VOLUME EQUATIONS FOR FORESTS OF INDIA, NEPAL AND BHUTAN

FOREST SURVEY OF INDIA
MINISTRY OF ENVIRONMENT AND FORESTS
GOVT. OF INDIA
1996

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सत्यमेव जयते

वन महानिरीक्षक एवं विशेष सचिव
भारत सरकार
INSPECTOR GENERAL OF FORESTS &
SPECIAL SECRETARY
GOVERNMENT OF INDIA

FOREWORD

In this "information age" importance of useful data does not require over emphasis. All over the world, including India, concerted efforts are being made to acquire as much relevant data as possible for the better management of natural resources like forests. The development of new technologies and methods to acquire, improve and update information is a natural corollary of this process. At the same time there is need to utilise the already available information, particularly in forest sector, generated through traditional methods.

It is a common knowledge among foresters that statistical data, on forestry particularly on volume equations for different timber species of India, is presently available in a scattered manner. Therefore, a need has long been felt to put together these volume equations in one document. This has been achieved by bringing out this book titled **Volume Equations for Forests of India, Nepal and Bhutan** wherein equations, developed by the Forest Survey of India, the Forest Research Institute and others are being presented together. The effort is praiseworthy not only because such a huge volume of information is presented in one place but also due to the fact that most of the volume equations are generated by the Forest Survey of India itself.

This book should be very useful to the forestry professionals in computing volume of trees and growing stock of forests.

(M.F. Ahmed)
Inspector General of Forests &
Special Secretary to the Govt. of India

New Delhi
14th November, 1996

ACKNOWLEDGEMENTS

During the last few decades with the rapid erosion of natural resources, essentially forests of the world, particularly of the developing countries, much has been written and discussed about the importance of using them sustainably. In order to achieve such a situation, availability of statistically generated adequate information is essential. Extraction from forests or assessment of the stock of timber in them is an essential requirement. Volume estimation are done through volume tables which are generally derived from volume equations. A humble but perhaps valuable effort has been made in this direction at the Forest Survey of India, during a period of more than 30 years. A large number of volume equations have been generated at the Forest Survey of India, the Forest Research Institute and by individuals. They are being presented in this book titled **Volume Equations for Forests of India, Nepal and Bhutan.** There are over 1000 equations on nearly 300 species.

The contributions of Dr. K.D. Singh IFS, S/Shri R.Chandra IFS, G.S. Negi ISS, T.K.T.S. Ramanujacharyulu, D.S. Rawat, M.S. Arora ISS, Sewa Nand ISS, S.K. Chakrabarti ISS, K.S. Gaharwar, K.V.S. Chauhan, R.S. Gondwal, V.P. Malik, N.S. Mathur, S.K. Sen, J.N. Sarkar, N.K. Bhatia, H.K. Tripathi, Suresh Kumar, Ravinder Singh and others of Forest Survey of India (or its precursor organisation PISFR) are acknowledged for the development of volume equations.

Similarly contribution of many others particularly of S/Shri A.N. Chaturvedi IFS, R.P. Sharma IFS, G.C. Pande IFS, S.P. Singh IFS, P.K. Bhattacharya, R.C. Jain and M.C. Mittal who worked in FRI and generated a large number of volume equations are equally acknowledged.

The major effort in bringing out this book in its present form has been from Shri S.K. Chakrabarti ISS, Shri D.L. Meena ISS, Smt. Ranjana Gupta IFS and Shri K.S. Gaharwar with supportive assistance of Shri Deep Kumar Gupta and data entry by Shri I.H. Rizvi.

My most sincere thanks to all the above mentioned and also to all those who collected the field data and processed it at various stages.

(Dr. S.N. Rai)
Director
Forest Survey of India

Dehra Dun
12 Nov, 1996

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Species for which Regional Volume Equations were developed by the Karnataka Forest Department

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INTRODUCTION

The capital of the forests, which is termed as "Growing stock" in forestry parlance, is as important to a forester as any other capital to an enterpreneur. Correct assessment of growing stock is very essential for sound forest management. The annual increase in growing stock (interest on the capital) is harvestable and, more often than not, guides the quantity prescribed for harvesting. For the management purposes, the forester is often concerned with determining the volume of a large number of trees falling within certain dimensions viz. diameter and height classes. This is where the volume tables come into picture, as they help in determining the volume of the trees. Volume tables are based on diameter and/or, height and/or form of the tree. A volume table may, therefore, be defined as a statement giving in tabular form the average volume of trees by girth, diameter, height or form classes. Generally, the volume of standing or felled trees is given. Volume tables are constructed from volume equations.

Trees with identical diameter and height even for the same species do not necessarily have the same volume. The variation in the form of the tree caused by natural forces or the pattern of utilisation is the reason for this. A single volume table that would apply to all conditions and species is therefore not possible. Cubic measures give the best possible approximation for the actual volume of the tree.

TYPES OF VOLUME EQUATIONS

(i) ***Local volume equation*** : The local volume equations have limited application for a forest or small locality and are based only on diameter at breast height(dbh).

The basic assumption involved in preparation of local volume equations is that the trees of same dbh have same height and form. It may be true as all the three dbh, height and form are the products of the site quality, age and other conditions affecting the growth.

A volume equation of this type applied to the sites with similar ecological conditions and productive values gives true result.

(ii) ***Regional volume equation*** : It is normally based on two variables such as dbh and height and covers a wide range of distributions of the species.

(iii) ***General or Standared volume equation:*** It is more broad based and covers the full distribution of the species.

As far as the accuracy under conditions of their application is concerned the first two are as accurate as the standard volume equation. Regional volume equation is a standard volume equation with limited application.

A local volume equation can be easily prepared from a standard or regional volume equation by finding out the dbh/height relationship of the species for the locality.

Preparation of Volume Tables :

Earlier methods of volume table preparation involved large scale data collection pertaining to diameter and height classes and their further processing by averaging, tabulation and graphic treatments. However, the present trend is to use multiple regression methods in which basal area, girth or dbh along with height or form factor is taken into consideration. These methods have certain inherent limitations, nevertheless, they give high degree of correlation and hence, statistically acceptable relationships.

Data Collection :

In respect of every species, effort was made to cover a good range of available diameter. Generally thirty or more trees were measured for the purpose and the equations are based on them.

The trees for measurements were selected at random. Two diameters at breast height (1.37 m from the ground level) were measured, at right angles to each other. These measurements were recorded, over bark. The height of the tree was measured with the help of an altimeter. The diameter measurement was recorded to the nearest milimeter and height was considered as such after computation. Thereafter, the trees were felled. The first log was marked at 2.74 m keeping the breast height mark in the centre and taking the bh girth as mid girth of the first log. The rest of the bole was divided into sections of 3 m length and mid girth of each section was recorded. The last section was allowed to vary between 2 to 4 meters. The lower diameter limit fixed for the measurement was 10 cm.

Volume Computation :

The volume of individual logs was calculated by Huber's formula, which

considers the cross sectional areas of the log at mid-point as a circle and when multiplied with the length of the log it gives the volume. The volume of all the logs produced by a tree was added together to get the volume of the tree.

General Volume Equations :

General volume equations (GVEs) i.e. regression function in volume, diameter and height were selected for each species. The General volume equations were obtained from felled tree data by applying multiple regression methods. Following regression equations were generally used :

(i) $V = a + bD^2H$

(ii) $V = a + bD + cD^2H$

(iii) $V = a + bD^2 + c(D^2H)^2$

(iv) $V = a + bD + cD^2H + d\ (D^2H)^2$

(v) $V = a + bD + cH + CD^2H$

(vi) $V = a + bD + CD^2 + dD^2H$

(vii) $\log_e V = a + b \log_e D + C \log_e H$

(viii) $V/D^2H = a + b\ D^2H$

(ix) $V/D^2H = a + b\ D^2H + C/D^2H$

where V = volume (m^3) under bark

D = diameter at breast height (1.37m) over bark in meter (Unless otherwise specified)

H = height of tree in meter

and 'a', 'b' and 'c' are statistical constants.

Local Volume Equations :

The Local volume equations (LVEs) were developed with only one independent variable i.e. diameter (D). Following types of regression equations were tried to obtain LVEs:

(i) $V = a + b\ D^2$

(ii) $V = a + b\ D + c\ D^2$

(iii) $V = a+bD +cD^2 +dD^3$

(iv) $V = a + b \sqrt{D} + c D^2$

(v) $\sqrt{V} = a + b D$

(vi) $\sqrt{V} = a + b D + c \sqrt{D}$

(vii) $V/D^2 = a + b/D^2$

(viii) $V/D^2 = a + b/D + c/D^2$

(ix) $V/D^2 = a + b/D^2 + c/D + dD$

(x) $\log_e V = a + \log_e D$

Where V = Volume (m^3) under bark

D = Diameter at breast height over bark in meters (Unless otherwise specified)

and 'a', 'b' and 'c' are statistical constants

The best fit regression equation was used to estimate the growing stock.

The choice of equations as described above has been done in case of FSI work, for others i.e. FRI and Karnataka data, the detailed description may be referred to in the relevant papers. For most of the Karnataka work equation of $V=a+bD^2H$ form was used.

WORK DONE BY FOREST SURVEY OF INDIA

Forest Survey of India has developed a total number of 753 volume equations for 198 species spread throughout India, Bhutan and parts of Nepal. The detailed general description for 198 species has been given. The 'n' (total number of sample trees on which regression equations were based) and 'R^2' (Co-efficient of determination) values have been given for 592 volume equations. The States and Union Territories covered through these studies are Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Gujarat, Goa, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Orissa, Punjab, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh, West Bengal and Andaman & Nicober Islands.

These volume equations are based on a large volume of data collected during the field inventory work and have been developed during the last 30

years. These volume equations help in determining the volume of trees and crops, growing stock, increment etc. These parameters/informations are in turn the basis for not only the judicious management of forests but also become important source of information for national level planning.

WORK DONE BY FOREST RESEARCH INSTITUTE AND KARNATAKA FOREST DEPARTMENT

About 118 volume equations are compiled from the Indian Forest Records published by the Forest Research Institute and from the papers published in the Indian Forester. The methodologies adopted are varied depending on respective research interests.

As regards the methodology adopted by the State Forest Department of Karnataka, the volume equations are based on regional data.

CHAPTER-I

The General (G) and Local (L) volume equations developed by the Forest Survey of India are given below for different species, alongwith a short descri tion of the species.

Abies densa

General description of the species

It is commonly called East Himalayan Silver Fir and is a tall evergreen tree, attaining a height of 60 m. If protected from fire, it forms crops of considerable density, but where fires rage the crop it tends to become open, as the species is sensitive to damage by fire. It is found in the eastern Himalayas, in Sikkim and Bhutan at 2700 m - 3900 m altitude. Above 3100 m, it often forms pure crops of considerable extent and below this elevation it is sometimes mixed with Spruce or Hemlock Spruce.

