TREE VOLUME TABLES FOR FOUR SPECIES GROWN IN PLANTATIONS IN BANGLADESH

SYZYGIUM GRANDE (WT.) WALD (DHAKIJAM)

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ARTOCARPUS CHAPLASHA ROXB. (CHAPALISH)

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GMELINA ARBOREA ROXB. (GAMAR)

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DIPTEROCARPUS TURBINATUS GAERTN.F. (TELI GARJAN)

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CHAPTER 3

TREE VOLUME TABLES FOR *ARTOCARPUS CHAPLASHA* ROXB. (CHAPALISH)

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INTRODUCTION

Chapalish or cham (Artocarpus chaplasha Roxb.) is a large, deciduous tree with a tall, straight bole. It attains a height of 30 - 35m. (100-120 ft.) or more, and a girth of 3-4.5m. (10-15 ft.) or more. It also develops a large spreading crown. The wood is yellowish-brown and known for its durability and good quality. It is used for furniture, building construction, boat-building, and so on.

DATA AND TRACT COVERED

Data for preparation of these tables were collected from the plantation forests of Chittagong, Chittagong Hill Tracts and Sylhet Forest Divisions. (Table 3.1) Five-year age gradations and five-centimetre (two-inch) diameter classes were taken. Diameter at breast height, total height (H) and diameter at intervals of 3.05m. (10 ft.) up the trunk from a point 30cm. (1 ft.) above ground level were measured in imperial units. Diameters were corrected to the nearest 0.25 cm. (0.1 inch) and heights to the nearest 30 cm. (1 ft.). The trees were measured up to a top diameter of 20 cm. (8 in.). At each point of measure, bark thicknesses were obtained in two directions perpendicular to each other and the mean was taken as the bark thickness at that point.

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METHOD OF STRATIFICATION AND SELECTION OF SAMPLE TREES FOR MEASUREMENT.

Stratification was first done in the office. Beats/Ranges were selected where there were adequate plantations of Chapalish. It was decided to measure at least 10 trees, if available, of each of the diameter classes from each Beat/Range. The sample trees of the required diameter classes were then selected in the field as being representative of the crop at the site. Trees were required to have minimum apparent defect. The number of trees was 427 distributed in diameter and height classes as shown in Table 3.2

COMPILATION

Following collection, the data were sent to the Commonwealth Forestry Institute, Oxford, U.K., for processing. Using a graphical method, volume data for individual trees were recast by computer processing to provide total volume under and overbark (excluding stump and branch volume) and volume to various top-end diameter limits (2, 4, 6 and 8 in. for imperial units and approximately 5, 10, 15 and 20 cm. for metric units). Branch volume was also computed for each tree.

In addition to the primary variables of Volume (V), Diameter at breast height (D) and total Height (H), various functions and ratios of these variables (D^2, $1/D$, $1/D^2$, Log (V), Log (D), DH, D^2H, V/D^2H, $1/DH$, $1/D^2H$, H/D^2, H/D and Log (H) were derived to provide additional variables for testing in regression analyses.

Following inspection of the correlation matix of all primary and derived variables, fifteen models were constructed for testing:

1. $V = a + bD$

2. $V = a + bD + cD^2$

3. $V = a + bD^2$

4. $V = a + bD^2H$

5. $V = a + bd^2 + cH + dD^2H$

6. $V = a + bD^2 + cDH + dD^2H$

7. $\text{Log}(V) = a + b\,\text{Log}(D)$

8. $\text{Log}(V) = a + b\,\text{Log}(D) + c\,\text{Log}(H)$

9. $V/D^2 = a + b/D^2 + c/D$

10. $V/D^2H = a + b/D^2H$

11. $V/D^2H = a + b/D^2H$

12. $V/D^2H = a + b/D^2 + cH/D^2 + dH$

13. $V/D^2H = a + b/D^2H + c\,H + d/D^2$

14. $V/D^2 = a + b = D^2H + c\,H + d/D$

where V, D and H are as given above, a is the regression constant and b, c and d are regression coefficients. The logarithmic functions are logarithms to the base e (natural logarithms).

These models were run first with imperial data. Results are shown in Table 3.3. The regression models of best fit were selected on the basis of lowest furnival index and highest multiple correlation cofficient.

For a one-way table, the model of best fit was No.7 (Furnival index = 3.27).

Substituting computed values for a and b in model 7 results in the equation (in imperial units):

$$\text{Log}(V) = 2.24074\,\text{Log}(D) - 2.52685 \quad \ldots\ldots\ldots\ldots (1)$$

For a two-way table (incorporating both D and H), the model of best fit was No.8 (Furnival index = 2.67).

Substituting computed values for a, b, and c results in the equation :

$$\text{Log}(V) = 1.82851\,\text{Log}(D) + 0.735381\,\text{Log}(H) - 4.55 \ldots (2)$$

Analyses of variance for regressions (1) and (2) are given in Tables 3.4 and 3.5 respectively.

Substituting girth at breast height (G) instead of diameter (D), the equations (still in imperial units) become :

$$\text{Log}(V) = 2.24074\,\text{Log}(G) - 5.09189 \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$\text{Log}(V) = 1.82851\,\text{Log}(G) + 0.735381\,\text{Log}(H) - 6.6431485 . (4)$$

The same models were run again with metric data to derive metric equations. Firstly, for a one-way table:

$$\text{Log}(V) = 2.24074\ \text{Log}(D) - 8.179774 \qquad (5)$$

and, secondly, for a two-way table:

$$\text{Log}(V) = 1.82851\ \text{Log}(D) + 0.735381\ \text{Log}(H) - 8.9449526 \qquad (6)$$

For two tables only (Volume against Diameter and Volume against Diameter and Height, both in imperial units), confidence limits have been computed to give the user some idea of the precision to be expected from the regression models used.

