



VOLUME TABLE OF *Acacia auriculiformis* A. CUNN. EX BENTH. AND *Acacia mangium* WILLD. PLANTED IN WOODLOT OF SOCIAL FORESTRY PROJECT IN DHAKA FOREST DIVISION OF BANGLADESH

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Abstract: Tree volume, the traditional measurement of wood quantity is a function of trees' height, basal area, shape, and bark thickness. Tree volume table is the statement of expected tree volume of nominated dimensions in a particular forest stand or population. *Acacia auriculiformis* A. Cunn. ex. Benth. and *Acacia mangium* Willd. are two fast growing and hardy leguminous (Leguminosae, Mimosaceae) exotic species have widely been planted in the woodlot of Asian Development Bank financed Social Forestry Project in Bangladesh. In this study, models for calculating tree stem volume and a two way volume tables for both *A. auriculiformis* and *A. mangium* were developed. Data were collected from the social forestry woodlot of the respective species in Dhaka Forest Division, Bangladesh. Simple linear, logarithmic, polynomial, power and exponential regression models were developed. Best-fit model was selected based on highest R^2 among seven linear regression models for volume calculation of *A. auriculiformis* and *A. mangium*. Regression R^2 of the simple linear regression model for both the species was either higher or at least equal in comparison with said logarithmic, polynomial, power, and exponential regression models. Therefore, simple linear regression model as a function of height (h) and diameter at breast height (dbh) were adopted for the preparation of two way local volume table for both the species due to its simplicity in application.

Key words: Growth and productivity; participation; plantation; regression analysis

Introduction

Tree volume is the traditional measure of wood quantity as a function of trees' height, basal area, shape and bark thickness are the most difficult parameters to estimate (Avery and Burkhart, 1983; Chaturvedi and Khanna, 1982). This can be measured either after the tree has been felled or when it is standing using distinct methods of calculation for each category. Volume estimation is often purpose oriented (biological volume¹, merchantable

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volume², gross volume³, and net volume⁴), and its interpretation depends on the units of measurement, standard of use and other specifications (Chaturvedi and Khanna, 1982).

Tree volume can be estimated either by using direct (fluid displacement, graphical, standard sectional and taper line) or indirect (volume tables, volume equations, integrating taper equations and variance reduction) methods (Avery and Burkhart, 1983). Tree volume table is the statement of expected tree volume of nominated dimensions in a particular forest stand or population. It contains average contents of tree logs or sawn timber for one or more given dimensions such as dbh alone; dbh and height in combination; dbh, height and some other measure of form or taper factor in combination for a given tree species (Chaturvedi and Khanna, 1982). Volume table may be of single entry or local⁵, double entry or standard⁶ and multiple entry or regional⁷ types (Avery and Burkhart, 1983).

Acacia auriculiformis, a fast growing and hardy leguminous tree species native to the savannas of Papua New Guinea, the Islands of the Torres Strait, and the Northern Australia (Hawkins, 1987). It has been introduced in several tropical countries such as Solomon Islands, Indonesia, Malaysia, India, Nigeria, Tanzania, the Philippines and Bangladesh (Anon, 1996) due to its very high adaptability from rich to very poor sites (Anon, 2000).

Acacia auriculiformis has been planted in every agroecological regions of Bangladesh (Ghani, 1990; Brammer *et al.*, 1988). The total height can reach up to 30 m and 60 cm in dbh under certain favorable condition (Zabala, 1990; Hawkins, 1987). It prefers mean annual temperature from 26°C to 30°C and mean annual rainfall ranges from 1500 mm to 2000 mm (Zabala, 1990). It can withstand in a wide range of deep or shallow soils and in any problem soils such as eroding hillslopes, mining spoil, as well as highly acid to alkaline soils with pH ranges from 3.0 to 9.5 (Hawkins, 1987). The species can be found in an altitudinal range from 0 up to 600 m above sea level (Zabala, 1990).

