RFRI Report 5

Magnolia champaca (Champak) Volume, Biomass and Carbon Tables for Meghalaya



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Photograph: *Magnolia champaca*

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Magnolia champaca (L.) Baill. ex Pierre

Volume, Biomass and Carbon Tables for Meghalaya

Introduction

Magnolia champaca (Family-Magnoliaceae) is native to south and central China as well as India. It is also commonly found in Bangladesh, Indonesia, Malaysia, Vietnam, Laos, Cambodia, Myanmar, Nepal and Thailand between 200 to 1,600 m a.s.l. In India it is mainly found in Arunachal Pradesh, Assam, Meghalaya, Manipur, Tripura, Nagaland, Mizoram, Sikkim and Western Ghats.

Habitat and ecology

M. champaca is an evergreen or semi-deciduous, medium sized, emergent canopy tree up to 50 m tall and 200 cm in dbh. It is found scattered in riparian primary lowland to montane evergreen broadleaf forests in moist vegetation. It flowers from June to July and September to October.

Uses of the tree

M. champaca is used as an ornamental tree in urban landscaping. Flowers are also used for perfume, worn as hair decoration and room decoration. The wood is used for fuel and furniture making. It is also used for making doors, windows, general carpentry and light construction. The heartwood is light yellowish to olive brown. It is straight grained and medium fine textured, somewhat lustrous with smooth feel. It has potential for commercial oil extraction for various uses. It also has medicinal values; a decoction of the bark and leaves is given after child birth; the bark is used as a febrifuge. Its fatty oils extracted from the seeds have antibacterial activity. In India and Southeast Asia, it is logged for its valuable timber (Khela, 2014).

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, *M. champaca* 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 *M. champaca* 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 (0.670 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:

Khela, S. 2014. *Magnolia champaca*. The IUCN Red List of Threatened Species 2014: e.T191869A15267603. http://dx.doi.org/10.2305/IUCN.UK.2014.

Table 1: Volume table for *Magnolia champaca* (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	0.036	0.039	0.043	0.046	0.049	0.052	0.056	0.059	0.062	0.065	0.069	0.072	0.075	0.078	0.082
11	0.044	0.047	0.051	0.055	0.059	0.063	0.067	0.071	0.075	0.079	0.083	0.087	0.091	0.095	0.099
12	0.052	0.057	0.061	0.066	0.071	0.075	0.080	0.085	0.089	0.094	0.099	0.104	0.108	0.113	0.118
13	0.061	0.066	0.072	0.077	0.083	0.088	0.094	0.099	0.105	0.111	0.116	0.122	0.127	0.133	0.138
14	0.071	0.077	0.083	0.090	0.096	0.103	0.109	0.115	0.122	0.128	0.135	0.141	0.147	0.154	0.160
15	0.081	0.088	0.096	0.103	0.110	0.118	0.125	0.132	0.140	0.147	0.155	0.162	0.169	0.177	0.184
16	0.092	0.100	0.109	0.117	0.126	0.134	0.142	0.151	0.159	0.167	0.176	0.184	0.193	0.201	0.209
17	0.104	0.113	0.123	0.132	0.142	0.151	0.161	0.170	0.180	0.189	0.198	0.208	0.217	0.227	0.236
18	0.117	0.127	0.138	0.148	0.159	0.170	0.180	0.191	0.201	0.212	0.222	0.233	0.244	0.254	0.265
19	0.130	0.142	0.153	0.165	0.177	0.189	0.201	0.212	0.224	0.236	0.248	0.260	0.272	0.283	0.295
20	0.144	0.157	0.170	0.183	0.196	0.209	0.222	0.235	0.249	0.262	0.275	0.288	0.301	0.314	0.327
21	0.159	0.173	0.187	0.202	0.216	0.231	0.245	0.260	0.274	0.288	0.303	0.317	0.332	0.346	0.361
22	0.174	0.190	0.206	0.222	0.237	0.253	0.269	0.285	0.301	0.317	0.332	0.348	0.364	0.380	0.396
23	0.190	0.208	0.225	0.242	0.259	0.277	0.294	0.311	0.329	0.346	0.363	0.381	0.398	0.415	0.432
24	0.207	0.226	0.245	0.264	0.283	0.301	0.320	0.339	0.358	0.377	0.396	0.414	0.433	0.452	0.471
25	0.225	0.245	0.266	0.286	0.307	0.327	0.347	0.368	0.388	0.409	0.429	0.450	0.470	0.491	0.511
26	0.243	0.265	0.287	0.309	0.332	0.354	0.376	0.398	0.420	0.442	0.464	0.486	0.508	0.531	0.553
27	0.262	0.286	0.310	0.334	0.358	0.381	0.405	0.429	0.453	0.477	0.501	0.524	0.548	0.572	0.596
28	0.282	0.308	0.333	0.359	0.385	0.410	0.436	0.461	0.487	0.513	0.538	0.564	0.590	0.615	0.641
29	0.303	0.330	0.358	0.385	0.413	0.440	0.468	0.495	0.523	0.550	0.578	0.605	0.633	0.660	0.688
30	0.324	0.353	0.383	0.412	0.441	0.471	0.500	0.530	0.559	0.589	0.618	0.647	0.677	0.706	0.736

