Greening the Globe: The Carbon Sequestration Power of Agroforestry

Chethan B L[1]*, Ramesh S Rathod[2], Akhilraj T M[3] and Dattappa[4]

[1]Ph.D. Scholar, Department of Silviculture and Agroforestry, College of Forestry, Sirsi
[2]Associate Professor, Department of Silviculture and Agroforestry, College of Forestry, Sirsi
[3]Assistant Professor, Department of Forest Product and Utilization, College of Forestry, Sirsi
[4]Ph.D. Scholar, Department of Forest Biology and Tree improvement, College of Forestry, Sirsi University of Agricultural Sciences, Dharwad-580005, Karnataka, India

Corresponding Author
Chethan B L
Email: chethan1820@gmail.com

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ABSTRACT

Agroforestry, the intentional integration of trees with crops and livestock, offers a sustainable land-use system that delivers multiple environmental, social, and economic benefits. Among its many advantages, agroforestry plays a significant role in climate change mitigation through carbon sequestration. By capturing atmospheric carbon dioxide (CO_2) and storing it in plant biomass and soils, agroforestry systems act as natural carbon sinks. Various studies from India, Pakistan, and Bangladesh have demonstrated that agroforestry systems such as Silvipastoral systems, boundary planting and tree-based intercropping exhibit high potential for carbon storage. Species selection, management practices, and system design greatly influence sequestration rates. Beyond climate benefits, agroforestry improves biodiversity, soil health, and farmers' livelihoods, making it a viable solution for sustainable agriculture. Scaling up agroforestry practices can significantly contribute to global efforts aimed at reducing greenhouse gas emissions while enhancing environmental resilience.

INTRODUCTION

As the world grapples with the impacts of climate change, solutions that are eco-friendly, sustainable, and economically viable are in high demand. One such nature-based solution is Agroforestry, the intentional integration of trees with crops and livestock. Beyond improving agricultural productivity, agroforestry systems offer a crucial environmental service—carbon sequestration, which plays a vital role in mitigating global warming. Carbon sequestration refers to the process of capturing atmospheric carbon dioxide (CO_2) and storing it in plants, soils, oceans, and geologic formations. Agroforestry systems act as significant carbon sinks, storing carbon in both above-ground biomass (trunks, branches, leaves) and below-ground biomass (roots and soil organic matter).

Why Carbon Sequestration Matters

The alarming rise in greenhouse gases (GHGs), especially CO_2, due to deforestation, fossil fuel burning, and industrial activities, has led to global climate changes like rising temperatures, erratic rainfall, and frequent natural disasters. Reducing atmospheric CO_2 levels is essential to controlling these changes. Agroforestry presents a win-win situation by combining environmental benefits with socio-economic advantages for farmers.

According to the Kyoto Protocol, agroforestry is recognized as a potential greenhouse gas mitigation strategy. It provides an opportunity for both industrialized and developing countries to tackle climate change while promoting sustainable land use.

Agroforestry Systems and Carbon Storage Potential

Agroforestry systems are diverse and adaptable to different climatic zones. Various studies conducted across India, Pakistan, and Bangladesh highlight the immense carbon sequestration potential of agroforestry systems.

1. **Silvipastoral Systems in Arid Regions** Patidar *et al*. (2023) in Rajasthan's hot arid regions demonstrated that silvipastoral systems could sequester significant amounts of carbon. *Colophospermum mopane* trees with grasses sequestered the highest carbon—10.19 tonnes per hectare—compared to other species.

2. **Tree-Based Land Use in Karnataka** Uthappa and Devakumar (2021) found that *Artocarpus hirsutus* plantations sequestered 3182.03 Mg CO_2 per hectare, outperforming other species like Terminalia bellirica.

3. **Traditional Agroforestry in Pakistan** Yasin *et al.* (2023) revealed that boundary planting systems stored maximum carbon 33.44 tonnes per hectare—enhancing soil fertility, biodiversity, and farm income.

4. **Agroforestry Species in Bangladesh** Hanif *et al*. (2015) found *Leucaena leucocephala* sequestered 135 Mg C/ha/year, outperforming other species like *Melia azedarach* and *Albizia lebbeck.*

5. **Carbon Storage Potential in Punjab** Sarangle *et al*. (2018) found *Eucalyptus tereticornis* plantations stored the highest carbon stock—654.91 tonnes per hectare.

Measurement and Management of Carbon Sequestration

Measuring carbon sequestration involves calculating tree biomass using destructive and non-destructive methods, as well as remote sensing and GIS technologies.

Plate: 1: Measurement of Tree height and D.B.H for Biomass estimation

Management Practices Enhancing Carbon Sequestration:

- Species Selection
- Pruning and Thinning
- Soil Management
- Stand-Density Management

Benefits of Agroforestry Beyond Carbon Sequestration:

- Enhanced biodiversity
- Improved soil fertility
- Increased farm resilience
- Additional income
- Reduced soil erosion and better water conservation

CONCLUSION:

Agroforestry is a practical and promising solution for climate change mitigation. It bridges agriculture and forestry, turning farms into climate-friendly landscapes. By sequestering carbon, conserving biodiversity, and improving livelihoods, agroforestry aligns perfectly with the global sustainable development goals (SDGs).

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