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# Carbon Sequestration of Tree Plantation in Casfos Campus, Coimbatore Tamil Nadu, India

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## Abstract

*The study was carried out for analysing carbon sequestration of tree plantation in CASFOS Campus, Coimbatore Tamil Nadu. There were 362 tree counts are recorded with Crescentia cujete showed better carbon sequestration potential rate with 0.321 tons/tree of carbon and Muntingia calabura has the lowest sequestration rate which sequestered 0.004 tons/tree of carbon as compared to other species. An average of 0.113 tons per tree carbon is sequestered and total carbon sequestered 40.842 tons/tree in the CASFOS Campus. This study helps to improve the carbon sequestration areas to reduce the atmospheric carbon and act as carbon sinks in urban areas.*

**Keywords:** *Above Ground Biomass, Basal Area, Below Ground Biomass, Carbon Sequestration, Tree Biomass*

## 1.0 Introduction

Carbon sequestration is the removal of carbon-dioxide from the atmosphere and stored in the terrestrial forms for more time. Plants store carbon in the form of biomass in all its parts. $CO_2$ is absorbed naturally by photosynthesis by plants and is a natural process[1,2]. The $CO_2$ sinks and store the excess carbon in the form of biomass, which driven by photosynthesis. This biomass stores in all parts of plants[2-4]. The increased air pollution, mainly due to increased $CO_2$ level from developmental activities led to global warming as it is the major greenhouse gas. Thus, increases the temperature of the atmosphere through greenhouse effect. This is the main concern in Kyoto Protocol and Montreal Protocol[5].

Terrestrial vegetation and soil are considered to be main carbon sinks[6], and accounting for 24 percent of net annual anthropogenic emission of greenhouse gases to the environment[7]. An estimation stated that the standing biomass and carbon sequestration potential of multipurpose tree species at Mohand Range of Dehradun Forest Division in Uttarakhand revealed a carbon storage of 56.7% in *Albizzia lebbeck* and 48.7% in *Eucalyptus tereticornis*[8]. The experimental study showed carbon sequestration capacity of *Dalbergia sissoo* increased biomass and carbon sequestration during 8$^{th}$,16$^{th,}$ and 24$^{th}$ months period of time after plantation[9]. A study recorded higher carbon sequestration capacity of wild mango trees varieties compared to cultivated grafted mangoes occupied degraded lands of lateritic origin in the Konkan region of India[10]. A review stated that different groups of tree species for afforestation-driven soil organic carbon sequestration and showed less variation in the SOC sequestration rates in deciduous broadleaved, evergreen broadleaved and evergreen conifer relatively than evergreen and deciduous, or broadleaved and conifer forests[11]. Soil potential to store organic carbon in agroecological region is also depend on the crops grown in the region as they influenced by the nitrogen and other chemical factors in the soil[12]. Hence carbon sequestration

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in the agroforestry and tree plantations may be influenced by other factors in the region. This study aimed to assess carbon sequestration potential of various tree species of State Forest Service campus, Coimbatore, Tamil Nadu.

## 2.0 Materials and Methods

### 2.1 Study Area

The study area is located in Central Academy for State Forest Service, Coimbatore, Coimbatore District, and Tamil Nadu State, India covering an area of 12.45 ha. Coimbatore city lies between 76° 57› 41.8752» E Longitude and 11°0'16.4"N Latitude. The average rainfall of this area is 550 mm to 900 mm which categorised it as Southern Tropical Thorn and Southern Tropical Dry Deciduous Forest types. Temperature varies between 20°C to 37°C. The total area of CASFOS academy shares the space of exquisite forest campus along with 2 more premier Forestry Institution viz., Tamil Nadu Forest Academy (TNFA) and Institute of Forest genetics and tree breeding and in remaining land dominant exotic forestry tree species *Prosopis juliflora* were abundant present and due to government order of Tamil Nadu it is replacing with native species (Figure 1).

