The Pharma Innovation Journal 2022; 11(3): 810-813

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(3): 810-813

www.thepharmajournal.com
Received: 08-12-2021
Accepted: 28-02-2022

**Sudip Sarkar**
ICAR-Research Complex for Eastern Region, Patna, Bihar, India

**Dipty Kumar Das**
Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar, India

**Corresponding Author:**
**Sudip Sarkar**
ICAR-Research Complex for Eastern Region, Patna, Bihar, India

# Carbon stock and tree biomass assessment of agroforestry systems in Bihar

**Sudip Sarkar and Dipty Kumar Das**

**Abstract**
Climate change and the greenhouse effect are currently regarded as critical hot topics. An investigation was conducted on 'Carbon stock and biomass assessment in agroforestry systems (AFS) in Bihar' by focusing on these current issues. The research was carried out on three agroforestry systems: Kadamb (*Anthocephalus cadamba* Miq.) based agrisilvicultural system, Simarouba (*Simarouba glauca* DC) based agrisilvicultural system, Litchi (*Litchi chinensis* Sonn.) based agrihorticultural system, and one open system (without trees). Aboveground biomass, belowground biomass, long-lived carbon storage, and $CO_2$ mitigation by trees were all determined, in addition to the biophysical parameters. Among the three plantations, Simarouba trees had the highest carbon storage and $CO_2$ mitigation ability of any tree species. This study backs up the idea that these trees could be a good pick for agroforestry development because they have good carbon storing and $CO_2$ mitigation capabilities.

**Keywords:** Carbon stock assessment, tree biomass, agroforestry, $CO_2$ mitigation, Simarouba

## Introduction

Trees are thought to be the most important reservoirs of long-term carbon storage and carbon di-oxide mitigation of global warming and climate change [1]. Rapid population growth and their attempts at deforestation, primarily to meet local demands for food, fodder, forage, and other products, endangers the existence of forests on our planet. According to research, forest ecosystems have been depleted indiscriminately in the past. It is also becoming more difficult to feed the world's growing population, as cultivated land is shrinking due to urbanisation and industrialization of cultivable farmlands. According to previous data, tropical forests account for only 7% of total global land cover, but they play a critical role in global carbon mitigation [2]. Carbon dioxide ($CO_2$) is regarded as the major greenhouse gas accelerating current global warming and climate change, and there is a need to explore alternative solutions to these challenges. Agroforestry, which combines agriculture and forestry, may be a good choice in this regard. Several studies have shown that agroforestry can provide all-year crop production while also sustaining ecosystems, soil, and mitigating atmospheric carbon. Trees play critical roles in global carbon storage [3], trapping atmospheric $CO_2$ after transformation into plant biomass [4]. As a result, it is critical to determine tree biomass in order to determine the carbon stock of that area and gain a better understanding of the ability of tree species to store carbon [5]. The current study was carried out with the goal of determining tree biomass and carbon stock in various agroforestry systems in the Samastipur district of Bihar, India.

## Materials and methods

The experiment, titled "Carbon stock and tree biomass assessment of agroforestry systems in Bihar," included three agroforestry systems: I Kadamb (*Anthocephalus cadamba* Miq.) based Agrisilviculture system, ii) Simarouba (*Simarouba glauca* DC) based agrisilvicultural system, iii) Litchi (Litchi chinensis Sonn. The kadamb and simarouba-based agrisilvicultural system was 13 years old, with tree spacing maintained at 5m x 4m for kadamb and 7m x 7m for litchi. Among the two sites one located at Rajendra Prasad Central Agricultural University, Pusa, Bihar another at Pusa Farm and the other at Birauli Farm. The place has subtropical climates with distinct seasons: rainy (June to September), winter (October to February), and summer (March to May). Locations of experimental sites are shown in Fig-1 and general information are given in Table-1. The optical Reading Clinometer model no.PM-5/360 PC was used to measure the heights of the trees. The following formulas are used to calculate various parameters.

Diameter in breast height (DBH) = Girth/ 3.14)

Tree girth measured at the height of 1.37 m from tree base by simple measuring tape.

