

Assessment of Carbon Sequestration Potential in four Different Plantation Species in Dharwad District of Northern Karnataka

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Abstract Carbon dioxide (CO₂) and other greenhouse gases (GHGs) are recognized as a serious environmental issue of the twenty-first century. Forest plantations represent an important carbon sink. There is considerable interest to increase the carbon storage capacity of terrestrial vegetation through land use practices such as afforestation, reforestation, and natural forests and is regeneration and agroforestry system. As different trees have variable capacity to sequester carbon, therefore in order to study the potentiality of carbon sequestration of different tree species under block were selected to assess carbon sequestered in Dharwad district of Karnataka. Among the selected plantation *Eucalyptus teriticornis* recorded the maximum volume (0.19 m³), biomass (984.65 tons/ha) and carbon sequestration (492.33 tons/ha) followed by *Casuarina equisetifolia* and *Acacia auriculiformis* respectively. The least volume (0.06 m³), biomass (310.93 tons/ha) and carbon sequestration (155.46 tons/ha) was recorded in *Tectona grandis*.

Carbon sequestration in five and ten-year-old plantations due to management practices was 3.98 and 12.50 tons higher per hectare respectively when compared to poorly managed teak plantations. On an average 0.796 and 1.25 tons of excess carbon has been sequestered per hectare per year in better managed plantations over conventional grown (poorly managed) five and ten year old teak plantations respectively and to conclude high input management practices followed at initial years (2-3 years) had increased the carbon sequestration in five and ten year old teak plantations.

Keywords Forest plantations, Carbon sink, Afforestation, Agroforestry, Management practices.

Introduction

Currently, global warming is more certain and alarming than ever. Most of the observed increase in global average temperatures is due to the observed steady increase of CO₂ in our atmosphere, i.e. from 280 parts per million (ppm) in 1850 up to 394 ppm in 2012 (NOAA). At the 16th conference of the parties held in 2010, parties to the UNFCCC agreed that future global warming should be limited below 2°C relative to the pre-industrial temperature level. Forest cover more than one third of the world's land area and constitute the major terrestrial carbon pool. The amount of carbon sequestered and stored in forest varies greatly based on a large number of factors, including the type of forest, its net primary produc-

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tion, the age of the forest and its overall composition [1]. Carbon storage in forest ecosystems involves numerous components including biomass carbon and soil carbon. As more photosynthesis occurs, more CO₂ is converted into biomass, reducing carbon in the atmosphere and sequestering it in plant tissue above and below ground resulting in growth of different parts [2]. Biomass production in different forms plays important role in carbon sequestration in trees. Above ground biomass, below ground biomass, dead wood, litter and soil organic matter are the major carbon pools in any ecosystem. Assessment of carbon stocks and stock changes in tree biomass are relevant to deal with the United Nation Framework Convention on Climate Change (UNFCCC) and Kyoto Protocol report.

The emphasis of land use systems that have higher carbon content than existing plant community can help achieve net gains in carbon, specifically and significant increases in carbon storage can be achieved by moving from lower biomass land uses (e.g. grasslands, crop fallows) to tree based systems such as forests, plantation forests and agroforestry. Agroforestry provides a unique opportunity to combine the twin objectives of climate change adaptation and mitigation. Although agroforestry systems are not primarily designed for carbon sequestration, there are many recent studies that substantiate the evidence that agroforestry systems can play a major role in storing carbon in above ground biomass and in soil and in below ground biomass [3]. Some of the earliest assessments of national and global terrestrial carbon dioxide sinks reveal two beneficial attributes of agroforestry systems (a) direct near term storage (decades to centuries) in trees and soils and (b) the potential to offset immediate GHG emissions associated with deforestation and subsequent shifting cultivation.

It is unlikely that these degraded and deforested sites will be returned to natural forest cover. The need for transforming some of the lower biomass land uses (such as arable croplands and fallows) to carbon-rich tree based systems such as plantation forests and agroforestry therefore assumes significance. Agroforestry systems (AFS) spread over one billion ha in diverse eco regions around the world have a special

relevance in this respect. These woody perennial-based land use systems have relatively high capacities for capturing and storing atmospheric CO₂ in vegetation, soils and biomass production [4]. As different trees have variable capacity to sequester carbon, therefore in order to study the potentiality of carbon sequestration of different tree species, the study was undertaken to estimate among of carbon sequestered in different tree species planted under block plantation in Dharwad district of Karnataka.

Materials and Methods

This study area, belong under zone-8 of Karnataka between 76° 46' East longitude and 15°-17' North latitude at an altitude of 678 m MSL. Area receives annual rain fall of about 750 mm during South-West monsoon season, average varying from 500-1000 mm. The mean annual temperature is approximately 30°C during March to April and about 60% of RH recorded. The least fertile red loamy soil is found in the study area. The field study was conducted during 2014-2015, on the four existing block plantation of twenty five year old and each stand have 10 acre and it replicated thrice. The species selected are *Acacia auriculiformis*, *Tectona grandis*, *Casuarina equisetifolia* and *Eucalyptus teriticornis*. Each species considered as treatment and 50 trees randomly taken for observation from each replication. The same set of procedure followed in five and ten year age old plantations of teak taken to know the management practice affect on the carbon sequestration potential. The plant height was measured from base of the plant to the tip of the main stem using graduated pole and expressed in meters. The diameter at breast height was measured with digital caliper at 1.37 m above the base of the plant and expressed in centimeter, total volume in cubic meter and basal area square meter. The above ground biomass of standing trees was estimated to work out the amount of carbon sequestration by reducing the total biomass yield to its 50% [5]. The data collected were tabulated and statistically analyzed under randomized complete block design.