### 2.2 Carbon Estimation

Basal area and volume of plants were calculated by using height girth of plants using Ravi altimeter at a distance of 20 m and girth was measured at breast height of trees having more than 20 cm[13]. The below ground biomass estimated[14,15] and the carbon content in the plants is about 50 percent[16]. Hence, weight of the carbon in trees are calculated to be 50% as shown below[17]:

Carbon Storage = Biomass × 50% or Biomass/2 (kg/tree)

Basal area, volume, above ground biomass (AGB), below ground biomass (BGB), total biomass and carbon storage of trees is calculated by the following formulae:

Basal area = girth$^2$/ 4$\pi$

Volume (m$^3$) = Basal area (m$^2$) x Height (m)

AGB (ton) = volume of biomass (cm$^3$) x wood density (g/cm$^3$)

BGB (ton) = 0.26 × Above ground biomass (ton).

Total Biomass (TB) = Above Ground Biomass + Below Ground Biomass

Carbon Storage = Biomass (ton) × 50% or Biomass/2

## 3.0 Results and Discussion

Increase in the development area, human encroaching the wild areas of forest and other spaces for different activities. The maintenance of green cover for carbon sinks are difficult in the built-up area. The educational institutes campuses and public parks are most suitable for carbon sequestration and act as carbon sinks. The direct relationship among urban trees, people and environment will increase the benefits from trees for urban designs[18]. There were 25 species recorded




**Figure 1.** Study area of CASFOS, Coimbatore, Tamil Nadu, India.

in Central Academy for State Forest Service campus having varied wood densities. Highest wood density in *Caesalpinia coriaria* followed by *Mimusops elengi, Casuarina equisetifolia* and *Cassine glauca* and the lowest wood density observed in *Muntingia calabura and Bombax ceiba* (Table 1).

**Table 1.** Wood density of different tree species in the study area

| S. No. | Scientific name | Vernacular name | Wood density |
|---|---|---|---|
| 1 | *Aegle marmelos* | Bilwa | 0.75 |
| 2 | *Azadirachta indica* | Neem | 0.72 |
| 3 | *Bombax ceiba* | Silk cotton tree | 0.33 |
| 4 | *Caesalpinia coriaria* | Hulimeesehoo | 1.13 |
| 5 | *Cassine glauca* | Ceylon Tea | 0.8 |
| 6 | *Casuarina equisetifolia* | Galimara | 0.83 |
| 7 | *Crescentia cujete* | Beggar bowl | 0.64 |
| 8 | *Delonixregia* | Kattimara | 0.51 |
| 9 | *Ficus religiosa* | Aralimara | 0.44 |
| 10 | *Hardwickia binata* | Kamara | 0.73 |
| 11 | *Leucaena leucocephala* | Subabul | 0.63 |
| 12 | *Millingtonia hortensis* | Akaashamallige | 0.6 |
| 13 | *Mimusops elengi* | Bakula | 0.88 |
| 14 | *Morinda tinctoria* | Maddi | 0.54 |
| 15 | *Muntingia calabura* | Gasagase | 0.3 |
| 16 | *Peltophorump terocarpum* | Copper pod | 0.59 |
| 17 | *Pithecellobium dulce* | KaaduHunase | 0.66 |
| 18 | *Pongamia pinnata* | Honge | 0.47 |
| 19 | *Prosopis juliflora* | BallaryJaali | 0.75 |
| 20 | *Samanea saman* | Male mara | 0.46 |
| 21 | *Santalum album* | Shrigandha | 0.71 |
| 22 | *Swietenia mahagoni* | Mahagani | 0.6 |
| 23 | *Tamarindus indica* | Hunase | 0.68 |
| 24 | *Thespesia populina* | Bugari Mara | 0.77 |
| 25 | *Thevetia nerifolia* | GanteHoo | 0.72 |