Tree volume calculated by quarter girth formulae; Volume = (G/4)2 × H

Where, G = Girth of tree at breast height (i.e. at the height of 1.37 m from tree base), H = tree height.

Aboveground biomass (AGB) (q $tree^{-1}$) = 10 × specific gravity × timber volume.

Belowground biomass (BGB) (q $tree^{-1}$) = AGB × 15% [6].

Carbon storage in tree biomass (q $tree^{-1}$) = Tree biomass× 45% [7].

Long-lived carbon storage (q $tree^{-1}$) = Carbon storage in tree stem × 42% [8].

$CO_2$ mitigation by the tree biomass (q $tree^{-1}$) = Carbon storage × 3.67

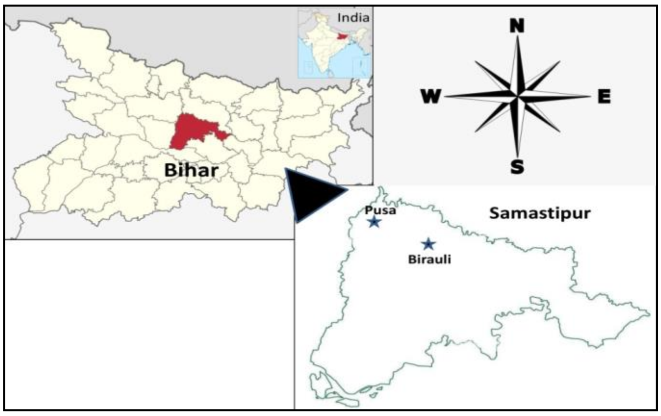


**Fig 1:** Location of Experimental sites.

**Table 1:** General information about the experimental sites

| Climate | Sub-tropical |
|---|---|
| Temperature | 10-36 ºC (during the experiment) |
| Rainfall | 930 mm (annual) |
| Latitude longitude | Pusa Plot: 25.9780° N, 85.6488° E<br>Birauli Plot: 26.4677° N, 85.6756° E |
| Soil pH | 8.3-9.1 |
| Soil organic matter | 0.95%-3.20% |

## Results

### Biophysical parameters

It was discovered that among three types of trees, kadamb trees (9.95m) were the tallest and litchi trees (5.15m) were the shortest (Fig-2). According to Fig. 3, simarouba trees (0.24m) had the largest diameter at breast height, while kadanb trees (0.22m) had the smallest diameter at breast height. According to the findings, simarouba trees had a higher tree volume than kadamb trees, which had a higher tree volume than litchi trees (Fig-4). Simarouba (0.29 $m^3$) and kadamb (0.28 $m^3$) trees had higher tree volumes than litchi trees (0.17 $m^3$).

Above ground biomass and below ground biomass were higher in simarouba trees than in kadamb trees, while kadamb trees were higher than litchi trees (Fig-5). Aboveground biomass contributed 87 percent of total tree biomass on average, with belowground biomass contributing the remaining 13 percent. Above and below ground biomass in simarouba trees ranged from 7.97 and 1.35 q $tree^{-1}$ to 5.91 and 0.92 q $tree^{-1}$ in litchi trees.