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

Table 2: Volume table for *Magnolia champaca* (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	0.392	0.418	0.444	0.471	0.497	0.523	0.549	0.575	0.601	0.627	0.653	0.680	0.706	0.732	0.758	0.784
32	0.418	0.446	0.473	0.501	0.529	0.557	0.585	0.613	0.641	0.668	0.696	0.724	0.752	0.780	0.808	0.836
33	0.444	0.474	0.504	0.533	0.563	0.592	0.622	0.652	0.681	0.711	0.741	0.770	0.800	0.829	0.859	0.889
34	0.472	0.503	0.535	0.566	0.597	0.629	0.660	0.692	0.723	0.755	0.786	0.818	0.849	0.880	0.912	0.943
35	0.500	0.533	0.566	0.600	0.633	0.666	0.700	0.733	0.766	0.800	0.833	0.866	0.900	0.933	0.966	1.000
36	0.529	0.564	0.599	0.635	0.670	0.705	0.740	0.776	0.811	0.846	0.881	0.917	0.952	0.987	1.022	1.058
37	0.559	0.596	0.633	0.670	0.707	0.745	0.782	0.819	0.856	0.894	0.931	0.968	1.005	1.043	1.080	1.117
38	0.589	0.628	0.668	0.707	0.746	0.786	0.825	0.864	0.903	0.943	0.982	1.021	1.060	1.100	1.139	1.178
39	0.621	0.662	0.703	0.745	0.786	0.827	0.869	0.910	0.952	0.993	1.034	1.076	1.117	1.158	1.200	1.241
40	0.653	0.696	0.740	0.783	0.827	0.870	0.914	0.957	1.001	1.044	1.088	1.132	1.175	1.219	1.262	1.306
41	0.686	0.732	0.777	0.823	0.869	0.914	0.960	1.006	1.052	1.097	1.143	1.189	1.235	1.280	1.326	1.372
42	0.720	0.768	0.816	0.864	0.912	0.960	1.008	1.056	1.104	1.152	1.200	1.248	1.295	1.343	1.391	1.439
43	0.754	0.805	0.855	0.905	0.956	1.006	1.056	1.106	1.157	1.207	1.257	1.308	1.358	1.408	1.458	1.509
44	0.790	0.843	0.895	0.948	1.001	1.053	1.106	1.159	1.211	1.264	1.316	1.369	1.422	1.474	1.527	1.580
45	0.826	0.881	0.936	0.991	1.047	1.102	1.157	1.212	1.267	1.322	1.377	1.432	1.487	1.542	1.597	1.652
46	0.863	0.921	0.978	1.036	1.094	1.151	1.209	1.266	1.324	1.381	1.439	1.496	1.554	1.612	1.669	1.727
47	0.901	0.961	1.021	1.082	1.142	1.202	1.262	1.322	1.382	1.442	1.502	1.562	1.622	1.682	1.742	1.803
48	0.940	1.003	1.065	1.128	1.191	1.253	1.316	1.379	1.441	1.504	1.567	1.629	1.692	1.755	1.817	1.880
49	0.980	1.045	1.110	1.176	1.241	1.306	1.371	1.437	1.502	1.567	1.633	1.698	1.763	1.829	1.894	1.959
50	1.020	1.088	1.156	1.224	1.292	1.360	1.428	1.496	1.564	1.632	1.700	1.768	1.836	1.904	1.972	2.040

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

Table 3: Volume table for *Magnolia champaca* (>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	1.034	1.103	1.172	1.241	1.310	1.379	1.447	1.516	1.585	1.654	1.723	1.792	1.861	1.930	1.999	2.068	2.137	2.206	2.275	2.344	2.412
52	1.075	1.146	1.218	1.290	1.361	1.433	1.505	1.576	1.648	1.720	1.791	1.863	1.935	2.006	2.078	2.150	2.221	2.293	2.365	2.436	2.508
53	1.117	1.191	1.265	1.340	1.414	1.489	1.563	1.638	1.712	1.787	1.861	1.935	2.010	2.084	2.159	2.233	2.308	2.382	2.456	2.531	2.605
54	1.159	1.236	1.314	1.391	1.468	1.545	1.623	1.700	1.777	1.855	1.932	2.009	2.086	2.164	2.241	2.318	2.395	2.473	2.550	2.627	2.705
55	1.202	1.283	1.363	1.443	1.523	1.603	1.683	1.764	1.844	1.924	2.004	2.084	2.164	2.245	2.325	2.405	2.485	2.565	2.645	2.726	2.806
56	1.247	1.330	1.413	1.496	1.579	1.662	1.745	1.828	1.911	1.994	2.078	2.161	2.244	2.327	2.410	2.493	2.576	2.659	2.742	2.826	2.909
57	1.291	1.378	1.464	1.550	1.636	1.722	1.808	1.894	1.980	2.066	2.152	2.239	2.325	2.411	2.497	2.583	2.669	2.755	2.841	2.927	3.013
58	1.337	1.426	1.515	1.605	1.694	1.783	1.872	1.961	2.050	2.140	2.229	2.318	2.407	2.496	2.585	2.674	2.764	2.853	2.942	3.031	3.120
59	1.384	1.476	1.568	1.660	1.753	1.845	1.937	2.029	2.122	2.214	2.306	2.398	2.491	2.583	2.675	2.767	2.860	2.952	3.044	3.136	3.229
60	1.431	1.526	1.622	1.717	1.813	1.908	2.003	2.099	2.194	2.290	2.385	2.480	2.576	2.671	2.767	2.862	2.957	3.053	3.148	3.244	3.339
61	1.479	1.578	1.676	1.775	1.874	1.972	2.071	2.169	2.268	2.367	2.465	2.564	2.662	2.761	2.860	2.958	3.057	3.155	3.254	3.353	3.451
62	1.528	1.630	1.732	1.834	1.935	2.037	2.139	2.241	2.343	2.445	2.547	2.649	2.750	2.852	2.954	3.056	3.158	3.260	3.362	3.463	3.565
63	1.578	1.683	1.788	1.893	1.998	2.104	2.209	2.314	2.419	2.524	2.629	2.735	2.840	2.945	3.050	3.155	3.261	3.366	3.471	3.576	3.681
64	1.628	1.737	1.845	1.954	2.062	2.171	2.279	2.388	2.497	2.605	2.714	2.822	2.931	3.039	3.148	3.256	3.365	3.473	3.582	3.690	3.799
65	1.679	1.791	1.903	2.015	2.127	2.239	2.351	2.463	2.575	2.687	2.799	2.911	3.023	3.135	3.247	3.359	3.471	3.583	3.695	3.807	3.919
66	1.732	1.847	1.962	2.078	2.193	2.309	2.424	2.540	2.655	2.770	2.886	3.001	3.117	3.232	3.348	3.463	3.578	3.694	3.809	3.925	4.040
67	1.784	1.903	2.022	2.141	2.260	2.379	2.498	2.617	2.736	2.855	2.974	3.093	3.212	3.331	3.450	3.569	3.688	3.807	3.926	4.045	4.164
68	1.838	1.961	2.083	2.206	2.328	2.451	2.573	2.696	2.818	2.941	3.063	3.186	3.308	3.431	3.554	3.676	3.799	3.921	4.044	4.166	4.289
69	1.892	2.019	2.145	2.271	2.397	2.523	2.649	2.776	2.902	3.028	3.154	3.280	3.406	3.533	3.659	3.785	3.911	4.037	4.163	4.290	4.416
70	1.948	2.078	2.207	2.337	2.467	2.597	2.727	2.857	2.987	3.116	3.246	3.376	3.506	3.636	3.766	3.896	4.025	4.155	4.285	4.415	4.545