**Table 2.** Basal area, volume, AGB and BGB of trees in CASFOS, Coimbatore, Tamil Nadu, India

| S. No. | Scientific name | Basal area ($m^2$) | Volume ($m^3$) | AGB (tons/tree) | BGB (tons/tree) |
|---|---|---|---|---|---|
| 1 | *Aegle marmelos* | 0.006 | 0.019 | 0.014 | 0.004 |
| 2 | *Azadirachta indica* | 0.015 | 0.063 | 0.046 | 0.012 |
| 3 | *Bombax ceiba* | 0.100 | 1.268 | 0.418 | 0.109 |
| 4 | *Caesalpinia coriaria* | 0.018 | 0.084 | 0.095 | 0.025 |
| 5 | *Cassine glauca* | 0.025 | 0.130 | 0.104 | 0.027 |
| 6 | *Casuarina equisetifolia* | 0.039 | 0.261 | 0.217 | 0.056 |
| 7 | *Crescentia cujete* | 0.130 | 0.795 | 0.509 | 0.132 |
| 8 | *Delonix regia* | 0.026 | 0.129 | 0.066 | 0.017 |
| 9 | *Ficus religiosa* | 0.006 | 0.019 | 0.008 | 0.002 |
| 10 | *Hardwickia binata* | 0.021 | 0.155 | 0.113 | 0.029 |
| 11 | *Leucaena leucocephala* | 0.015 | 0.103 | 0.065 | 0.017 |
| 12 | *Millingtonia hortensis* | 0.040 | 0.477 | 0.286 | 0.074 |
| 13 | *Mimusops elengi* | 0.005 | 0.016 | 0.014 | 0.004 |
| 14 | *Morinda tinctoria* | 0.080 | 0.637 | 0.344 | 0.089 |
| 15 | *Muntingia calabura* | 0.005 | 0.019 | 0.006 | 0.002 |
| 16 | *Peltophorum pterocarpum* | 0.052 | 0.030 | 0.018 | 0.005 |
| 17 | *Pithecellobium dulce* | 0.029 | 0.229 | 0.151 | 0.039 |
| 18 | *Pongamia pinnata* | 0.005 | 0.015 | 0.007 | 0.002 |
| 19 | *Prosopis juliflora* | 0.024 | 0.132 | 0.099 | 0.026 |
| 20 | *samanea saman* | 0.091 | 0.911 | 0.419 | 0.109 |
| 21 | *Santalum album* | 0.013 | 0.079 | 0.056 | 0.015 |
| 22 | *Swietenia mahagoni* | 0.005 | 0.015 | 0.009 | 0.002 |
| 23 | *Tamarindus indica* | 0.046 | 0.323 | 0.219 | 0.057 |
| 24 | *Thespesia populina* | 0.013 | 0.059 | 0.046 | 0.012 |
| 25 | *Thevetia nerifolia* | 0.008 | 0.019 | 0.014 | 0.004 |

The study recorded the highest AGB in *Crescentia cujete* (0.509 tons/tree) followed by *Samanea saman* (0.419 tons/tree) and lowest reported in *Muntingia calabura* (0.006 tons/tree). Highest BGB was recorded in *Crescentia cujete* (0.132 tons/tree) followed *by Samanea saman* (0.109 tons/tree) and lowest in *Muntingia calabura* (0.002 tons/tree) (Table 2).

*Tamarindus indica* are abundant in CASFOS Campus with 129 trees and 17.829 tons of carbon is sequestrated. The major tree species for carbon sequestration were *Millingtonia hortensis* (12.449 tons) with 69 trees followed by *Casuarina equisetifolia* (1.912 tons) with 14 trees, *Bombax ceiba* (1.845 tons) with 7 trees, *Crescentia cujete* (1.60 tons) with 5 trees, *Prosopis juliflora* (1.001 tons) with 16 trees. The *Swietenia mahagoni* (0.006 ton), *Ficus religiosa* (0.005 ton), *Pongamia pinnata* (0.004 ton) having one tree each recorded lowest carbon sequestration in the campus. Similarly, more $CO_2$ is sequestered by *Tamarindus indica* (8440.783 tons) *followed by Millingtonia hortensis* (3152.460 tons), *Peltophorum pterocarpum* (124.945 tons) and *Casuarina equisetifolia* (98.238 tons) and the lowest was recorded by *Pongamia pinnata* (0.0147 ton) (Table 3).

