Journal of Multidisciplinary Engineering Science and Technology (JMEST)
ISSN: 2458-9403
Vol. 3 Issue 5, May - 2016

Carbon Sequestration Efficacy Of Trees Of Vinoba Bhave University Campus, Hazaribag

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***Abstract*—Excessive use and burning of fossil use as a source of energy has resulted in increasing concentration of atmospheric CO_2 and other green house gases which is causing rise in atmospheric temperature. This climate change is causing loss of biodiversity, decline in agricultural productivity, changed pattern of rain fall, desertification, melting of polar ice cap etc. trees provide a solution to all these problems as they possess a unique property of sequestering of carbon through the process of photosynthesis. The present study was conducted to find out the carbon sequestration efficacy of trees planted in Vinoba Bhave University (V.B.U.) Campus, Hazaribag.**

Keywords—Carbon sequestration, V.B.U. campus, height, weight, girth etc.

I) INTRODUCTION:

Industrial revolution has definitely transformed human life and has also helped in socioeconomic development of world. But on the other hand, man is also paying heavily because of environmental degradation and climate change. Excessive use and burning of fossil use as a source of energy has resulted in increasing concentration of atmospheric CO_2 and other Green House Gases which is causing rise in atmospheric temperature. Atmospheric CO_2 has risen by considerable 25% since industrial revolution. Earth System Research Laboratory has reported that in December 2015 CO_2 concentration rose to 401.62 ppm and the rate of rise was 3.01 ppm/year. Manifestation of rise in atmospheric CO_2 in rise in temperature has been differently estimated by different workers and range from 1.5 to 4.00 degree Celsius (Atwell *et.al* 1999). This hike in temperature has a highly complicated impact of other climatic parameters as well. This climate change is affecting almost all aspects of earth as well as our life. Loss of biodiversity, decline in agricultural productivity, changed pattern of rain fall, desertification, melting of polar ice cap, outbreak of diseases, displacement and social anarchy are a few to name.

Trees are good tool in our arsenal to address this problem. Trees possess unique property of effective sequestration of carbon as they store it in their above ground and below ground biomass as product of photosynthesis (Borough 1998). Trees synthesise various carbon rich compounds like, cellulose, hemicelluloses, lignin, starch, lipid and wax which are stored in their secondary tissue. Trees have three major components which all together account for sequestration of carbon.

- Uptake and assimilation during photosynthesis.
- Carbon transport and allocation in metabolic processes and structural configuration.
- Return of carbon to atmosphere via biological decay and forest products.

The rate of carbon sequestration depends upon many factors. Age and stage of growth of tree, growth parameter and rate of photosynthesis and density of wood are some important among them.

Present study was aimed at studying carbon sequestration efficacy of trees planted in Vinoba Bhave University campus which is located in Hazaribag district of Jharkhand state of India.

II) MATERIALS AND METHODS.-

The basic methodology adopted for estimating amount of carbon sequestered by trees of campus is described below:

- Total green weight of tree species was calculated.
- Total dry weight of tree species was estimated.
- Weight of carbon in tree was estimated.
- Weight of CO_2 sequestered was calculated.

Green weight of a tree is calculated by following formula –

W – Above ground weight of the tree in lbs.
D - Diameter of the trunk inches.
H – Height of the tree in feet.
For tree with diameter < 11
$W = 0.25D^2H$
For trees with diameter >= 11
$W = 0.15D^2H$

The root system weighs about 20% as much as the weight of above ground weight of tree. Hence total green weight of the tree can be calculated by multiplying above ground weight of tree by 120%.

Dry weight of tree –

De Wald et al. Of University of Nebraska (2005) has reported that on an average a tree possess

72.5% dry matter and 27.5% moisture. The same calculation was adopted during this study as well.

Weight of carbon in tree –

Birdsay (1992) of United States Department of Agriculture Forest Services, Radnor has reported that average carbon content in a tree is about 50% of its total volume. The carbon content of tree was estimated following this formula.

Weight of carbon dioxide sequestered in tree –

Carbon dioxide has got one molecule of carbon and two molecules of Oxygen.

Carbon has atomic weight – 12.001115

Oxygen has atomic weight – 15.9994

Molecular weight of CO_2 - C + OX2 = 43.999915.