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

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Table 4 Biomass table (kg/tree) for *Magnolia champaca* (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	27.42	29.91	32.40	34.89	37.39	39.88	42.37	44.86	47.36	49.85	52.34	54.83	57.33	59.82	62.31
11	33.17	36.19	39.21	42.22	45.24	48.25	51.27	54.28	57.30	60.32	63.33	66.35	69.36	72.38	75.40
12	39.48	43.07	46.66	50.25	53.84	57.42	61.01	64.60	68.19	71.78	75.37	78.96	82.55	86.14	89.73
13	46.33	50.55	54.76	58.97	63.18	67.39	71.61	75.82	80.03	84.24	88.46	92.67	96.88	101.09	105.30
14	53.74	58.62	63.51	68.39	73.28	78.16	83.05	87.93	92.82	97.70	102.59	107.47	112.36	117.24	122.13
15	61.69	67.29	72.90	78.51	84.12	89.73	95.33	100.94	106.55	112.16	117.77	123.37	128.98	134.59	140.20
16	70.19	76.57	82.95	89.33	95.71	102.09	108.47	114.85	121.23	127.61	133.99	140.37	146.75	153.13	159.51
17	79.23	86.44	93.64	100.84	108.05	115.25	122.45	129.65	136.86	144.06	151.26	158.47	165.67	172.87	180.08
18	88.83	96.90	104.98	113.06	121.13	129.21	137.28	145.36	153.43	161.51	169.58	177.66	185.73	193.81	201.88
19	98.97	107.97	116.97	125.97	134.96	143.96	152.96	161.96	170.95	179.95	188.95	197.95	206.94	215.94	224.94
20	109.67	119.64	129.60	139.57	149.54	159.51	169.48	179.45	189.42	199.39	209.36	219.33	229.30	239.27	249.24
21	120.91	131.90	142.89	153.88	164.87	175.86	186.86	197.85	208.84	219.83	230.82	241.81	252.80	263.80	274.79
22	132.70	144.76	156.82	168.89	180.95	193.01	205.07	217.14	229.20	241.26	253.33	265.39	277.45	289.52	301.58
23	145.03	158.22	171.40	184.59	197.77	210.96	224.14	237.33	250.51	263.70	276.88	290.07	303.25	316.44	329.62
24	157.92	172.27	186.63	200.99	215.34	229.70	244.06	258.41	272.77	287.12	301.48	315.84	330.19	344.55	358.91
25	171.35	186.93	202.51	218.09	233.66	249.24	264.82	280.40	295.97	311.55	327.13	342.71	358.28	373.86	389.44
26	185.33	202.18	219.03	235.88	252.73	269.58	286.43	303.28	320.12	336.97	353.82	370.67	387.52	404.37	421.22
27	199.87	218.04	236.20	254.37	272.54	290.71	308.88	327.05	345.22	363.39	381.56	399.73	417.90	436.07	454.24
28	214.94	234.48	254.03	273.57	293.11	312.65	332.19	351.73	371.27	390.81	410.35	429.89	449.43	468.97	488.51
29	230.57	251.53	272.49	293.46	314.42	335.38	356.34	377.30	398.26	419.22	440.18	461.14	482.10	503.07	524.03
30	246.75	269.18	291.61	314.04	336.47	358.91	381.34	403.77	426.20	448.63	471.06	493.50	515.93	538.36	560.79

