Journal of Biotechnology and Crop Science
Vol. 10, No. 15, January-December, 2022, 132-138

doi: 10.5958/2582-5089.2022.00015.9

Research Article

Quantitative analysis on carbon storage of valuable tree species of KNIPSS campus Sultanpur, Uttar Pradesh

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ABSTRACT

On Earth, trees serve as a carbon sink. The only method in nature by which carbon moves through ecosystems is used by plants as CO_2 in photosynthesis. Every year, there is a global decline in the number of trees; everyone is aware of the causes contributing to global climate change. By using a non-destructive or allometric technique, we calculated the carbon storage from the height and girth data that were accessible**.** A study was carried out on the main campus of the Kamla Nehru Institute of Physical and Social Sciences (KNIPSS), which covers approximately 45 acres of land. The data was gathered through an extensive field survey. Study shows two families are dominant on campus that is Caesalpiniaceae and Moraceae. Maximum carbon stock and carbon sequestration were found to be respectively 2065.758 kg/tree and 7581.332 CO_2eq/tree in the species named *Ficus bengalensis* belonging to the Moraceae family.

Keywords: Tree species, allometric technique, carbon stock, carbon Sequestration, biomass

INTRODUCTION

In terms of biodiversity, India is one of the wealthiest nations on earth. The current notion of biodiversity includes genetic variation, species diversity, and ecosystem variety. A total of 1,26,188 plant and animal species are found in India. The origins and diversity of many plant species are said to have originated in India, which has a total area of around 3029 million hectares and is one of the mega biodiversity hotspots among twelve. The forest ecosystem serves as a carbon storage facility in nature. They hold enormous amounts of carbon and control the carbon cycle through the exchange of CO_2 from the atmosphere (Pandya, 2013). The forest ecosystem is one of the terrestrial ecosystem's most significant carbon sinks. Through the process of photosynthesis, it absorbs carbon dioxide and stores it in soils, plant tissues, and forest litter.

Using the biosphere as a storage space, carbon sequestration removes carbon from the atmosphere (Chavan & Rasal, 2012). Uttar Pradesh is abundantly blessed with natural resources. The state is home to a large variety of plants and animals. Nearly every type of plant can be found in the area's flora, and it can be estimated that woods cover about 12.8% of the state's land area. Tropical Moist Deciduous Forests are the most prevalent types of forests in the state. All areas of the plains have tropical dry deciduous forests; however, they are more prevalent in the central, eastern, and western sectors. The southwestern regions of the State are home to the Tropical Thorny Forest. Rhododendrons, silver fir, spruce, deodar, chir, oak, sal, enormous haldu, dhak, teak, mahua, salai, sisso, chironji, and tendu are a few of the more prevalent plants in Uttar Pradesh.

Increasing needs for fuel-wood and timber, various agro-forestry practices, anthropogenic impact on the

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ecosystem, and other factors all contribute to the global degradation of forests, species biodiversity, and tree populations. Calculating the quantity of carbon stored in trees on the main campus of KNIPSS in Sultanpur, Uttar Pradesh, and its environs are our main objectives in this investigation.

MATERIALS AND METHODS

Study site

At 25°58' to 26°40'N and 81°33' to 82°40'E, the main campus of Kamla Nehru Institute of Physical and Social Sciences is about 3 km from Sultanpur city. The Sultanpur district is a part of India's Indo-Gangetic Plains physiographic region.

The Gomti River's alluvial sediments are spread around the institute's site. The texture of the soil is sandy loam, which is fertile. With three distinct seasons-cold (November to February), hot (march to mid-June), and wet (mid-June to September)-the climate is tropical monsoonal type (Singh et al., 2017). However, October is only considered to be a transitional month. In Sultanpur, the yearly average temperature is 26.5°C. Around 990 mm of rain precipitation occurs each year.

In the KNIPSS campus, a total of six sample sites were chosen based on most of the vegetation there. All the chosen sites and their surrounding vegetation were investigated (Figure 1) i.e., 1) KNIPSS main gate, 2) KNIPSS Field, 3) New Science faculty, 4) NH-96, 5) Art faculty, 6) Science faculty.

