NOTES

BIOMASS OF TEAK PLANTATIONS IN TAMIL NADU, INDIA AND COSTA RICA COMPARED

C. Buvaneswaran[1], M. George[2], D. Perez[3,*] & M. Kanninen[4]

[1]*Institute of Forest Genetics and Tree Breeding, Tamil Nadu, India*
[2]*Rain Forest Research Institute, Jorhat, Assam, India*
[3]*Ambiente Tierra S.A., Costa Rica. E-mail:diegoperez@costarricense.cr*
[4]*Center for International Forestry Research (CIFOR), Bogor, Indonesia*

In the present study, prediction equations for biomass were generated from easily measurable parameters such as diameter at breast height (dbh) and total height. Cross validation was carried out between two localities to test whether equations developed for one locality could be used for other localities. Two localities were compared within India and a further comparison was made with teak growing in Costa Rica, Central America.

Based on rainfall, temperature, soil type and other ecological conditions, seven agroclimatic zones have been identified in the state of Tamil Nadu, India (Anonymous 1993). Of the seven agroclimatic zones, the present study was carried out in two, viz. southern and western zones of Tamil Nadu. Man-planted teak stands were selected in both zones for this study. In Tamil Nadu the climate in general is hot and dry. Temperature ranges between 31 and 38 °C. The study area receives an average annual rainfall of 1100 mm. The teak stands in Costa Rica were in the wet and humid zones, with annual temperatures between 21 and 33 °C. Annual precipitation varies between 1600 and 4000 mm.

Data on dry weight of all biomass components of sample trees were used to develop prediction equations from easily measurable parameters such as dbh and total height (h). Per hectare aboveground biomass (agb) was calculated using the allometric models developed in this study. For this, the first step was to calculate foliage, branch, and stem biomass of trees in each dbh class in the sample plots. The second step was to estimate biomass per hectare using the dbh distribution of each sample plot. Five different models, namely, (1) linear ($y = a + bx$), (2) polynomial ($y = a + bx^2 + cx$), (3) logarithmic ($y = a + b \log x$), (4) power ($y = ax^b$) and (5) exponential ($y = ae^{bx}$) were tested using dbh, h and dbh^2h as independent variables (x) but only dbh models were selected at the end. The best-fitting model in each case was selected using r^2, standard error and residual autocorrelation as criteria.

The biomass in Costa Rica has been previously reported by Perez and Kanninen (2003). When comparing teak plantations with ages from 20 to 47 years old in Tamil Nadu with that from 18 to 47 years old in Costa Rica, the foliage, branch and bole biomass distribution followed the pattern shown in Figures 1(a) and (b).

The best-fit equations developed for different tree components are given for southern zone in Table 1 and for western zone in Table 2.

In the present study, the power equations proved superior to other equations as evident from its greater values of coefficient of determination (r^2) as well as from lesser values of standard error for most of the biomass components, both in southern and western zones. Allometric models are widely used for biomass estimation (Kamacharya & Singh 1992). In contrast to our present results, studies of biomass carried out in Costa Rica by Perez and Kanninen (2002, 2003) and Morataya *et al.* (1999), identified linear and logarithmic equations as the best-fit models for estimating biomass components from easy-to-measure variables such as dbh and total height.

It is clear from this study that best-fit models developed for one zone cannot be used for other zones. We agree with Wang *et al.* (1995) that errors in biomass estimation can be reduced to a minimum only by employing site-specific equations. Hence, there is an imperative need to develop predictive equations on a regional basis in order to improve their accuracy.