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

Table 5 Biomass table (kg/tree) for *Magnolia champaca* (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	262.70	280.21	297.73	315.24	332.75	350.27	367.78	385.29	402.81	420.32	437.83	455.34	472.86	490.37	507.88	525.40
32	279.92	298.58	317.24	335.90	354.57	373.23	391.89	410.55	429.21	447.87	466.53	485.20	503.86	522.52	541.18	559.84
33	297.69	317.53	337.38	357.23	377.07	396.92	416.76	436.61	456.46	476.30	496.15	515.99	535.84	555.69	575.53	595.38
34	316.00	337.07	358.14	379.20	400.27	421.34	442.41	463.47	484.54	505.61	526.67	547.74	568.81	589.87	610.94	632.01
35	334.87	357.19	379.51	401.84	424.16	446.49	468.81	491.14	513.46	535.79	558.11	580.43	602.76	625.08	647.41	669.73
36	354.27	377.89	401.51	425.13	448.75	472.37	495.98	519.60	543.22	566.84	590.46	614.08	637.69	661.31	684.93	708.55
37	374.23	399.18	424.13	449.08	474.02	498.97	523.92	548.87	573.82	598.77	623.72	648.67	673.61	698.56	723.51	748.46
38	394.73	421.05	447.36	473.68	499.99	526.31	552.62	578.94	605.26	631.57	657.89	684.20	710.52	736.83	763.15	789.46
39	415.78	443.50	471.22	498.94	526.66	554.37	582.09	609.81	637.53	665.25	692.97	720.69	748.41	776.12	803.84	831.56
40	437.38	466.53	495.69	524.85	554.01	583.17	612.33	641.48	670.64	699.80	728.96	758.12	787.28	816.44	845.59	874.75
41	459.52	490.15	520.79	551.42	582.06	612.69	643.33	673.96	704.59	735.23	765.86	796.50	827.13	857.77	888.40	919.04
42	482.21	514.35	546.50	578.65	610.80	642.94	675.09	707.24	739.38	771.53	803.68	835.83	867.97	900.12	932.27	964.41
43	505.44	539.14	572.83	606.53	640.23	673.92	707.62	741.32	775.01	808.71	842.40	876.10	909.80	943.49	977.19	1010.89
44	529.22	564.51	599.79	635.07	670.35	705.63	740.91	776.20	811.48	846.76	882.04	917.32	952.60	987.89	1023.17	1058.45
45	553.55	590.46	627.36	664.26	701.17	738.07	774.98	811.88	848.78	885.69	922.59	959.49	996.40	1033.30	1070.20	1107.11
46	578.43	616.99	655.55	694.12	732.68	771.24	809.80	848.36	886.93	925.49	964.05	1002.61	1041.17	1079.74	1118.30	1156.86
47	603.85	644.11	684.37	724.62	764.88	805.14	845.39	885.65	925.91	966.16	1006.42	1046.68	1086.93	1127.19	1167.45	1207.70
48	629.82	671.81	713.80	755.79	797.77	839.76	881.75	923.74	965.73	1007.71	1049.70	1091.69	1133.68	1175.67	1217.65	1259.64
49	656.34	700.09	743.85	787.60	831.36	875.12	918.87	962.63	1006.38	1050.14	1093.90	1137.65	1181.41	1225.16	1268.92	1312.67
50	683.40	728.96	774.52	820.08	865.64	911.20	956.76	1002.32	1047.88	1093.44	1139.00	1184.56	1230.12	1275.68	1321.24	1366.80