Acacia mangium is a native species to three small areas of Queensland in Australia, the southwestern portion of Papua New Guinea and Molluca (local name *Maluku*) Islands of Eastern Indonesia. It grows very fast with clear straight bole of 30 m height and 90 cm dbh in its natural habitat (Zabala, 1990). It was introduced in Bangladesh in 1978 and became one of the most important reforestation and afforestation species like many other tropical countries (Anon, 1996). It prefers mean maximum temperature from 31 to 34° C while mean minimum temperature from 12 to 16° C. and mean annual rainfall for successful plantation is 2000 mm (Zabala, 1990). It can be grown profitably in wet soils near stream but is tolerant of seasonal inundation or a degree of impeded drainage and even in dry and poor soils, especially in the hilly, barren and undulating areas. It can tolerate the soils with pH ranges from 4.5 to 9.0 and the altitude up to 800 m above sea level (Anon, 2000).

Volume tables of this two commonly planted fast growing tree species in social forestry woodlot of Dhaka Forest Division in Bangladesh are not yet documented. In this study two-way local volume tables for those two species were developed. The study findings can be used in calculating stem volume as a function of height and dbh in the study site and will also provide baseline information for further research conduction and

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comparison. Objective of this study was to prepare local volume tables for *A. auriculiformis* and *A. mangium*. These local volume tables will serve the Bangladesh Forest Department in calculating the estimated stem volume of *A. auriculiformis* and *A. mangium* immediately before auction sale of the woodlot.

Materials and Methods

Study area: Dhaka Forest Division is one of the 16 Forest Divisions in the Forestry Sector Project in Bangladesh (Fig. 1) is surrounded by Mymensingh district in the North, Narasingdi district in the East, Dhaka and Narayanganj district in the South and Tangail district in the West. The entire forest division has an area of 1,74,153 ha of which 26,311 ha is forest (Anon, 1996). It lies in a tropical climate (20°53' and 24°20' N and 90°10' and 90°35' E) has three marked seasons, rainy (mean annual rainfall 2478 mm), summer (maximum average temperature 31.7 to 33.7 °C) and winter (minimum average temperature 11.7 to 13.3 °C) (Amin, 1994). It is located in the densely populated central part of the country having 1,489 persons mile⁻² with a national average of 1,566 persons mile⁻² (Amin, 1994).

Sampling design: Existing woodlots of *A. auriculiformis* and *A. mangium* were identified from the land use and forest cover map of the Dhaka Forest Division. The Forest Division is consisting of four forest ranges namely Sreepur, Kaliakoir, Rajendrapur and Kachighata with definite administrative boundary were stratified for sampling. A total of 200 woodlots for each species (50 from each strata i.e., each forest range) with an area of 1.0 ha (10000 m²) each were selected randomly as sample plots. Every sample plot was divided in 100 grid cells (10m x 10m) with an identification number from 1 to 100. 5% i.e., 5 grid cells were randomly selected as sample grid cells in order to measure the total height (m) and dbh (cm) of all individual trees from the grid cell. A total of 2000 trees (2 from each grid cell, 10 from each sample plot, 500 from each strata or forest range) were selected randomly for measuring cross sectional diameter at 3 meter regular interval starting from dbh to merchantable height (up to 3 cm top diameter).

Data measurement: Merchantable height of randomly selected sample trees to be used for measuring sectional diameter and total height of all individual trees in each sample grid cells were measured and recorded accordingly. Sectional diameter at 3 meter regular interval of sample trees and dbh of all individual trees in each sample grid cell were measured and recorded accordingly. Similar procedure was followed for both the species. Spiegel Relaskop™ was used for measuring both height and diameter of trees.