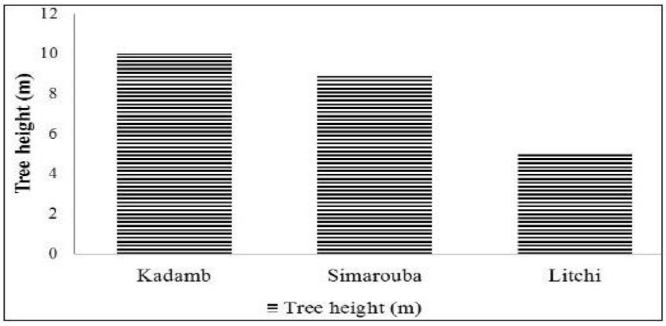


**Fig 2:** Heights of different trees under different AFS

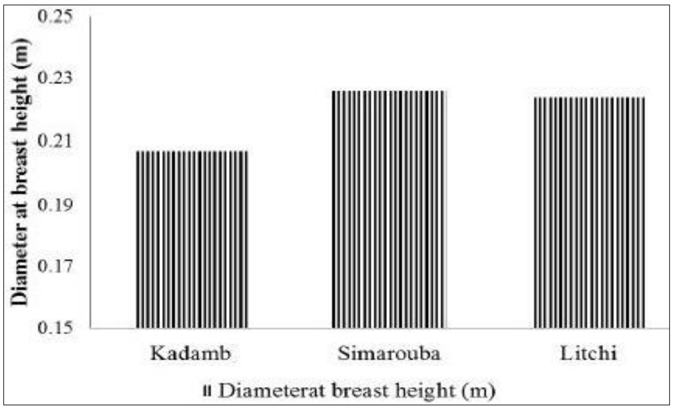


**Fig 3:** Diameter at breast heights of different trees under AFS

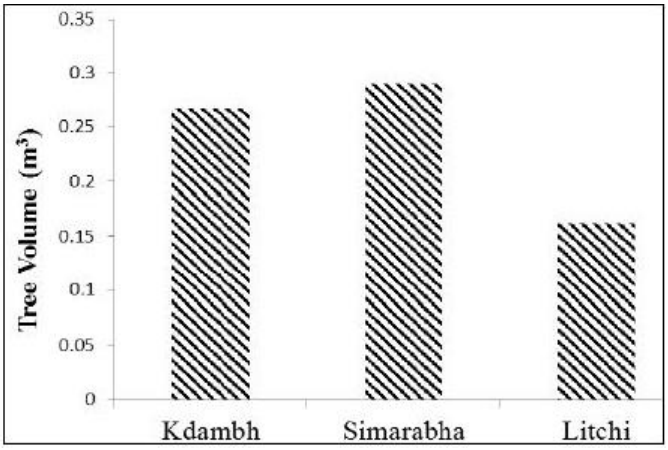


**Fig 4:** Tree volumes of different tree species

### Carbon stock in trees

In was found that simarouba trees had higher long-lived carbon storage over kadamb trees which were higher long-lived carbon storage over litchi trees (Fig-6). Long-lived carbon stock in tree biomass varied from 1.69 q $tree^{-1}$ in simarouba trees to 1.13 q $tree^{-1}$ in litchi trees.Simarouba trees were recorded higher $CO_2$ mitigation over kadamb trees which were higher $CO_2$ mitigation over litchi trees (Fig-7). It was also found that $CO_2$ mitigation by trees varied from 15.13 q $tree^{-1}$ by simarouba trees to 12.11 q $tree^{-1}$ by litchi trees.

