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Toona ciliata (Toon Tree) Volume, Biomass and Carbon Tables for Meghalaya



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Photograph: *Toona ciliata*

Toona ciliata Roxb. ex Willd

Volume, Biomass and Carbon Tables for Meghalaya

Introduction

Toona ciliata (Family- Meliaceae) is found naturally across much of South and Southeast Asia from Pakistan and western China to Indonesia, Malaysia and parts of Oceania, including Australia and islands of the western Pacific Ocean. On the Indian subcontinent, *T. ciliata* is distributed from eastern Pakistan to Bangladesh, North East including the tropical parts of the sub-Himalayan tract and the Western Ghats (Conn and Damas, 2006).

Habitat and ecology

In the western sub-Himalayan tract of India, *T. ciliata* is found in moist localities, sheltered ravines, along streams and even in swamp forest, while in the Western Ghats, it is found mostly in wet evergreen forests. In India, the climate of the natural habitat comprises rainfall from 1100–4000 mm per year and temperatures ranging from about 0-35°C. The species is frost tolerant, however, sensitive to drought.

Uses of the tree

T. ciliata is mostly grown for its versatile timber, which is used for building houses, high value goods such as furniture, musical instruments and carvings. The flowers yield reddish dye stuff, while the bark is used to tan leather or to produce string. Leaves and bark are used in traditional medicine. *T. ciliata* is commonly cultivated as an avenue tree in India (Edmonds, 1995) and as an ornamental and wayside tree throughout much of tropical Africa and Asia (Fenton et al. 1977).

Need for volume, biomass and carbon tables

Volume tables are used to estimate the quantity of timber available in the forest or plantation in terms of merchantable timber yield. The volume of trees is calculated either after felling the tree or in the standing form. For volume estimation of standing trees, mathematical models developed through multiple regression analyses are the most suitable methods which avoid felling of trees or destructive approach for volume, biomass and carbon stock estimation in the forest ecosystems. Once developed the volume and biomass tables can be used either by the owners of the tree or the buyer to decide on the value. The carbon tables are useful, if the trees are raised as a part of any project

involving carbon trading. In Meghalaya, *T. ciliata* is available in the forests owned by the Government as well as the communities and used for different purposes. Therefore, a need was felt for volume, biomass and carbon tables of this species in Meghalaya.

Methodology (non destructive method)

The following parameters were recorded for development of volume/biomass equations

1. Girth at breast height (GBH) at 1.37 m above ground level for each individual tree was measured using measuring tape and converted into diameter at breast height (DBH) using the following formula:

$$(\text{DBH}) = \frac{\text{Girth at 1.37 m above ground}}{3.14}$$

2. Girth at the base of trees were measured and converted into basal diameter.

$$\text{Basal diameter} = \frac{\text{Girth at the base of tree}}{3.14}$$

Height of each individual tree was measured using **Nikon 550A Laser Range Finder**. Diameter at each end point and at the centre portion of frustum (smaller logs) was measured in standing trees using **Haglof Mantax Black Caliper with Gator Eyes** and the height of the lower and upper ends of the frustum were measured using Nikon 550A Laser range finder, to arrive at the centre of frustum. Stem volume (m^3) of *T. ciliata* was estimated using diameter class wise regression models developed in this study. The stem volume was converted into biomass (kg/tree) using wood specific gravity (0.560 gm/cm^3) for preparation of regional biomass tables. The stem biomass was further converted into carbon content multiplying with 0.5 to prepare carbon tables (kg/tree).

Utilization of volume, biomass and carbon tables

Stem volume tables were prepared considering height and DBH as an independent variables and volume as a dependent variable in the form of ($V=d^2h$). Volume tables were also prepared using tree DBH as a single independent variable in the form of ($V=d^2$). The regional volume tables prepared for three diameter classes *viz.*, 10-30, 31-50 and >50 cm can be used by the Researchers, Academicians, Forest Officials and Farmers to estimate volume of standing trees for timber extraction from forest areas and community owned plantations (Table 1-3). Table 4-9 shows biomass and carbon values (kg/tree) of particular diameter and height classes (having diameter class interval of 1 cm and height

class interval of 1 m). Table 10-11 shows the volume, biomass and carbon content estimated using regression models in the form of ($V=d^2$). The regional yield, carbon tables and best fit regression models can be used for forest biomass and carbon sequestration studies as well as developing projects under REDD+ activities, Clean Development Mechanism (CDM) and National Green House Gas inventories.

References:

Conn, B.J. and Damas, K.Q. 2006. *Toona ciliata* M. Roem. Guide to trees of Papua New Guinea.

Edmonds, J.M. 1995. Toona. In: Meliaceae, Mabberley, D.J., Pannell, C.M. and Singh, A.M. (*eds*). Flora Malesiana, Series Spermatophyta, 12(1): 358-371.

Fenton, R., Roper, R.E. and Watt, G.R. 1977. Lowland tropical hardwoods. An annotated bibliography of selected species with plantation potential. Wellington, New Zealand: External Aid Division, Ministry of Foreign Affairs.