Results and Discussion

In the present study volume, biomass and carbon se-

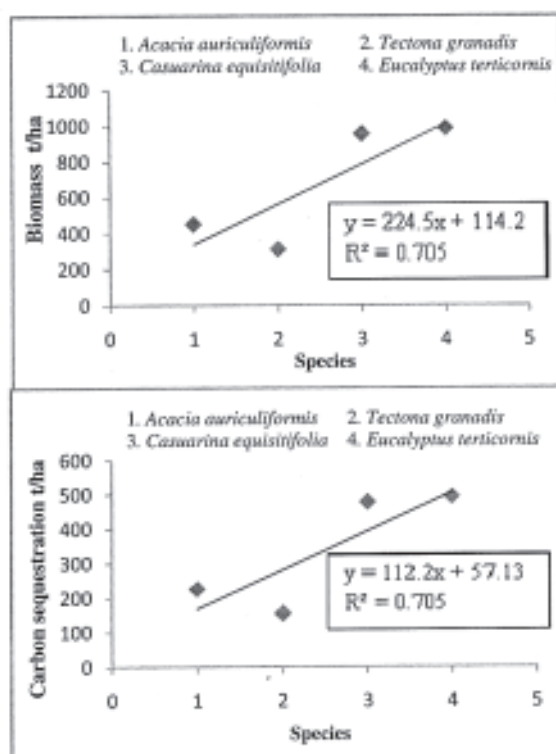


Fig. 1. Biomass and carbon sequestration correlation with different tree species of twenty five year aged planted under block plantation.

questration showed non significant difference among four different tree species (Fig. 1). The maximum volume was observed in *Eucalyptus tereticornis* (0.19 m^3) followed by *Casuarina equisetifolia* (0.18 m^3) and least was found in *Tectona grandis* (0.06 m^3). Biomass

Table 1. Growth performance and carbon sequestration of different tree species of twenty five year aged planted under block plantation in UAS, Dharwad.

| Species | Height (m) | Diameter (m) | Basel | |
|--------------------------------|------------|--------------|------------------------|--------------------------|
| | | | area (m ²) | Volume (m ³) |
| <i>Acacia auriculiformis</i> | 7.38 | 0.52 | 0.023 | 0.08 |
| <i>Tectona grandis</i> | 6.45 | 0.46 | 0.018 | 0.06 |
| <i>Casuarina equisetifolia</i> | 8.70 | 0.70 | 0.040 | 0.18 |
| <i>Eucalyptus tereticornis</i> | 9.12 | 0.67 | 0.038 | 0.19 |
| SEm± | 0.33 | 2.27 | 0.002 | 0.02 |
| CD @ 5% | 1.00 | 6.89 | 0.007 | 0.05 |
| CV | 7.22 | 6.64 | 13.32 | 22.96 |

accumulation was maximum in *Eucalyptus tereticornis* (984.65 ton/ha), followed by *Casuarina equisetifolia* (955.33 ton/ha) and least biomass accumulation was found in *Tectona grandis* (310.93 ton/ha). The fast growing tree species viz., *E. tereticornis* and *C. equisetifolia* produced higher biomass than other species of present study. This was in confirmation of the results of Kaul et al. [6], who have showed that the higher annual biomass in *Eucalyptus* and poplar due to its fast growth and rapid storage of carbon. Maximum amount of carbon sequestration was observed in *Eucalyptus tereticornis* (492.33 ton/ha) followed by *Casuarina equisetifolia* (477.66 ton/ha) and the smallest amount was found in *Tectona grandis* recorded lowest carbon sequestration (155.46 ton/ha) (Table 1). On the other hand, the study also observed that under better management practice of five (7.879 tones/ha) and ten years (23.896) tones/ha old teak plantation, the carbon sequestration was superior



Fig. 2. Carbon sequestration in five and ten year old better and poorly managed teak plantations.

over poorly managed teak (3.89 and 11.33 tones/ha) (Fig. 2) and this study in line with the Koppad and Rao [7], exposed that extensively managed teak plantation sequester the excess 0.976 to 2.579 tons of carbon per hectare per year. The weeding and inter cultivation especially at seedling stage avoids competition for light and nutrients between plants and weeds, resulted in better growth of teak in turn help to sequester more carbon from atmosphere. On an average teak plantation of 20 years old can sequester carbon of 330 tons/ha as compare with 10 and 20 years plantation [8].

Among the four different tree species of block plantation, *Eucalyptus tereticornis* (0.19 m³) and *Casuarina equisetifolia* (0.18 m³) showed better performance with respect to volume growth (Table 1). However age can significantly affect the biomass, as was earlier reported that at 4 year plantation of total volume in *Acacia auriculiformis* species was less as compared to 6 year plantation. Similarly in present study maximum biomass accumulation was observed in *Eucalyptus tereticornis* and *Casuarina equisetifolia*. Similar observation were recorded earlier in *Dalbergia sissoo* produced higher biomass among four species tried. Similarly in the present study, the amount of carbon sequestration was greater in *Eucalyptus tereticornis*, and *Casuarina equisetifolia* due to fast growth and higher resource utilization capacity (Fig. 1). Zhang et al. [9] showed that *Acacia* plantations can generate a higher biomass than *Eucalyptus*, as similar trend of observation was recorded in present study between *Eucalyptus*, *Casuarina* and *Acacia*.

Therefore study revealed that among four different tree species planted under block plantation in Dharwad district, such as *Eucalyptus tereticornis*, *Casuarina equisetifolia* and *Acacia auriculiformis* showed superior performance with respect to volume production, biomass accumulation and carbon sequestration. The management practices followed in early growth period of five and ten year old teak plantation has indicated significant variation in carbon sequestration. So that carbon storage potential depends on the growth performance, biomass accumulation and the management practices of the species and these attributes and practices should be considered while choosing and managing tree species for plantation in different sites.

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