Volume equations developed

SIKKIM

1. South Western part

G $V/D^2 = 0.01945/D^2+0.00009565 +0.00002896\ H$ (diameter in cm) (n=24, R^2=0.8949)

L $V = 0.12167 - 0.0114\ D + 0.000812\ D^2$ (diameter in cm) (n=49, R^2=0.9594)

BHUTAN

2. North Western parts

G $\log_e V = -0.919947+1.859733 \log_e D +0.907633 \log_e H$ (n=73)

L $\sqrt{V} = - 0.084305 + 3.060072\ D$ (n=810)

3. Central and Eastern parts. The general volume equation was also used for Southern parts.

G $\log_e V = -1.38883+1.77028 \log_e D + 1.04424 \log_e H$ (n=164, R^2=.989)

L $\sqrt{V} = - 0.050899+3.087220\ D$ (n=1871)

4. Southern parts and this local volume equation was also used for Gedu and Changekha areas of Western parts.

L $V/D^2 = 0.10774/D^2 - 2.09529/\ D +12.62008 - 1.61065\ D$ (n=653, R^2=.48061)

Abies pindrow

General description of the species

Commonly called West Himalayan low-level Silver Fir. It is a tall evergreen tree with a dense conical crown of dark green foliage and extends throughout the western Himalayas from Afghanistan to Nepal, between 2250 m to 3300 m altitude but sometimes descending below 2100 m in cool ravines or ascending to 3600 m.

The species prefers cool moist locality, deep rich soil and is found most commonly on northern aspects. Within its natural habitat the rainfall including the winter snowfall varies for the most part from 113 cm to 250 cm. The maximum shade temperature seldom reaches 32°C.

The Silver Fir is a shade bearer, trees on exposed situations are apt to be thrown by wind, frost hardy, it suffers little from snow break, and is sensitive to fire. Wood white, used for building, planking, boxes, shingles, etc. and is suitable for match-manufacture and wood-pulp.

Volume equations developed

	HIMACHAL PRADESH			
5.	Kulu,Seraj and Kotgarh (Kulu and Shimla districts). The general and local volume equations were also used for *Picea smithiana.* These general volume equations were also used for Chenab Valley Catchment Jammu Region-Udhampur, Jammu, Khathua and Rajouri districts of Jammu and Kashmir	G	$V = 0.070762 + 0.302174\ D^2\ H$ (for diameter ≤ 10 cm) (n=43, R^2=0.9584)	
		G	$V = 0.859831+0.250497\ D^2H$ (for diameter ≥ 10 cm) (n=47, R^2=0.8995)	
		L	$V = 0.293884-3.441808\ D +15.922114D^2$ (n=1514, R^2=.5539)	
6.	Chir belt area-Bilaspur, Hamirpur, Kangra, Mandi, Solan and Una districts. The general volume equation was also used for Shimla, Rohru and Chopal of Shimla district, Bhagirathi, Bhilangana and Yamuna	G	$V = 0.17507+0.22606\ D^2\ H$ (n=22, R^2=0.9525)	
		L	$V/D^2 = 0.309813/D^2-2.124183/\ D +10.687124$ (n=125)	

	catchments, Lansdowne Forest division and parts of Yamuna, Tehri and Garhwal Forest division,(Balance area of Tehri and Garhwal circle), Alaknanda catchment, major portion of district Chamoli and parts of Pauri Garhwal, Almora districts and Western parts of Nepal.		
7.	Shimla, Rohru and Chopal (Shimla district). The local volume equation was also used for Chamba, Lahaul-Spiti and Kinnaur districts.	L	$V/D^2 = 0.03728/D^2+8.55347$ (n=606, R^2=.21673)
	JAMMU & KASHMIR		
8.	Kashmir Valley. The local volume equation for dia 10-20 cm was also used for *Abies smithiana* for Kashmir Valley.	G	$V = 0.34360\ D^2H-2.4051\ D^2+0.01027H - 0.04053$ (for dia. 20-60 cm)
		G	$V = 0.25412\ D^2H -1.83911\ D^2 + 0.07907\ H -1.40296$ (for dia. 60-200 cm)
		L	$V = 0.25506-3.31830\ D+15.15131\ D^2$ (for dia. 10-20 cm)
		L	$V = 0.88145-6.36683\ D+17.44453\ D^2$ (for dia. 20-60 cm)
		L	$V = 1.96538-6.19497\ D+14.40079\ D^2$ (for dia. 60-200 cm)
9.	Chenab Valley catchment. The local volume equation was also used for *Picea smithiana.*	L	$V/D^2 = 0.177741/D^2-2.448384/D +13.434214$ (n=1178, R^2=.379)
10.	Jammu Region-Udhampur Jammu, Kathua and Rajouri districts.	L	$V = 0.15631-1.95132\ D +12.33046\ D^2$ (n=54, R^2=.67218)

	UTTAR PRADESH		
11.	Bhagirathi, Bhilangana and Yamuna catchments. The local volume equation was also used for Rajgarh and Nahan districts of Himachal Pradesh.	L	$V = 0.419832-2.725510\ D+10.893578D^2$ ($n=259$, $R^2=.9582$)
12.	Lansdowne Forest division and parts of Yamuna,Tehri and Garhwal Forest division (Balance area of Tehri and Garhwal circle)	L	$V = 0.26949- 1.61804\ D + 8.79495\ D^2 +2.49489\ D^3$ ($n=44$, $R^2=.9936$)
13.	Alaknanda catchment major portion of district Chamoli and parts of Pauri Garhwal and Almora districts. The local volume equation was also used for *Picea smithiana* of this area.	L	$V = 0.22742 - 1.06194\ D +7.21004\ D^2 + 3.04194\ D^3$ ($n=603$, $R^2=.27324$)
	(F.A.O. Project area)		
14.	Himachal Pradesh, Uttar Pradesh and Haryana.	G	$V = -0.065 + 0.256\ D^2H$

Abies smithiana

General description of the species

A very large and lofty evergreen tree. Bark rough, reddish or greyish-brown, with very shallow furrows both longitudinal and horizontal, causing small rounded or some what quadrangular plates to fall off. Wood white, soft to moderately hard; no heartwood, sometimes with a reddish or brown tinge,sometimes (in old wood, seasoned log) grey. Annual rings conspicuously marked, the spring wood soft and spongy. Medullary rays fine, very numerous, prominent on a radical section. Resin-ducts very scanty or none.

It is found in the Himalaya, at 2100-3400 m extending in west to Afghanistan, east to Bhutan; in the Kuram forests at 2400-3700 m.

The Himalayan spruce is a very fine tree, which though not perhaps reaching so great a girth as the Deodar, attains very often a greater height.

Measurement of large trees made near Mundali in Jaunsar gave from 54 to 66 m height with the girth of 6 to 7 m.

Volume equations developed

HIMACHAL PRADESH

15.	Rajgarh and Nahan (Sirmour district). The local volume equation was also used for Bhagirathi, Bhilangana and Yamuna catchments.	L	V	= 0.298532-4.54131 D+16.32524 D^2 (n=51, R^2=.9955)

JAMMU and KASHMIR

16.	Kashmir Valley	G	V	= 0.22935 D^2H+0.23756 D^2 + 0.02249 H - 0.23450 (for dia. 60-100 cm)
		G	V	= 0.08497 D^2 H + 3.60349 D^2 + 0.03913 H - 0.58245 (for dia. 20-60 cm)
		L	V	= 0.45708 -3.33657 D+ 12.54195 D^2 (for dia. 20-150 cm)
17.	Jammu Region-Udhampur, Jammu, Kathua and Rajouri districts. The general volume equation was also used for Bhagirathi, Bhilangana and Yamuna catchments of U.P.	G	V	= 0.03370+0.28318D^2H (n=18, R^2=0.1847)
		L	$\sqrt{V}$	= 0.20050+ 4.58840 D- 1.42603 $\sqrt{D}$ (n=107, R^2=.98378)

Acacia catechu

General Description of the species

It is commonly called the Cutch tree or Khair. Khair is a small or medium sized deciduous tree attaining a height of 12-15 m with light feathery crown, the branchlets armed with paired and recurved spines. Bark thick, dark grey or greyish brown, rough, exfoliating in long narrow strips, brown and red inside. There are 3 distinct varieties :

Var. catechu - Found chiefly in Punjab, Garhwal and Kumaon, Bihar and Orissa. It also occurs in North Kanara and Konkan. In the sub-himalayan tract and the outer Himalayas, it

ascends upto 900-1200 m elevation.

Var. Catechuoides - Found chiefly in Sikkim, West Bengal and Assam.

Var.Sundra(chundra)-Found chiefly in the peninsular India.

Khair occurs on a variety of geological formations and soils, though it thrives best on porous alluvium composed of sand and shingle. Along with Sissoo, it forms the first tree association to colonise freshly formed islands in river beds and on freshly deposited sandy or gravelly alluvial soil along the banks of rivers. It grows also on black cotton soil. It occurs in localities where the normal rainfall varies from 50-220 cm. In its natural habitat, the absolute maximum shade temperature varies from 40-49°C, and the absolute minimum from minus 1° to 13°C.

Khair is a strong light demander, it is frost hardy, xerophilous in character, good coppicer and produces root suckers. It withstands fire considerably.

The leaves are used as fodder. Cutch wood is used for the production of cutch and Katha. The timber has a variety of uses. e.g. house construction, agricultural implements etc. The bark is sometimes used for tanning. Khair is a very good host plant for lac. The bark and flowers have medicinal uses.

Volume equations developed

GUJARAT

18. Surat circle-Dangs, Surat, Bulsar and Bharuch districts. The general volume equation was also used for Southern and Eastern Rajasthan, Southern Region of U.P. namely-Agra, Etawah, Jalaun, Jhansi, Lalitpur, Hamirpur, Banda, Allahabad, Mirzapur and Varanasi districts. And also for Acacia species for South-Eastern parts of Rajasthan. These general and local volume equations were also used for Mewasi Forest division. The local volume equation was also used for Dhulia, Nasik, Thane and Raigarh districts of Maharashtra,

G V = $-0.009686 + 0.367188\ D^2H - 0.012914\ (D^2H)^2$ ($n=64, R^2=.9427$)

L V = $-0.048108 + 5.873169\ D^2$ ($n=114, R^2=.95068$)

	Dadra and Nagar Haveli, Chitradurga, Tumkur, Kolar, Bangalore and Bellary districts of Karnataka, Khargone, Khandwa, Jhabua, Dewas and Dhar districts of Madhya Pradesh.		
	HARYANA and PUNJAB		
19.	Shivalik region of Haryana and Punjab-Ambala, Ropar, Hoshiarpur and Gurdaspur districts. The general volume equation was also used for Chir-Belt area of Bilaspur, Hamirpur, Kangra, Mandi, Solan and Una districts of Himachal Pradesh and for Rest of the species of Bhagirathi, Bhilangana and Yamuna catchment of U.P.	G	$V/D^2H = 0.00817/D^2H + 0.29886$
	HIMACHAL PRADESH		
20.	Chir Belt area-Bilaspur Hamirpur, Kangra, Mandi, Solan and Una districts.	L	$V = 0.048535\text{-}0.183567 \sqrt{D}+3.787825D^2$ (N=304)
	RAJASTHAN		
21.	Southern and Eastern parts.	L	$V = -0.02471 +0.16897 D +1.12083 D^2 + 2.9328 D^3$ ($n=285$, $R^2=.98393$)
	MADHAYA PRADESH		
22.	Balaghat, Seoni and Mandla districts. The general volume equation was also	G	$V = 0.043849 -0.552735 D +2.952386D^2 +0.334508 D^2 H$ (n=46)

	used for Tarai region of U.P. (Saharanpur, Bijnore, Moradabad, Rampur, Bareilly, Pilibhit, Kheri, Bahraich, Gonda, Basti Gorakhpur and Deoria districts).	L	$V = 0.04235 - 0.74240\ D + 7.26875\ D^2$ ($n=46$, $R^2=.97915$)
	UTTAR PRADESH		
23.	Hill region-Almora, Nainital, Pithoragarh and parts of Chamoli district, Dehradun, Garhwal and Tehri districts.	L	$V = 0.02384 - 0.72161\ D + 7.46888\ D^2$ ($n=126$, $R^2=.94358$)
24.	Tarai region-Saharanpur Bijnore, Moradabad, Rampur, Bareilly, Pilibhit, Kheri, Bahraich, Gonda, Basti, Gorakhpur and Deoria districts.	L	$V/D^2 = 0.16609/D^2 - 2.78851/D + 17.22127 - 11.60248\ D$ ($n=119$, $R^2= .62324$)
25.	Southern region-Agra Etawah, Jalaun, Jhansi, Lalitpur, Hamirpur, Banda, Allahabad, Mirzapur and Varanasi districts.	L	$V = 0.21612 - 4.16597\ D + 24.50948\ D^2 - 29.6773\ D^3$ ($n=136$, $R^2=.97168$)

Acacia species

Volume equations developed

	RAJASTHAN		
26.	South and Eastern parts.	L	$\sqrt{V} = -0.00142 + 2.61911D - 0.54703\ \sqrt{D}$ ($n=151$, $R^2=.95768$)

Acer campbellii

General Description of the species

It is commonest Maple of the eastern Himalaya, occuring at 2100-3000 m altitude. It is a large deciduous tree, the seedlings come up very freely self-sown, provided there is not much shade.