Table 1: Volume table for *Toona ciliata* (10-30 cm diameter class) in m^3

Diameter at breast height (cm)	Height (m)														
	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
10	0.033	0.036	0.039	0.042	0.045	0.048	0.051	0.054	0.057	0.060	0.063	0.066	0.069	0.072	0.075
11	0.040	0.043	0.047	0.050	0.054	0.058	0.061	0.065	0.069	0.072	0.076	0.079	0.083	0.087	0.090
12	0.047	0.051	0.056	0.060	0.064	0.069	0.073	0.077	0.082	0.086	0.090	0.094	0.099	0.103	0.107
13	0.055	0.060	0.065	0.071	0.076	0.081	0.086	0.091	0.096	0.101	0.106	0.111	0.116	0.121	0.126
14	0.064	0.070	0.076	0.082	0.088	0.093	0.099	0.105	0.111	0.117	0.123	0.128	0.134	0.140	0.146
15	0.074	0.080	0.087	0.094	0.101	0.107	0.114	0.121	0.127	0.134	0.141	0.148	0.154	0.161	0.168
16	0.084	0.092	0.099	0.107	0.114	0.122	0.130	0.137	0.145	0.153	0.160	0.168	0.175	0.183	0.191
17	0.095	0.103	0.112	0.121	0.129	0.138	0.146	0.155	0.164	0.172	0.181	0.189	0.198	0.207	0.215
18	0.106	0.116	0.126	0.135	0.145	0.154	0.164	0.174	0.183	0.193	0.203	0.212	0.222	0.232	0.241
19	0.118	0.129	0.140	0.151	0.161	0.172	0.183	0.194	0.204	0.215	0.226	0.237	0.247	0.258	0.269
20	0.131	0.143	0.155	0.167	0.179	0.191	0.203	0.215	0.226	0.238	0.250	0.262	0.274	0.286	0.298
21	0.145	0.158	0.171	0.184	0.197	0.210	0.223	0.237	0.250	0.263	0.276	0.289	0.302	0.315	0.329
22	0.159	0.173	0.188	0.202	0.216	0.231	0.245	0.260	0.274	0.288	0.303	0.317	0.332	0.346	0.361
23	0.173	0.189	0.205	0.221	0.236	0.252	0.268	0.284	0.300	0.315	0.331	0.347	0.363	0.378	0.394
24	0.189	0.206	0.223	0.240	0.257	0.275	0.292	0.309	0.326	0.343	0.360	0.378	0.395	0.412	0.429
25	0.205	0.224	0.242	0.261	0.279	0.298	0.317	0.335	0.354	0.373	0.391	0.410	0.428	0.447	0.466
26	0.222	0.242	0.262	0.282	0.302	0.322	0.342	0.363	0.383	0.403	0.423	0.443	0.463	0.483	0.504
27	0.239	0.261	0.282	0.304	0.326	0.348	0.369	0.391	0.413	0.434	0.456	0.478	0.500	0.521	0.543
28	0.257	0.280	0.304	0.327	0.350	0.374	0.397	0.421	0.444	0.467	0.491	0.514	0.537	0.561	0.584
29	0.276	0.301	0.326	0.351	0.376	0.401	0.426	0.451	0.476	0.501	0.526	0.551	0.576	0.601	0.627
30	0.295	0.322	0.349	0.375	0.402	0.429	0.456	0.483	0.510	0.536	0.563	0.590	0.617	0.644	0.671

(The values in darker region are within the range of observed data)

Table 2: Volume table for *Toona ciliata* (31-50 cm diameter class) in m^3

Diameter at breast height (cm)	Height (m)															
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	0.268	0.286	0.304	0.322	0.340	0.357	0.375	0.393	0.411	0.429	0.447	0.465	0.483	0.500	0.518	0.536
32	0.286	0.305	0.324	0.343	0.362	0.381	0.400	0.419	0.438	0.457	0.476	0.495	0.514	0.533	0.552	0.571
33	0.304	0.324	0.344	0.365	0.385	0.405	0.425	0.446	0.466	0.486	0.506	0.527	0.547	0.567	0.587	0.608
34	0.323	0.344	0.366	0.387	0.409	0.430	0.452	0.473	0.495	0.516	0.538	0.559	0.581	0.602	0.624	0.645
35	0.342	0.365	0.387	0.410	0.433	0.456	0.478	0.501	0.524	0.547	0.570	0.592	0.615	0.638	0.661	0.684
36	0.362	0.386	0.410	0.434	0.458	0.482	0.506	0.530	0.554	0.579	0.603	0.627	0.651	0.675	0.699	0.723
37	0.382	0.407	0.433	0.458	0.484	0.509	0.535	0.560	0.586	0.611	0.637	0.662	0.688	0.713	0.738	0.764
38	0.403	0.430	0.457	0.483	0.510	0.537	0.564	0.591	0.618	0.645	0.671	0.698	0.725	0.752	0.779	0.806
39	0.424	0.453	0.481	0.509	0.538	0.566	0.594	0.622	0.651	0.679	0.707	0.736	0.764	0.792	0.820	0.849
40	0.446	0.476	0.506	0.536	0.565	0.595	0.625	0.655	0.684	0.714	0.744	0.774	0.804	0.833	0.863	0.893
41	0.469	0.500	0.532	0.563	0.594	0.625	0.657	0.688	0.719	0.750	0.782	0.813	0.844	0.875	0.907	0.938
42	0.492	0.525	0.558	0.591	0.623	0.656	0.689	0.722	0.755	0.787	0.820	0.853	0.886	0.919	0.952	0.984
43	0.516	0.550	0.585	0.619	0.653	0.688	0.722	0.757	0.791	0.825	0.860	0.894	0.929	0.963	0.997	1.032
44	0.540	0.576	0.612	0.648	0.684	0.720	0.756	0.792	0.828	0.864	0.900	0.936	0.972	1.008	1.044	1.080
45	0.565	0.603	0.640	0.678	0.716	0.753	0.791	0.829	0.866	0.904	0.942	0.979	1.017	1.055	1.092	1.130
46	0.590	0.630	0.669	0.708	0.748	0.787	0.827	0.866	0.905	0.945	0.984	1.023	1.063	1.102	1.141	1.181
47	0.616	0.657	0.698	0.740	0.781	0.822	0.863	0.904	0.945	0.986	1.027	1.068	1.109	1.150	1.192	1.233
48	0.643	0.686	0.729	0.771	0.814	0.857	0.900	0.943	0.986	1.029	1.071	1.114	1.157	1.200	1.243	1.286
49	0.670	0.715	0.759	0.804	0.849	0.893	0.938	0.982	1.027	1.072	1.116	1.161	1.206	1.250	1.295	1.340
50	0.698	0.744	0.791	0.837	0.884	0.930	0.977	1.023	1.070	1.116	1.163	1.209	1.256	1.302	1.349	1.395

