Biomass Models for *Bambusa bambos* - Grown in the Plantations in India

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Abstract

Bambusa bambos has been successfully planted in India to increase the productivity of bamboos. To prepare the biomass models for this species, equations were selected to estimate the green weight of the whole bamboo culm, weights of the branches, leaves, and rhizomes. Diameter and height (DH) were found to be closely correlated with total above ground biomass and therefore selected for the prediction of total biomass.

সারসংক্ষেপ

বাঁশের উৎপাদন বৃদ্ধিকল্পে ভারতে *Bambusa bambos* প্রজাতির বাঁশের চাষ সফলভাবে করা হয়েছে। উক্ত প্রজাতির বায়োমাস মডেল (biomass models) প্রণয়ণের জন্য সম্পূর্ণ কাণ্ডের (whole bamboo culm) কাঁচা অবস্থায় ওজন, কঞ্চি, পাতা ও মোথার ওজন নির্ণয়ের জন্য বায়োমাস সমীকরণ সমূহ (biomass equations) নির্বাচিত করা হয়। ভূ-উপরিস্থ সম্পূর্ণ বায়োমাসের সংগে ব্যাস এবং উচ্চতার (DH) পারস্পরিক সম্পর্ক দেখতে পাওয়া যায় বিধায় সম্পূর্ণ বায়োমাস নির্ণয়ের জন্য উহাদের নির্বাচিত করা হয়।

Key words : *Bambusa bambos*, bamboo, biomass models, India

Introduction

Bamboo is integral to the culture of South - East Asia. India perhaps, has the world's richest resource of bamboo, claiming about 130 species occurring over an area of 9.57 million hectares. This is about 12.8 per cent of the total forest area of the country. However, bamboo resources in their natural habitat are dwindling due to over exploitation, gregarious flowering, shifting cultivation practices and extensive forest fires.

Artificial plantations of bamboos can ensure sustained bamboo productions. Now many countries are going for bamboo plantations to meet the demands of pulp and paper industries. *Bambusa bambos* plantations have recently been raised in India. Biomass studies may be of interest to the growers to assess the performance of species in terms of total biological production.

For biomass estimation regression equations obviate the difficulty of felling of standing trees (George 1977). Literature survey reveals that almost no work has been done on biomass estimation of bamboos from India. However, a report is available for *Gigantochloa scortechnii* from Malaysia (Othman 1992). So regression equations were worked out on the basis of easily measurable parameters utilizing the actual biomass data of *B. bambos* in plantations. Therefore, an attempt was made to prepare biomass models for *B. bambos* in plantations from India.

Materials and methods

Study area

The study area is a six years old plantation of *B. bambos* at Kallipatty, Tamilnadu, India. The area lies between 11° 28′ and 12°E latitude and 76°, 59′ and 77°47′ N longitude. Its altitude is 540 m above mean sea level. The mean annual rainfall is 600 mm and the mean temperature is 31°C. The soil is laterite, red to brown and sandy loam is texture. The soil pH ranges between 7.4 - 7.8. The total soil concentrations in N, P, K, Ca and Mg were 3800, 360, 1600 and 1800 kg per hectare respectively.

Methods

Data were collected by harvesting culms and rhizomes through random sampling. Samples were collected from age groups of 1 to 6 years old. In each age group 15 sample culms were felled. Total 90 bamboo culms were felled for above ground biomass estimation. For estimating below ground biomass a total of 18 rhizomes, three from each group were excavated. After felling of culms, the total height of each culm, diameter at breast height (DBH), basal area, number of nodes were measured and subdivided into leaves, branches, culms and rhizomes. Fresh weight of the components was estimated in the field and sub samples from each component were brought to the laboratory in plastic bags. The sub samples were then oven dried at 103° + 2°C at a constant weight. From the oven dry weight of the samples, the total standing biomass of each age group was calculated by multiplying the total number of the bamboos of different ages with the average dry weight of the sample. The data obtained were fitted to the prediction equations. The following lineraized curvilinear equations of total yield with one variable (diameter) as with two variables (diameter and height) were derived.

(i) Regression equations with single independent variable

Linearized curvilinear model (Whittaker and Woodwell 1968).

$$\log (Y) = a + b \log (x_1)$$
$$\log (Y) = a + b \log (x_2)$$
$$\log (Y) = a + b \log (x_3)$$
$$\log (Y) = a + b \log (x_4)$$
$$\log (Y) = a + b \log (x_5)$$
$$\log (Y) = a + b \log (x_6)$$

Where Y = biomass (kg), x_1 = diameter (D) ; $x_2 = D^2H$; x_3 = BAH; $x_5 = D^2$; x_6 = BA. a, b = are usual constants and log is to the base e.