Locally the wood of Maple is used for planking, tea boxes, construction and for turning into drinking-cups and other utensils.

Volume equations developed

SIKKIM

27.	South West parts of Sikkim. The general and local volume equations were also used for *Alnus nepalensis, Betula alnoides, Juglans regia, Evodia roxburghii, Macaranga species, Symingtonia populnea, Exbucklandia populnea* and *Toona fabrifuga.*	G	$V/D^2 = -0.0258/D^2 + 0.000172 + 0.0000332$ H (dia. in cm)
		L	$V/D^2 = 0.06674/D^2 - 0.02039/D + 0.001559$ (dia. in cm)

WEST BENGAL

28.	North-Eastern and Eastern parts of Kalimpong Forest division. The local volume equation was also used for Singalila and Tonglu Ranges of Darjeeling division and also for Darjeeling district.	L	$V = -0.0962 - 0.0145$ D $+0.0008$ D^2 (for plywood).
		L	$V = -0.3077 + 0.00078$ D^2 (for total timber.)
29.	Singalila and Tonglu Ranges of Darjeeling division.	G	$V = -0.2835 + 0.000026$ D^2H (for plywood)
		G	$V = 0.0094 + 0.0000263$ D^2H (for total timber.)

Acer species

General Description of the species

Wood generally shining, soft and closed grained and no heartwood. Annual rings generally well marked, Pores small and very small, uniformly distributed. Medullary rays fine and very fine, often of two sizes. Concentric medullary patches frequent. (The structure of wood of the different species of maple- European, Indian, and American, is so uniform that it is very difficult to distinguish the different species by it alone).

Volume equations developed

UTTAR PRADESH

30. Alaknanda catchment- major portion of district Chamoli, parts of Pauri Garhwal and Almora districts. The general volume equation was also used for Central, Eastern and Southern parts of Bhutan.

G $V = -0.038730 + 0.362730\ D^2H$ ($n=150$, $R^2=0.933$)

L $\sqrt{V} = -0.10851 + 3.04250\ D$ ($n=92$, $R^2=.93099$)

HIMACHAL PRADESH

31. Kulu, Seraj and Kotgarh-Kulu and Shimla districts. The general volume equation was also used for *Aesculus indica, Quercus* species and *Taxus baccata* found in the above region.

G $V = 0.05026 + 0.296846\ D^2H$

L $V = 0.269129 - 0.885866\ \sqrt{D} + 8.488416\ D^2$ ($n=113$, $R^2=.9434$)

32. Shimla, Rohru and Chopal -Shimla district. The General volume equation was also used for North Western parts of Bhutan.

G $\log_e V = 0.59555 + 2.02481\ \log_e D + 0.854745\ \log_e H$ ($n=70$)

L $V/D^2 = 0.18259/D^2 - 2.20276/D + 11.18911$ ($n=79$, $R^2=.72106$)

BHUTAN

33.	North Western parts.	L	$\sqrt{V}$ = -0.162945+3.109717 D (n=89, R^2=.9826)
34.	Central and Eastern parts.	L	$\sqrt{V}$ = 0.374246+4.759591D -1:89151$\sqrt{D}$ (n=262)
35.	Southern parts. The local volume equation was also used for Gedu and Changekha areas of Western Bhutan.	L	V/D^2 = 0.20762/D^2 -2.49698 /D +12.94655 (n=231, R^2=.62567)

Acrocarpus fraxinifolius

General description of the species

It is a very large deciduous tree attaining a height of upto 60 m usually with large buttresses at the base. Leaves bipinnate, with three or four pairs of pinnae each about a foot long. The young leaves are bright red. It occurs in evergreen forests of the Western Ghats (chiefly on hill slopes upto 1200 m) in Sikkim, Duars, Assam, Chittagong and Burma. It is a tree of the region of heavy rainfall.

The tree is sensitive to frost, and is light demanding. Heartwood is light red, moderately hard, used for shingles, tea boxes,furniture and building construction.

Volume equations developed

ASSAM

36.	North Cachar.The general and local volume equations were also used for Nowgong and Karbi Anglong and for *Ailanthus altissima/ grandis, Anthocephalus cadamba* and *Sterculia alata* in the aforesaid areas.	G	V/D^2H = -0.0000009136/D^2H +0.00003654 (dia. in cm)
		L	V/D^2 = -0.0941/D^2 +0.00097 (dia. in cm)

Adina cordifolia

General description of the species

It is commonly called Haldu and is a large deciduous tree with a large dark green crown, erect trunk and horizontal branches, attaining a height upto 40 m. It occurs scattered in the deciduous forests throughout the greater part of India except the arid regions of Rajasthan. It grows well on loams, both clayey and sandy and poorly on stiff clay. In its natural habitat, the absolute maximum shade temperature varies from 38°C to 50°C and the absolute minimum from 3°C to 15°C .The rainfall ranges from 90 to 400 cm. The tree is associated with a number of important commercial timber trees, e.g., Teak, Sal, Semal, Gamari, Laurel, Kindal, Rosewood, Bijasal, Benteak etc. This species is a strong light demander, fairly resistant to fire, drought and frost and coppices readily. The timber of Haldu is used for furniture, building, agricultural implements, railways carriages etc.

Volume equations developed

ASSAM

37. North Cachar Hills. The general and local volume equations were also used for *Adina khasiaculnea, Artocarpus lakoocha, Betula alnoides, Bischofia javanica, Bursera serrata, Canarium bengalense, Celtis* species, *Cryptocarya amygdalina, Cynometra polyandra, Dysoxylum hamiltonii, Eugenia grandis, Eugenia jambosa, Garuga pinnata, Mangifera sylvatica, Mansonia dipikae, Palaquim polyanthum, Podocarpus neriifolia, Pterospermum acerifolium, P.lanceaefolium, Stereospermum personatum, Syzygium cuminii,*

G $V/D^2H = 0.00801/D^2H + 0.0000279$ (dia in cm)

L $V = 0.0549 - 0.0131\ D + 0.001\ D^2$ (dia. in cm)

	Terminalia belerica, T. citrana, Toona ciliata, Trewia nudiflora, Ulmus lancifolia and *Vitex peduncularis* in Nowgong and Karbi Anglong inventory work. These equations have also been used for *Artocarpus chaplasa, A.integrifolia* and *Castonopsis* species in North Cachar, Nowgong and Karbi Anglong, for *Alstonia scholaris* in North Cachar and for *Chickrassia tabularis, Cinnamomum fragrantissima* in Assam (15 districts).		
38.	Assam survey (15 districts).	L	$\sqrt{V}$ = -0.16354 +2.81144 D (n=39, R^2=.99147)
	BIHAR		
39.	Santhal Pargana, Ranchi district and part of Bhagalpur district. The general and local volume equations were also used for Bankura and Midnapur districts of West Bengal.	G	V/D^2H= -0.0052355/D^2H +0.55615 (n=37, R^2=0.9054)
		L	V/D^2= 0.04472/D^2 -1.3527 /D +13.437 (n=14, R^2=0.4329)
	GUJARAT		
40.	Surat Circle-Dangs, Surat, Bulsar and Bharuch districts. The general and local volume equations were also used for Mewasi Forest division and this local volume equation was also used for Nasik, Thane and Raigarh districts of Maharashtra and for Khargone, Khandwa, Dewas, Jhabua and Dhar districts of M.P. and also for Dadra and Nagar Haveli.	G	V/D^2H= 0.007155/D^2H +0.28865 + 0.001202 D^2H (n=77, R^2=.2752)
		L	$\sqrt{V}$ = 0.21569+4.329878D-1.504977 $\sqrt{D}$ (n=127, R^2=.98976)

KARNATAKA

41.	Chikmaglur and Hassan districts. The local volume equation was also used in Kerala and Tamilnadu for this species and for *Bombax ceiba* in Chikmaglur and Hassan districts, for *Dalbergia latifolia* and *Macaranga peltata* in Chikmaglur, Hassan and Shimoga districts and in Kerala and Tamilnadu.	L	$V = 0.296 - 2.829\ D + 12.207\ D^2$
	(FAO Project Area)		
42.	Kerala and Tamilnadu. The general volume equation was also used for *Dalbargia latifolia* and *Macaranga peltata* in Kerala and Tamilnadu and for *Dalbargia latifolia* in Kodagu district of Karnataka.	G	$V = 0.0043\ H + 0.278\ D^2\ H$

MADHYA PRADESH

43.	Rajnandgaon and Durg districts.	G	$V/D^2H = 0.002446/D^2H + 0.347602$ (n=19, R^2=.102608)
		L	$V = 0.09527 - 1.90716\ D + 13.30622\ D^2 - 7.50357\ D^3$ (n=74, R^2=.89276)
44.	Balaghat, Seoni and Mandla districts. The general volume equation was also used for Raigarh and Bilaspur districts.	G	$V/D^2H = 0.006163/D^2H + 0.465160$
		L	$\sqrt{V} = -0.21219 + 3.57003\ D$ (n=144)

45.	Raigarh District	L	$\sqrt{V}$ = 0.00845 +1.97513 D (n=19, R^2=.8818)
46.	Bilaspur district.	L	V = 0.20539 +3.11826 D -9.87112 D^2 + 29.56842 D^3 (n=26, R^2=.99765)
	MAHARASHATRA		
47.	Melghat Forest division.	G	$\log_e V$ = -0.453207 +2.172866 $\log_e D$ +0.86072 $\log_e H$ (n=96, R^2=.9866)
		L	V = 0.060564 -1.509868 D +11.156229 D^2 (n=96,R^2=.7524)
	ORISSA		
48.	Phulbani catchment (Phulbani, Kalahandi and Ganjam districts).	G	V/D^2H = -0.002392/D^2H +0.319951
		L	$\sqrt{V}$ = -0.15336 +2.802965 D (n=98, R^2=.9775)
49.	Koraput district.	G	V = -0.117924 +1.041595 D +0.256368D^2H (n=39, R^2=.9748)
		L	V/D^2 = -0.08507/D^2+0.19669/D+7.16812 (n=32, R^2=.9195)
	(F.A.O. Project area)		
50.	Madhya Pradesh, Andhra Pradesh and Orissa. The general volume equation has also been used for *Anogeissus* spp. of this area.	G	V = 0.036 +0.279 D^2 H
		L	V = -0.168 +0.449 D +5.809 D^2

Adina oligocephala

General description of the species

It is a tree found mainly in the Khasi hills. It is a middle sized tree.