(The values in darker region are within the range of observed data)

Table 3: Volume table for *Toona ciliata* (>50 cm diameter class) in m^3

Diameter at breast height (cm)	Height (m)																				
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
51	0.987	1.053	1.119	1.184	1.250	1.316	1.382	1.448	1.514	1.579	1.645	1.711	1.777	1.843	1.908	1.974	2.040	2.106	2.172	2.237	2.303
52	1.026	1.095	1.163	1.231	1.300	1.368	1.437	1.505	1.573	1.642	1.710	1.779	1.847	1.916	1.984	2.052	2.121	2.189	2.258	2.326	2.394
53	1.066	1.137	1.208	1.279	1.350	1.421	1.492	1.563	1.635	1.706	1.777	1.848	1.919	1.990	2.061	2.132	2.203	2.274	2.345	2.416	2.487
54	1.107	1.180	1.254	1.328	1.402	1.475	1.549	1.623	1.697	1.771	1.844	1.918	1.992	2.066	2.139	2.213	2.287	2.361	2.435	2.508	2.582
55	1.148	1.225	1.301	1.378	1.454	1.531	1.607	1.684	1.760	1.837	1.913	1.990	2.066	2.143	2.219	2.296	2.373	2.449	2.526	2.602	2.679
56	1.190	1.269	1.349	1.428	1.507	1.587	1.666	1.745	1.825	1.904	1.984	2.063	2.142	2.222	2.301	2.380	2.460	2.539	2.618	2.698	2.777
57	1.233	1.315	1.397	1.480	1.562	1.644	1.726	1.808	1.891	1.973	2.055	2.137	2.219	2.302	2.384	2.466	2.548	2.630	2.713	2.795	2.877
58	1.277	1.362	1.447	1.532	1.617	1.702	1.787	1.872	1.958	2.043	2.128	2.213	2.298	2.383	2.468	2.553	2.638	2.723	2.809	2.894	2.979
59	1.321	1.409	1.497	1.585	1.673	1.761	1.849	1.938	2.026	2.114	2.202	2.290	2.378	2.466	2.554	2.642	2.730	2.818	2.906	2.994	3.082
60	1.366	1.457	1.548	1.639	1.731	1.822	1.913	2.004	2.095	2.186	2.277	2.368	2.459	2.550	2.641	2.732	2.823	2.915	3.006	3.097	3.188
61	1.412	1.506	1.600	1.695	1.789	1.883	1.977	2.071	2.165	2.259	2.354	2.448	2.542	2.636	2.730	2.824	2.918	3.013	3.107	3.201	3.295
62	1.459	1.556	1.653	1.751	1.848	1.945	2.042	2.140	2.237	2.334	2.431	2.529	2.626	2.723	2.820	2.918	3.015	3.112	3.209	3.307	3.404
63	1.506	1.607	1.707	1.807	1.908	2.008	2.109	2.209	2.310	2.410	2.510	2.611	2.711	2.812	2.912	3.012	3.113	3.213	3.314	3.414	3.515
64	1.554	1.658	1.762	1.865	1.969	2.073	2.176	2.280	2.383	2.487	2.591	2.694	2.798	2.902	3.005	3.109	3.212	3.316	3.420	3.523	3.627
65	1.603	1.710	1.817	1.924	2.031	2.138	2.245	2.352	2.459	2.565	2.672	2.779	2.886	2.993	3.100	3.207	3.314	3.421	3.527	3.634	3.741
66	1.653	1.763	1.874	1.984	2.094	2.204	2.314	2.425	2.535	2.645	2.755	2.865	2.976	3.086	3.196	3.306	3.416	3.527	3.637	3.747	3.857
67	1.704	1.817	1.931	2.044	2.158	2.271	2.385	2.499	2.612	2.726	2.839	2.953	3.066	3.180	3.294	3.407	3.521	3.634	3.748	3.861	3.975
68	1.755	1.872	1.989	2.106	2.223	2.340	2.457	2.574	2.691	2.808	2.925	3.042	3.159	3.276	3.393	3.510	3.627	3.744	3.861	3.978	4.095
69	1.807	1.927	2.048	2.168	2.289	2.409	2.530	2.650	2.770	2.891	3.011	3.132	3.252	3.373	3.493	3.614	3.734	3.855	3.975	4.095	4.216
70	1.860	1.984	2.107	2.231	2.355	2.479	2.603	2.727	2.851	2.975	3.099	3.223	3.347	3.471	3.595	3.719	3.843	3.967	4.091	4.215	4.339

(The values in darker region are within the range of observed data)

Table 4 Biomass table (kg/tree) for *Toona ciliata* (10-30 cm diameter class)