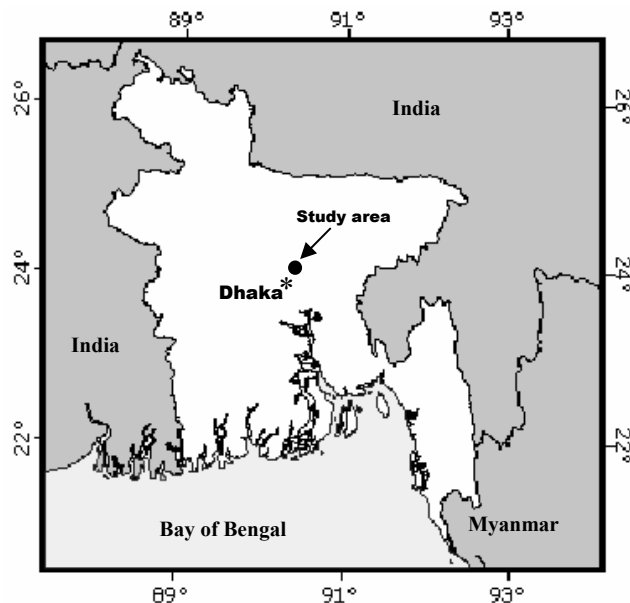


Fig. 1. Map of Bangladesh showing the location of the study area

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Data analysis: Average diameter of each section of the sample trees was computed using diameter at the base and the top of the section. Average diameter and length of each section was used for computing actual volume of the section employing the formula used for calculating volume of a cylinder ($\pi r^2 l$). This formula was employed considering the difference between the average diameter of each section and the diameter at any points throughout the length of the section is negligible even though the sections were not exactly cylindrical. The actual total volume of a sample tree was computed by summing up the volume of all sections of the said tree. Regression techniques were employed to relate the individual tree volume and several relationships among dbh, height and average form factor of 2000 sample trees (Table 1) using various functions and transformations as required in the models. R^2 of linear, logarithmic, polynomial, power and exponential regression were also computed for each of the seven models tested

- 1) $V = b_0 + b_1 (F * dbh * h)$ (Avery and Burkhardt, 1983)
- 2) $V = b_0 + b_1 (F * dbh^2 * h)$ (Avery and Burkhardt, 1983)
- 3) $V = b_0 + b_1 (dbh^2 * h)$ (Latif *et al.*, 2000; Edminster *et al.*, 1980; Burkhardt, 1977; Spurr, 1952 in Avery and Burkhardt, 1983)
- 4) $V = b_0 + b_1 (dbh * h)$ (Hawkins, 1987; Hussain, 1987)
- 5) $V = b_0 + b_1 (dbh + dbh^2 + dbh^2 * h)$ (Chaturvedi and Khanna, 1982)
- 6) $V = b_0 + b_1 (dbh^2 + h + dbh^2 * h)$ (Chaturvedi and Khanna, 1982)
- 7) $V = b_0 + b_1 (dbh^2 + dbh * h + dbh^2 * h)$ (Latif *et al.*, 2000; Chaturvedi and Khanna, 1982)

Where, V = stem volume (m^3), b_0 and b_1 = regression coefficients, F = form factor, h = tree height (m), dbh = diameter at breast height (cm)

Results

From the regression statistics, seven models were developed and equally applied against a constant height and dbh to compute tree volume for both the species. Volume tables for *A. auriculiformis* and *A. mangium* were prepared using the primary data collected from Dhaka Forest Division in Bangladesh in 2001. Seven linear, logarithmic, polynomial, power, and exponential regression models (Sig. $F < 0.0001$ for all models) were developed for the preparation of volume table of *A. auriculiformis* (Table 1) and *A. mangium* (Table 2). The R^2 values of linear regression models were somewhat greater than or equal to the R^2 of logarithmic, polynomial, power, and exponential regression models for both the species. Regression R^2 were then considered in selecting the best-fit model for volume calculation. Linear regression model always depicts its simplicity in application. Thus, the highest or equal regression R^2 and easeness in application of linear regression model demanded its ultimate adoption in calculating volume for both the species.

Table 1. Regression statistics and linear regression models of *Acacia auriculiformis*.

Sl. No.	Linear regression models	R^2					Sig. F
		Linear	Logarithmic	Polynomial ⁵	Power	Exponential	
1	$V = b_0 + b_1(F \times dbh \times h)$	0.950	0.948	0.970	0.962	0.878	< 0.0001
2	$V = b_0 + b_1(F \times dbh^2 \times h)$	0.972	0.917	0.973	0.974	0.887	< 0.0001
3	$V = b_0 + b_1(dbh^2 \times h)$	0.973	0.888	0.972	0.970	0.917	< 0.0001
4	$V = b_0 + b_1(dbh \times h)$	0.950	0.878	0.971	0.963	0.948	< 0.0001
5	$V = b_0 + b_1(dbh + dbh^2 + dbh^2 \times h)$	0.974*	0.919	0.974	0.974	0.889	< 0.0001
6	$V = b_0 + b_1(dbh^2 + h + dbh^2 \times h)$	0.971	0.919	0.974	0.974	0.889	< 0.0001
7	$V = b_0 + b_1(dbh^2 + dbh \times h + dbh^2 \times h)$	0.973	0.920	0.974	0.974	0.889	< 0.0001

* = Highest R^2 and Sig. F for linear models

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Table 2. Regression statistics and linear regression models of *Acacia mangium*.