Volume equation developed

ASSAM

51.	Assam survey (15 districts)	L	$\sqrt{V}$ = -0.08687 +2.72192 D (n=27, R^2=.98554)

Aesculus indica

General description of the species

Commonly called Indian Horse-chestnut. It is a large handsome deciduous tree attaining a height of 30 m with a large spreading crown, drooping branches, and digitate leaves. This species occurs in Western Himalaya from Nepal westwards, at 1200 -2700 m altitude, usually in moist shady ravines on rich soil, frequent on northern aspects. In its natural habitat, the absolute maximum shade temperature ordinarily varies from 27° C to 39°C and the absolute minimum from -4°C to -12°C or lower. The normal rainfall varies from 100 cm to 250 cm. The tree is a moderate light demander, good coppicer and produces root suckers. Wood pale pink, soft, used for planking, boxes and turning into cups, plates etc.

Volume equation developed

HIMACHAL PRADESH

52.	Kulu, Seraj and Kotgarh -Kulu and Shimla districts	L	$\sqrt{V}$ = 0.220191+3.923711 D-1.117475 $\sqrt{D}$ (n=134, R^2=.9588)

Ailanthus grandis

General description of the species

A large deciduous tree. bark grey, smooth, with minute vertical furrows. It is tall tree attaining a height of 36 - 45 m, leaflets, entire, 5-8 pairs. The samaras attain a length of 12 cm and 4 cm breadth.

It occurs in Assam, Sikkim and Darjeeling hills in the Ryang valley. The timber is suitable for plywood, tea chests etc.

Wood white, soft. Pores large, scanty, single or sub-divided into 2 or 3. Medullary rays moderately broad, numerous annual rings not distinct.

Volume equations developed

ARUNACHAL PRADESH

53.	Lohit	L	$V = -0.09362+9.93014D^2$	$(n=23, R^2=.96323)$
54.	Tirap	L	$\sqrt{V} = -0.41331+2.66051D+0.94576\sqrt{D}$	$(n=20, R^2=.9942)$

BHUTAN

55.	Central and Eastern parts. General volume equation was also used in Southern parts.	G	$\log_e V = -1.94825+1.72730 \log_e D$ $+1.16690 \log_e H$	$(n=103, R^2=.991)$
56.	Southern parts.	L	$\sqrt{V} = 0.32056 +5.16781 D -1.83345 \sqrt{D}$	$(n=48, R^2=.96963)$

Albizia lebbeck

General Description of the species

It is commonly called East Indian Walnut, Siris or Kokko. *Albizzia lebbeck* is a moderate to large sized deciduous tree attaining a height of 20 -30 m with dark grey rather rough bark, red or crimson inside. It is found in the mixed deciduous forests, in both dry and moist types, also in semi-evergreen or evergreen forests. It occurs naturally in the sub-Himalayan tract, Bengal, Assam, peninsular India and Andamans. In the Himalayas, it ascends upto 1,500 m

altitude. Kokko grows in a variety of soils and climates, the rainfall varying from 64 cm to over 250 cm. The mean monthly temperature varies from 5°C to 45°C, mean temperature for the year being 26°C. It prefers a well-drained loam and can grow fairly well on laterite or black cotton soil.

The species is a moderate light demander, good coppicer, fairly resistant to drought and frost. It is planted as an avenue tree and in tea and coffee plantations as a shade tree. The tree is lopped for fodder. The bark is used for tanning and dyeing. Its timber is used for high class furniture, cabinet work, interior decoration, panelling, building, agricultural implements, railway sleepers etc. The leaves, bark, flowers and pods have medicinal value.

Volume equations developed

	ARUNACHAL PRADESH		
57.	Debang	L	$V = 0.07389+4.47501\ D^2$ ($n=51$, $R^2=.89969$)
	ASSAM		
58.	North Cachar hills. The general and local volume equations were also used for Nowgong and Karbi Anglong Survey and for the *Albizia lucida*, *Albizia odoratissima*, *Albizia procera*, *Albizia stipulata*, *Cassia nodosa*, *Endospermum chinense* and *Gmelina arborea* in Nowgong, Karbi Anglong and North Cachar hills survey.	G	$V/D^2H = -0.00858/D^2H +0.0000316$ (dia. in cm)
		L	$V/D^2 = 0.0211/D^2-0.004\ /D +0.000546 +0.0000065\ D$ (dia. in cm)
59.	Assam survey (15 Districts)	L	$V = -0.03670 +5.87369\ D^2$ ($n=37$, $R^2=.96366$)
	(F.A.O.Project area)		
60.	Madhya Pradesh, Andhra Pradesh and Orissa.	G	$V = -0.034 +0.291\ D^2\ H$
		L	$V = 0.270 -2.953\ D +12.336\ D^2$

Albizia lucida

General description of the species

A large deciduous tree. Bark dark brown. Wood very hard; sapwood white; heartwood brown, with dark streaks and alternating dark and light coloured concentric bands, pores moderate-sized, numerous, enclosed by groups in round patches of soft tissue. Medullary rays fine and numerous. It is found in the valleys of the North-East Himalaya up to 600 m extending perhaps westward in Kumaon. Wood hard and good but not much used. Lac is obtained on it in Assam. A handsome tree, easily recognized by its larger leaves and few leaflets.

ARUNACHAL PRADESH

Volume equation developed

61. Lohit L $\sqrt{V} = 0.44360+5.25340D-2.16829\sqrt{D}$ ($n=61$, $R^2=.98207$)

Albizia procera

General description of the species

Commonly called White Siris. It is a large tree with a long clean bole, often branching at a considerable height and forming a somewhat light crown. Bark smooth yellowish or greenish grey, exfoliating in thin flakes, red inside. The species occurs throughout the sub-Himalayan tract, common from the Yamuna eastwards, Assam, Bengal, Chhota-Nagpur, the Indian peninsula, Burma and the Andamans. The tree is found most commonly on alluvial ground along streams and in moist, even swampy places; it is particularly common in low-lying moist savannahs, as in the Duars of Bengal and Assam and elsewhere, in such places it is often gregarious. The clean light-coloured boles being very conspicuous. In its natural habitat the absolute maximum shade temperature varies from 37°C to 46°C, the absolute minimum from -1°C to 18°C and the normal rainfall from 100 cm to 500 cm. The tree is a light demander, drought resistant and produces root suckers. The sapwood is large, whitish, the heartwood brown with streaks of darker or lighter colour, used for house-posts, agricultural implements etc.

Volume equations developed

ANDHRA PRADESH

62.	Mahboob Nagar Forest division. The general volume equation was also used for *Chloroxylon swietenia* and *Lagerstroemia parviflora* of this area. The local volume equation was also used for *Pterocarpus marsupium* of this area	G L	$V = 0.009134 + 0.17315\ D^2\ H$ $V = -0.043832 + 3.262852\ D^2$ $(n=255,\ R^2=0.75)$

ASSAM

63.	Assam survey. (15 districts)	L	$V = 0.13817 - 2.16947\ D + 11.40870\ D^2 + 1.11636\ D^3$ $(n=135,\ R^2=.96698)$

TRIPURA

64.	Tripura Survey.	L	$\sqrt{V} = -0.23861 + 3.22483\ D$

Albizia stipulata

General description of the species

It is a large deciduous tree with feathery foliage and large stipules. The crown is often spreading and flat- topped. Bark dark grey, fairly smooth, with occasional prominent horizontal wrinkles and furrows and numerous small vertical wrinkles. This species occurs throughout the sub-himalayan tract and Himalayan valleys up to 1200 m altitude Bengal, Assam, Chhota Nagpur, the moister parts of the Indian peninsula, Andamans and Nicobar. In its natural habitat the absolute maximum shade temperature varies from 35°C to 43°C, the absolute minimum from -1°C to 18°C and the normal rainfall from 112 cm to 500 cm. The tree is a moderate light demander.Sapwood large, white, heartwood brown, soft, not very durable, used for building, furniture, domestic utensils etc. It is used as a shade tree in tea plantations in Assam and the Bengal Duars.

Volume equation developed

TRIPURA

65.	Tripura Survey.	L	$\sqrt{V} = -0.25706 + 3.16251\ D$

Albizia species

Volume equations developed

ASSAM

66.	Assam Survey (15 districts).	G	V/D^2H	= -0.00000096/D^2H +0.0000384 (dia. in cm)
	The general volume equation was also used for the species *Amoora wallichii, Bauhinia* spp, *Callicarpa* spp, *Canarium, strictum, Canarium* spp, *Careya arborea, Casearia* spp, *Cassia siamea, Cassia* spp, *Castonopsis indica, Cinnamomum cecidodaphne, Cordia* spp, *Drypetes assamica, Cyclostemon assamicus, Dalbergia* spp, *Dillenia pentagyna, Dillenia indica, Diospyros malabarica, Diospyros* spp, *Dipterocarpus macrocarpus, Dysoxylum binectariferum, Ehretia laevis, Elaeocarpus* spp, *Emblica officinalis, Erythrina* spp, *Eugenia* spp, *Euphoria longana, Ficus* spp, *Grewia tiliaefolia, Grewia* spp, *Holarrhena antidysenterica, Hymenodictyon excelsum, Kydia calycina, Lagerstroemia* spp, *Lannea coromandelica, Macaranga denticulata, Macaranga indica, Macaranga peltata, Machilus* spp, *Mallotus philippinensis, Mesua ferrea, Michelia champaca, Michelia* spp, *Miliusa* spp, *Mansonia* spp, *Phoebe cooperiana, Pinus kesyia, Premna* spp, *Pterospermum*	L	$\sqrt{V}$	= -0.07109 +2.99732 D-0.26953 $\sqrt{D}$ (n=77, R^2=.96596)

spp, *Quercus* spp, *Schima khasiana, Schima wallichii, Semecarpus anacardium, Shorea robusta, Spondias pinnata, Stereospermum chelonoides, Syzygium* spp, *Tectona grandis, Terminalia myriocarpa, Terminalia* spp, *Tetrameles nudiflora, Vateria indica, Xerospermum glabratum,* for the 15 districts of Assam and for rest of species in Nowgong and Karbi Anglong and North Cachar hills area.

MEGHALAYA

67.	Meghalaya Survey. The general and local volume equations were also used for *Bombax ceiba* and *Duabanga sonneratiodies.*	G	$V = -1.5567 + 0.0006182\ D^2 + 0.0000054684\ D^2H + 0.090192\ H$ (dia. in cm) ($n=36$, $R^2=0.8649$)
		L	$V = 0.29208 + 0.00092412\ D^2$ (dia. in cm) ($n=48$, $R^2=0.8281$)

Alnus nepalensis

General description of the species

Commonly called Nepalese Alder. It is a large deciduous tree, attaining a height of 24-30 m. This species occurs throughout the Himalaya from the Ravi in Kashmir to Assam eastwards at 900 - 2700 m altitude sometimes lower, Khasi hills and the hills of Upper Burma. Wood pinkish, even-grained, soft, suitable for tea-boxes.