Diameter at breast height (cm)	Height (m)														
	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
10	18.36	20.03	21.69	23.36	25.03	26.70	28.37	30.04	31.71	33.38	35.04	36.71	38.38	40.05	41.72
11	22.21	24.23	26.25	28.27	30.29	32.31	34.33	36.35	38.37	40.38	42.40	44.42	46.44	48.46	50.48
12	26.43	28.84	31.24	33.64	36.05	38.45	40.85	43.26	45.66	48.06	50.46	52.87	55.27	57.67	60.08
13	31.02	33.84	36.66	39.48	42.30	45.12	47.94	50.76	53.59	56.41	59.23	62.05	64.87	67.69	70.51
14	35.98	39.25	42.52	45.79	49.06	52.33	55.60	58.88	62.15	65.42	68.69	71.96	75.23	78.50	81.77
15	41.30	45.06	48.81	52.57	56.32	60.08	63.83	67.59	71.34	75.10	78.85	82.61	86.36	90.12	93.87
16	46.99	51.27	55.54	59.81	64.08	68.35	72.63	76.90	81.17	85.44	89.71	93.99	98.26	102.53	106.80
17	53.05	57.87	62.70	67.52	72.34	77.17	81.99	86.81	91.63	96.46	101.28	106.10	110.93	115.75	120.57
18	59.48	64.88	70.29	75.70	81.10	86.51	91.92	97.32	102.73	108.14	113.55	118.95	124.36	129.77	135.17
19	66.27	72.29	78.32	84.34	90.37	96.39	102.41	108.44	114.46	120.49	126.51	132.54	138.56	144.58	150.61
20	73.43	80.10	86.78	93.45	100.13	106.80	113.48	120.15	126.83	133.50	140.18	146.85	153.53	160.20	166.88
21	80.95	88.31	95.67	103.03	110.39	117.75	125.11	132.47	139.83	147.19	154.55	161.91	169.27	176.63	183.99
22	88.85	96.92	105.00	113.08	121.15	129.23	137.31	145.39	153.46	161.54	169.62	177.69	185.77	193.85	201.92
23	97.11	105.94	114.76	123.59	132.42	141.25	150.08	158.90	167.73	176.56	185.39	194.21	203.04	211.87	220.70
24	105.74	115.35	124.96	134.57	144.18	153.80	163.41	173.02	182.63	192.25	201.86	211.47	221.08	230.69	240.31
25	114.73	125.16	135.59	146.02	156.45	166.88	177.31	187.74	198.17	208.60	219.03	229.46	239.89	250.32	260.75
26	124.09	135.37	146.65	157.94	169.22	180.50	191.78	203.06	214.34	225.62	236.90	248.18	259.47	270.75	282.03
27	133.82	145.99	158.15	170.32	182.48	194.65	206.81	218.98	231.15	243.31	255.48	267.64	279.81	291.97	304.14
28	143.92	157.00	170.08	183.17	196.25	209.33	222.42	235.50	248.58	261.67	274.75	287.83	300.92	314.00	327.08
29	154.38	168.42	182.45	196.48	210.52	224.55	238.59	252.62	266.66	280.69	294.73	308.76	322.80	336.83	350.87
30	165.21	180.23	195.25	210.27	225.29	240.31	255.33	270.35	285.36	300.38	315.40	330.42	345.44	360.46	375.48

(The values in darker region are within the range of observed data)

Table 5 Biomass table (kg/tree) for *Toona ciliata* (31-50 cm diameter class)

Diameter at breast height (cm)	Height (m)															
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	150.15	160.16	170.17	180.18	190.19	200.20	210.21	220.22	230.22	240.23	250.24	260.25	270.26	280.27	290.28	300.29
32	159.99	170.66	181.32	191.99	202.65	213.32	223.99	234.65	245.32	255.98	266.65	277.32	287.98	298.65	309.31	319.98
33	170.15	181.49	192.83	204.17	215.52	226.86	238.20	249.55	260.89	272.23	283.58	294.92	306.26	317.60	328.95	340.29
34	180.61	192.65	204.70	216.74	228.78	240.82	252.86	264.90	276.94	288.98	301.02	313.06	325.10	337.15	349.19	361.23
35	191.39	204.15	216.91	229.67	242.43	255.19	267.95	280.71	293.47	306.23	318.99	331.75	344.51	357.27	370.03	382.79
36	202.49	215.99	229.49	242.98	256.48	269.98	283.48	296.98	310.48	323.98	337.48	350.98	364.48	377.98	391.47	404.97
37	213.89	228.15	242.41	256.67	270.93	285.19	299.45	313.71	327.97	342.23	356.49	370.75	385.01	399.27	413.53	427.79
38	225.61	240.65	255.69	270.73	285.77	300.81	315.85	330.90	345.94	360.98	376.02	391.06	406.10	421.14	436.18	451.22
39	237.64	253.48	269.33	285.17	301.01	316.85	332.70	348.54	364.38	380.23	396.07	411.91	427.75	443.60	459.44	475.28
40	249.98	266.65	283.32	299.98	316.65	333.31	349.98	366.64	383.31	399.97	416.64	433.31	449.97	466.64	483.30	499.97
41	262.64	280.15	297.66	315.17	332.68	350.19	367.70	385.20	402.71	420.22	437.73	455.24	472.75	490.26	507.77	525.28
42	275.61	293.98	312.36	330.73	349.10	367.48	385.85	404.22	422.60	440.97	459.35	477.72	496.09	514.47	532.84	551.21
43	288.89	308.15	327.41	346.67	365.92	385.18	404.44	423.70	442.96	462.22	481.48	500.74	520.00	539.26	558.52	577.78
44	302.48	322.65	342.81	362.98	383.14	403.31	423.47	443.64	463.80	483.97	504.13	524.30	544.47	564.63	584.80	604.96
45	316.39	337.48	358.57	379.66	400.76	421.85	442.94	464.03	485.13	506.22	527.31	548.40	569.49	590.59	611.68	632.77
46	330.60	352.64	374.68	396.72	418.76	440.81	462.85	484.89	506.93	528.97	551.01	573.05	595.09	617.13	639.17	661.21
47	345.13	368.14	391.15	414.16	437.17	460.18	483.19	506.20	529.21	552.21	575.22	598.23	621.24	644.25	667.26	690.27
48	359.98	383.98	407.97	431.97	455.97	479.97	503.97	527.97	551.96	575.96	599.96	623.96	647.96	671.96	695.96	719.95
49	375.13	400.14	425.15	450.16	475.17	500.18	525.19	550.19	575.20	600.21	625.22	650.23	675.24	700.25	725.26	750.26
50	390.60	416.64	442.68	468.72	494.76	520.80	546.84	572.88	598.92	624.96	651.00	677.04	703.08	729.12	755.16	781.20