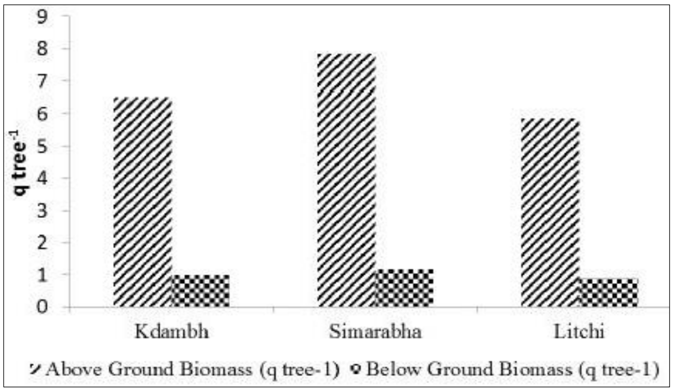


**Fig 5:** Above ground biomass and below ground biomass presence in different tree species

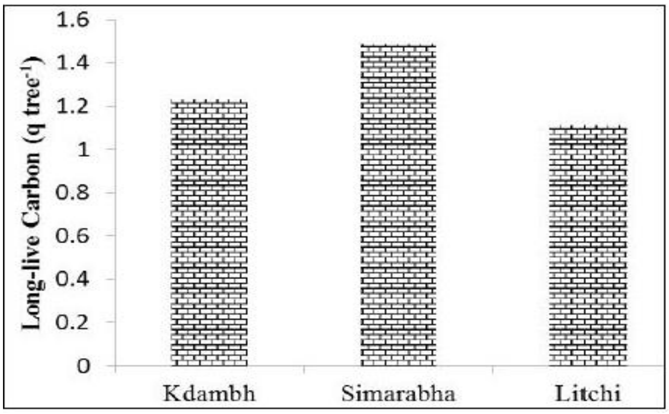


**Fig 6:** Long lived carbon presence in different tree species

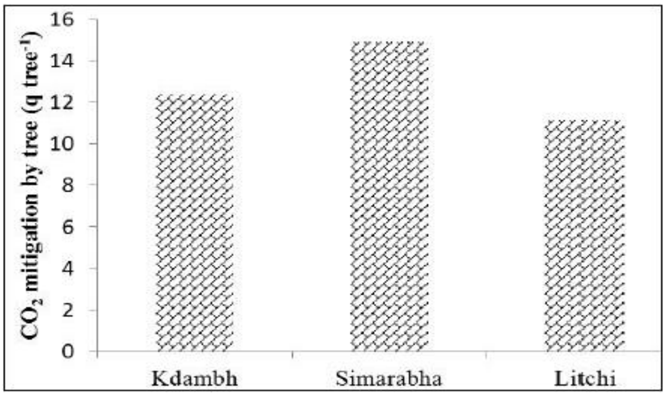


**Fig 7:** $CO_2$ mitigation by different tree species

## Discussion

### Biophysical parameters

It was discovered that among the three types of trees, kadamb trees were the tallest and litchi trees were the shortest, which may be due to pruning of litchi trees for easy fruit harvesting, whereas kadamb and simarouba plantations develop with close spacing and no pruning. Simarouba trees had the largest diameter at breast height, while kadanb trees had the smallest. Kar *et al.* (2019) [9] previously reported that trees with close spacing have higher heights and larger diameters at breast height. According to the findings, simarouba trees had a higher tree volume than kadamb trees, which had a higher tree volume than litchi trees. The tree volume of Simarouba and kadamb trees is significantly greater than that of litchi trees. Trimming during the season may result in a reduction in tree volume of litchi.

Above ground biomass (AGB) refers to all above ground tree parts such as stems, branches, bark, seeds, foliage, and so on, whereas below ground biomass (BGB) refers to plant roots [10]. AGB and BGB in simarouba trees were higher than in kadamb trees, while kadamb trees were higher than litchi trees. Several previous works [11, 12, 13] have mentioned AGB and BGB variations among tree species. On average, AGB contributed the majority of total tree biomass, with BGB providing the remainder. Similarly, Sohrabi *et al.*, (2016) [11], Gebrewahid *et al.*, (2018) [12], and Yadav *et al.*, (2019) [13] discovered that AGB contributed more to total tree biomass than BGB.

### Carbon stock in trees

It was discovered that simarouba trees had greater long-term carbon storage than kadamb trees, which had greater long-term carbon storage than litchi trees. Long-term carbon storage through agroforestry development has a significant advantage over crop production [14]. Long-lived trees, also known as long-lived pioneers, contribute the majority of carbon storage in tropical rainforests and play an important role in combating climate change [15].

Agroforestry has been widely recognised as having a high potential for carbon sequestration in all land types [16]. Simarouba trees were found to have greater $CO_2$ mitigation than kadamb trees, which were found to have greater $CO_2$ mitigation than litchi trees. Grote (2009) [17], Costa *et al.* (2018) [18], and Naik *et al.* (2018) [19] have all mentioned the importance of tree species in $CO_2$ mitigation.

## Conclusion

All recorded biophysical and carbon stock parameters varied between three tree species, as each tree species has different growth patterns. It is also worth noting that all tree species have an excellent ability to store long-term carbon in their long-lived bodies. Among the tree species, simarouba trees were discovered to have the most carbon stock and the greatest potential for $CO_2$ mitigation. Finally, given the current climate change concerns, these tree species can be good options for agroforestry development because they store a lot of carbon over time and help to reduce $CO_2$.