Volume equations developed

WEST BENGAL

68.	Singalila and Tonglu ranges of Darjeeling	G	$V = -0.1554 + 0.0000292\ D^2\ H$ (for plywood) (dia in cm)

division and Darjeeling district. The general volume equation for plywood was also used for *Cinnamomum* spp of this area.	G	$V = 0.2021 + 0.0000281\ D^2\ H$ (for total timber) (dia in cm)
	L	$V = 0.2248 - 0.0353\ D + 0.0013\ D^2$ (for plywood) (dia in cm)
	L	$V = 0.7287 - 0.042628\ D + 0.00137\ D^2$ (for total timber) (dia in cm)

Alnus species

General description of the species

A decidous tree. Leaves alternate, penniveined, often with tufts of hairs in the axils of the nerves. Male flower in pendulous catkins, female flower in short erect spikes.

Volume equations developed

ARUNACHAL PRADESH

69. Debang		L	$V = 0.01115 - 0.11716D + 7.11672D^2 - 4.54544D^3$ ($n=145$, $R^2=.95529$)

BHUTAN

70. Southern parts. The general volume equation is also used for *Schima wallichi, Beilschemidia* spp, *Duabanga sonneratioides, Picea spinulosa, Pinus roxburghii* and rest of the species of this area and also for rest of the species of North Eastern parts of Bhutan.		G	$\log_e V = -0.56532 + 1.98460 \log_e D + 0.82294 \log_e H$
		L	$V = 0.41455 - 1.37120\ \sqrt{D} + 11.33119\ D^2$ ($n=102$, $R^2=.97058$)

Altingia excelsa

General description of the species

A lofty deciduous tree. Bark smooth, light grey, exfoliating, in large thin flakes. Wood hard red, cross-grained. Pores small, uniform and uniformally distributed in lines between the medullary rays. Medullary rays fine, equidistant, prominent on a radial section.

It is found in the forests of Assam, locally abundant, growth moderate, 6 rings per inch of radius. As a rule it is a gregarious tree remarkably tall and straight; the girth is from 2 m to 3 m and the clear bole 15 to 18 m, while the crown is often over 43 m from the ground level. If it is to be sawn, it should be cut when green or not quite dry. In the green state it is not at all difficult to cut and has a close grain; when dry it is extremely hard and difficult to cut either with edged tools or saws. It is extremely good for planks or indoor work in dry places, but too heavy for tea-boxes. Felled and left in the forest it decays rapidly, being quite gone at the end of three years. The timber is the chief building material.

Volume equations developed

ARUNACHAL PRADESH

71.	Lohit	L	$\sqrt{V}$	= -1.58432-0.67366D+5.04182$\sqrt{D}$ (n=31, R^2=.9407)
72.	Tirap	L	V	= 0.09164-1.21122D+7.76693 D^2 +2.17361D^3 (n=49, R^2=.99517)

Amoora wallichii

General description of the species

It is an evergreen tree and occurs in Assam, Sikkim and Andamans. It has male and female flowers on the same panicle. The timber is used for boat building and railway carriages.

Volume equations developed

AURNACHAL PRADESH

73.	Lohit and Tirap districts. The general and local volume equations were also used for Lohit and Tirap districts for *Chickrassia tabularis* and *Gmelina arborea.*	G	$V = 0.0778 + 0.0000286\ D^2\ H$ (dia in cm)
		L	$V/D^2 = 0.1305/D^2 - 0.01248\ /D + 0.00094$ (dia in cm)
74.	Lohit	L	$V = -0.10099 + 0.93273D + 5.28022D^2$ ($n=33$, $R^2=.95518$)
75.	Tirap	L	$V = 0.07128 - 0.12271D + 2.72995D^2 + 11.17203D^3$ ($n=38$, $R^2=.98422$)
76.	Kameng and Subansiri districts.	G	$V = -1.4424 + 7.1845\ D^2 + 0.0829\ H$ (dia. in cm) ($n=41$, $R^2=0.9920$)
		L	$V = -0.11195 + 0.0011575\ D^2 - 0.034859\ \sqrt{D}$ (dia. in cm) ($n=59$, $R^2=0.9564$)

ASSAM

77.	Assam survey (15 districts)	L	$\sqrt{V} = 0.00905 + 3.7648\ D - 0.64993\ \sqrt{D}$ ($n=196$, $R^2=.96991$)

MEGHALAYA

78.	The general and local volume equations were also used for *Gmelina arborea* and *Kydia calycina.*	G	$V = 0.0914 + 0.0001527\ D^2 + 0.0000314\ D^2\ H$ (dia in cm) ($n=39$, $R^2=0.9604$)
		L	$V = -0.0087 + 0.003675\ D + 0.0007398\ D^2$ (dia in cm) ($n=47$, $R^2=0.9604$)

Amoora rohituka

General Description of the species

It is a moderate sized, handsome, evergreen, shade-bearing tree with a comparatively short bole and a dense spreading crown with large imparipinnate leaves. This species is widely distributed but seldom very abundant in the sub-Himalayan tract from Gonda and Gorakhpur eastwards through, the Tarai, the Bengal and Assam Duars and the outer hills upto 1800 m altitude, Assam, Chittagong, Burma, Andamans, Chhota Nagpur, western and southern India. The tree is typical of moist localities occuring in ravines, banks of streams and in moist tropical forests.

Volume equations developed

	BHUTAN		
79.	Central and Eastern parts. The general volume equation was also used for southern parts.	G	$V = -0.09768+0.01051H+0.31875\ D^2\ H$ ($n=48$, $R^2=.967$)
		L	$\sqrt{V} = -0.00144+3.94308D-0.79729\sqrt{D}$ ($n=54$)

Anogeissus latifolia

General description of the species

It is a moderate sized to large deciduous tree with a somewhat feathery rounded crown and drooping branchlets. Bark thin smooth, greenish or greyish white, exfoliating in irregular thin rounded scales which leave shallow depressions; the outer layer contains chlorophyll. The bark sheds rapidly. This species occurs throughout the sub-Himalayan tract and outer hills from the Ravi to Nepal, ascending to 1200 m altitude, Bihar, Chhota Nagpur, Central India, and southwards throughout the greater part of the Indian peninsula, ascending the hills of southern India to 1200 m altitude. In the outer Himalaya, it often marks a distinct zone towards the upper limit of the low level species, at about 750 -1200 m altitude. In its natural habitat, the absolute maximum shade temperature varies from 39°C to 48°C, the absolute minimum from -1°C to 16°C and the normal rainfall from 62 cm to 225 cm. The tree is a light demander and not very frost tender. The wood which is hard, very strong and tough, is used for cart axles, axe handles, furniture, agricultural implements, poles and rafters,

boat building and other purposes. The leaves are rich in tannin and are collected for the purposes; the bark is also used for tanning, and yields a gum much used in calico-printing. Apart from its economic uses, the tree is useful silviculturally in clothing dry hill-sides and is an important constituent in certain dry types of forests.

Volume equations developed

ANDHRA PRADESH

80.	East Godavari, West Godavari, Vishakhapatnam and Khamam districts. The general volume equations and local volume equations were also used for *Xylia xylocarpa, Terminalia tomentosa* for this area of A.P. and the general volume equation was also used for West Bengal.	G	$V/D^2H = 0.001/D^2H + 0.340$ (for dia<30 cm) (n=229, R^2=.923)
		G	$V = 0.023+0.306\ D^2H$ (for dia ≥ 30 cm)
		L	$\log_e V = 2.3424 + 2.4970 \log_e D$ (for dia < 30 cm)
		L	$\log_e V = 1.9902 + 2.2111 \log_e D$ (for dia. ≥ 30 cm)
81.	East Godavari	L	$V = .345341-4.684510D+22.3767D^2 -19.1675D^3$ (n=85, R^2=.94867)
82.	Mahboob Nagar Forest division.This general volume equation was also used for *Lannea coromandelica.*	G	$V = 0.002659 + 0.24233\ D^2\ H$
		L	$V = 0.055883 + 5.603009\ D^3$ (n=533, R^2=.81)
83.	Adilabad district.	G	$V = -0.0069 + 0.4108\ D^2\ H$
		L	$V = 0.034725 - 0.78412\ D + 7.1873\ D^2 + 6.9495\ D^3$ (n=375, R^2=.9762)

BIHAR

84.	South West Bihar, Chapra Kodarma, Giridih, Munger Shahbad, Gaya,Daltonganj	G	$V = 0.020760 + 0.447658\ D^2\ H$
		L	$\sqrt{V} = -0.07738 + 2.592167D$

	Garwa, Katihar, Hazaribagh, Ranchi Forest division. The general volume equation was also used for Southern parts. the general and local volume equations were also used for *Terminalia chebula, Diospyros melanoxylon, Lannea coromandelica.* The local volume equation was also used for the rest of the species for this area and also used for Ranchi Forest division and Singhbum district.		
85.	Santhal Parganas and part of Bhagalpur district and Ranchi district. The local volume equation was also used for Singhbum district of Bihar, Purulia, Bankura and Midnapur districts of West Bengal.	G	$V/D^2H = 0.00161/D^2H+0.4511$ ($n=44$, $R^2=0.9135$)
		L	$V = 0.028653 - 0.97687\ D + 11.024\ D^2$ ($n=54$, $R^2=0.9883$)
86.	West Champaran district.	L	$V/D^2 = -0.01777/D^2 + 5.07688$
	GUJARAT		
87.	Surat circle-Dangs Surat, Bulsar and Bharuch districts. The general volume equation was also used for Khargone, Khandwa, Dewas, Jhabua and Dhar districts of	G	$V/D^2H = -0.012484/D^2H + 0.424503 - 0.009419\ (D^2\ H)$ ($n=59$, $R^2=.29767$)
		L	$\sqrt{V} = 0.357373 + 2.430449\ D + 0.794626\ \sqrt{D}$ ($n=122$, $R^2=.97912$)

	M.P. For *Anogeissus pendula,* Southern and Eastern parts of Rajasthan. Southern Region of U.P. Agra, Etawah, Jalaun, Jhansi, Lalitpur, Hamirpur, Banda, Allahabad, Mirzapur and Varanasi districts. The general and local volume equations were also used for Mewasi Forest division. The local volume equation was also used for Dhulia, Nasik, Thane and Raigarh districts of Maharashtra and also for Dadra and Nagar Haveli.		
	HIMACHAL PRADESH		
88.	Chir belt Area-Bilaspur, Hamirpur, Kangra, Mandi Solan and Una districts	L	$V/D^2 = -0.011053/D^2 +0.087418\ /D +2.545701 +4.766918\ D$ (n=289)
	KARNATAKA		
89.	Chikmagalur, Hassan and Shimoga districts. It was also used for *Terminalia tomentosa* in these districts and for *Cassia fistula* in the areas of Chikmagalur, Hassan districts, Kerala and Tamilnadu.	L	$V = 0.289 -2.653\ D +11.771\ D^2$
90.	Chitradurga, Tumkur, Kolar, Bangalore and Bellary.	L	$\sqrt{V} = -0.004378 +4.575823\ D^2$
91.	Kodagu district.	L	$V = -0.06868+1.56245D-2.91615D^2 +12.44122D^3$