(The values in darker region are within the range of observed data)

Table 6 Biomass table (kg/tree) for *Toona ciliata* (>50 cm diameter class)

Diameter at breast height (cm)	Height (m)																				
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
51	552.76	589.62	626.47	663.32	700.17	737.02	773.87	810.72	847.57	884.42	921.27	958.13	994.98	1031.83	1068.68	1105.53	1142.38	1179.23	1216.08	1252.93	1289.78
52	574.65	612.96	651.27	689.58	727.90	766.21	804.52	842.83	881.14	919.45	957.76	996.07	1034.38	1072.69	1111.00	1149.31	1187.62	1225.93	1264.24	1302.55	1340.86
53	596.97	636.77	676.56	716.36	756.16	795.96	835.76	875.55	915.35	955.15	994.95	1034.75	1074.54	1114.34	1154.14	1193.94	1233.74	1273.53	1313.33	1353.13	1392.93
54	619.71	661.02	702.34	743.65	784.96	826.28	867.59	908.91	950.22	991.53	1032.85	1074.16	1115.47	1156.79	1198.10	1239.42	1280.73	1322.04	1363.36	1404.67	1445.99
55	642.87	685.73	728.59	771.45	814.31	857.16	900.02	942.88	985.74	1028.60	1071.46	1114.31	1157.17	1200.03	1242.89	1285.75	1328.60	1371.46	1414.32	1457.18	1500.04
56	666.46	710.89	755.32	799.76	844.19	888.62	933.05	977.48	1021.91	1066.34	1110.77	1155.20	1199.63	1244.06	1288.49	1332.93	1377.36	1421.79	1466.22	1510.65	1555.08
57	690.48	736.51	782.54	828.57	874.60	920.64	966.67	1012.70	1058.73	1104.76	1150.80	1196.83	1242.86	1288.89	1334.92	1380.95	1426.99	1473.02	1519.05	1565.08	1611.11
58	714.92	762.58	810.24	857.90	905.56	953.22	1000.88	1048.55	1096.21	1143.87	1191.53	1239.19	1286.85	1334.51	1382.17	1429.83	1477.50	1525.16	1572.82	1620.48	1668.14
59	739.78	789.10	838.42	887.74	937.06	986.38	1035.69	1085.01	1134.33	1183.65	1232.97	1282.29	1331.61	1380.93	1430.25	1479.56	1528.88	1578.20	1627.52	1676.84	1726.16
60	765.07	816.08	867.08	918.09	969.09	1020.10	1071.10	1122.11	1173.11	1224.12	1275.12	1326.12	1377.13	1428.13	1479.14	1530.14	1581.15	1632.15	1683.16	1734.16	1785.17
61	790.79	843.51	896.23	948.94	1001.66	1054.38	1107.10	1159.82	1212.54	1265.26	1317.98	1370.70	1423.42	1476.14	1528.85	1581.57	1634.29	1687.01	1739.73	1792.45	1845.17
62	816.93	871.39	925.85	980.31	1034.77	1089.24	1143.70	1198.16	1252.62	1307.08	1361.54	1416.01	1470.47	1524.93	1579.39	1633.85	1688.32	1742.78	1797.24	1851.70	1906.16
63	843.49	899.72	955.96	1012.19	1068.42	1124.66	1180.89	1237.12	1293.35	1349.59	1405.82	1462.05	1518.29	1574.52	1630.75	1686.98	1743.22	1799.45	1855.68	1911.91	1968.15
64	870.48	928.51	986.55	1044.58	1102.61	1160.64	1218.67	1276.71	1334.74	1392.77	1450.80	1508.84	1566.87	1624.90	1682.93	1740.96	1799.00	1857.03	1915.06	1973.09	2031.12
65	897.90	957.76	1017.62	1077.48	1137.34	1197.20	1257.06	1316.92	1376.78	1436.64	1496.50	1556.35	1616.21	1676.07	1735.93	1795.79	1855.65	1915.51	1975.37	2035.23	2095.09
66	925.74	987.45	1049.17	1110.88	1172.60	1234.32	1296.03	1357.75	1419.46	1481.18	1542.90	1604.61	1666.33	1728.04	1789.76	1851.47	1913.19	1974.91	2036.62	2098.34	2160.05
67	954.00	1017.60	1081.20	1144.80	1208.40	1272.00	1335.60	1399.20	1462.80	1526.40	1590.00	1653.60	1717.20	1780.80	1844.40	1908.00	1971.60	2035.20	2098.81	2162.41	2226.01
68	982.69	1048.21	1113.72	1179.23	1244.74	1310.26	1375.77	1441.28	1506.80	1572.31	1637.82	1703.33	1768.85	1834.36	1899.87	1965.38	2030.90	2096.41	2161.92	2227.44	2292.95
69	1011.81	1079.26	1146.72	1214.17	1281.62	1349.08	1416.53	1483.98	1551.44	1618.89	1686.35	1753.80	1821.25	1888.71	1956.16	2023.62	2091.07	2158.52	2225.98	2293.43	2360.88
70	1041.35	1110.77	1180.19	1249.62	1319.04	1388.46	1457.89	1527.31	1596.73	1666.16	1735.58	1805.00	1874.43	1943.85	2013.27	2082.70	2152.12	2221.54	2290.97	2360.39	2429.81

(The values in darker region are within the range of observed data)

Table 7 Carbon table (kg/tree) for *Toona ciliata* (10-30 cm diameter class)