(ii) Regression equation with two independent variables

$$\text{Log } Y = a + b_1 \log x_1 + b_2 \log x_2$$

Where Y = biomass (kg).
x_1 = diameter; x_2 = height.
a, b are usual constants.

Results and discussion

Simple correlation co-efficient between pairs of the variables, total yield, diameter (D), height (H), diameter and height (DH), square of diameter and height (D^2H), square of diameter (D^2), basal area (BA), basal area and diameter (BAH) were calculated.

All the correlation co-efficient (except for rhizome and grand total biomass) were highly significant (i.e at 1% level of significance). On the basis of the value of determination of co-efficient, the following regression equation was found to be the best:

$\log y = a + b_1 \log x_1^{(D)} + b_2 \log x_2^{(H)}$ (Table 1)

Note : A regression model was fitted between the oven dry weights of tree components as dependent variable, Diameter and height (DH) as independent variable; the model is $\log Y = a + b \log DH$.

Where Y is oven dry weight of tree components, D is diameter in centimeter is the height in metres.

As far as the leaf, branch, culm and total above ground biomass are concerned, the character diameter and height explain 93 to 99 per cent variation. Whereas it is comparatively lower in other components, (rhizome and grand total biomass). This may be mainly due to only 18 bamboos were evaluated for estimation of rhizome biomass and grand total biomass. Therefore, comparatively lesser variation is explained in case of rhizome and grand total biomass.

Table 1 : Regression equation between diameter and height (DH) and dry weight of component (Y) *Bambusa bambos*.

Component	Regression equation	Determination co-efficient (R^2)
Leaf	$\log y = -1.2293 + 1.0850 \log D + 0.1691 \log H$	0.9324
Branches	$\log y = -0.4210 - 0.5014 \log D + 1.2739 \log H$	0.9523
Culms	$\log y = -0.6464 + 0.9394 \log D + 1.0748 \log H$	0.9870
Total above ground biomass	$\log y = -0.3003 + 0.6804 \log D + 1.0440 \log H$	0.9915
Rhizome	$\log y = -0.1109 - 0.8413 \log D + 0.6500 \log H$	0.8180
Grand total biomass	$\log y = -0.0836 + 0.7943 \log D + 0.7586 \log H$	0.8327

Regarding choice of equations there is almost a silent agreement among the workers on use of allometric regression, which employ exponential or logarithmic form of parameters. Ogawa *et al.* (1965) have given several allometric regressions for stem weight, branch weight and root weight, which are dependent upon log – log models. The weight of leaves and height of trees are related to DBH by reciprocal equations. Crow (1971) concluded that the allometric functions proved superior but convenient linear forms could be applied with only a negligible reduction in reliability.

Othman (1992) reported that diameter square and height (D^2H) were found to be closely correlated with total above ground biomass in *Gigantochloa scortechnii*.

Results of this study indicate that variable height and diameter in combination could be used to predict bamboo biomass with reliable precision.

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References

Crow, T. R. 1971. Biomass and production regressions for trees and woody shrubs common to Enterprise forest. *In.* Zavikovski, J. (ed). *The Enterprise Wisconsin Radiation Forest - Radio Ecological Studies.* pp. 63 - 67.

George. M. 1977. *Organic Productivity and Nutrient Cycling in Eucalyptus Hybrid Plantations.* Ph. D Thesis, Department of Botany, Meerut Univeristy, Meerut, India.

Ogawa, H., Yoda, K., Kira, T., Ogino, K. Shidei, Ratanawongs, D., and Apasutaya, C. 1965. Comparative ecological studies on the three main types of forest vegetation in Thailand. I Structure and Floristic composition. *The South East Asian Studies, Kyoto* 4 : 13 - 48.

Othman, A. R. 1992. Culm composition and above ground biomass of *Gigantochloa scortechnii* stands. Paper presented in the International Symposium on Industrial Use of Bamboo, Beijing, China. 7 - 11 December 1992.

Whittakar., R. H. and Woodwell, G. M. 1968. Dimension and production relations of trees and shrubs in the brookehaven forest. *New York J. Ecol.* 56 : 1 - 25.