	MADHYA PRADESH		
92.	Balaghat, Seoni and Mandla districts. The general volume equation was also used for Raigarh and Bilaspur districts.	G	$V/D^2H = 0.016615/D^2H + 0.47929$ (n=133)
		L	$V/D^2 = 0.11242/D^2 - 2.13817/D + 16.4304 - 7.23272\ D$ (n=447, R^2=.60116)
93.	Narayanpur catchment-Bastar district.	G	$V = 0.00203 + 0.38646\ D^2\ H$ (n=78, R^2=.94028)
		L	$V = 0.13053 - 1.94625\ D + 11.67213\ D^2$ (n=416, R^2=.961225)
94.	Rajnandgaon and Durg districts	G	$\log_e V = -3.977276 + 1.404908 \log_e D + 1.841234 \log_e H$ (n=25, R^2=.989899)
		L	$V/D^2 = 0.05793/D^2 - 1.48829/D + 14.27687 - 8.64437\ D$ (n=938, R^2=.45472)
95.	Raigarh district.	L	$\sqrt{V} = 0.31277 + 5.08978\ D - 1.85236\ \sqrt{D}$ (n=175, R^2=.95623)
96.	Bilaspur district.	L	$V/D^2 = -0.02958/D^2 + 8.05003$ (n=332, R^2=.48413)
97.	Raipur district.	L	$\sqrt{V} = 0.28802 + 5.12791\ D - 1.87116\ \sqrt{D}$ (n=251, R^2=.92310)
	MAHARASHTRA		
98.	Ballarshah catchment Chandrapur	G	$\log_e V = -0.544476 + 2.096749 \log_e D + 0.883803 \log_e H$ (n=70, R^2=.962)
		L	$V/D = 0.145667/D - 2.704089 + 17.4656\ D - 10.4903\ D^2$ (n=118, R^2=.932)
99.	Wadsa catchment (Chandrapur)	G	$V = 0.00931 + 0.38507\ D^2\ H$ (n=30, R^2=.9278)
	The general volume equation was also used for Sondad catchment-Bhandara district.	L	$V/D = -0.006854/D - 0.036762 + 4.5577\ D + 5.25567\ D^2$ (n=112, R^2=.193)

100.	Sondad catchment-Bhandara district.	L	$V = -0.061856 + 7.952136\ D^2$ ($n=135$, $R^2=.9093$)
101.	Melghat Forest Division .	G	$V = -0.001064 + 0.461272\ D^2\ H$ ($n=167$, $R^2=.0226$)
		L	$V = 0.030502 - 1.105937D + 12.261268D^2$ ($n=165$, $R^2=.6666$)
	RAJASTHAN		
102.	Udaipur Forest Division, Southern and Eastern parts of Rajasthan.	G	$V = -0.016909 + 0.252906\ D + 0.359305\ D^2\ H$ ($n=77$, $R^2=.9593$)
103.	Southern and Eastern parts.	L	$V = -0.01662 + 4.4268\ D^2$ ($n=183$, $R^2=.94217$)
	ORISSA		
104.	Phulbani catchment (Phulbani, Ganjam and Kalahandi districts). The general volume equation was used for Tarai Region of U.P.- Saharanpur, Bijnore, Moradabad, Rampur, Bareilly, Pilibhit, Kheri, Bahraich, Gonda, Basti, Gorakhpur, Deoria disticts, hill region of U.P.-Almora, Nainital, Pithoragarh, part of Chamoli district, Dehra Dun, Garhwal and Tehri districts.	G	$\log_e V = -0.305765 + 2.042219 \log_e D + 0.788251 \log_e H$
		L	$V/D^2 = 0.045731/D^2 - 1.020606\ /D + 9.656667$ ($n=748$, $R^2=.5608$)
105.	Koraput district.	G	$V = -0.009211 + 0.500013\ D^2\ H - 0.022211\ (D^2\ H)^2$ ($n=76$, $R^2=.98833$)
		L	$V = 0.13928 - 2.87067\ D + 20.22404\ D^2 - 13.80572\ D^3$ ($n=76$, $R^2=.97193$)

UTTAR PRADESH

106.	Tarai Region : Saharanpur, Bijnore, Moradabad, Rampur Bareilly, Pilibhit, Kheri, Bahraich, Gonda, Basti, Gorakhpur and Deoria districts.	L	$\sqrt{V}$= 0.2122 +4.947663 D -1.59290 $\sqrt{D}$ (n=76, R^2=.9822)
107.	Hill region : Almora, Nainital, Pithoragarh and part of Chamoli districts, Dehra Dun, Garhwal and Tehri districts, Lansdowne and part of Yamuna Forest division.	L	$\sqrt{V}$= 0.46976 +5.99849 D -2.60729 $\sqrt{D}$ (n=64)
108.	Lansdowne, part of Yamuna, Tehri and Garhwal Forest divisions.	G	V/D^2H= 0.01662/D^2H +0.47929 (n=133)

Anogeissus pendula

General description of the species

It is a small tree, with a short usually crooked bole. This specie has a decidedly limited distribution. It extends from the Aravalli hills in Rajputana to Bundelkhand and from the Kishangarh state and the Jhansi, Hamirpur and Banda districts of U.P. on the north to the Panchmahals in the south. Within its natural habitat the absolute maximum shade temperature varies from 46° to 49°C, the absolute minimum temperature from -1°C to 3°C and the normal rainfall from 42 cm to 88 cm. The tree stands a fair amount of shade, is frost hardy, coppices and pollards well and produces root suckers freely. The bole yields little or no timber but poles cut from the branches are in demand for building and other purposes. The leaves contain tannin. In the dry regions in which it occurs, this is an important tree, not only as a source of timber and fuel but also for clothing dry tracts.

Volume equation developed

RAJASTHAN

109.	Southern and Eastern.	L	$V/D^2 = 0.00085/D^2 - 0.35165/D + 4.77386 - 0.90585\ D$ ($n=1177$, $R^2=.46419$)

Anogeissus species

Volume equations developed

UTTAR PRADESH

110.	Southern Region: Agra, Etawah, Jalaun, Jhansi, Lalitpur, Hamirpur, Banda, Allahabad, Mirzapur and Varanasi districts.	L	$\sqrt{V} = -0.20236 + 3.13059\ D$ ($n=99$, $R^2=.96254$)

WEST BENGAL

111.	The local volume equation was also used for *Terminalia tomentosa.*	L	$\log_e V = 1.999 + 2.226 \log_e D$

(F.A.O. Project area)

112.	Madhya Pradesh, Andhra Pradesh and Orissa.	L	$V = 0.099 - 1.119\ D + 8.2\ D^2$

NEPAL

113.	Western parts.	L	$V = -0.07944 + 2.55960\ D$

Anthocephalus cadamba

General description of the species

It is a large deciduous or sometimes evergreen tree with spreading branches and rather large shining leaves with prominent veins. This species occurs in the sub-Himalayan tract from Nepal eastwards, Bengal, Assam, Chota Nagpur(valleys in Singhbhum), Burma, Northern Circars, and the west coast from North Kanara southwards to Travancore. In its natural habitat, the absolute maximum shade temperature varies from 36°C to 43°C, the absolute minimum temperature from 3°C to 15°C and the normal rainfall from 150 cm to 500 cm. The tree is a light demander, good coppicer, frost sensitive; young sapling are subject to damage from browsing by cattle and deer. Wood yellowish white, soft, used for making tea boxes, for planking, dug-out canoes, etc. This tree is a useful, fast-growing, soft wood species.

Volume equations developed

MEGHALAYA

114. The equations were also used for *Schima wallichii.*	G	$V = -0.13718 + 0.019097\ H + 0.000031049\ D^2\ H$ (dia in cm) ($n=38$, $R^2=0.9409$)
	L	$V = -0.0189 + 0.0008073\ D^2$ (dia. in cm) ($n=55$, $R^2=0.9801$)

Artocarpus chaplasha

General description of the species

It is a large deciduous tree with a tall straight bole, attaining a height of 30 m to 36 m or more and developing a large spreading crown. This species occurs in sub-Himalayan tract and outer hills from Nepal eastwards, ascending to 1500 m altitude, also in Assam, Chittagong, Burma, and the Andamans. In its natural habitat the absolute maximum shade temperature varies from 37°C to 41°C, the absolute minimum from 3°C to 16°C and normal rainfall from 200 cm to 500 cm. The tree is shade bearing, fire sensitive, good coppicer and young plants are browsed by deer and cattle. Wood yellowish brown, durable of good quality, used for furniture, building, boat building etc.

Volume equations developed

ANDAMAN AND NICOBAR ISLANDS

115.	South and Middle Andamans	G	V	=	$0.087647 + 0.2287\ D^2\ H$
		L	V	=	$-0.0035098 + 7.0797\ D^2$
116.	Little Andaman. The general volume equation was also used for *Artocarpus lakoocha.*	G	V/D^2H	=	$0.2275/D^2H + 0.00002417$ (dia. in cm) ($n=41$, $R^2=0.3160$)
		L	V	=	$1.5897 - 0.0611\ D + 0.00162\ D^2$ (dia. in cm) ($n=33$, $R^2=0.9629$)

ARUNACHAL PRADESH

117.	Lohit and Tirap districts The general and local volume equations have been used for *Artocarpus lakoocha* and *Terminalia myriocarpa* in this area.	G	V/D^2H	=	$0.0346/D^2H + 0.0000257$ (dia in cm)
		L	V/D^2	=	$0.1052/D^2 - 0.01336\ /D + 0.00092$ (dia. in cm)
118.	Lohit	L	$\sqrt{V}$	=	$0.50943 + 4.40226D + 2.15151\sqrt{D}$ ($n=21$, $R^2=.9977$)
119.	Kameng and Subansiri districts. The general and local volume equations have been used for *Artocarpus lakoocha, Chickrassia tabularis, Gmelina arborea, Schima wallichii, Tetrameles nudiflora, Toona ciliata* and rest of the species for these districts.	G	V	=	$-0.47453 - 5.456\ D^2 + 1.3968\ D\ H$
		L	V	=	$-0.079733 - 0.0021006\ D + 0.001114\ D^2$ (dia in cm)

ASSAM

120.	Assam survey (15 districts)	L	V	=	$1.65081 - 4.57531\sqrt{D} + 11.62114\ D^2$ ($n=29$, $R^2=.99209$)

TRIPURA

121.	Tripura	L	$\sqrt{V}$	=	$-0.15154 + 2.79983\ D$

Artocarpus hirsuta

General description of the species

It is a very tall handsome evergreen tree, attaining a height of 45 m with a straight clean stem and dense foliage. This species occurs in evergreen forests of the Western Ghats from the Konkan southwards, ascending to 1200 m altitude. It is fairly common in the Ghat forests of Karnataka and southwards in Kerala, where it is considered one of the most important timber trees. It requires heavy rainfall not less than 175 cm and thrives equally well on laterite soils, on decomposed gneiss and on rich soils. The tree can stand much shade, is fire sensitive, it coppices and produces root suckers. Young plants are browsed by deer. Wood moderately hard, yellowish brown, durable, of very good quality, much used for house, boat-building, furniture, and other purposes.