Sl. No.	Linear regression model	R ²					Sig. F
		Linear	Logarithmic	Polynomial ⁵	Power	Exponential	
1	$V = b_0 + b_1(F \times dbh \times h)$	0.924	0.920	0.931	0.931	0.890	< 0.0001
2	$V = b_0 + b_1(F \times dbh^2 \times h)$	0.947	0.909	0.946	0.943	0.912	< 0.0001
3	$V = b_0 + b_1(dbh^2 \times h)$	0.943	0.912	0.947	0.943	0.909	< 0.0001
4	$V = b_0 + b_1(dbh \times h)$	0.924	0.890	0.932	0.931	0.920	< 0.0001
5	$V = b_0 + b_1(dbh + dbh^2 + dbh^2 \times h)$	0.949*	0.909	0.948	0.948	0.914	< 0.0001
6	$V = b_0 + b_1(dbh^2 + h + dbh^2 \times h)$	0.945	0.909	0.948	0.948	0.914	< 0.0001
7	$V = b_0 + b_1(dbh^2 + dbh \times h + dbh^2 \times h)$	0.945	0.910	0.944	0.948	0.914	< 0.0001

* = Highest R² and Sig. F for linear models

Discussion

The linear regression models, “ $V = 0.010261511 + 0.0000288668 (dbh + dbh^2 + dbh^2 \times h)$ ” with R²=0.974 (Fig. 2) and Significant F=< 0.0001 for *A. auriculiformis* (Table 1) and “ $V = 0.008071515 + 0.0000280708 (dbh + dbh^2 + dbh^2 \times h)$ ” with R² = 0.949 (Fig. 3) and Significant F=< 0.0001 for *A. mangium* (Table 2) were found best-fit in calculating stem volume. Two 2-way tables: one for *A. auriculiformis* (Table 3) and one for *A. mangium* (Table 4) were then prepared using dbh from 5 to 30 cm (1 cm interval) and height 10 to 25 m (1 m interval).

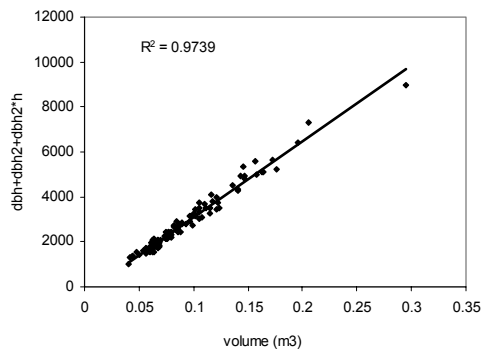


Fig. 2. Scattergram showing the best-fit line for *Acacia auriculiformis*.

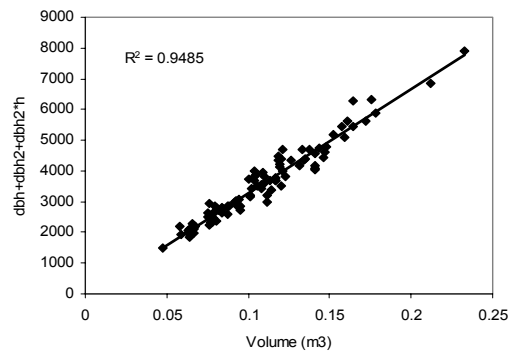


Fig. 3. Scattergram showing the best-fit line for *Acacia mangium*.

Volume of *A. auriculiformis* and *A. mangium* based on their respective models were compared. A set of variable dbh started from 5 to 30 cm with a constant height respectively of 10, 15, 20, and 25 m (Fig. 4) was computed to see the relationship of the trend line in volume increment with the increasing dbh within and between the species. Fig. 4 showed there is linear relationship in volume increment between the species while *A. auriculiformis* was leading in volume increment over *A. mangium* for any constant height and dbh.