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

Table 6 Biomass table (kg/tree) for *Magnolia champaca* (>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	692.71	738.89	785.07	831.25	877.43	923.62	969.80	1015.98	1062.16	1108.34	1154.52	1200.70	1246.88	1293.06	1339.24	1385.42	1431.60	1477.78	1523.96	1570.15	1616.33
52	720.14	768.15	816.16	864.17	912.18	960.19	1008.20	1056.21	1104.22	1152.23	1200.24	1248.25	1296.26	1344.27	1392.28	1440.29	1488.30	1536.30	1584.31	1632.32	1680.33
53	748.11	797.98	847.85	897.73	947.60	997.48	1047.35	1097.22	1147.10	1196.97	1246.84	1296.72	1346.59	1396.47	1446.34	1496.21	1546.09	1595.96	1645.84	1695.71	1745.58
54	776.60	828.38	880.15	931.92	983.70	1035.47	1087.25	1139.02	1190.79	1242.57	1294.34	1346.11	1397.89	1449.66	1501.43	1553.21	1604.98	1656.75	1708.53	1760.30	1812.08
55	805.63	859.34	913.05	966.76	1020.47	1074.18	1127.89	1181.60	1235.30	1289.01	1342.72	1396.43	1450.14	1503.85	1557.56	1611.27	1664.98	1718.68	1772.39	1826.10	1879.81
56	835.20	890.87	946.55	1002.23	1057.91	1113.59	1169.27	1224.95	1280.63	1336.31	1391.99	1447.67	1503.35	1559.03	1614.71	1670.39	1726.07	1781.75	1837.43	1893.11	1948.79
57	865.29	922.98	980.66	1038.35	1096.03	1153.72	1211.41	1269.09	1326.78	1384.46	1442.15	1499.84	1557.52	1615.21	1672.89	1730.58	1788.27	1845.95	1903.64	1961.32	2019.01
58	895.92	955.65	1015.37	1075.10	1134.83	1194.56	1254.28	1314.01	1373.74	1433.47	1493.20	1552.92	1612.65	1672.38	1732.11	1791.83	1851.56	1911.29	1971.02	2030.75	2090.47
59	927.08	988.88	1050.69	1112.49	1174.30	1236.10	1297.91	1359.71	1421.52	1483.32	1545.13	1606.93	1668.74	1730.54	1792.35	1854.15	1915.96	1977.76	2039.57	2101.38	2163.18
60	958.77	1022.69	1086.61	1150.52	1214.44	1278.36	1342.28	1406.20	1470.11	1534.03	1597.95	1661.87	1725.79	1789.70	1853.62	1917.54	1981.46	2045.38	2109.29	2173.21	2237.13
61	991.00	1057.06	1123.13	1189.19	1255.26	1321.33	1387.39	1453.46	1519.53	1585.59	1651.66	1717.73	1783.79	1849.86	1915.92	1981.99	2048.06	2114.12	2180.19	2246.26	2312.32
62	1023.75	1092.00	1160.25	1228.50	1296.75	1365.00	1433.25	1501.50	1569.76	1638.01	1706.26	1774.51	1842.76	1911.01	1979.26	2047.51	2115.76	2184.01	2252.26	2320.51	2388.76
63	1057.04	1127.51	1197.98	1268.45	1338.92	1409.39	1479.86	1550.33	1620.80	1691.27	1761.74	1832.21	1902.68	1973.15	2043.62	2114.09	2184.56	2255.03	2325.50	2395.97	2466.44
64	1090.87	1163.59	1236.32	1309.04	1381.77	1454.49	1527.21	1599.94	1672.66	1745.39	1818.11	1890.84	1963.56	2036.29	2109.01	2181.73	2254.46	2327.18	2399.91	2472.63	2545.36
65	1125.22	1200.24	1275.25	1350.27	1425.28	1500.30	1575.31	1650.33	1725.34	1800.36	1875.37	1950.39	2025.40	2100.42	2175.43	2250.45	2325.46	2400.48	2475.49	2550.51	2625.52
66	1160.11	1237.45	1314.79	1392.13	1469.47	1546.82	1624.16	1701.50	1778.84	1856.18	1933.52	2010.86	2088.20	2165.54	2242.88	2320.22	2397.56	2474.90	2552.25	2629.59	2706.93
67	1195.53	1275.24	1354.94	1434.64	1514.34	1594.04	1673.75	1753.45	1833.15	1912.85	1992.55	2072.26	2151.96	2231.66	2311.36	2391.07	2470.77	2550.47	2630.17	2709.87	2789.58
68	1231.49	1313.59	1395.69	1477.78	1559.88	1641.98	1724.08	1806.18	1888.28	1970.38	2052.48	2134.58	2216.68	2298.78	2380.87	2462.97	2545.07	2627.17	2709.27	2791.37	2873.47
69	1267.97	1352.50	1437.04	1521.57	1606.10	1690.63	1775.16	1859.69	1944.23	2028.76	2113.29	2197.82	2282.35	2366.88	2451.42	2535.95	2620.48	2705.01	2789.54	2874.07	2958.60
70	1304.99	1391.99	1478.99	1565.99	1652.99	1739.99	1826.99	1913.99	2000.99	2087.99	2174.99	2261.99	2348.99	2435.99	2522.99	2609.99	2696.98	2783.98	2870.98	2957.98	3044.98

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

Table 7 Carbon table (kg/tree) for *Magnolia champaca* (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	13.71	14.95	16.20	17.45	18.69	19.94	21.19	22.43	23.68	24.92	26.17	27.42	28.66	29.91	31.16
11	16.59	18.09	19.60	21.11	22.62	24.13	25.63	27.14	28.65	30.16	31.67	33.17	34.68	36.19	37.70
12	19.74	21.53	23.33	25.12	26.92	28.71	30.51	32.30	34.10	35.89	37.69	39.48	41.27	43.07	44.86
13	23.17	25.27	27.38	29.49	31.59	33.70	35.80	37.91	40.02	42.12	44.23	46.33	48.44	50.55	52.65
14	26.87	29.31	31.75	34.20	36.64	39.08	41.52	43.97	46.41	48.85	51.29	53.74	56.18	58.62	61.06
15	30.84	33.65	36.45	39.26	42.06	44.86	47.67	50.47	53.28	56.08	58.88	61.69	64.49	67.29	70.10
16	35.09	38.28	41.47	44.66	47.85	51.04	54.23	57.42	60.62	63.81	67.00	70.19	73.38	76.57	79.76
17	39.62	43.22	46.82	50.42	54.02	57.62	61.23	64.83	68.43	72.03	75.63	79.23	82.83	86.44	90.04
18	44.41	48.45	52.49	56.53	60.57	64.60	68.64	72.68	76.72	80.75	84.79	88.83	92.87	96.90	100.94
19	49.49	53.99	58.48	62.98	67.48	71.98	76.48	80.98	85.48	89.98	94.47	98.97	103.47	107.97	112.47
20	54.83	59.82	64.80	69.79	74.77	79.76	84.74	89.73	94.71	99.70	104.68	109.67	114.65	119.64	124.62
21	60.45	65.95	71.44	76.94	82.44	87.93	93.43	98.92	104.42	109.91	115.41	120.91	126.40	131.90	137.39
22	66.35	72.38	78.41	84.44	90.47	96.51	102.54	108.57	114.60	120.63	126.66	132.70	138.73	144.76	150.79
23	72.52	79.11	85.70	92.29	98.89	105.48	112.07	118.66	125.26	131.85	138.44	145.03	151.63	158.22	164.81
24	78.96	86.14	93.32	100.49	107.67	114.85	122.03	129.21	136.38	143.56	150.74	157.92	165.10	172.27	179.45
25	85.68	93.47	101.25	109.04	116.83	124.62	132.41	140.20	147.99	155.78	163.56	171.35	179.14	186.93	194.72
26	92.67	101.09	109.52	117.94	126.36	134.79	143.21	151.64	160.06	168.49	176.91	185.33	193.76	202.18	210.61
27	99.93	109.02	118.10	127.19	136.27	145.36	154.44	163.53	172.61	181.70	190.78	199.87	208.95	218.04	227.12
28	107.47	117.24	127.01	136.78	146.55	156.32	166.09	175.86	185.63	195.40	205.17	214.94	224.71	234.48	244.26
29	115.29	125.77	136.25	146.73	157.21	167.69	178.17	188.65	199.13	209.61	220.09	230.57	241.05	251.53	262.01
30	123.37	134.59	145.81	157.02	168.24	179.45	190.67	201.88	213.10	224.32	235.53	246.75	257.96	269.18	280.40