Volume equations developed

KARNATAKA

122.	Chickmaglur and Hassan districts. (F.A.O. Project area)	L	$V = 0.076 - 1.319\ D + 11.370\ D^2$
123.	Kerala and Tamilnadu. This equation is also used for *Carallia lucida* in Kerala and Tamilnadu.	G	$V = 0.026 + 0.316\ D^2\ H$

Artocarpus lakoocha

General description of the species

It is a large deciduous tree with a spreading crown and large elliptical or ovate entire leaves softly tomentose beneath. This species occurs in the sub-Himalayan tract and outer hills from Kumaon eastwards, ascending to 1200 m altitude. Assam, Burma, Chhota Nagpur, truly wild in the Saranda hills,

Singhbhum, Western Ghats from the Konkan southwards and Andamans. It is much cultivated throughout the greater part of India and Burma as a shade or ornamental tree or for the sake of its fruit. It occurs in tropical forests both deciduous to evergreen. In its natural habitat, the absolute maximum shade temperature varies from 35°C to 46°C, the absolute minimum from 2°C to 16°C; normal rainfall varies from 150 cm to 500 cm. The tree stands moderate shade in youth and is frost tender. Heartwood yellow turning brown, used for building, furniture, canoes etc. The fruit is eaten, though it is somewhat insipid.

Volume equations developed

ARUNACHAL PRADESH

124.	Tirap	L	$\sqrt{V} = 0.066962+2.61991D$ ($n=17$, $R^2=.98818$)

ANDMAN AND NICOBAR ISLANDS

125.	Little Andaman. The local volume equation was also used for North Andaman.	G	$V = 0.12951 +0.0000272\ D^2\ H$ (dia. in cm) ($n=36$, $R^2=0.1470$)
		L	$V = 0.1954 -0.004028\ D +0.000609\ D^2$ (Dia. in cm) ($n=26$, $R^2=0.9330$)

Bauhinia species

General Description of the species

There are about 32 species of which perhaps twelve are tree and shrubs and the rest climbers. They are all easily recognized through the typical bilobed, palmately veined leaves.

Volume equations developed

ASSAM

126.	Assam survey (15 districts)	L	$V = -0.04262 +6.09491\ D^2$ ($n=222$, $R^2=.94936$)

Beilschmiedia roxburghiana

General description of the species

It is a large or moderate sized evergreen tree with coriaceous leaves. It occurs in U.P., West Bengal, Sikkim, Assam, North Circars hills of Eastern Ghats on Mahendragiri, the Palkondas and in Rampa from Ganjam to the Godavari at an elevation of 450 - 1200 m. The wood is white, moderately hard, even grained, and is used for making boats, in construction works and for tea boxes.

Volume equations developed

	SIKKIM		
127.	South Western parts The general and local volume equations were also used for *Echinocarpus dasycarpus* in south western parts of Sikkim.	G	$V/D^2H = 0.0000389/D^2H + 0.02856$ (dia. in cm) ($n=27$, $R^2=0.1143$)
		L	$V/D^2 = 0.25564/D^2 - 0.030418/D + 0.0012897$ (dia. in cm) ($n=38$, $R^2=0.3928$)

Beilschemedia species

General description of the species

Trees or shurbs, as by nature they are evergreen.

Volume equation developed

	BHUTAN		
128.	Southern parts.	L	$V = 0.51191 - 1.78643\sqrt{D} + 11.19974\ D^2$ ($n=96$, $R^2=.99168$)

Betula alnoides

General description of the species

A large deciduous tree, bark grey, peeling off in horizontal rolls; lenticels large, oblong. Wood grey, light brown or white, moderately hard, closed-

grained. Annual rings marked by a line, pores small to moderate-sized, larger than in *B.utilis,* scanty, evenly distributed. Medullary rays fine to almost moderately broad, short, much further apart and less numerous than in *B.utilis,* prominent on a radial section. It is available in Himalaya, in the outer ranges from the Sutlej eastwards at 1500-3000 m; Khasi hills at 900-1500 m; This is the common birch of the Himalayan forests, so commonly seen at Shimla, Chakrata, Darjeeling etc. The growth is moderate. The bark of old trees is often seen covered with red fungus.

Volume equation developed

ARUNACHAL PRADESH

129.	Debang	L	$V = -0.12110+1.58826D+1.96643D^2$ ($n=108$, $R^2=.93399$)

Betula utilis

General description of the species

It is a moderate-sized deciduous tree, usually with somewhat irregular bole; sometimes a mere shrub. The bark is smooth, shining, reddish white or white, with white horizontal lenticels, the outer bark consisting of numerous thin papery layers exfoliating in broad horizontal rolls; inner cortex, red moist. In all but young trees the bark of the lower part of the stem becomes rough and dark coloured. This species occurs in the higher levels of the inner Himalaya from Bhutan westwards, chiefly at 3000-4200 m altitude, but sometimes descending sporadically as low as 2100 m and even to 1800 m altitude in the Kishenganga valley, Kashmir. The tree is a strong light demander. Wood pinkish white, even-grained, used for building in the inner Himalaya. The bark is used as paper for writing, packing, roofing, covering umbrellas and other purposes. The twigs are used for rope bridges and the leaves are lopped for cattle fodder.

Volume equations developed

SIKKIM

130.	South Western Part. The general and local volume equations were also used	G	$V/D^2 = -0.0177/D^2 +0.00006 +0.000032$ H (dia in cm) ($n=39$, $R^2=0.7458$)

for *Litsea species, Machilus edulis, Machilus gammieana, Machilus odoratissima, Nyssa javanica, Phoebe lanceolata* for this area.	L	$V = 0.12652 - 0.018037\ D + 0.000956\ D^2$ (dia in cm) ($n=68$, $R^2=0.8837$)
UTTAR PRADESH		
131. Alaknanda catchment- Major portion of district Chamoli and part of Pauri Garhwal and Almora districts. The general volume equation was also used for the western parts of Nepal and also for *Betula* spp. for the North-Western parts of Bhutan.	L	$V = -0.14780 + 2.9586\ D$ ($n=74$, $R^2=.96965$)
NEPAL		
132. Western parts	L	$\log_e V = 2.06820 + 2.18752 \log_e D$

Betula species

Wood tough, close grained, moderately hard, pores small not numerous, Medullary rays fine. Medullary patches scanty.

Volume equations developed

BHUTAN		
133. North Western parts. General Volume equation also used in Southern parts.	G	$\log_e V = -0.461510 + 2.039844 \log_e D + 0.837461 \log_e H$ ($n=77$)
	L	$V = 0.050548 - 1.295192\ D + 11.040967\ D^2$ ($n=222$, $R^2=.4386$)

134. Central and Eastern parts L $\log_e V = 2.460537 + 2.447069 \log_e D$ (n=272)

135. Gedu and Changekha areas of Western Bhutan L $\sqrt{V} = 0.37101 + 5.19075 D - 2.12667 \sqrt{D}$ (n=100, R^2=.9888)

Bischofia javanica

General description of the species

A deciduous tree. Bark rough, dark grey with a brown tinge, exfoliating in angular scales. Wood red, rough, moderately hard, heartwood darker, having a strong scent of vinegar when fresh cut. Pores moderately sized to large. It is found in lower Himalaya up to 1200 m and sub-Himalayan tract, from the Yamuna eastwards in West Bengal and Assam and in Western Ghats from North Kanara southwards. A characteristic tree of shady ravines, of swamps and river-banks and of valleys in the hills, but it is also often found on hillsides on the damper aspects. The growth is fast, sometimes as fast as 4 rings per inch of radius. It has a large and dense crown of rather dark foliage. The wood is of good quality and is largely used in Assam for bridges and other constructions. Although above ground, it warps and cracks and white ants attack it, in wet ground or under water, it is almost imperishable, so that it is particularly suited for pile foundations and railway sleepers.

Volume equations developed

ARUNACHAL PRADESH

136. Lohit L $\sqrt{V} = -0.00273 + 2.56199D$ (n=44, R^2=.95117)

137. Tirap L $V = 0.25771 - 2.33118D + 11.12071D^2$ (n=19, R^2=.99989)

Bombax ceiba

General description of the species

It is commonly called Silk Cotton Tree, Cotton Wood, Red Cotton Tree and Semal. It is a lofty deciduous tree attaining a height of 40 m. Mature stems are

invariably buttressed. The branches are whorled, spreading horizontally. The bark is pale ashy to silver grey, smooth upto middle age, becoming rough with irregular vertical cracks on older trees, young stems and branches are covered with sharp, straight, stout prickles. This species is widely distributed almost throughout India, including Andamans, excepting the arid regions, ascending upto 1,200 m. It grows in mixed deciduous forests in the sub-himalayan regions and the lower valleys, and even in Sal forests, being more typical of the alluvial savanna type of forests. It is also quite common in the dry mixed deciduous forests of the peninsula, the moist mixed deciduous forests of the West Coast, the evergreen forests of north-east India and in the Bhabar tracts of Uttar Pradesh and Bihar. In Punjab, it occurs upto an elevation of 900 m in Hoshiarpur and in Himachal Pradesh, upto 1,200 m in the Kangra and Shimla hills. Semal prefers a deep sandy loam derived from granite. In its natural habitat, excluding hilly locations, the absolute maximum shade temperature varies from 38°C to 50°C, the absolute minimum from 3°C to 18°C. It grows in regions with an annual precipitation ranging from 75 - 450 cm or more, thriving best in places with a high rainfall well distributed throughout the year. This species is a strong light demander, is affected by severe frost, is fairly drought-resistant, can resist damage by fire and is a good coppicer. It comes up well by root suckers and is readily browsed by animals.

Semal timber is used in the match industry, in the manufacture of plywood and packing cases and in construction works. The floss from Semal seeds yields the silk cotton or Indian kapok of commerce. It is used for the manufacture of life belts and other life-saving appliances. The bark exudes a gum which has medicinal value. Semal seeds yield an oil. The inner bark of semal yields a good fibre suitable for cordage. The leaves are used as fodder. All the parts of semal tree are used medicinally in India.

