INDIAN JOURNAL OF FORESTRY Vol. 16(4): 323-327. 1993

BIOMASS TABLES FOR *ACACIA AURICULIFORMIS* GROWN IN THE PLANTATIONS IN BANGLADESH

M. A. Latif and M.A. Habib
Bangladesh Forest Research Institute,
P.C. Box 273, Chittagong, Bangladesh.

Abstract

Acacia auriculiformis A. Cunn. ex Benth. (*Akashmoni*) is a promising fast growing tree species of the family *Leguminosae*. The species has been successfully introduced in Bangladesh and is being planted. An attempt was made to prepare the biomass tables for the species. Biomass equations were selected to estimate the green weight of the whole tree, weights of the stem, the branches and leaves + twigs. Diameter at breast height (D) - biomass and D- height - biomass relation ships were determined. It was observed that the logarithmic function to the base e gives good fit model for the same. Conversion factors were also determined to estimate the air-dry and oven-dry weight of the components.

Introduction

Acacia auriculiformis A. Cunn. ex Benth. (Akashmoni) is a promising fast growing tree species of the family *Leguminosae*. It is a vigorously growing small tree with generally crooked trunk up to 60.0 cm in diameter (Anon.,1980). The species is native to the savannahs of Papua New Guinea, island of the Torres strait and Northern Australia. Because of its ability to grow on very poor soils, it has been introduced into many countries including Bangladesh. The wood is well suited for fuelwood with high specific gravity (0.6-0.75) and a calorific value of 4800-4900 kcal per kg. The wood is also good for making excellent charcoal. The tree may also be used to produce woodpulp, as ornamental and shade tree.

The plantations raised in Bangladesh for fuelwood are ready for harvesting. But, there is no table available to estimate the biomass of the felled trees of the species. Therefore, an attempt was made to prepare biomass tables for the species in Bangladesh.

Material and Methods

Scattered plantations of akashmoni are available all over Bangladesh. The species is generally planted at a spacing of 1.83 m X 1.83 m. It was observed that maximum of the trees fall within the dbh range of 5-20 cm. This range was divided into 5-cm dbh classes, and an attempt was made to collect data of at least 30 trees from each class. Larger trees were also included whenever available. Trees having average to better stem form in a plantation were selected at random for data collection.

Diameters at breast height (dbh) of the standing trees were measured by diameter tape. Then the trees were felled leaving 7-10 cm stump and total length (height) was measured. Each selected tree was divided into three parts; the stem with bark on, the branches, and leaves and twigs. The stem and the branches were cut into 2-4 metre billets and weighed using a spring balance. Leaves, twigs and small branches were tied into suitable bundles and weighed with the same spring balance. A small billet of the stem was removed from a position at about

30% of the tree height in the stem, weighed and labelled for determination of dry weight. Small samples of green leaves including twigs and branches were also taken, weighed, bagged and labelled for the same. Air-dry weights of these samples were taken after six months storage in shade. Then the samples were oven-dried to a constant weight. Extrapolation was done to find out conversion factors to estimate the air-dry and oven-dry weights. The dbh-height class distribution of the sample trees are given in Table 1.

The collected data were summarized to obtain the above ground total green biomass (Total), weight of the stem (stem), branches (B) and leaves including twigs (LT) for individual tree. The following original and transformed variables were used to select the best suited regression models:

Dependent variables: B, log(B), B/D^2 and B/D^2H --(1)

Independent variables: D, D^2, H, D^2H, DH, log(D), log (H), $1/D^2$, 1/D, $1/D^2H$, H/D^2 and H/D -- (2)

Where: D is diameter at breast height in cm
H is total height in m
B is total green weight (biomass) of the component in kg/tree

The above mentioned four components of biomasses and their transformations given in (1) were regressed with all the independent variables, dbh and height and their transformations given in (2) and best relationships were selected by the step-wise regression techniques. All the 15 models used to develop the volume equations (Latif and Islam, 1984) were also tried where biomasses were considered in place of volumes. The regression models of best fit for each component were then chosen comparing various parameters describing the regressions, including high coefficient of determination, high F-value and minimum mean-square error.