Ratio of CO_2 to C is 43.999915/12.001115 = 3.6663.

Hence weight of CO_2 sequestered in a tree can be calculated by multiplying weight of tree by 3.6663.

Amount of CO_2 sequestered can be calculated by dividing the total CO_2 sequestered by age of tree.

TABLES

Table 1. Dimensions of different tree species of V.B.U. Campus

Sl. No.	Tree Species	Average Height (feet)	Average Girth (inches)	Weight of tree (lbs)
1.	*Tectona grandis*	31.65	30.01	4301.28
2.	*Gmelina arborea*	23.12	33.5	3891.96
3.	*Syzizium cumini*	19.024	27.4	2142.37
4.	*Polyalthia longifolia*	23.37	21.22	1578.49
5.	*Dalbergia sisoo*	39.36	31.83	5981.63
6.	*Psidium guajava*	19.68	11	357.19
7.	*Carica papaya*	10.66	11.9	226.43
8.	*Phoenix dachylifera*	13.66	45	4149.23
9.	*Ficus religiosa*	30.50	86.5	34231.29
10.	*Anthocephalous cadamba*	30.504	32.9	4952.67
11.	*Artocarpus heterophyllus*	22.96	33.15	3784.69
12.	*Ficus benghalensis*	20.336	21.25	1377.45
13.	*Jacaranda* sp.	28.044	54.25	12380.29
14.	Azadirachta indica	23.288	21	1540.50
15.	*Butea monosperma*	15.58	20.05	939.48
16.	*Tamarindus indica*	29.52	17	1279.69
17.	*Madhuca longifolia*	37.72	143	115700.44
18.	*Callistemon* sp.	20.77	30.66	2928.68
19.	*Araucaria* sp.	27.88	25	2613.75
20.	*Saraca asoca*	27.88	25	2613.75
21.	*Swietenia mahogany*	27.47	18.325	1383.69
22.	*Mangifera indica*	13.448	19	728.21
23.	*Peltoform* sp.	24.6	65	15590.25
24.	*Terminalia arjuna*	29.52	45.3	9086.65
25.	*Delonix regia*	36.08	50.5	13801.95

Table 2: Carbon sequestration by different trees of V.B.U. Campus

Sl. No.	Tree species	Average CO_2 sequestered (lbs)	Average CO_2 sequestered (tons)	Total no. of species	Total CO_2 sequestered (tons)
1.	*Tectona grandis*	6859.92	3.09	23	71.07
2.	*Gmelina arborea*	6207.06	2.79	3	8.37
3.	*Syzizium cumini*	3416.74	1.54	*9*	13.86
4.	*Polyalthia longifolia*	2517.44	1.13	*27*	30.51
5.	*Dalbergia sisoo*	9539.75	4.29	*9*	38.61
6.	*Psidium guajava*	569.66	0.26	5	1.30
7.	*Carica papaya*	361.12	0.16	*6*	0.96
8.	*Phoenix dachylifera*	6617.36	2.98	*1*	2.98
9.	*Ficus religiosa*	54593.45	24.57	*2*	49.14
10.	*Anthocephalous cadamba*	7898.73	3.55	*24*	85.20
11.	*Artocarpus heterophyllus*	6035.98	2.72	*1*	2.72
12.	*Ficus benghalensis*	2196.81	0.99	*10*	2.98
13.	*Jacaranda* sp.	19744.59	8.89	*3*	26.67
14.	Azadirachta indica	2456.85	1.11	2	2.22
15.	*Butea monosperma*	1498.32	0.67	*2*	1.34
16.	*Tamarindus indica*	2040.90	0.92	*2*	1.84
17.	*Madhuca longifolia*	184523.75	83.04	*1*	83.04
18.	*Callistemon* sp.	4670.78	2.10	*12*	25.20
19.	*Araucaria* sp.	4168.51	1.88	42	78.96
20.	*Saraca asoca*	4168.51	1.88	*2*	3.76
21.	*Swietenia mahogany*	2206.76	0.99	*53*	52.47
22.	*Mangifera indica*	1161.38	0.52	*3*	1.56
23.	*Peltoform* sp.	24863.96	11.19	37	414.03
24.	*Terminalia arjuna*	14491.76	6.52	*1*	6.52
25.	*Delonix regia*	22011.91	9.91	*16*	153.56

