm	Gymnasium	61.2	33	22247.91	16129.74	8064.87	29598.07	13425.46
6 feet	Mahogany	Gymnasium	61.2	35	23596.27	17107.29	8553.65	31391.89	14239.12
	Akashmoni	Khaleda Zia Hall	63.6	44	32036.08	23226.16	11613.08	42620.00	19332.11
	Shegun	West Residential area	70.8	50	45113.76	32707.48	16353.74	60018.22	27223.81
	Banyan tree	Rokeya Hall	241.2	37	387461.75	280909.77	140454.88	515469.43	233812.99
	Tal palm	Gymnasium	52.8	33	16559.77	12005.83	6002.92	22030.70	9992.96

CO₂ sequestration measured at 6 ft tree-trunk height

Table 1 also presents a study on CO₂ sequestration by various tree species, measured at a trunk height of 6 feet. In this analysis, *Swietenia macrophylla*, approximately 35 feet tall with a trunk diameter of 61.2 inches, sequestered 14,239.12 kg of CO₂. *Acacia auriculiformis*, with a height of approximately 44 feet and a trunk diameter of 63.6 inches, sequestered 19,332.1 kg of CO₂. A higher sequestration rate was observed in *Tectona grandis*, which sequestered 27,223.81 kg of CO₂ at a height of approximately 50 feet and a trunk diameter of 70.8 inches. The highest CO₂ sequestration was recorded in *Ficus benghalensis*, which stored 233,812.999 kg of CO₂ at a height of about 37 feet. In contrast, *Borassus flabellifer* exhibited the lowest sequestration rate, storing only 9,992.96 kg of CO₂ at an approximate height of 33 feet and a trunk diameter of 52.8 inches. In this case, the *Ficus benghalensis* showed the highest CO₂ sequestration potential, while the *Borassus flabellifer* had the lowest. A moderate level of CO₂ sequestration was observed in *Swietenia macrophylla*, *Acacia auriculiformis* and *Tectona grandis* (Fig. 1).

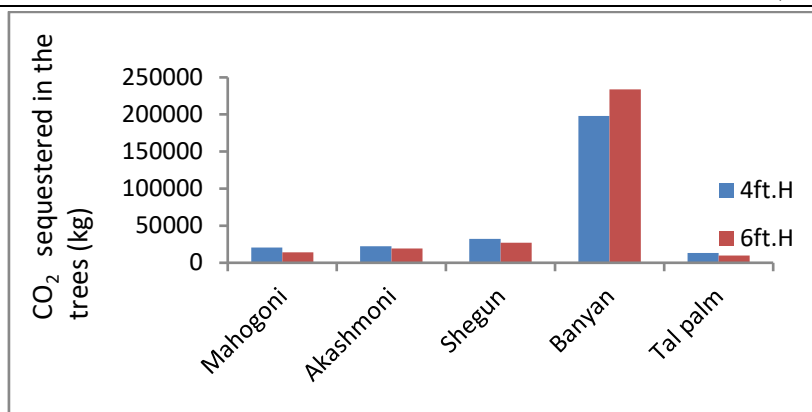


Fig. 1. CO₂ sequestration rate of different tree species.

The consistency of higher CO₂ sequestration values of *Ficus benghalensis* at both measurement heights demonstrated its superior biomass accumulation compared to the other species. Since carbon sequestration is directly related to tree biomass and trunk girth, the banyan tree's robust growth form and extensive woody structure justify it's the most efficient CO₂ sequestering species in this study. The findings are consistent with those of Chavan and Rasal (2010), and Simhadri et al. (2021). Pussinen et al. (2002) noted that carbon stock depends on several factors such as tree species, site characteristics, environmental conditions, age class and distribution.

Conclusion

The present investigation concludes that different tree species exhibit varying rates of CO₂ sequestration indicating that green trees absorb atmospheric CO₂ with different efficiencies. The results demonstrate that *Ficus benghalensis* showed the highest CO₂ sequestration among the studied species. Based on the present experiment on CO₂ sequestration potential, it is noted that, in the future, suitable tree species can be selected to enhance CO₂ trapping, thereby helping to mitigate greenhouse gas emissions and combat climate change, particularly at the local level.



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Authors contribution: SA, AA, AA, AR = Data collection, calculation and conducted experiments and prepare draft manuscript; MHR = Designed the experiment, supervised the study and finally corrected the manuscript. All authors have read and approved the final manuscript.

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