TREE VOLUME TABLES FOR FOUR SPECIES GROWN IN PLANTATIONS IN BANGLADESH

SYZYGIUM GRANDE (WT.) WALD (DHAKIJAM)
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CHAPTER 5

TREE VOLUME TABLES FOR *DIPTEROCARPUS TURBINATUS* GAERTN. F. (TELI GARJAN)

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INTRODUCTION

Teli Garjan (Dipterocarpus turbinatus Gaertn. f.) is a tall evergreen tree. It attains a height of 45m. (150ft.) or more, and a girth of 4.5m (15ft.) or more, with a long, clean cylindrical bole and an elevated crown; the bark is light grey, yellowish brown inside, exfoliating in irregular rounded flakes. The wood is used mainly for boat-making, dugout canoes, planking, construction, etc. The tree is tapped for wood-oil.

DATA AND TRACT COVERED

Data for preparation of these tables were collected from the plantation forests of Chittagong, Cox's Bazar and Sylhet Forest Divisions (Table 5.1). Five-year age gradations and five-centimetre (2in.) diameter classes were taken. Diameter at breast height (D), total height (H) and diameter at intervals of 3.05m. (10ft.) up the trunk from point 30cm. (1ft.) above ground level were measured in imperial units. Diameters were correct to the nearest 0.25cm. (0.1in.) and heights to the nearest 30cm. (1ft.). The tree were measured up to a top dimater of 20cm. (8in.). At each measure point, bark thicknesses were measured 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 Teli Garjan. 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 total number of trees was 436, distributed in diameter and height classes as shown in Table 5.2.

COMPILATION

Following collection, the data were sent to Commonwealth Forestry Institute, Oxford, U.K. for processing. Individual tree volume data were recast by computer to privide total volume under-bark (UB) and over-bark (OB) and to top diameter limits of 5, 10, 15 and 20cm. (2, 4, 6 and 8in.) using a graphical method. Over-bark branch volume was computed for each tree. Tables also were developed to read conversion factors for OB to UB total volume, volumes to four different top diameter limits and branch wood volume, by prediction from diameter, in metric and imperial units.

Functions and ratios of the primary variables of total height (H), diameter at breast height (D) and total volume OB (V) were derived for testing in regression analuses. These functions and ratios were D^2, V/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 and Log (H).

Fifteen models were tested, after checking the correlation matrices of all primary and derived variables. These models were:

1. $V = a + b\,D$
2. $V = a + b\,D + c\,D^2$
3. $V = a + b\,D^2$
4. $V = a + b\,D^2H$
5. $V = a + b\,D^2 + cH + d\,D^2H$
6. $V = a + b\,D^2 + c\,DH + d\,D^2H$
7. $\text{Log}(V) = a + b\,\text{Log}(D)$
8. $\text{Log}(V) = a + b\,\text{Log}(D) + c\,\text{Log}(H)$

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

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

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

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

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

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

15. $V/D^2H = a + b/D^2H + c/H + d/D$

Where a = regression constant and

b, c, d = regression coefficients,

and logarithmic functions are to the base e.

The models were run with imperial data for selecting those of best fit. The equation of best fit was selected on the basis of the following considerations:

(a) highest correlation coefficient (R)

(b) lowest furnival index (F.I.), which is the standard deviation of the deviations of estimates from actual values.

Regression model 14 was found to be the best fit for a two-way table (F.I. = 1.47) (Table 5.3). Substituting the computed values for a, b and c in the model results in the equation:

$V = 0.0890463 + 0.022793D^2 + 0.00404101\,DH + 0.0016713+DH$ for imperial units, and

$V = 0.000390878 + 0.000645\,49776D^2 + 0.000147827DH + 0.00002407D^2H$ for metric units.

For a one-way table, model 7 was found to be best fit (F.I. = 1.82) (Table 5.3). Substituting the computed values for a and b in the model results in the equations:

Log (V) = 2.35556 Log (D) - 2.75168 for imperial units, and

Log (V) = 2.35556 Log (D) - 8.51163 for metric units.

Analyses of variance of the regressions are given in Tables 5.4 and 5.5.

The equations have been modified for use with girth at breast height (G), if required, by substituting for diameter (d), as follows :

$$V = 0.022793 + 0.0090222765G^2 + 0.00128629GH + 0.000169342G^2H$$

and

$$\text{Log}(V) = 2.35556 \text{ Log}(G) - 448158$$

for two-way and one-way tables, respectively, in imperial units.