Table-1: Diameter at breast height and total height class distribution of the sample trees

Dbh class (cm)	Height Class in Metres Number of trees in each dbh class						
	6	8	10	12	14	16	Total
5-10	10	21	21	5			57
10-15		3	10	23	15		51
15-20			1	12	8	4	25
20-25				4	2		6
Total	10	24	32	44	25	4	139

Validation of the selected models: Data were also collected from 35 sample trees representing all the dbh and height classes for the purpose of validation of the provisionally selected models. The actual biomasses of these trees were collectively compared with the corresponding biomasses predicted by the selected models. The comparisons were made with the help of the absolute deviation per cent, paired t-test, chi-square and 45 degree line test (Islam *et al.*, 1992).

Results and Discussions

Regression models were selected for estimating the above ground green biomass of the total tree; the stem; the branches and

e-2: The selection and validation statistics of best suited regression equations for the estimating biomass produced by individual tree of akashmoni in plantations in Bangladesh

election statistics	R^2	MSE	F-ratio	Validation statistics Absolute deviations (%)	t-value	MSE	slope (degree)
Total 1	0.9674	0.0000	921.0	0.9	0.29	420.48	45.8
Total 2	0.9860	0.0084	1127.7	0.6	0.44	95.26	44.7
Stem 1	0.9698	0.0218	995.4	8.5	1.56	241.34	44.7
Stem 2	0.9830	0.0119	924.1	9.0	2.00	146.58	43.5
B 1	0.6219	0.2576	51.0	7.6	1.56	115.87	47.8
B 2	0.5995	0.2643	25.0	7.1	2.00	245.81	46.9
LT 1	0.7410	0.1588	88.6	10.0	2.00	157.93	40.0
LT 2	0.7900	0.1225	62.4	10.0	1.99	203.58	40.0

Where, 1 = Equation derived for one-way (Biomass-dbh)
2 = Equation derived for two-way (Biomass-dbh-height)
Total = Green weight of the above ground whole tree including stem, branches, leaves and twigs excluding 7-10 cm stump.
Stem = Main stem upto top diameter of about 2.0 cm overbark.
B = Branches with diameter approximately more than 3.0 cm.
LT = Leaves and twigs.

leaves + twigs. The selection and validation statistics are given in Table-2.

The equations of best fit were found out for biomass on diameter at breast height (dbh, D), and biomass on dbh and total height. The selected regression equations are:

log (total 1) = - 1.3577 + 2.4177*log (D)
log (total 2) = - 2.2782 + 1.9736*log (D)+ 0.8113*log(H)
log (stem 1) = - 2.3176 + 2.6075*log (D)
log (stem 2) = - 3.1661 + 2.1982*long (D) + 0.7477*log(H)
log (B 1) = - 2.2156 + 2.0303*log (D)
log (B 2) = - 2.5759 + 1.8565*log (D) + 0.3175*log (H)
log (LT 1) = - 2.1982 + 2.1005*log (D)
log (LT 2) = - 3.8776 + 1.2902* log (D) + 1.48*log (H)

Where: D is diameter at breast height in cm H is total height in m and others are as described earlier.

It was observed that the two-way biomass equations (biomass-dbh-height relationships) of akashmoni do not explain considerably higher percentage in comparison to one-way biomass equations (biomass - dbh relationships). Therefore, biomass tables based on dbh are given in Table-3. The two-way equations are given for use by the interested persons.

The biomass equations for each of the four component biomasses were derived independently. The component prediction

Table-3: Predicted biomass of individual felled akashmoni tree in the plantations in Bangladesh