Volume of *A. auriculiformis* of this study (Fig. 5) was compared with Latif *et al.* (2000) was carried out on the same species planted on the embankments and roadsides in the coastal areas of Bangladesh under the “Coastal Greenbelt Project”, “Community Forestry Project” and “Thana Banayan and Nursery Unnayan Project”. Fig. 5 represents linearity in volume increment of *A. auriculiformis* in Bangladesh condition. No such study for *A. mangium* was found to compare with this study in Bangladesh. Therefore, there was no

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scope to compare result of this study with someone else's result. However, there would be scope for further research in investigating the stem volume of *A. mangium* in Bangladesh and compare with this study.

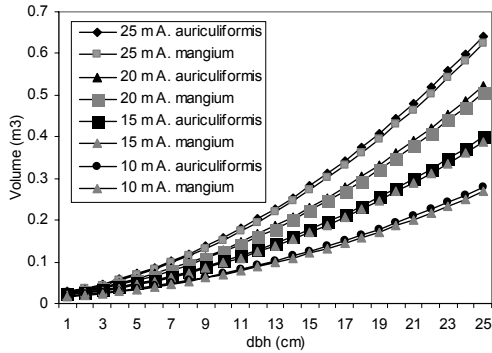


Fig. 4. Volume comparison between *Acacia auriculiformis* and *Acacia mangium* with a constant height and variable dbh

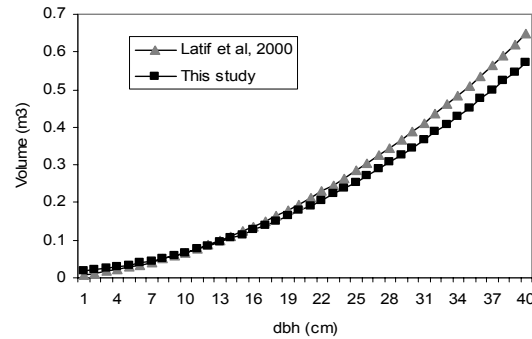


Fig. 5. Volume comparison of *Acacia auriculiformis* between this study and Latif et al. (2000).

Table 3. Volume table of *Acacia auriculiformis*, $V = b_0 + b_1(dbh + dbh^2 + dbh^2 \times h)$.

$$V = 0.010261511 + 0.0000288668(dbh + dbh^2 + dbh^2 \times h)$$

dbh (cm)	Height (m)															
	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
5	0.018	0.019	0.02	0.021	0.021	0.022	0.023	0.023	0.024	0.025	0.026	0.026	0.027	0.028	0.028	0.029
6	0.022	0.023	0.024	0.025	0.026	0.027	0.028	0.029	0.03	0.031	0.032	0.033	0.034	0.035	0.036	0.037
7	0.026	0.027	0.029	0.03	0.032	0.033	0.035	0.036	0.037	0.039	0.04	0.042	0.043	0.044	0.046	0.047
8	0.031	0.033	0.035	0.036	0.038	0.04	0.042	0.044	0.046	0.047	0.049	0.051	0.053	0.055	0.057	0.059
9	0.036	0.039	0.041	0.043	0.046	0.048	0.05	0.053	0.055	0.057	0.06	0.062	0.064	0.067	0.069	0.071
10	0.042	0.045	0.048	0.051	0.054	0.057	0.06	0.063	0.065	0.068	0.071	0.074	0.077	0.08	0.083	0.086
11	0.049	0.052	0.056	0.059	0.063	0.066	0.07	0.073	0.077	0.08	0.084	0.087	0.091	0.094	0.098	0.101
12	0.056	0.06	0.065	0.069	0.073	0.077	0.081	0.085	0.09	0.094	0.098	0.102	0.106	0.11	0.115	0.119
13	0.064	0.069	0.074	0.079	0.084	0.089	0.094	0.098	0.103	0.108	0.113	0.118	0.123	0.128	0.133	0.137
14	0.073	0.079	0.084	0.09	0.096	0.101	0.107	0.113	0.118	0.124	0.129	0.135	0.141	0.146	0.152	0.158
15	0.082	0.089	0.095	0.102	0.108	0.115	0.121	0.128	0.134	0.141	0.147	0.154	0.16	0.167	0.173	0.18
16	0.092	0.099	0.107	0.114	0.122	0.129	0.136	0.144	0.151	0.159	0.166	0.173	0.181	0.188	0.195	0.203
17	0.103	0.111	0.119	0.128	0.136	0.144	0.153	0.161	0.169	0.178	0.186	0.194	0.203	0.211	0.219	0.228
18	0.114	0.123	0.132	0.142	0.151	0.16	0.17	0.179	0.188	0.198	0.207	0.217	0.226	0.235	0.245	0.254
19	0.125	0.136	0.146	0.157	0.167	0.178	0.188	0.198	0.209	0.219	0.23	0.24	0.25	0.261	0.271	0.282
20	0.138	0.149	0.161	0.172	0.184	0.196	0.207	0.219	0.23	0.242	0.253	0.265	0.276	0.288	0.3	0.311
21	0.151	0.164	0.176	0.189	0.202	0.215	0.227	0.24	0.253	0.265	0.278	0.291	0.304	0.316	0.329	0.342
22	0.165	0.179	0.193	0.206	0.22	0.234	0.248	0.262	0.276	0.29	0.304	0.318	0.332	0.346	0.36	0.374
23	0.179	0.194	0.209	0.225	0.24	0.255	0.271	0.286	0.301	0.316	0.332	0.347	0.362	0.377	0.393	0.408
24	0.194	0.21	0.227	0.244	0.26	0.277	0.294	0.31	0.327	0.343	0.36	0.377	0.393	0.41	0.427	0.443
25	0.209	0.227	0.246	0.264	0.282	0.3	0.318	0.336	0.354	0.372	0.39	0.408	0.426	0.444	0.462	0.48
26	0.226	0.245	0.265	0.284	0.304	0.323	0.343	0.362	0.382	0.401	0.421	0.44	0.46	0.479	0.499	0.518
27	0.243	0.264	0.285	0.306	0.327	0.348	0.369	0.39	0.411	0.432	0.453	0.474	0.495	0.516	0.537	0.558