Diameter at breast height (cm)	Height (m)														
	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
10	9.18	10.01	10.85	11.68	12.52	13.35	14.18	15.02	15.85	16.69	17.52	18.36	19.19	20.03	20.86
11	11.11	12.12	13.13	14.13	15.14	16.15	17.16	18.17	19.18	20.19	21.20	22.21	23.22	24.23	25.24
12	13.22	14.42	15.62	16.82	18.02	19.22	20.43	21.63	22.83	24.03	25.23	26.43	27.64	28.84	30.04
13	15.51	16.92	18.33	19.74	21.15	22.56	23.97	25.38	26.79	28.20	29.61	31.02	32.43	33.84	35.25
14	17.99	19.63	21.26	22.90	24.53	26.17	27.80	29.44	31.07	32.71	34.34	35.98	37.61	39.25	40.89
15	20.65	22.53	24.41	26.28	28.16	30.04	31.92	33.79	35.67	37.55	39.43	41.30	43.18	45.06	46.94
16	23.50	25.63	27.77	29.90	32.04	34.18	36.31	38.45	40.59	42.72	44.86	46.99	49.13	51.27	53.40
17	26.53	28.94	31.35	33.76	36.17	38.58	40.99	43.41	45.82	48.23	50.64	53.05	55.46	57.87	60.29
18	29.74	32.44	35.14	37.85	40.55	43.26	45.96	48.66	51.37	54.07	56.77	59.48	62.18	64.88	67.59
19	33.13	36.15	39.16	42.17	45.18	48.19	51.21	54.22	57.23	60.24	63.26	66.27	69.28	72.29	75.30
20	36.71	40.05	43.39	46.73	50.06	53.40	56.74	60.08	63.41	66.75	70.09	73.43	76.76	80.10	83.44
21	40.48	44.16	47.84	51.52	55.20	58.88	62.55	66.23	69.91	73.59	77.27	80.95	84.63	88.31	91.99
22	44.42	48.46	52.50	56.54	60.58	64.62	68.65	72.69	76.73	80.77	84.81	88.85	92.89	96.92	100.96
23	48.55	52.97	57.38	61.80	66.21	70.62	75.04	79.45	83.87	88.28	92.69	97.11	101.52	105.94	110.35
24	52.87	57.67	62.48	67.29	72.09	76.90	81.70	86.51	91.32	96.12	100.93	105.74	110.54	115.35	120.15
25	57.37	62.58	67.80	73.01	78.23	83.44	88.66	93.87	99.09	104.30	109.52	114.73	119.95	125.16	130.38
26	62.05	67.69	73.33	78.97	84.61	90.25	95.89	101.53	107.17	112.81	118.45	124.09	129.73	135.37	141.01
27	66.91	72.99	79.08	85.16	91.24	97.32	103.41	109.49	115.57	121.66	127.74	133.82	139.90	145.99	152.07
28	71.96	78.50	85.04	91.58	98.13	104.67	111.21	117.75	124.29	130.83	137.38	143.92	150.46	157.00	163.54
29	77.19	84.21	91.22	98.24	105.26	112.28	119.29	126.31	133.33	140.35	147.36	154.38	161.40	168.42	175.43
30	82.61	90.12	97.62	105.13	112.64	120.15	127.66	135.17	142.68	150.19	157.70	165.21	172.72	180.23	187.74

(The values in darker region are within the range of observed data)

Table 8 Carbon table (kg/tree) for *Toona ciliata* (31-50 cm diameter class)

Diameter at breast height (cm)	Height (m)															
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	75.07	80.08	85.08	90.09	95.09	100.10	105.10	110.11	115.11	120.12	125.12	130.13	135.13	140.14	145.14	150.15
32	79.99	85.33	90.66	95.99	101.33	106.66	111.99	117.33	122.66	127.99	133.32	138.66	143.99	149.32	154.66	159.99
33	85.07	90.74	96.42	102.09	107.76	113.43	119.10	124.77	130.44	136.12	141.79	147.46	153.13	158.80	164.47	170.15
34	90.31	96.33	102.35	108.37	114.39	120.41	126.43	132.45	138.47	144.49	150.51	156.53	162.55	168.57	174.59	180.61
35	95.70	102.08	108.46	114.84	121.22	127.60	133.98	140.36	146.74	153.12	159.50	165.87	172.25	178.63	185.01	191.39
36	101.24	107.99	114.74	121.49	128.24	134.99	141.74	148.49	155.24	161.99	168.74	175.49	182.24	188.99	195.74	202.49
37	106.95	114.08	121.21	128.34	135.47	142.60	149.72	156.85	163.98	171.11	178.24	185.37	192.50	199.63	206.76	213.89
38	112.81	120.33	127.85	135.37	142.89	150.41	157.93	165.45	172.97	180.49	188.01	195.53	203.05	210.57	218.09	225.61
39	118.82	126.74	134.66	142.58	150.51	158.43	166.35	174.27	182.19	190.11	198.03	205.96	213.88	221.80	229.72	237.64
40	124.99	133.32	141.66	149.99	158.32	166.66	174.99	183.32	191.65	199.99	208.32	216.65	224.99	233.32	241.65	249.98
41	131.32	140.07	148.83	157.58	166.34	175.09	183.85	192.60	201.36	210.11	218.87	227.62	236.38	245.13	253.88	262.64
42	137.80	146.99	156.18	165.36	174.55	183.74	192.93	202.11	211.30	220.49	229.67	238.86	248.05	257.23	266.42	275.61
43	144.44	154.07	163.70	173.33	182.96	192.59	202.22	211.85	221.48	231.11	240.74	250.37	260.00	269.63	279.26	288.89
44	151.24	161.32	171.41	181.49	191.57	201.65	211.74	221.82	231.90	241.98	252.07	262.15	272.23	282.32	292.40	302.48
45	158.19	168.74	179.29	189.83	200.38	210.92	221.47	232.02	242.56	253.11	263.66	274.20	284.75	295.29	305.84	316.39
46	165.30	176.32	187.34	198.36	209.38	220.40	231.42	242.44	253.46	264.48	275.50	286.52	297.54	308.56	319.58	330.60
47	172.57	184.07	195.58	207.08	218.58	230.09	241.59	253.10	264.60	276.11	287.61	299.12	310.62	322.13	333.63	345.13
48	179.99	191.99	203.99	215.99	227.99	239.98	251.98	263.98	275.98	287.98	299.98	311.98	323.98	335.98	347.98	359.98
49	187.57	200.07	212.57	225.08	237.58	250.09	262.59	275.10	287.60	300.11	312.61	325.11	337.62	350.12	362.63	375.13
50	195.30	208.32	221.34	234.36	247.38	260.40	273.42	286.44	299.46	312.48	325.50	338.52	351.54	364.56	377.58	390.60