CONVERSION FACTORS

For conversion of volume overbark to volume underbark, total volume to volume for various top-diameter limits and determination of branchwood volume as a proportion of total volume, conversion factors have been computed. All factors (F) are predicted from diameter at breast height overbark (D) and are meant to be applied to total volume overbark in the appropriate imperial or metric units.

Twelve regression models were examined :

1. $Y = a+bX$
2. $Y = a+b/X$
3. $Y = a+bX+cX^2$
4. $Y = a+be^{-cx}$
5. $Y = a\ 1 - e^{-bx}$
6. $Y = a+b\ (X^c)$
7. $Y = a\ (X^b)$
8. $Y = 1/(a+bX)$
9. $Y = X/(a+bX)$
10. $Y = 1/(a+be^{-cx})$
11. $Y = a/(1-e^{-bx})^c$
12. $Y = X/(a-bX+c^2)$

where X = D, and Y represents, in turn decimal factors (F) for the ratios :

i) Total Volume underbark: total volume overbark,

ii) Volume to 2 in. or 5cm. top diameter: total volume overbark,

iii) Volume to 4 in. or 10cm. top diameter: total volume overbark,

iv) Volume to 6 in. or 15cm. top diameter: total volume overbark,

v) Volume to 8in. or 20cm. top diameter: total volume overbark,

vi) Branchwood volume: total volume overbark.

and e^x is the exponential function.

Factors were computed in both metric or imperial units, as appropriate. Below are given the regression equations of best fit :

Firstly, for imperial units :

Underbark volume (Model 3):

$$F = 0.7653916 + 0.009084665D - 0.0002084166D^2 \ldots\ldots(7)$$

(This equation is meant to be applied to maximum D of 20in. then held constant, for larger diameters, at a value of o.864).

Volume to 2in. top-diameter (Model 6):

$$F = 0.999391 - (3.371329D)^{-3.148441} \ldots\ldots\ldots\ldots\ldots(8)$$

Volume to 4in. top diameter (model 6):

$$F = 0.9940039 - (76.51808D)^{-3.231572} \ldots\ldots\ldots\ldots\ldots(9)$$

Volume to 6in. top diameter (Model 11)

$$F = 0.9567597\ (1-e^{-0.6795386D})^{604.5896} \ldots\ldots\ldots\ldots\ldots(10)$$

Branchwood volume (Model 12)

$$F = D/(130.6549-15.51663D+ 1.082542D^2) \ldots\ldots\ldots\ldots\ldots(12)$$

where F is the decimal factor to be applied to total volume overbark, in imperial units. (Graphical representations of these regressions are presented in Figures 1-6).

Secondly, for metric units :

Underbark volume (Model 3):

$$F = 0.7653916+0.00357664D-0.00003230464D^2 \quad \text{..........(13)}$$

Volume to 5cm. top diameter (Model 6):

$$F = 0.999391-(72.85429D)^{-3.148441} \quad \text{..................(14)}$$

Volume to 10cm. top diameter (Model 6):

$$F = 0.9940039-(1556.2135D)^{-3.231572} \quad \text{...............(15)}$$

Volume to 15cm. top diameter (Model 11):

$$F = 0.9567597\ (1-e^{0.261233D})^{106.1058} \quad \text{..............(16)}$$

Volume to 20cm. top diameter (Model 11):

$$F = 0.9219663\ (1-e^{-0.26753488D})^{604.5896} \quad \text{...........(17)}$$

Branchwood volume (Model 12):

$$F = D/(130.6549-6.10890945D+0.16779435D^2) \quad \text{..........(18)}$$

where F is the decimal factor to be applied to total volume overbark, in metric units.

VOLUME TABLES

For greatest precision, the regression formulae should be applied directly, using a desktop calculator. Where this is not possible or where less precision is acceptable, the user may consult the attached tables, or use these tables to construct curves from which values between those listed in the tables can be read. Tables available are

Metric units :

1. Total volume overbark : one-way table with D given in 2cm. intervals from 6cm. to 132cm. inclusive (Table 3.6).

2. Total volume overbark : two-way table with D given in 2cm. intervals from 6cm. to 132cm. inclusive and H given in 2m. intervals from 5m. to 41m. inclusive (Table 3.7).

3. Conversion factors to be applied to total volume overbark to obtain total volume underbark and volume to 5, 10, 15 and 20cm. top diameter limits and branchwood volume, with D given in intervals of 1cm. from 5cm. to 75cm. inclusive (Table 3.8).

Imperial Units :

1. Total volume overbark: one-way table with D given in 1in. intervals from 2in. to 52in. inclusive and including 95 percent confidence limits. (Table 3.9).

2. Total volume overbark: two-way table with D given in 1in. intervals from 1in. to 52in. inclusive and H given in 5ft. intervals from 15ft. to 130ft. inclusive and including 95 percent. confidence limits (Table 3.10).

3. Total volume overbark: one-way table with G given in 3in. intervals from 6in. to 162in. inclusive (Table 3.11).

4. Total volume overbark: two-way table with G given in 5ft. intervals from 15ft. to 130ft. inclusive (Table 3.12).

5. Conversion factors to be applied to total volume overbark to obtain total volume underbark and volume to 2, 4, 6 and 8in. top diameter limits and branchwood volume with D given in intervals of 1in. from 2in. to 50in. inclusive (Table 3.13).

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