**Table 3.** Carbon storage of trees in CASFOS, Coimbatore, Tamil Nadu, India

| S. No. | Scientific name | Total Biomass (tons/tree) | Total C (tons/tree) | $CO_2$ (tons/tree) | Tree Count | Total $CO_2$ (tons) |
|---|---|---|---|---|---|---|
| 1 | *Aegle marmelos* | 0.0177 | 0.009 | 0.033 | 1 | 0.033 |
| 2 | *Azadirachta indica* | 0.4591 | 0.230 | 0.844 | 8 | 6.753 |
| 3 | *Bombax ceiba* | 3.6894 | 1.845 | 6.771 | 7 | 47.398 |
| 4 | *Caesalpinia coriaria* | 0.7204 | 0.360 | 1.321 | 6 | 7.927 |
| 5 | *Cassine glauca* | 1.1771 | 0.589 | 2.162 | 9 | 19.455 |
| 6 | *Casuarina equisetifolia* | 3.8246 | 1.912 | 7.017 | 14 | 98.239 |
| 7 | *Crescentia cujete* | 3.2063 | 1.603 | 5.883 | 5 | 29.415 |
| 8 | *Delonix regia* | 0.6645 | 0.332 | 1.218 | 8 | 9.748 |
| 9 | *Ficus religiosa* | 0.0104 | 0.005 | 0.018 | 1 | 0.018 |
| 10 | *Hardwickia binate* | 0.5711 | 0.286 | 1.050 | 4 | 4.198 |
| 11 | *Leucaena leucocephala* | 0.6535 | 0.327 | 1.200 | 8 | 9.601 |
| 12 | *Millingtonia hortensis* | 24.8982 | 12.449 | 45.688 | 69 | 3152.460 |
| 13 | *Mimusops elengi* | 0.0179 | 0.009 | 0.033 | 1 | 0.033 |
| 14 | *Morinda tinctoria* | 0.4331 | 0.217 | 0.796 | 1 | 0.796 |
| 15 | *Muntingia calabura* | 0.0147 | 0.007 | 0.026 | 2 | 0.051 |
| 16 | *Peltophorum pterocarpum* | 1.2380 | 0.619 | 2.272 | 55 | 124.945 |
| 17 | *Pithecellobium dulce* | 0.1906 | 0.095 | 0.349 | 1 | 0.349 |
| 18 | *Pongamia pinnata* | 0.0088 | 0.004 | 0.015 | 1 | 0.015 |
| 19 | *Prosopis juliflora* | 2.0016 | 1.001 | 3.674 | 16 | 58.779 |
| 20 | *samanea saman* | 1.5840 | 0.792 | 2.907 | 3 | 8.720 |
| 21 | *Santalum album* | 0.3531 | 0.177 | 0.650 | 5 | 3.248 |
| 22 | *Swietenia mahagoni* | 0.0113 | 0.006 | 0.022 | 1 | 0.022 |
| 23 | *Tamarindus indica* | 35.6588 | 17.829 | 65.432 | 129 | 8440.783 |
| 24 | *Thespesia populina* | 0.2294 | 0.115 | 0.422 | 4 | 1.688 |
| 25 | *Thevetia nerifolia* | 0.0517 | 0.026 | 0.095 | 3 | 0.286 |

## 4.0 Conclusion

*Crescentia cujete* has the better carbon sequestration potential with 0.321 tons/tree of carbon while *Muntingia calabura* with 0.0037 tons/tree of carbon sequestration as compared to other species. With a total tree count of 362, an average of 0.113 tons per tree carbon is sequestered and total carbon sequestered 40.842 tons/tree in the study area. Similar campuses include educational institutions, public parks, and other public spaces with proper management of suitable tree species for carbon sequestration in developed areas.

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