(The values in darker region are within the range of observed data)

Table 9 Carbon table (kg/tree) for *Toona ciliata* (>50 cm diameter class)

Diameter at breast height (cm)	Height (m)																				
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
51	276.38	294.81	313.23	331.66	350.08	368.51	386.94	405.36	423.79	442.21	460.64	479.06	497.49	515.91	534.34	552.76	571.19	589.62	608.04	626.47	644.89
52	287.33	306.48	325.64	344.79	363.95	383.10	402.26	421.41	440.57	459.72	478.88	498.03	517.19	536.34	555.50	574.65	593.81	612.96	632.12	651.27	670.43
53	298.48	318.38	338.28	358.18	378.08	397.98	417.88	437.78	457.68	477.57	497.47	517.37	537.27	557.17	577.07	596.97	616.87	636.77	656.67	676.56	696.46
54	309.85	330.51	351.17	371.82	392.48	413.14	433.80	454.45	475.11	495.77	516.42	537.08	557.74	578.39	599.05	619.71	640.37	661.02	681.68	702.34	722.99
55	321.44	342.87	364.29	385.72	407.15	428.58	450.01	471.44	492.87	514.30	535.73	557.16	578.59	600.01	621.44	642.87	664.30	685.73	707.16	728.59	750.02
56	333.23	355.45	377.66	399.88	422.09	444.31	466.52	488.74	510.95	533.17	555.39	577.60	599.82	622.03	644.25	666.46	688.68	710.89	733.11	755.32	777.54
57	345.24	368.25	391.27	414.29	437.30	460.32	483.33	506.35	529.37	552.38	575.40	598.41	621.43	644.45	667.46	690.48	713.49	736.51	759.53	782.54	805.56
58	357.46	381.29	405.12	428.95	452.78	476.61	500.44	524.27	548.10	571.93	595.76	619.59	643.43	667.26	691.09	714.92	738.75	762.58	786.41	810.24	834.07
59	369.89	394.55	419.21	443.87	468.53	493.19	517.85	542.51	567.17	591.83	616.49	641.14	665.80	690.46	715.12	739.78	764.44	789.10	813.76	838.42	863.08
60	382.54	408.04	433.54	459.04	484.55	510.05	535.55	561.05	586.56	612.06	637.56	663.06	688.56	714.07	739.57	765.07	790.57	816.08	841.58	867.08	892.58
61	395.39	421.75	448.11	474.47	500.83	527.19	553.55	579.91	606.27	632.63	658.99	685.35	711.71	738.07	764.43	790.79	817.15	843.51	869.87	896.23	922.58
62	408.46	435.69	462.93	490.16	517.39	544.62	571.85	599.08	626.31	653.54	680.77	708.00	735.23	762.47	789.70	816.93	844.16	871.39	898.62	925.85	953.08
63	421.75	449.86	477.98	506.10	534.21	562.33	590.44	618.56	646.68	674.79	702.91	731.03	759.14	787.26	815.38	843.49	871.61	899.72	927.84	955.96	984.07
64	435.24	464.26	493.27	522.29	551.31	580.32	609.34	638.35	667.37	696.39	725.40	754.42	783.43	812.45	841.47	870.48	899.50	928.51	957.53	986.55	1015.56
65	448.95	478.88	508.81	538.74	568.67	598.60	628.53	658.46	688.39	718.32	748.25	778.18	808.11	838.04	867.97	897.90	927.83	957.76	987.69	1017.62	1047.55
66	462.87	493.73	524.58	555.44	586.30	617.16	648.02	678.87	709.73	740.59	771.45	802.31	833.16	864.02	894.88	925.74	956.60	987.45	1018.31	1049.17	1080.03
67	477.00	508.80	540.60	572.40	604.20	636.00	667.80	699.60	731.40	763.20	795.00	826.80	858.60	890.40	922.20	954.00	985.80	1017.60	1049.40	1081.20	1113.00
68	491.35	524.10	556.86	589.62	622.37	655.13	687.88	720.64	753.40	786.15	818.91	851.67	884.42	917.18	949.94	982.69	1015.45	1048.21	1080.96	1113.72	1146.47
69	505.90	539.63	573.36	607.08	640.81	674.54	708.27	741.99	775.72	809.45	843.17	876.90	910.63	944.35	978.08	1011.81	1045.53	1079.26	1112.99	1146.72	1180.44
70	520.67	555.39	590.10	624.81	659.52	694.23	728.94	763.66	798.37	833.08	867.79	902.50	937.21	971.92	1006.64	1041.35	1076.06	1110.77	1145.48	1180.19	1214.91

(The values in darker region are within the range of observed data)

Table 10 Volume, biomass and carbon table for *Toona ciliata* (DBH 10 -51 cm)