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28	0.26	0.283	0.305	0.328	0.351	0.373	0.396	0.418	0.441	0.464	0.486	0.509	0.532	0.554	0.577	0.599
29	0.278	0.302	0.327	0.351	0.375	0.4	0.424	0.448	0.472	0.497	0.521	0.545	0.569	0.594	0.618	0.642
30	0.297	0.323	0.349	0.375	0.401	0.427	0.453	0.479	0.505	0.531	0.557	0.583	0.609	0.635	0.661	0.687

Where, V = Volume (m³), dbh = Diameter at breast height (cm), h = Height (m), and b₀ and b₁ = Regression coefficients.

Table 4. Volume table of *Acacia mangium*, $V = b_0 + b_1(\text{dbh} + \text{dbh}^2 + \text{dbh}^2 \times h)$.

$$V = 0.008071515 + 0.0000280708(\text{dbh} + \text{dbh}^2 + \text{dbh}^2 \times h)$$

DBH (cm)	Height (m)															
	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
5	0.016	0.017	0.017	0.018	0.019	0.02	0.02	0.021	0.022	0.022	0.023	0.024	0.024	0.025	0.026	0.027
6	0.019	0.02	0.021	0.022	0.023	0.025	0.026	0.027	0.028	0.029	0.03	0.031	0.032	0.033	0.034	0.035
7	0.023	0.025	0.026	0.028	0.029	0.03	0.032	0.033	0.035	0.036	0.037	0.039	0.04	0.041	0.043	0.044
8	0.028	0.03	0.032	0.034	0.035	0.037	0.039	0.041	0.043	0.044	0.046	0.048	0.05	0.052	0.053	0.055
9	0.033	0.036	0.038	0.04	0.043	0.045	0.047	0.049	0.052	0.054	0.056	0.058	0.061	0.063	0.065	0.068
10	0.039	0.042	0.045	0.048	0.051	0.053	0.056	0.059	0.062	0.065	0.067	0.07	0.073	0.076	0.079	0.081
11	0.046	0.049	0.053	0.056	0.059	0.063	0.066	0.07	0.073	0.076	0.08	0.083	0.087	0.09	0.093	0.097
12	0.053	0.057	0.061	0.065	0.069	0.073	0.077	0.081	0.085	0.089	0.093	0.097	0.101	0.106	0.11	0.114
13	0.061	0.065	0.07	0.075	0.08	0.084	0.089	0.094	0.099	0.103	0.108	0.113	0.118	0.122	0.127	0.132
14	0.069	0.075	0.08	0.086	0.091	0.097	0.102	0.108	0.113	0.119	0.124	0.13	0.135	0.141	0.146	0.152
15	0.078	0.084	0.091	0.097	0.103	0.11	0.116	0.122	0.129	0.135	0.141	0.148	0.154	0.16	0.166	0.173
16	0.088	0.095	0.102	0.109	0.116	0.124	0.131	0.138	0.145	0.152	0.16	0.167	0.174	0.181	0.188	0.195
17	0.098	0.106	0.114	0.122	0.13	0.138	0.147	0.155	0.163	0.171	0.179	0.187	0.195	0.203	0.211	0.22
18	0.109	0.118	0.127	0.136	0.145	0.154	0.163	0.172	0.181	0.191	0.2	0.209	0.218	0.227	0.236	0.245
19	0.12	0.13	0.14	0.151	0.161	0.171	0.181	0.191	0.201	0.211	0.222	0.232	0.242	0.252	0.262	0.272
20	0.132	0.143	0.155	0.166	0.177	0.188	0.2	0.211	0.222	0.233	0.245	0.256	0.267	0.278	0.289	0.301
21	0.145	0.157	0.17	0.182	0.194	0.207	0.219	0.232	0.244	0.256	0.269	0.281	0.293	0.306	0.318	0.331