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

Table 8 Carbon table (kg/tree) for *Magnolia champaca* (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	131.35	140.11	148.86	157.62	166.38	175.13	183.89	192.65	201.40	210.16	218.92	227.67	236.43	245.19	253.94	262.70
32	139.96	149.29	158.62	167.95	177.28	186.61	195.94	205.28	214.61	223.94	233.27	242.60	251.93	261.26	270.59	279.92
33	148.84	158.77	168.69	178.61	188.54	198.46	208.38	218.31	228.23	238.15	248.07	258.00	267.92	277.84	287.77	297.69
34	158.00	168.54	179.07	189.60	200.14	210.67	221.20	231.74	242.27	252.80	263.34	273.87	284.40	294.94	305.47	316.00
35	167.43	178.60	189.76	200.92	212.08	223.24	234.41	245.57	256.73	267.89	279.06	290.22	301.38	312.54	323.70	334.87
36	177.14	188.95	200.76	212.56	224.37	236.18	247.99	259.80	271.61	283.42	295.23	307.04	318.85	330.66	342.47	354.27
37	187.11	199.59	212.06	224.54	237.01	249.49	261.96	274.44	286.91	299.38	311.86	324.33	336.81	349.28	361.76	374.23
38	197.37	210.52	223.68	236.84	250.00	263.15	276.31	289.47	302.63	315.79	328.94	342.10	355.26	368.42	381.57	394.73
39	207.89	221.75	235.61	249.47	263.33	277.19	291.05	304.91	318.77	332.62	346.48	360.34	374.20	388.06	401.92	415.78
40	218.69	233.27	247.85	262.43	277.00	291.58	306.16	320.74	335.32	349.90	364.48	379.06	393.64	408.22	422.80	437.38
41	229.76	245.08	260.39	275.71	291.03	306.35	321.66	336.98	352.30	367.61	382.93	398.25	413.57	428.88	444.20	459.52
42	241.10	257.18	273.25	289.32	305.40	321.47	337.54	353.62	369.69	385.77	401.84	417.91	433.99	450.06	466.13	482.21
43	252.72	269.57	286.42	303.27	320.11	336.96	353.81	370.66	387.51	404.35	421.20	438.05	454.90	471.75	488.59	505.44
44	264.61	282.25	299.89	317.53	335.18	352.82	370.46	388.10	405.74	423.38	441.02	458.66	476.30	493.94	511.58	529.22
45	276.78	295.23	313.68	332.13	350.58	369.04	387.49	405.94	424.39	442.84	461.30	479.75	498.20	516.65	535.10	553.55
46	289.21	308.50	327.78	347.06	366.34	385.62	404.90	424.18	443.46	462.74	482.02	501.31	520.59	539.87	559.15	578.43
47	301.93	322.05	342.18	362.31	382.44	402.57	422.70	442.82	462.95	483.08	503.21	523.34	543.47	563.60	583.72	603.85
48	314.91	335.90	356.90	377.89	398.89	419.88	440.88	461.87	482.86	503.86	524.85	545.85	566.84	587.83	608.83	629.82
49	328.17	350.05	371.92	393.80	415.68	437.56	459.44	481.31	503.19	525.07	546.95	568.83	590.70	612.58	634.46	656.34
50	341.70	364.48	387.26	410.04	432.82	455.60	478.38	501.16	523.94	546.72	569.50	592.28	615.06	637.84	660.62	683.40