Received March 2005
** Author for correspondence*

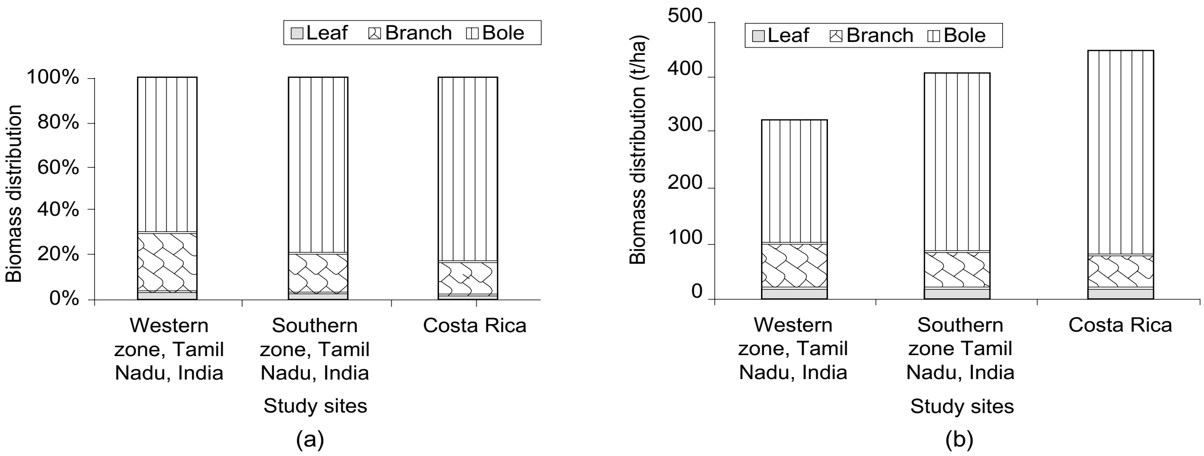

Figure 1 Biomass distribution (a) in percentage of agb and (b) in absolute values (t ha^{-1}) in teak plantations in Tamil Nadu, India and in Costa Rica at comparables ages

Table 1 Best-fit equations developed for predicting biomass in southern zone

Biomass component	Best-fit equation	r^2	Standard error
Leaf	$y = 0.0037x^{2.459}$	0.689	0.393
Branch	$y = 0.0718x^{2.085}$	0.542	0.453
Branch wood	$y = 0.001x^{3.063}$	0.465	0.788
Bark	$y = 0.1065x^2 - 2.1243x + 25.013$	0.794	11.90
Bole	$y = 0.025x^{2.817}$	0.922	0.194
Agb	$y = 0.0904x^{2.551}$	0.938	0.155
Root	$y = 0.097x^{2.023}$	0.830	0.217
Total	$y = 0.142x^{2.469}$	0.943	0.143

Where x = dbh (cm); y = dry weight (kg $tree^{-1}$)

Table 2 Best-fit equations developed for predicting biomass in western zone

Biomass component	Best-fit equation	r^2	Standard error
Leaf	$y = 0.0116x^{2.1524}$	0.710	0.332
Branch	$y = 0.0122x^{2.523}$	0.801	0.355
Branch wood	$y = 0.001x^{3.0634}$	0.465	0.948
Bark	$y = 0.0573x^{1.933}$	0.871	0.195
Bole	$y = 0.0581x^{2.523}$	0.949	0.168
Agb	$y = 0.0785x^{2.578}$	0.965	0.153
Root	$y = 0.185x^2 - 3.747x + 51.498$	0.918	9.748
Total	$y = 0.202x^{2.353}$	0.970	0.130

Where x = dbh (cm); y = dry weight (kg $tree^{-1}$)

ACKNOWLEDGEMENTS

The authors express their sincere gratitude to the World Bank, the Principle Chief Conservator of Forest and the staff of Tamil Nadu Forest Department.

REFERENCES

Anonymous. 1993. *Manual on Agroforestry in Dry Lands.* Directorate of Agriculture, Madras.

Karmacharya, S. B. & Singh, K. P. 1992. Biomass and net production of teak plantations in a dry tropical region in India. *Forest Ecology and Management* 55: 233–247.

Morataya, R., Galloway, G., Berninger, F. & Kanninen, M. 1999. Foliage–biomass–sapwood (area and volume) relationships of *Tectona grandis* L.F. and *Gmelina arborea* Roxb: silvicultural implications. *Forest Ecology and Management* 113: 231–239.

Perez, L. D. & Kanninen, M. 2002. Wood specific gravity and aboveground biomass of *Bombacopsis quinata* plantations in Costa Rica. *Forest Ecology and Manangement* 165: 1–9.

PEREZ, L. D. & KANNINEN, M. 2003. Aboveground biomass of *Tectona grandis* plantations in Costa Rica. *Journal of Tropical Forest Science* 15(1): 199–213

WANG, J. K., ZHONG, A. L., COMEAU, P., TSZE, M. & KIMMIN, J. P. 1995. Above ground biomass and nutrient accumulation in an age sequence of aspen (*Populus tremuloides*) in the boreal white and black spruce zone, British Columbia. *Forest Ecology and Management* 78: 127–138.