22	0.158	0.172	0.185	0.199	0.213	0.226	0.24	0.253	0.267	0.281	0.294	0.308	0.321	0.335	0.348	0.362
23	0.172	0.187	0.202	0.217	0.232	0.246	0.261	0.276	0.291	0.306	0.321	0.336	0.35	0.365	0.38	0.395
24	0.187	0.203	0.219	0.235	0.251	0.268	0.284	0.3	0.316	0.332	0.348	0.365	0.381	0.397	0.413	0.429
25	0.202	0.219	0.237	0.254	0.272	0.29	0.307	0.325	0.342	0.36	0.377	0.395	0.412	0.43	0.447	0.465
26	0.218	0.237	0.256	0.275	0.294	0.313	0.331	0.35	0.369	0.388	0.407	0.426	0.445	0.464	0.483	0.502
27	0.234	0.254	0.275	0.295	0.316	0.336	0.357	0.377	0.398	0.418	0.439	0.459	0.48	0.5	0.521	0.541
28	0.251	0.273	0.295	0.317	0.339	0.361	0.383	0.405	0.427	0.449	0.471	0.493	0.515	0.537	0.559	0.581
29	0.269	0.292	0.316	0.339	0.363	0.387	0.41	0.434	0.458	0.481	0.505	0.528	0.552	0.576	0.599	0.623
30	0.287	0.312	0.337	0.363	0.388	0.413	0.438	0.464	0.489	0.514	0.54	0.565	0.59	0.615	0.641	0.666

Where, V = Volume (m³), dbh = Diameter at breast height (cm), h = Height (m), and b₀ and b₁ = Regression coefficients.

Conclusion

Social Forestry Project of Bangladesh carried out a rough inventory in estimating the stem volume per tree basis immediately before the auction sale of the woodlot plantation. Findings of this study (volume table and model for volume calculation) would be of great use for both the Bangladesh Forest Department and the beneficiaries of the plantation in estimating the volume and value of the woodlot. Besides this, time to time growth and productivity estimate could also be carried out for the woodlot in testing the performance of the plantation.

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¹ It is the volume of stem with branches trimmed at the junction with the stem, but usually excluding irregularities not part of the natural growth habit.

² It excludes some volume within irregularities of the bole shape caused by normal growth in addition to those irregularities not part of natural growth.

³ Estimates would include defective and decayed wood.

⁴ Estimates would exclude defective and decayed wood.

⁵ Normally 'Diameter at Breast Height (DBH)' or 'Basal Area' is the only measurement. It is applicable for local area only.

⁶ Table gives volumes as a function of DBH and Height of tree. It can be applied for larger area.

⁷ Measurements correspond to bark thickness or taper of the tree. Tables with more dimensions are likely to be more accurate.