Total CO_2 sequestered- 1165.79 tons

III) **RESULTS AND DISCUSSION:**

Dimension of 25 tree sp. present in the Vinoba Bhave University campus is presented in the Table 1. As the methodology adopted require all the dimensions of imperial system, hence height of the tree, girth of the tree and the weight of the tree is represented in feet, inches and pounds. Average height of *Tectona grandis* was recorded 31.65 feet whereas the average girth was 30.01 inches. Average weight of the tree was 4301.21 lbs. Average height of *Gmelina arborea* was recorded 23.12 feet whereas the average girth was 33.50 inches. Average weight of the tree was 3891.96 lbs. Average height of *Syzizium cumini* was recorded 19.02 feet whereas the average girth was 27.40 inches. Average weight of the tree was 2142.37 lbs. Average height of *Polyalthia longifolia* was recorded 23.37 feet whereas the average girth was 21.22 inches. Average weight of the tree was 1578.49 lbs. Average height of *Dalbergia sisoo* was recorded 39.36 feet whereas the average girth was 31.83 inches. Average weight of the tree was 5981.63 lbs. Average height of *Psidium guajava* was recorded 19.68 feet whereas the average girth was 11 inches. Average weight of the tree was 357.19 lbs. Average height of *Carica papaya* was recorded 10.66 feet whereas the average girth was 11.9 inches. Average weight of the tree was 226.43 lbs. Average height of *Phoenix dachylifera* was recorded 13.66 feet whereas the average girth was 45 inches. Average weight of the tree was 4149.23 lbs. Average height of *Ficus religiosa* was recorded 30.50 feet whereas the average girth was 86.50 inches. Average weight of the tree was 34231.29 lbs. Average height of *Anthocephalous cadamba* was recorded 30.50 feet whereas the average girth was 32.90 inches. Average weight of the tree was 4952.67 lbs. Average height of

Artocarpus heterophyllus was recorded 22.96 feet whereas the average girth was 33.15 inches. Average weight of the tree was 3784.69 lbs. Average height of *Ficus benghalensis* was recorded 20.34 feet whereas the average girth was 21.25 inches. Average weight of the tree was 1377.45 lbs. Average height of *Jacaranda* sp. was recorded 28.04 feet whereas the average girth was 54.25 inches. Average weight of the tree was 12380.29 lbs. Average height of *Azadirachta indica* was recorded 23.29 feet whereas the average girth was 21 inches. Average weight of the tree was 1540.50 lbs. Average height of *Butea monosperma* was recorded 15.58 feet whereas the average girth was 20.05 inches. Average weight of the tree was 939.48 lbs. Average height of *Tamarindus indica* was recorded 29.52 feet whereas the average girth was 17 inches. Average weight of the tree was 1279.69 lbs. Average height of *Madhuca longifolia* was recorded 37.72 feet whereas the average girth was 143 inches. Average weight of the tree was 115700.44 lbs. Average height of *Callistemon* sp. was recorded 20.77 feet whereas the average girth was 30.66 inches. Average weight of the tree was 2928.68 lbs. Average height of *Araucaria* sp. was recorded 27.88 feet whereas the average girth was 25 inches. Average weight of the tree was 2613.75 lbs. Average height of *Saraca asoca* was recorded 27.88 feet whereas the average girth was 25 inches. Average weight of the tree was 2613.75 lbs. Average height of *Swietenia mahogany* was recorded 27.47 feet whereas the average girth was 18.33 inches. Average weight of the tree was 1383.69 lbs. Average height of *Mangifera indica* was recorded 13.45 feet whereas the average girth was 19 inches. Average weight of the tree was 728.21 lbs. Average height of *Peltoform* sp. was recorded 24.6 feet whereas the average girth was 65 inches. Average weight of the tree was 15590.25 lbs. Average height of *Terminalia arjuna* was recorded 29.52 feet whereas the average girth was 45.30 inches. Average weight of the tree was 9086.65 lbs. Average height of *Delonix regia* was recorded 36.08 feet whereas the average girth was 50.50 inches. Average weight of the tree was 13801.95 lbs.