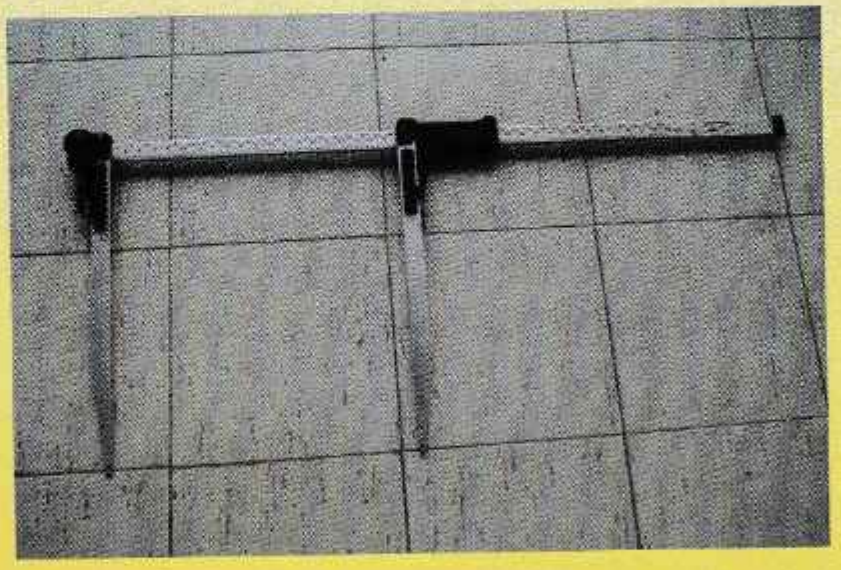
DBH (cm)	Volume (m^3)	Biomass (kg/tree)	Carbon (kg/tree)	DBH (cm)	Volume (m^3)	Biomass (kg/tree)	Carbon (kg/tree)
10	0.049	27.42	13.71	31	0.409	228.88	114.44
11	0.059	33.18	16.59	32	0.436	243.88	121.94
12	0.071	39.49	19.74	33	0.463	259.36	129.68
13	0.083	46.35	23.17	34	0.492	275.32	137.66
14	0.096	53.75	26.87	35	0.521	291.76	145.88
15	0.110	61.70	30.85	36	0.551	308.67	154.33
16	0.125	70.20	35.10	37	0.582	326.05	163.03
17	0.142	79.25	39.63	38	0.614	343.91	171.96
18	0.159	88.85	44.43	39	0.647	362.25	181.13
19	0.177	99.00	49.50	40	0.680	381.07	190.53
20	0.196	109.69	54.85	41	0.715	400.36	200.18
21	0.216	120.94	60.47	42	0.750	420.13	210.06
22	0.237	132.73	66.36	43	0.786	440.37	220.19
23	0.259	145.07	72.53	44	0.823	461.09	230.55
24	0.282	157.96	78.98	45	0.861	482.29	241.15
25	0.306	171.40	85.70	46	0.900	503.96	251.98
26	0.331	185.38	92.69	47	0.939	526.11	263.06
27	0.357	199.92	99.96	48	0.980	548.74	274.37
28	0.384	215.00	107.50	49	1.021	571.84	285.92
29	0.412	230.63	115.31	50	1.063	595.42	297.71
30	0.441	246.81	123.40	51	1.714	960.019	480.01

Table 11 Volume, biomass and carbon table for *Toona ciliata* (DBH 51-100 cm)

DBH (cm)	Volume (m^3)	Biomass (kg/tree)	Carbon (kg/tree)	DBH (cm)	Volume (m^3)	Biomass (kg/tree)	Carbon (kg/tree)
51	1.714	960.019	480.01	76	3.807	2131.898	1065.95
52	1.782	998.036	499.02	77	3.908	2188.370	1094.19
53	1.851	1036.791	518.40	78	4.010	2245.580	1122.79
54	1.922	1076.284	538.14	79	4.113	2303.528	1151.76
55	1.994	1116.515	558.26	80	4.218	2362.214	1181.11
56	2.067	1157.485	578.74	81	4.324	2421.639	1210.82
57	2.141	1199.193	599.60	82	4.432	2481.802	1240.90
58	2.217	1241.639	620.82	83	4.541	2542.702	1271.35
69	2.294	1284.823	642.41	84	4.651	2604.341	1302.17
60	2.373	1328.746	664.37	85	4.762	2666.719	1333.36
61	2.453	1373.406	686.70	86	4.875	2729.834	1364.92
62	2.534	1418.805	709.40	87	4.989	2793.688	1396.84
63	2.616	1464.942	732.47	88	5.104	2858.279	1429.14
64	2.700	1511.817	755.91	89	5.221	2923.609	1461.80
65	2.785	1559.431	779.72	90	5.339	2989.678	1494.84
66	2.871	1607.782	803.89	91	5.458	3056.484	1528.24
67	2.959	1656.872	828.44	92	5.579	3124.029	1562.01
68	3.048	1706.700	853.35	93	5.701	3192.311	1596.16
69	3.138	1757.266	878.63	94	5.824	3261.332	1630.67
70	3.230	1808.570	904.29	95	5.948	3331.091	1665.55
71	3.323	1860.613	930.31	96	6.074	3401.589	1700.79
72	3.417	1913.394	956.70	97	6.201	3472.824	1736.41
73	3.512	1966.913	983.46	98	6.330	3544.798	1772.40
74	3.609	2021.170	1010.58	99	6.460	3617.510	1808.75
75	3.707	2076.165	1038.08	100	6.591	3690.960	1845.48



Nikon Laser 550A Range Finder: Used for measurement of total tree height, height at the occurrence of first branch of each individual tree and length of frustum.



Mantax Black Calliper with Gator Eyes, Make: Haglof Sweden: Used for measurement of diameter from a distance with laser beam (diameter measurement at different height of each tree)

Summary

Toona ciliata is commonly found in Meghalaya, entire North Eastern region and other parts of the Country which is used for commercial purpose. The report provides the volume tables and biomass tables of the utilizable stem portion, for use by the forest department, community and dealers in timber. The information on equivalent carbon content is also provided. This is a major component of the above ground biomass and can be used in projects related to carbon trading.



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