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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DIPTEROCARPUS TURBINATUS GAERTN.F. (TELI GARJAN)
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CHAPTER 2

TREE VOLUME VOLUME TABLES FOR *SYZYGIUM GRANDE* (WT.) WALD (DHAKIJAM)

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INTRODUCTION

Dhakijam (Syzygium grande Wt. Wald) is a moderate sized tree. It occurs mainly in the natural and plantation forests of Sylhet, Chittagong, Chittagong Hill Tracts and Cox's Bazar Forest Divisions. The timber is medium textured, strong and hard, not difficult to saw and takes a good finish. The timber is suitable for construction work, house building and sleepers.

DATA AND TRACT COVERED

Data for preparation of these tables were collected from the plantation forests of Chittagong, Cox's Bazar and Chittagong Hill Tracts Forest Divisions (Table 2.1). Five-year age gradations and five-centimetre (two-inch) diameter classes were taken. Diameter at breast height (D), total height (H) and diameter at intervals of 3.05m (10ft.) up the trunk from a point 30cm (1ft .) above the ground level were measured in imperial units. Diameters were corrected to the nearest 0.25cm (0.1 inch) and heights to the nearest 30 cm (1ft.). The trees were measured up to a top diameter of 20cm (8in). 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 Dhakijam. 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 used in construction of the volume tables was 314, distributed in diameter and height classes as shown in Table 2.2.

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 over bark (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 cms 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 matrix 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. $V/D^2 = a + b/D$
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. $V/D^2 = a + b/D^2 + cH/D + dH$
15. $V/D^2H = a + b/D^2H + c/H + d/D$

where V, D and H are 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 2.3. The regression model of best fit was selected on the basis of lowest furnival index.

For a one-way table, the model of best fit was No.9 (Furnival index = 1.61).

Substituting computed values for a, b, and c in model 9 results in the equation in imperial units):

$$V/D^2 = 0.178721 + 0.194971/D^2 - 0.253102/D$$
$$\text{or } V = 0.178721D^2 + 0.194971 - 0.253102D \quad \ldots\ldots \quad (1)$$

For a two-way table (incorporating both D and H), the model of best fit was No.14 (Furnival index = 1.18).

Substituting computed values for a, b, c and d in model 14 results in the equation:

$$V/D^2 = 0.00681399 + 0.00670617/D^2 + 0.0068048 4H/D + 0.00169227H$$
$$\text{or } V = 0.00681399D^2 + 0.00670627 + 0.0068048 4DH + 0.001699227D^2H \quad \ldots\ldots \quad (2)$$

Analyses of variance for regressions (1) and (2) are given in Tables 2.4 and 2.5 respectively.

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

$$V = 0.178721\ G^2 + 0.0620612 - 0.0256446\ G \quad \ldots\ldots \quad (3)$$
$$V = 0.00681399\ G^2 + 0.000679477 + 0.00216605\ GH + 0.000171463\ G^2H \quad \ldots\ldots \quad (4)$$

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

$$V = 0.00506138\ D^2 + 0.00217385 - 0.00111102\ D \quad \ldots\ldots \quad (5)$$

secondly, for a two-way table:

$$V = 0.00019297\ D^2 + 0.000029437 + 0.0002489\ DH + 0.0000243726\ D^2H \quad \ldots\ldots \quad (6)$$

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 (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. $Y = X/(a + bX + cX^2)$

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 8 in. or 20cm. top diameter: total volume overbark;

vi) Branchwood volume: total volume overbark.

and ex is the exponential function.

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

Firstly, for <u>imperial units</u>:

Underbark volume (Model 12):

$$F = D/(- 0.092642 + 1.281747D = 0.007311588D^2) \quad \ldots\ldots\ldots (7)$$

Volume to 2 in. top diameter (Model 11):

$$F = 0.99798(1 - e^{-0.7671276D})^{1.715096} \quad \ldots\ldots\ldots (8)$$

Volume to 4 in. top diameter (Model 11):

$$F = 0.98404(1 - e^{-0.614798D})^{16.65083} \quad \ldots\ldots\ldots (9)$$

Volume to 6 in. top diameter (Model 11):

$$F = 0.952015(1 - e^{-0.586599D})^{57.51946} \quad \ldots\ldots\ldots (10)$$

Volume to 8 in. to diameter (Model 11):

$$F = 0.940938(1 - e^{-0.4412536D})^{66.24374} \quad \ldots\ldots\ldots (11)$$

Branch wood Volume (Model 3):

$$F = - 0.0497893 + 0.028307D - 0.00129911\ D^2 \quad \ldots\ldots\ldots (12)$$

where F is the decimal factor to be applied to total volume overbark, in imperial units. Graphical representations of these regressions are given in Figures 2.1 - 2.6).

Secondly, for <u>metric units</u>:

Underbark volume (Model 12):

$$F = D/(- 0.235311 + 0.5046248\ D - 0.0185714\ D^2) \quad \ldots\ldots\ldots (13)$$

Volume to 5cm. top diameter (Model 11):

$$F = 0.99798(1 - e^{-0.30201874\ D})^{1.7115096} \quad \ldots\ldots\ldots (14)$$

Volume to 10cm. top diameter (Model 11):

$$F = 0.98404(1 - e^{-0.24184241\ D})^{16.65083} \quad \ldots\ldots\ldots (15)$$

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

$$F = 0.952015(1 - e^{-0.2309444882D})^{57.51946} \quad \ldots\ldots\ldots (16)$$

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

$$F = 0.940938(1 - e^{-0.17372189\ D})^{66.24374} \quad \text{.....(17)}$$

Branch wood Volume (Model 3):

$$F = -0.0497893 + 0.0111444881D - 0.000201362452D^2 \quad \text{.....(18)}$$

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 to stand data, 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 in the tables can be read. Tables available are:

Metric units:

1. Total volume overbark : one-way table with D given in 1 cm. intervals from 5 cm. to 75 cm. inclusive (Table 2.6).

2. Total volume overbark : two-way table with D given in 1 cm. intervals from 5 cm. to 75 cm. inclusive and H given in 2 m. intervals from 4 m. to 46 m. inclusive (Table 2.7).

3. Conversion factors to be applied to total volume overbark to obtain total volume underbark and volume to 5, 10, 15 and 20 cm. top-diameter limits and branchwood volume with D given in intervals of 1 cm. from 5 cm. to 100 cm. inclusive (Table 2.8).

Imperial Units.

1. Total volume overbark : one-way table with D given in 1 in. intervals from 2 in. to 24 in. inclusive and including 95 percent confidence limits (Table 2.9).

2. Total volume overbark : two-way table with D given in 1 in. intervals from 2 in. to 24 in. inclusive and H given in 5 ft. intervals from 10 ft. to 100 ft. inclusive and including 95 percent confidence limits (Table 2.10).

3. Total volume overbark : one-way table with G given in 1 in. intervals from 5 in. to 75 in. inclusive (Table 2.11).

4. Total volume overbark : two-way table with G given in 1 in. intervals from 5 in. to 75 in. inclusive and H given in 5 ft. intervals from 10 ft. to 100 ft. inclusive (Table 2.12).

5. Conversion factors to be applied to total volume overbark to obtain total volume underbark and volume to 2, 4, 6 and 8 in. top diameter limits and branchwood volume with D given in intervals of 1 in. from 2 in. to 50 in. inclusive (Table 2.13).

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