Field observation

The destructive approach and the non-destructive method, both of which have gained the support of numerous researchers, are the two methods used to estimate carbon in different tree species. For the purpose of estimating carbon, we used a non-destructive procedure that spared the tree and didn't need us to remove the complete bio-volume. The tree's girth is calculated at 1.32 meters above ground level or the girth at breast height (GBH). According to Bohre et al (2012), tree diameter (D) was calculated as GBH/3.14, which corresponds to the species' actual marked girth. The

Figure 1 Satellite image from google earth of study site KNIPSS main campus.

height of the tree is measured by using a measuring tape and Abney's level.

Data analysis

By merely applying biostatistics-based allometric equations, biomass is estimated in the tree species. By multiplying the bio-volume by the green wood density of different tree species, above-ground biomass (AGB) is calculated. By multiplying the diameter and height of each type of tree by a factor of 3.14, the tree bio-volume (TBV) value is calculated.

$$Bio\text{-}volume\ (TBV) = 3.14*(D)*H$$

Where D=diameter (meter) determined from GBH, and H=height (meter), 3.14= value of pie assuming the tree trunk is cylindrical. The Global Wood Density Database (Zanne et al., 2009) is used to calculate wood density.

Above-ground biomass

AGB, or above-ground biomass, refers to all living biomass that is located above the soil. It is calculated by multiplying the Volume of the tree by the wood density of a tree (Bhardwaj et al., 2016).

Above Ground Biomass (AGB) = Volume(V) * Wood Density (W_d)

Where, AGB= Above Ground Biomass in kg, V= Volume of the tree in m^3 and W_d= Wood Density of species from global density data (Zanne et al., 2009). Wherever the density value for a tree species is unavailable, the standard average density of 0.6 g/cm^3 is used.

Below-ground biomass

The root: shoot ratio has been used to multiply the above-ground biomass (AGB) by 0.26 to compute the below-ground biomass (Hangarge et al., 2012).

$$BGB= AGB*0.26$$

Total biomass

Total Biomass is the sum of the AGB and BGB (Sheikh et al., 2011).

$$TB= AGB+BGB$$

Where, TB= Total Biomass, AGB= Above Ground Biomass, BGB= Below Ground Biomass

Carbon stock

In general, any plant species' biomass is thought to contain 50% carbon (Pearson et al., 2005). In order to measure the weight of carbon in the tree, the biomass of the tree was multiplied by 50% (Birdsey, 1992).

$$\text{Carbon Stock (kg/tree)} = \text{Biomass} \times 50\%$$

Carbon sequestration

Carbon sequestration refers to the storage of carbon that has the immediate potential to become carbon dioxide gas (Hangarge et al., 2012).

$$\text{Carbon Sequestration} = \text{Carbon Stock}* 3.67$$

RESULTS AND DISCUSSION

The tree species of KNIPSS on the main campus of Sultanpur, along with their Hindi name, common name, and botanical name, along with their families (Table 1). A total of 31 tree species were recorded from the Kamla Nehru Institute of Physical & Social Sciences main campus from 18 families with different heights and girth sizes.

The maximum number of tree species in the sample site area is represented by the family Caesalpiniaceae (05 species) followed by the family Moraceae (04 species). Therefore, the study indicates that Caesalpiniaceae, Moraceae, and Arecaceae are the dominant families of the tree species of the KNIPSS main campus. These three families together constitute more than one-third of the tree species of KNIPSS main campus.