CONVERSION FACTORS

These factors have been developed for conversion of volume OB to volume UB; total volume to volume for various top diameter limits and determination of branch wood volume as a proportion of total wood volume. All the factors have been predicted from D for application to total volume OB in metric or imperial units as appropriate. The following regression models were examined :

1. $y = a + bx$
2. $y = a + b/x$
3. $y = a + bx + cx^2$
4. $y = a + b\, e^{-cx}$
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, $x = D$, e^x = exponential function and y represents in turn the decimal factors (F) for the following ratios:

i) Total volume UR: Total volume OB

ii) Volume to 2 in or 5cm top diameter: Total volume OB

iii) Volume to 4in. or 10cm. top diameter: Total volume OB

iv) Volume to 6in. or 15cm. top diameter: Total volume OB

v) Volume to 8in. or 20cm. top diameter: Total volume OB

vi) Branch wood volume: Total volume OB.

The factors were computed in metric as well as imperial units. The following equations of best fit were obtained.

Equations of the conversion factors:

Volume UB (Model 3) -

$F = 0.7549622 + 0.00302795D - 0.0000195105D^2$ (Metric)

$F = 0.7549622 + 0.007691D - 0.000125874D^2$ (Imperial)

to a maximum of 75cm. or 30in , respectively.

Volume upto 5cm./2in. top diameter (Model 6) -

$F = 0.999379 - 3.468647D - 0.3558229D^{-167.707}$ (Metric)

$F = 0.999379 - 6.611901D^{-3.468647}$ (Imperial)

Volume upto 10cm./4in. top diameter (Model 11) -

$F = 0.9817652\ (1 - e^{-0.3558229D})^{69.50948}$ (Metric)

$F = 0.9817652\ (1 - e^{-0.9037903D})^{69.50948}$ (Imperial)

Volume upto 15cm./6in. top diameter (Model 11) -

$F = 0.9567033\ (1-e^{-0.29757685})^{273.6787}$ (Metric)

$F = 0.9567033\ (1-e^{-0.7558452D})^{273.6787}$ (Imperial)

Volume upto 20cm./8in. top diameter (Model 11) -

$F = 0.9280634\ (1-e^{-0.27812992})^{1156.116}$ (Metric)

$F = 0.9280634\ (1-e^{-0.70645D})^{1156.116}$ (Imperial)

Volume of branch wood (Model 11)

$F = 0.03835995\ (1-e^{-0.04170208660D})^{4.103903}$ (Metric)

$F = 0.03835995\ (1-e^{-0.1059233D})^{4.103903}$ (Imperial)

Where F is the decimal factor to be multiplied with the total volume OB to calculate the appropriate volume.

VOLUME TABLES

Volume can be calculated from the one-variable or two-variable regression equations, as appropriate, using an electronic calculator. It can also be found from the tables if less precision is acceptable. The tables have been constructed in metric as well as imperial units as follows:

Metric Units

a. One way tables -

Provides total volume OB in cu.m. with D given in 1cm. intervals from 5cm. to 75cm. (Table 5.6).

b. Two-way table -

This table provides total volume OB in cu.m. with D given in 1cm. intervals from 5cm. to 75cm. and H given in 2m. intervals from 4m. to 46m. (Table 5.7).

c. Conversion factors.

These decimal factors are to be applied to total volume OB to obtain total volume UB and volumes to 5, 10, 15 and 20cm. top diameter limits and branch wood, as appropriate. These conversion factors are provided against D from 5cm. to 75cm. in 1cm. intervals (Table 5.8).

Imperial Units

a. One-Way tables -

i) Provides total volume OB in cu.ft. with D given in inches, from 2in. to 24in. Confidence limits at the 95% level also have been provided against D from 2in. to 22in. at 5in. intervals (Table 5.9).

ii) Provides total volume OB in cu.ft. with G given in inches, from 5in. at 1in. intervals (Table 5.10).

b. Two-way tables -

i) Provides total volume OB in cu.ft. with D given in inches, from 2in. to 24in. and H given in feet, from 10ft. to 100ft. at 5ft. intervals. Confidence limits at the 95% level are provided also against D from 2in. to 22in. at 5in. intervals (Table 5.11).

ii) Provides total volume OB in cu.ft. with G given in inches from 5in. to 75in. at 1in. intervals and H given in feet from 10ft. to 100ft. at 5ft. intervals (Table 5.12).

c. Conversion factors -

These decimal factors are to be applied to total volume OB to determine total volume UB and volumes to 2, 4, 6 and 8in. top diameter limits and branch wood volume. The conversion factors are provided against D given in inches from 2in. to 30in. in 1in. intervals (Table 5.13).

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