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

Table 8 Carbon table (kg/tree) for *Magnolia champaca* (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	131.35	140.11	148.86	157.62	166.38	175.13	183.89	192.65	201.40	210.16	218.92	227.67	236.43	245.19	253.94	262.70
32	139.96	149.29	158.62	167.95	177.28	186.61	195.94	205.28	214.61	223.94	233.27	242.60	251.93	261.26	270.59	279.92
33	148.84	158.77	168.69	178.61	188.54	198.46	208.38	218.31	228.23	238.15	248.07	258.00	267.92	277.84	287.77	297.69
34	158.00	168.54	179.07	189.60	200.14	210.67	221.20	231.74	242.27	252.80	263.34	273.87	284.40	294.94	305.47	316.00
35	167.43	178.60	189.76	200.92	212.08	223.24	234.41	245.57	256.73	267.89	279.06	290.22	301.38	312.54	323.70	334.87
36	177.14	188.95	200.76	212.56	224.37	236.18	247.99	259.80	271.61	283.42	295.23	307.04	318.85	330.66	342.47	354.27
37	187.11	199.59	212.06	224.54	237.01	249.49	261.96	274.44	286.91	299.38	311.86	324.33	336.81	349.28	361.76	374.23
38	197.37	210.52	223.68	236.84	250.00	263.15	276.31	289.47	302.63	315.79	328.94	342.10	355.26	368.42	381.57	394.73
39	207.89	221.75	235.61	249.47	263.33	277.19	291.05	304.91	318.77	332.62	346.48	360.34	374.20	388.06	401.92	415.78
40	218.69	233.27	247.85	262.43	277.00	291.58	306.16	320.74	335.32	349.90	364.48	379.06	393.64	408.22	422.80	437.38
41	229.76	245.08	260.39	275.71	291.03	306.35	321.66	336.98	352.30	367.61	382.93	398.25	413.57	428.88	444.20	459.52
42	241.10	257.18	273.25	289.32	305.40	321.47	337.54	353.62	369.69	385.77	401.84	417.91	433.99	450.06	466.13	482.21
43	252.72	269.57	286.42	303.27	320.11	336.96	353.81	370.66	387.51	404.35	421.20	438.05	454.90	471.75	488.59	505.44
44	264.61	282.25	299.89	317.53	335.18	352.82	370.46	388.10	405.74	423.38	441.02	458.66	476.30	493.94	511.58	529.22
45	276.78	295.23	313.68	332.13	350.58	369.04	387.49	405.94	424.39	442.84	461.30	479.75	498.20	516.65	535.10	553.55
46	289.21	308.50	327.78	347.06	366.34	385.62	404.90	424.18	443.46	462.74	482.02	501.31	520.59	539.87	559.15	578.43
47	301.93	322.05	342.18	362.31	382.44	402.57	422.70	442.82	462.95	483.08	503.21	523.34	543.47	563.60	583.72	603.85
48	314.91	335.90	356.90	377.89	398.89	419.88	440.88	461.87	482.86	503.86	524.85	545.85	566.84	587.83	608.83	629.82
49	328.17	350.05	371.92	393.80	415.68	437.56	459.44	481.31	503.19	525.07	546.95	568.83	590.70	612.58	634.46	656.34
50	341.70	364.48	387.26	410.04	432.82	455.60	478.38	501.16	523.94	546.72	569.50	592.28	615.06	637.84	660.62	683.40

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

Table 9 Carbon table (kg/tree) for *Magnolia champaca* (>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	346.36	369.45	392.54	415.63	438.72	461.81	484.90	507.99	531.08	554.17	577.26	600.35	623.44	646.53	669.62	692.71	715.80	738.89	761.98	785.07	808.16
52	360.07	384.08	408.08	432.09	456.09	480.10	504.10	528.10	552.11	576.11	600.12	624.12	648.13	672.13	696.14	720.14	744.15	768.15	792.16	816.16	840.17
53	374.05	398.99	423.93	448.86	473.80	498.74	523.67	548.61	573.55	598.49	623.42	648.36	673.30	698.23	723.17	748.11	773.04	797.98	822.92	847.85	872.79
54	388.30	414.19	440.08	465.96	491.85	517.74	543.62	569.51	595.40	621.28	647.17	673.06	698.94	724.83	750.72	776.60	802.49	828.38	854.26	880.15	906.04
55	402.82	429.67	456.53	483.38	510.23	537.09	563.94	590.80	617.65	644.51	671.36	698.22	725.07	751.92	778.78	805.63	832.49	859.34	886.20	913.05	939.91
56	417.60	445.44	473.28	501.12	528.96	556.80	584.64	612.48	640.32	668.16	696.00	723.84	751.68	779.52	807.36	835.20	863.04	890.87	918.71	946.55	974.39
57	432.64	461.49	490.33	519.17	548.02	576.86	605.70	634.55	663.39	692.23	721.07	749.92	778.76	807.60	836.45	865.29	894.13	922.98	951.82	980.66	1009.50
58	447.96	477.82	507.69	537.55	567.41	597.28	627.14	657.01	686.87	716.73	746.60	776.46	806.33	836.19	866.05	895.92	925.78	955.65	985.51	1015.37	1045.24
59	463.54	494.44	525.34	556.25	587.15	618.05	648.95	679.86	710.76	741.66	772.56	803.47	834.37	865.27	896.17	927.08	957.98	988.88	1019.79	1050.69	1081.59
60	479.39	511.34	543.30	575.26	607.22	639.18	671.14	703.10	735.06	767.02	798.98	830.93	862.89	894.85	926.81	958.77	990.73	1022.69	1054.65	1086.61	1118.57
61	495.50	528.53	561.56	594.60	627.63	660.66	693.70	726.73	759.76	792.80	825.83	858.86	891.90	924.93	957.96	991.00	1024.03	1057.06	1090.09	1123.13	1156.16
62	511.88	546.00	580.13	614.25	648.38	682.50	716.63	750.75	784.88	819.00	853.13	887.25	921.38	955.50	989.63	1023.75	1057.88	1092.00	1126.13	1160.25	1194.38
63	528.52	563.76	598.99	634.23	669.46	704.70	739.93	775.17	810.40	845.64	880.87	916.10	951.34	986.57	1021.81	1057.04	1092.28	1127.51	1162.75	1197.98	1233.22
64	545.43	581.80	618.16	654.52	690.88	727.24	763.61	799.97	836.33	872.69	909.06	945.42	981.78	1018.14	1054.50	1090.87	1127.23	1163.59	1199.95	1236.32	1272.68
65	562.61	600.12	637.63	675.13	712.64	750.15	787.66	825.16	862.67	900.18	937.69	975.19	1012.70	1050.21	1087.72	1125.22	1162.73	1200.24	1237.75	1275.25	1312.76
66	580.06	618.73	657.40	696.07	734.74	773.41	812.08	850.75	889.42	928.09	966.76	1005.43	1044.10	1082.77	1121.44	1160.11	1198.78	1237.45	1276.12	1314.79	1353.46
67	597.77	637.62	677.47	717.32	757.17	797.02	836.87	876.72	916.58	956.43	996.28	1036.13	1075.98	1115.83	1155.68	1195.53	1235.38	1275.24	1315.09	1354.94	1394.79
68	615.74	656.79	697.84	738.89	779.94	820.99	862.04	903.09	944.14	985.19	1026.24	1067.29	1108.34	1149.39	1190.44	1231.49	1272.54	1313.59	1354.64	1395.69	1436.73
69	633.99	676.25	718.52	760.78	803.05	845.32	887.58	929.85	972.11	1014.38	1056.64	1098.91	1141.18	1183.44	1225.71	1267.97	1310.24	1352.50	1394.77	1437.04	1479.30
70	652.50	696.00	739.50	783.00	826.50	870.00	913.49	956.99	1000.49	1043.99	1087.49	1130.99	1174.49	1217.99	1261.49	1304.99	1348.49	1391.99	1435.49	1478.99	1522.49