Table 1: Species found in Main Campus of KNIPSS, Sultanpur, Uttar Pradesh

S.No.	Hindi Name	Common Name	Botanical Name	Family	DBH (m)	Height (m)
1	Saptaparni	Scholar tree	*Alstonia scholaris*	Apocynaceae	0.85	7.1
2	Chandani	Jasmine	*Tabernaemontanadi vericata*	Apocynaceae	0.60	5.5
3	Aam	Mango	*Mangifera indica*	Anacardiaceae	1.10	10.0
4	Semal	Silk cotton tree	*Bombax ceiba*	Bombacaceae	1.30	14.5
5	Amaltas	Indian laburnum	*Cassia fistula*	Caesalpiniaceae	0.76	10.1
6	Imli	Tamarind	*Tamarindus indica*	Caesalpiniaceae	0.87	15.3
7	Kachnar	Orchid tree	*Bauhinia variegate*	Caesalpiniaceae	0.62	7.3
8	Gulmohar	Flame tree	*Delonix regia*	Caesalpiniaceae	1.60	17.6
9	Seemia	Spectacular Cassia	*Senna spectabilis*	Caesalpiniaceae	0.56	10.25
10	Papita	Papaya	*Carica papaya*	Caricaceae	0.45	4.7
11	Sheesham	IndianRosewood	Delbergia sisso	Febaceae	1.74	16.8
12	Dhak	Sacred tree	Butea monosperma	Febaceae	1.04	15.0
13	Sagwan	Teak	*Tectona grandis*	Lamiaceae	0.94	17.5
14	Neem	Indian Lilac	*Azardirachta indica*	Meliaceae	1.62	17.0
15	Saras (Sheersa)	Siris tree	*Albizia lebbeck*	Mimosaceae	0.95	17.9
16	Babool	Indian gum Arabic tree	*Acacia nilotica*	Mimosaceae	1.30	12.5
17	Anjeer	Fig	*Ficus carica*	Moraceae	0.76	13.6
18	Gular	Cluster fig	*Ficus racemosa*	Moraceae	0.90	19.0
19	Peeple	Sacred Fig	*Ficus religiosa*	Moraceae	3.47	23.0
20	Bargad	Banyan	*Ficus bengalensis*	Moraceae	5.20	21.0
21	Sehjana	Drumstick tree	*Moringa oleifera*	Moringaceae	1.25	14.5
22	Kadamb	Kadam	*Neolamarckia cadamba*	Rubiaceae	0.92	16.0
23	Mahua	Mahua tree	*Madhuca indica*	Sapotaceae	1.85	20.5
24	Chilbil	Jungle cork Tree	*Holoptelea integrifolia*	Ulmaceae	1.46	18.5
25	Bismarkia Palm	Bismarck Palm	*Bismarckia nobilis*	Arecaceae	0.45	12.0
26	Pygmy Date Palm	Pygmy Date Palm	*Phoenix roebelenii*	Arecaceae	0.40	7.0
27	Taad	Royal palm	*Roystonea regia*	Arecaceae	1.20	21.5
28	Kewda	Screw pine	*Pandanus odorifer*	Pandanaceae	0.60	10.0
29	Christmas tree	Monkey Puzzles	*Araucaria columnaris*	Araucariaceae	1.35	18.5
30	Japanese sagopalm	Sago Palm	*Cycus revoluta*	Cycadaceae	0.20	3.0
31	Vidya	Cypress	*Cupressus torulosa*	Cupressaceae	0.72	15.0

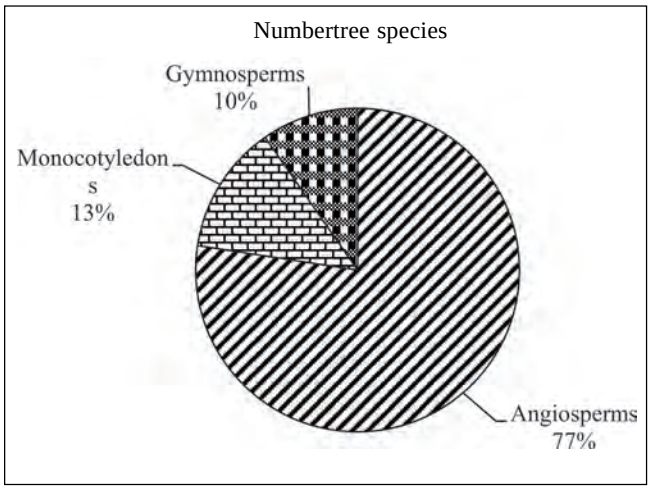

Figure 2: Percentage of tree species from different groups in KNIPSS Campus.

Furthermore, the Angiosperms group of plants has 24 species. Monocotyledons have 4 woody tree species, followed by Gymnosperms having 3 species in the Kamla Nehru Institute of Physical & Social Sciences main campus. Thus it shows Angiosperms woody plants dominate over the other tree species plants in the KNIPSS main campus (Figure 2).

The analysis of 31 woody tree species shows *Ficus bengalensis* recorded a twenty-one-meter height, which is the highest among all, followed by its diameter at breast height 5.2 meters. *Cycus revolute* has the smallest height and diameter at breast height, 3 meter and 0.20 respectively among the all. The analysis of habits of the

Table 2: List of tree species with above ground biomass, below ground biomass, total biomass with carbon stock and carbon-sequestration potential.