Dbh (cm)	Green biomass in kg total	stem	leaves & twigs	branches
2	1.4	0.6	0.5	0.4
3	3.7	1.7	1.1	1.0
4	7.3	3.7	2.0	1.8
5	12.6	6.5	3.3	2.9
6	19.6	10.5	4.8	4.1
7	28.4	15.7	6.6	5.7
8	39.2	22.3	8.8	7.4
9	52.2	30.3	11.2	9.4
10	67.3	39.9	14.0	11.7
11	84.7	51.2	17.1	14.2
12	104.6	64.2	20.5	16.9
13	126.9	79.1	24.3	19.9
14	151.8	95.9	28.4	23.2
15	179.4	114.9	32.8	26.6
16	209.7	135.9	37.5	30.4
17	242.8	159.2	42.6	34.4
18	278.8	184.8	48.1	38.6
19	317.7	212.7	53.9	43.1
20	359.6	243.2	60.0	47.8
21	404.7	276.2	66.5	52.8
22	452.8	311.8	73.3	58.0
23	504.2	350.1	80.5	63.5
24	558.8	391.2	88.0	69.2
25	616.8	435.1	95.9	75.2

Table-4: Conversion factors for estimating different forms of biomasses of akashmoni in the plantations of Bangladesh

	Conversion factor
For totals	
Air-dry : Total biomass	0.537
Oven-dry : Total biomass	0.375
Stem wood: Total biomass	0.649
Leaves and twigs: Total biomass	0.211
Branches : Total biomass	0.140
Leaves and twigs	
Air-dry : Green biomass	0.394
Oven-dry : Green biomass	0.337
Main stem	
Air-dry : Green biomass	0.582
Oven-dry : Green biomass	0.387

are not additive (Kozak, 1970). This means, for example, that the predicted weight of stem plus the branches may not be equal to the predicted values for stem and branch. To overcome this limitation, the biomasses were calculated for individual components as well as for combination of the components (Hawkins, 1987).

Conversion factors: Conversion factors (F) were computed to estimate the total air-dry biomass, total oven-dry biomass, weight of leaves including twigs and small branches from total above ground green biomass (Table 4).

Confidence limit: Extrapolation much outside the range of height and diameter indicated by the stand table should only be done with caution. These biomass tables should not be used to estimate the biomass of an individual tree in a stand. The mean height and diameter of the stand should be calculated first. Then this mean may be used to read of the mean tree biomass. The mean tree biomass should then be multiplied by the number of stems in a stand to get the total biomass of the stand (Davidson and Choudhury, 1984).

Acknowledgements

The authors are grateful to Mr. M.N.A. Katebi, Chief Conservator of Forests for allowing to fell the trees for data collection and also all the officers and staff of Forest Department who had rendered their cooperation at the time of data collection. The authors are very much thankful to the officers and staff of Forest Inventory Division for their help and cooperation at different stages in preparing the manuscript. Special thanks are also due to Mr. N.A. Reza, Senior Research Officer of BFRI for his assistance with necessary computer program and Mr. M.K. Alam, Senior

Research Officer of BFRI for his suggestions to improve the manuscript. The authors also acknowledge the financial support extended by Bangladesh Agricultural Research Council, Dhaka for the present study.

References

Anonymous (1980). *Firewood crops, Shrub and Tree species for energy production.* National Academy of Sciences. Washington D.C. 120-121.

Davidson, J. and Choudhury, J.H. (1984). Guide for using tree volume tables. In: Tree volume tables for four species grown in plantations in Bangladesh. Bulletin no. 2. Inventory Division, Bangladesh Forest Research Institute, Chittagong. 1-24.

Hawkins, T. (1987). Biomass and volume tables for *Eucalyptus camaldulensis, Dalbergia sissoo, Acacia auriculiformis* and *Cassia siamea* in the central Bhabar - Terai of Nepal. Oxford Forestry Institute Occasional Paper no. 33. Nepal/UK For. Res. Proj., Dep. For Kathmandu. Nepal. 43pp.

Islam, S.S.; Reza, N.A. and Waziullah, A.K.M. (1992). Validation of the existing volume tables of teli garjan (*Dipterocarpus turbinatus* in Bangladesh. *Bangladesh Jor. For. Sc.* (In press).

Kozak, A. (1970). Methods for ensuring additivity of biomass components by regression analysis. *For. Chron.*, **45:** 1-3.

Latif, M.A. and Islam, M.H. (1984). Tree volume tables for *Syzygium grande* (Wt.) Wald. (dhakijam). In: Tree volume tables for four species grown in plantations in Bangladesh. Bulletin no. 2. Inventory Division, Bangladesh Forest Research Institute, Chittagong. 25-57.