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

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Table 10 Volume, biomass and carbon table for *Magnolia champaca* (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	0.061	41.00	20.50	31	0.550	368.74	184.37
11	0.074	49.61	24.81	32	0.586	392.92	196.46
12	0.088	59.05	29.52	33	0.624	417.86	208.93
13	0.103	69.30	34.65	34	0.662	443.57	221.78
14	0.120	80.37	40.18	35	0.702	470.04	235.02
15	0.138	92.26	46.13	36	0.742	497.29	248.64
16	0.157	104.97	52.49	37	0.784	525.30	262.65
17	0.177	118.50	59.25	38	0.827	554.08	277.04
18	0.198	132.85	66.43	39	0.871	583.62	291.81
19	0.221	148.02	74.01	40	0.916	613.93	306.97
20	0.245	164.02	82.01	41	0.963	645.01	322.51
21	0.270	180.83	90.41	42	1.010	676.86	338.43
22	0.296	198.46	99.23	43	1.059	709.48	354.74
23	0.324	216.91	108.46	44	1.109	742.86	371.43
24	0.353	236.18	118.09	45	1.160	777.01	388.51
25	0.383	256.28	128.14	46	1.212	811.93	405.96
26	0.414	277.19	138.59	47	1.265	847.61	423.81
27	0.446	298.92	149.46	48	1.320	884.07	442.03
28	0.480	321.47	160.74	49	1.375	921.29	460.64
29	0.515	344.84	172.42	50	1.432	959.27	479.64
30	0.551	369.04	184.52	51	1.700	1138.83	569.42

Table 11 Volume, biomass and carbon table for *Magnolia champaca* (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	1.700	1138.83	569.42	76	3.775	2528.99	1264.50
52	1.767	1183.93	591.97	77	3.875	2595.98	1297.99
53	1.836	1229.91	614.95	78	3.976	2663.85	1331.92
54	1.906	1276.76	638.38	79	4.078	2732.59	1366.30
55	1.977	1324.48	662.24	80	4.182	2802.21	1401.10
56	2.049	1373.08	686.54	81	4.288	2872.70	1436.35
57	2.123	1422.56	711.28	82	4.394	2944.07	1472.03
58	2.198	1472.91	736.46	83	4.502	3016.31	1508.16
69	2.275	1524.14	762.07	84	4.611	3089.43	1544.72
60	2.353	1576.24	788.12	85	4.722	3163.43	1581.72
61	2.432	1629.22	814.61	86	4.833	3238.30	1619.15
62	2.512	1683.08	841.54	87	4.946	3314.05	1657.02
63	2.594	1737.81	868.90	88	5.061	3390.67	1695.34
64	2.677	1793.41	896.71	89	5.176	3468.17	1734.09
65	2.761	1849.90	924.95	90	5.293	3546.54	1773.27
66	2.847	1907.25	953.63	91	5.412	3625.79	1812.90
67	2.934	1965.49	982.74	92	5.531	3705.92	1852.96
68	3.022	2024.60	1012.30	93	5.652	3786.92	1893.46
69	3.111	2084.58	1042.29	94	5.774	3868.80	1934.40
70	3.202	2145.44	1072.72	95	5.898	3951.55	1975.78
71	3.294	2207.18	1103.59	96	6.023	4035.18	2017.59
72	3.388	2269.79	1134.89	97	6.149	4119.68	2059.84
73	3.483	2333.28	1166.64	98	6.276	4205.06	2102.53
74	3.579	2397.64	1198.82	99	6.405	4291.32	2145.66
75	3.676	2462.88	1231.44	100	6.535	4378.45	2189.23



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

Magnolia champaca is commonly found in Meghalaya and other parts of North East India and 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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