Carbon sequestered by the trees is represented in Table 2. Individual tree of *Tectona grandis sequester 6859.92* pounds of carbon. Total tree belonging to this species sequester 71.07 tons of CO_2. Individual tree of *Gmelina arborea* sequester *6207.06* pounds of carbon. Total tree belonging to this species sequester 8.37 tons of CO_2. Individual tree of *Syzizium cumini* sequester *3416.74* lbs of carbon. Total tree belonging to this species sequester 13.86 tons of CO_2. Individual tree of *Polyalthia longifolia* sequester *2517.44* lbs of carbon. Total tree belonging to this species sequester 30.51 tons of CO_2. Individual tree of *Dalbergia sisoo* sequester *9539.75* lbs of carbon. Total tree belonging to this species sequester 38.61 tons of CO_2. Individual tree of *Psidium guajava* sequester *569.66* lbs of carbon. Total tree belonging to this species sequester 1.30 tons of CO_2. Individual tree of *Carica papaya* sequester *361.12* lbs of carbon. Total tree belonging to this species sequester 0.96 tons of CO_2. Individual tree of *Phoenix dachylifera* sequester *6617.36* lbs of carbon. Total tree belonging to this species sequester 2.98 tons of CO_2. Individual tree of *Ficus religiosa* sequester *54593.45* lbs of carbon. Total tree belonging to this species sequester 49.14 tons of CO_2. Individual tree of *Anthocephalous cadamba* sequester *7898.73* lbs of carbon. Total tree belonging to this species sequester 85.20 tons of CO_2. Individual tree of *Artocarpus heterophyllus* sequester *6035.98* lbs of carbon. Total tree belonging to this species sequester 2.92 tons of CO_2. Individual tree of *Ficus benghalensis* sequester *2196.81* lbs of carbon. Total tree belonging to this species sequester 9.90 tons of CO_2. Individual tree of *Jacaranda* sp. sequester *19744.59* lbs of carbon. Total tree belonging to this species sequester 26.67 tons of CO_2. Individual tree of *Azadirachta indica* sequester *2456.85* lbs of carbon. Total tree belonging to this species sequester 2.22 tons of CO_2. Individual tree of *Butea monosperma* sequester *1498.32* lbs of carbon. Total tree belonging to this species sequester 1.34 tons of CO_2. Individual tree of *Tamarindus indica* sequester *2040.90* lbs of carbon. Total tree belonging to this species sequester 1.84 tons of CO_2. Individual tree of *Madhuca longifolia* sequester *184523.75* lbs of carbon. Total tree belonging to this species sequester 83.04 tons of CO_2. Individual tree of *Callistemon* sp. sequester *4670.78* lbs of carbon. Total tree belonging to this species sequester 25.20 tons of CO_2. Individual tree of *Araucaria* sp. sequester *4168.51* lbs of carbon. Total tree belonging to this species sequester 78.96 tons of CO_2. Individual tree of *Saraca asoca* sequester *4168.51* lbs of carbon. Total tree belonging to this species sequester 3.76 tons of CO_2. Individual tree of *Swietenia mahogany* sequester *2206.76* lbs of carbon. Total tree belonging to this species sequester 52.47 tons of CO_2. Individual tree of *Mangifera indica* sequester *1161.38* lbs of carbon. Total tree belonging to this species sequester 1.56 tons of CO_2. Individual tree of *Peltoform* sp. sequester *24863.96* lbs of carbon. Total tree belonging to this species sequester 414.03 tons of CO_2. Individual tree of *Terminalia arjuna* sequester *14491.76* lbs of carbon. Total tree belonging to this species sequester 6.52 tons of CO_2. Individual tree of *Delonix regia* sequester *22011.91* lbs of carbon. Total tree belonging to this species sequester 153.56 tons of CO_2. So total CO_2 sequestered by all the the trees of Vinoba Bhave University Campus is 1165.79 tons.

ACKNOWLEDGMENT : The authors of this paper sincerely acknowledge the Department of Botany, Hazaribag for providing support throughout the research. Authors are also thankful to all those who directly or indirectly helped in making this research a successful one.

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