## References

1. Arasa-Gisbert R, Vayreda J, Roman Cuesta RM, Villela SA, Mayorga R, Retana J. Forestdiversity plays a key role in determining the stand carbon stocks of Mexican forests. Forest Ecology and Management. 2018;415:160-171.
2. Nascimento HE, Laurance WF. Total aboveground biomass in central Amazonian rainforests: A landscape-scale study. Forest Ecology and Management. 2002;168(1-3):311-321.
3. Shirima DD, Totland Ø, Munishi PK, Moe SR. Relationships between tree species richness, evenness and aboveground carbon storage in montane forests and miombo woodlands of Tanzania. Basic and Applied Ecology. 2015;16(3):239-249.
4. Ravindranath NH, Somashekhar BS, Gadgil M. Carbon flow in Indian forests. Climatic Change. 1997;35(3):297-320.
5. Malhi YA, Baldocchi DD, Jarvis PG. The carbon balance of tropical, temperate and boreal forests.Plant, Cell & Environment. 1999;22(6):715-740.

6. Marak T, Khare N. Carbon sequestration potential of selected tree species in the campus of Shuats, 2017. IJSRD/Vol.5/Issue 06/2017/016.
7. Magnussen S, Reed D. Modeling for estimation and monitoring, Faoiufro, 2004.
8. Wang X, Feng Z. Atmospheric carbon sequestration through agroforestry in China. Energy. 1995;20:117-121.
9. Kar S, Pant KS, Chandel A, Roshanzada SR. Trend of soil parameters under different spacings of Grewia based agroforestry system in the mid hill zones of Himachal Pradesh. International Journal of Chemical Studies. 2019;7(1):1904-1907.
10. IPCC. IPCC (Intergovernmental Panel on Climate Change) guidelines for greenhouse gasInventories. Agriculture, forestry and other land use, 2006, 4.
11. Sohrabi H, Bakhitiarvand-Bhakhtiari S, Ahmadi K. Above and below-ground biomass and carbon stocks of different tree plantations in central Iran. Journal of Arid Land. 2016;8(1):138-145.
12. Gebrewahid Y, Gebre-Egziabhier TB, Teka K, Gebrewahid EB. Carbon stock potential of scattered trees on farmland along an altitudinal gradient in Tigray, Northern Ethiopia. Ecological Processes. 2018;7:40.
13. Yadav RP, Gupta B, Bhutia PL, Bisht JK, Pattanayak A, Meena VS, *et al*. Biomass and carbon budgeting of sustainable agroforestry systems as ecosystem service in Indian Himalayas. International Journal of Sustainable Development & World Ecology. 2019;26(5):460-470.
14. Kaul M, Mohren GMJ, Dadhwal VK. Carbon storage and sequestration potential of selected tree species in India. Mitig Adapt Strateg Glob Change. 2010;15:489-510.
15. Rüger N, *et al*. Demographic trade-offs predict tropical forest dynamics. Science, Apr 10th, 2020. DOI: 10.1126/science.aaz4797
16. IPCC. Land use, land-use change, and forestry. Cambridge University Press, Cambridge, UK, 375 A special report of the IPCC, 2000.
17. Gorte WR. Carbon Sequestration in Forests, Congressional Research Service, Natural Resources Policy, Report for Congress, 2009, 7-5700 www.crs.gov RL31432.
18. Costa END, Souza MFL, Marrocos PCL, Lobão D, Silva DML. Soil organic matter and CO2 fluxes in small tropical watersheds under forest and cacao agroforestry. July 16, 2018. https://doi.org/10.1371/journal.pone.0200550
19. Naik SK, Sarkar PK, Das B, Singh K, Bhatt BP. Predict model for dry biomass and carbon stock estimation in Litchi Chinensis under hot and dry sub-humid climate. Archives of Agronomy and Soil Science, 2018, 64(10).