S.No.	Botanical Name	AGB	BGB	TB	CSkg/tree	C.Sq. kg/tree
1	*Alstonia scholaris*	181.2147	47.11583	228.3306	114.1653	418.9866
2	*Tabernaemontanadi vericata*	99.09008	25.76342	124.8535	62.42675	229.1062
3	*Mangifera indica*	330.3003	85.87807	416.1783	208.0892	763.6873
4	*Bombax ceiba*	566.0146	147.1638	713.1783	356.5892	1308.682
5	*Cassia fistula*	230.4895	59.92728	290.4168	145.2084	532.9149
6	*Tamarindus indica*	399.6934	103.9203	503.6136	251.8068	924.131
7	*Bauhinia variegate*	135.9035	35.33492	171.2385	85.61924	314.2226
8	*Delonix regia*	845.5687	219.8479	1065.417	532.7083	1955.039
9	*Senna spectabilis*	172.3567	44.81274	217.1694	108.5847	398.5059
10	*Carica papaya*	63.50773	16.51201	80.01975	40.00987	146.8362
11	*Delbergia sisso*	877.758	228.2171	1105.975	552.9875	2029.464
12	*Butea monosperma*	468.4258	121.7907	590.2166	295.1083	1083.047
13	*Tectona grandis*	493.949	128.4268	622.3758	311.1879	1142.06
14	*Azardirachta indica*	826.9518	215.0075	1041.959	520.9796	1911.995
15	*Albizia lebbeck*	510.6142	132.7597	643.3739	321.6869	1180.591
16	*Acacia nilotica*	487.9436	126.8653	614.8089	307.4045	1128.174
17	*Ficus carica*	310.3621	80.69416	391.0563	195.5282	717.5883
18	*Ficus racemosa*	513.4668	133.5014	646.9682	323.4841	1187.187
19	*Ficus religiosa*	2396.479	623.0844	3019.563	1509.782	5540.898
20	*Ficus bengalensis*	3278.981	852.535	4131.516	2065.758	7581.332
21	*Moringa oleifera*	544.2448	141.5036	685.7484	342.8742	1258.348
22	*Neolamarckia cadamba*	442.0018	114.9205	556.9223	278.4611	1021.952

Table 2 contd....

S.No.	Botanical Name	AGB	BGB	TB	CSkg/tree	C.Sq. kg/tree
23	*Madhuca indica*	1138.785	296.0842	1434.869	717.4347	2632.985
24	*Holoptelea integrifolia*	811.0373	210.8697	1021.907	510.9535	1875.199
25	*Bismarckia nobilis*	162.1474	42.15833	204.3057	102.1529	374.901
26	*Phoenix roebelenii*	84.07643	21.85987	105.9363	52.96815	194.3931
27	*Roystonea regia*	774.7043	201.4231	976.1274	488.0637	1791.194
28	*Pandanus odorifer*	180.1638	46.84258	227.0064	113.5032	416.5567
29	*Araucaria Columnaris*	749.9318	194.9823	944.914	472.457	1733.917
30	*Cycas revoluta*	18.01638	4.684258	22.70064	11.35032	41.65567
31	*Cupressus torulosa*	324.2948	84.31665	408.6115	204.3057	749.802

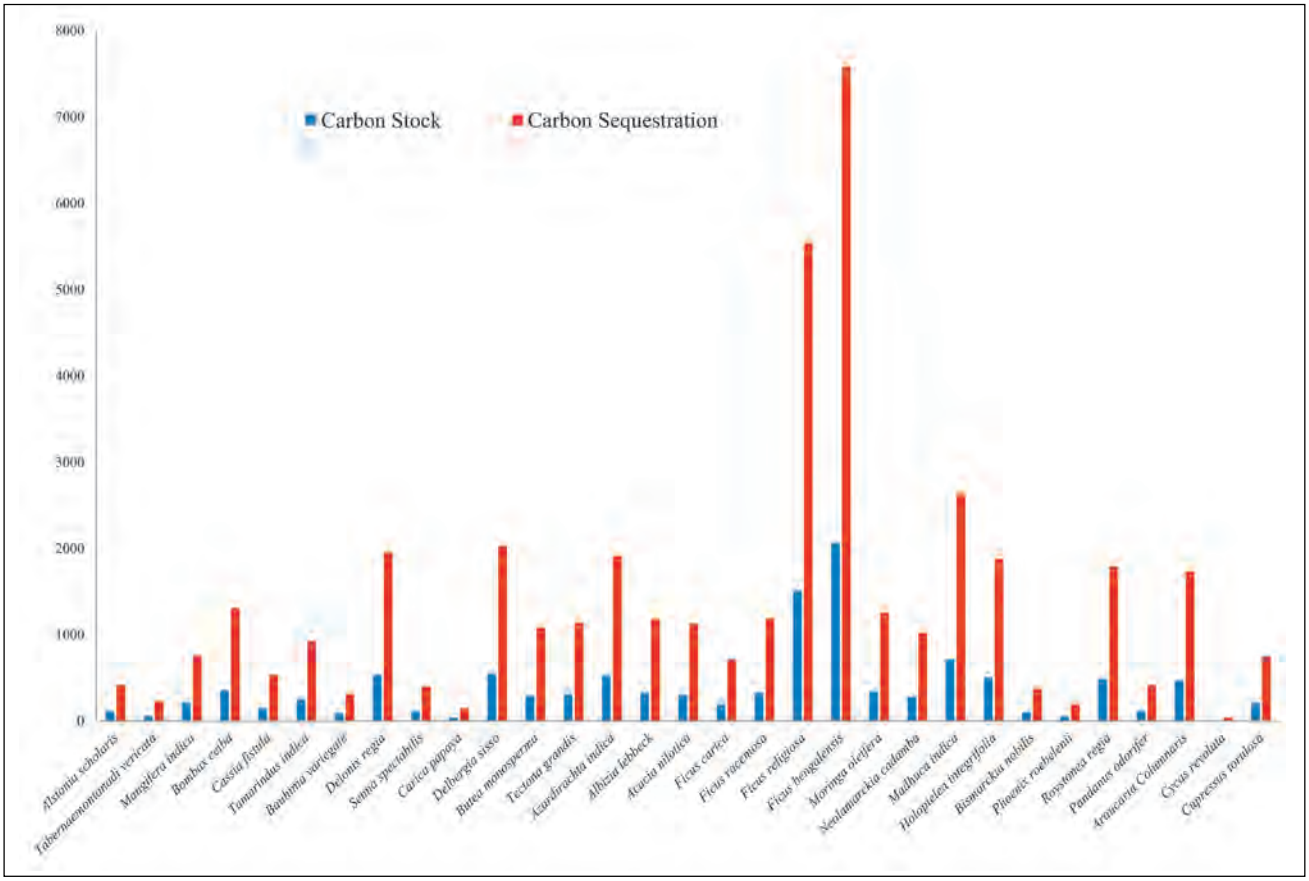

Figure 3: Carbon Stock and carbon-sequestration potential of different tree species in KNIPSS campus.

woody plants of the institute campus reveals that there are total of 31 tree species in the Kamla Nehru Institute of Physical & Social Sciences, Sultanpur, Uttar Pradesh main campus. The present study has main objective is to find the campus tree's carbon stock and sequestration to find out the species with the greater potential. On calculating the carbon stock and carbon sequestrating potential founds to the maximum in two tree species belonging to the same family Moraceae that is *Ficus bengalensis* and *Ficus religiosa* and their carbon stock

is found to be is 2065.758 kg/tree and 1509.782 kg/tree, and carbon sequestration potential is 7581.332 tonnes CO_2eq/tree and 5540.898 tonnes CO_2eq/tree respectively. *Cycas revoluta* records lowest carbon stock, 11.35 kg/tree, and carbon sequestration, 41.65 CO_2eq/tree, respectively (Figure 3). However, it is crucial to increase biodiversity by planting suitable native species in the study area for in situ conservation as well as an efficient way to preserve the species through ex-situ methods, such as by introducing botanical gardens and perhaps collecting seed banks for preservation in suitable repositories (Singh et al., 2022). To improve our understanding of the current state of overall floral diversity, it is also crucial to compile an exhaustive checklist of the campus's overall floristic biodiversity.

ACKNOWLEDGEMENT

The authors are highly thankful to the Principal, KNIPSS, for providing the necessary help for collecting samples from different sites on campus.

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