Volume equations developed

ARUNACHAL PRADESH

138.	East and West Kameng and Subansiri districts.	G	$V = -0.020028 + 7.8346\ D^2 + 0.039545\ D^2H$ (dia. in cm) ($n=20$, $R^2=0.9662$)
		L	$V = 0.32575 - 0.028412\ D + 0.0013205\ D^2$ (dia. in cm) ($n=32$, $R^2=0.9525$)
139.	Lohit and Tirap districts	G	$V = 0.06076 + 0.0000294 D^2\ H$ (dia. in cm)
		L	$V = 0.2219 - 0.02827\ D + 0.001284\ D^2$ (dia. in cm)

140.	Debang	L	V	= -0.10513+0.28329D+6.11575D^2 (n=38, R^2=.97435)
	ASSAM			
141.	North Cachar hills Nowgong and Karbi Anglong. The general and local volume equations were also used for *Bombax insigne, Hibiscus macrophyllus* and *Sterculia villosa* for these areas. The general volume equation was used for *Sterculia villosa.* These equations have also been used for *Zanthoxylum rhetsa* for Nowgong and Karbi Anglong districts.	G	V/D^2H	= 0.0331/D^2H +0.000034 (dia. in cm)
		L	V	= 0.0589 +0.000956 D^2 (dia in cm)
142.	Assam survey (15 districts)	L	V	= 0.03429 -0.16536 D +5.03740 D^2 + 4.60460 D^3 (n=35, R^2=.99624)
	MADHYA PRADESH			
143.	Balaghat, Seoni, Mandla districts.	G	V/D^2H	= 0.002994/D^2H +0.457283 -0.00054 D^2 H (n=102)
		L	V/D^2	= 0.18573/D^2-2.85418/D +15.03576 (n=102, R^2=.85773)
144.	Rajnandgaon and Durg district.	G	V/D^2H	= 0.019066/D^2H +0.291634 +0.011777 (D^2 H) (n=19, R^2=.705126)
		L	V/D^2	= 0.0417/D^2-0.47789 /D +3.50714 + 9.76048 D (n=34, R^2=.70256)
	ORISSA			
145.	Phulbani catchment (Phulbani and Ganjam districts).	G	V/D^2H	= -0.00399/D^2H +0.310272
		L	V/D^2	= 0.136196/D^2-2.07674/D +10.1566 (n=71, R^2=.6288)

146. Koraput district.	G	V/D^2H	= -0.004022/D^2H +0.311630 ($n=28$, $R^2=.148043$)
	L	V	= 0.02834 +4.68381 D^2 ($n=17$, $R^2=.9204$)
TRIPURA			
147. Tripura Survey.	L	$\sqrt{V}$	= -0.24276+2.95525 D
(F.A.O. Project)			
148. Madhya Pradesh, Andhra Pradesh and Orissa. The general volume equation was also used for Himachal Pradesh, U.P. and Haryana.	G	V	= 0.076+0.228D^2H
	L	V	= -0.032-0.619D+7.208D^2
BHUTAN			
149. Central and Eastern parts. The general volume equation was also used for Southern parts.	G	$\log_e V$	= -0.70448+2.13777 $\log_e$ D +0.91127 $\log_e$ H ($n=82$, $R^2=.993$)
150. Southern parts. The local volume equation was also used for Gedu and Changekha area of Western parts.	L	V/D^2	= 0.04507/D^2-0.93461 /D+5.48513 +9.16037 D ($n=82$)

Boswellia serrata

General description of the species

It is a moderate-sized to large deciduous gregarious tree, attaining a height of 9 to 15 m with light spreading crown, somewhat drooping branches and compound imparipinnate leaves, bark greenish grey to yellow or reddish, fairly thick, smooth, exfoliatig in thin papery flakes, resinous inside. This species is common and usually gregarious on dry hills throughout the greater part of India; it does not occur in Assam or Burma. It is able to thrive and to reach fair

dimensions where every other species, with the possible exception of *Sterculia urens,* remains stunted. It always forms comparatively open forests. In its natural habitat, the absolute maximum shade temperature varies from 43°C to 49°C., the absolute minimum from -1°C to 7°C and the normal rainfall from 50 cm to 125 cm.

This species is a strong light-demander, it stands fire better than almost any other species in the dry tracts, it is frost-tender, it is not readily browsed by cattle. Porcupines do much damage to the trees in certain localities by eating off the bark and sometimes girdling and killing the trees. Pigs have a great partiality for the seedlings, which they grub up. This species produces root-suckers but its power of producing coppice and pollard shoots is variable. Wood is moderately hard, whitish, resinous, with a small brown heartwood, used for rough planking, boxes, well contruction etc. and for match manufacture. A fragrant gum resin exudes from wounds in the bark and is used as incense and in medicine. The branches are lopped for fodder. The tree is a most useful one for clothing dry, barren hills.

Volume equations developed

ANDHRA PRADESH

151. Mehboobnagar Forest division. The general volume equation was also used for *Wrightia tinctoria* of this area and for Southern and Eastern parts of Rajasthan. The local volume equation was also used for *Cochlospermum gossypium, Dalbargia paniculata* and *Wrightia tinctoria* of this area.

G $V = 0.009486 + 0.232207\ D^2\ H$

L $V = 0.028917 + 7.777047\ D^3$

(n=207)

152. Adilabad district.

G $V/D^2H = 0.00517/D^2H + 0.34375$

L $V/D = -0.76369/D + 0.710215 + 0.4976\ D + 11.0387\ D^2$

(n=281, R^2=.8888)

BIHAR

153. South West Bihar.

G $V = -0.200382 + 2.091911\ D + 0.18818\ D^2\ H$

L $V = 0.026499 + 2.592167\ D^2$

154. Ranchi district. The general volume equation was also used for Purulia, Bankura and Midnapur districts of West Bengal.

G $V/D^2H = 0.0057489/D^2H - 0.0018469/D^2 + 0.43527$ ($n=51$, $R^2=0.2548$)

155. Singhbhum district. The local volume equation was also used for Purulia, Bankura and Midnapur districts of West Bengal.

L $V/D^2 = 0.03356/D^2 - 1.124\ /D + 10.306$ ($n=29$, $R^2=0.7132$)

KARNATAKA

156. Chitradurga, Tumkur, Kolar Bangalore and Bellary districts. The local volume equation has also been used for Udaipur Forest division of Rajasthan, Indore catchment-Mandsour Ratlam, Ujjain and Shajapur of M.P.

L $\sqrt{V} = -0.155316 + 2.714875\ D$

MADHYA PRADESH

157. Rajanandgaon, Durg and Raipur districts.

G $V = -0.009747 + 0.434050\ D^2\ H - 0.009295\ (D^2\ H)^2$ ($n=26$, $R^2=.956087$)

L $V/D^2 = 0.10511/D^2 - 2.19414/D + 15.02014 - 7.63722\ D$ ($n=1666$, $R^2=.56778$)

158. Balaghat, Seoni and Mandla districts. The general volume equation was also used in Raigarh district of M.P.

G $V = 0.003941 + 0.506093\ D^2\ H$ ($n=138$)

L $V = 0.00642 - 0.19774\ D + 6.90556\ D^2 + 5.54843\ D^3$ ($n=301$, $R^2=.96426$)

159. Bilaspur district.	L	V =	0.10370-1.72225D+12.98261D^2 ($n=229$, $R^2=.97946$)
160. Raipur district.	L	V/D^2 =	$0.044621/D^2$ -1.25694 /D +10.86801 -3.009085 D ($n=130$, $R^2=.77897$)
161. Raigarh district.	L	V =	-0.18564+3.38452D ($n=63$, $R^2=.97938$)
MAHARASHTRA			
162. Wadsa catchment (Chanda Priority-I). The general volume equation has also been used in Sondad catchment-Bhandara district.	G	V/D^2H=	$-0.00761/D^2H$ +0.36068 ($n=36$, $R^2=.306$)
	L	V/D=	0.153684/D -2.641645 +15.0564 D -6.2061 D^2 ($n=38$, $R^2=.9426$)
163. Melghat Forest division.	G	$\log_e V$ =	-0.72821 +2.178597 $\log_e$ D + 0.978936 $\log_e$ H ($n=163$, $R^2=.9683$)
	L	V =	0.050452 -1.228748 D +9.123381 D^2 ($n=163$, $R^2=.7538$)
164. Sondad catchment-Bhandara district	L	V/D^2=	$0.09856/D^2$-1.938118/D+11.867328 -3.26808 D ($n=43$, $R^2=.5331$)
ORISSA			
165. Kalahandi district.	G	V =	-0.020177 +0.377885 D^2 H
166. Phulbani catchment (Phulbani and Ganjam district).	L	$\sqrt{V}$ =	-0.188655 +3.021335 D ($n=151$, $R^2=.9666$)
167. Koraput district. This local volume equation was also used for Sambalpur, Mayurbhanj and Balasore districts.	G	V =	0.004783 +0.301536 D^2 H + 0.021818 $(D^2 H)^2$ ($n=34$, $R^2=.98833$)
	L	V =	0.36432 -1.32768 $\sqrt{D}$ +9.48471 D^2 ($n=29$, $R^2=.99284$)

PUNJAB and HARYANA

168.	Shiwalik region of Haryana and Punjab-Ambala, Ropar, Hoshiarpur districts. Also in Udaipur Forest division and Southern and Eastern parts of Rajasthan.	G	$V = -0.000751 + 0.382544\ D^2\ H$

UTTAR PRADESH

169.	Southern region-Agra, Etawah, Jalaun, Jhansi, Lalitpur, Hamirpur, Banda, Allahabad, Mirzapur and Varanasi districts.	L	$\sqrt{V} = -0.1503 + 2.79425\ D$ ($n=95$, $R^2=.95254$)

RAJASTHAN

170.	Southern and Eastern part.	L	$\sqrt{V} = -0.11629 + 2.4254\ D$ ($n=671$, $R^2=.96528$)

(F.A.O. Project area)

171.	Madhya Pradesh and Orissa.	G	$V = -0.007 + 0.268\ D^2\ H$
		L	$V = 0.058 - 0.996\ D + 7.137\ D^2$

Bridelia retusa

General description of the species

It is a moderate-sized or large deciduous tree with variable coriaceous leaves with straight parallel lateral veins. Bark grey to dark brown, longitudinally cracked. Young trees often have the stems covered with strong spines. This species occurs throughout the greater part of India and Burma but not in the driest parts of India. It is common in mixed deciduous forests, though it is not gregarious; it is a common accessory species in Sal forests. The tree stands moderate but not heavy shade, is frost tender, drought hardy, good coppicer and produces root suckers. Wood grey to olive-brown, durable, used for house-posts, carts, cart-shafts and agricultural implements. The bark is used for tanning and the leaves for cattle fodder.

Volume equations developed

ASSAM

172. North cachar hills Nowgong and Karbi Anglong. The General volume equation was also used in the 15 districts of Assam, for *Cassia fistula* in Nowgong and Karbi Anglong and North Cachar hills and also used for *Lagerstroemia parviflora, Lagerstroemia flosreginae* for Nowgong and Karbi Anglong.	G	$V/D^2H =$	$0.01409/D^2H + 0.0000312$ (Dia in cm)
	L	$V =$	$0.14451 - 0.013827\ D + 0.0010286\ D^2$ (Dia in cm)
173. Assam survey. (15 districts)	L	$V =$	$-0.00021 + 0.06175\ D + 3.97424\ D^2$ ($n=33$, $R^2=.92939$)

ORISSA

174. Phulbani catchment (Phulbani and Ganjam districts).	G	$V/D^2H =$	$-0.003872/D^2H + 0.383012$
	L	$V/D =$	$0.035142/D - 0.839708 + 8.157614\ D$ ($n=165$, $R^2=.8902$)
175. Koraput district. The local volume equation was also used for Sambalpur, Mayurbhanj and Balasore districts.	G	$\log_e V =$	$0.794669 + 2.315417 \log_e D + 0.534416 \log_e H$ ($n=58$, $R^2=.99128$)
	L	$\sqrt{V} =$	$0.1162 + 4.12711\ D - 1.085085\ \sqrt{D}$ ($n=81$, $R^2=.9907$)

Buchanania angustifolia

General description of the species

It is a middle sized tree, youngest shoots slightly pubescent, leaves elliptic or linear-oblong, obtuse, glabrous on both sides. The nuts from the fruits are edible. The wood is used for construction of temporary sheds, yokes and sometimes for planking.

Volume equations developed

ANDHRA PRADESH

176.	Adilabad district. These general and local volume equations have also been used for *Buchanania latifolia, Emblica officinalis.* The general volume equation was also used for *Lagerstroemia parviflora* and for *Madhuca latifolia* in Adilabad.	G	$V = 0.00508 + 0.35820\ D^2\ H$
		L	$V = -0.309862 + 5.7058D - 31.819D^2 + 72.355D^3$ ($n=67$, $R^2=0.9159$))
177.	East Godavari, West Godavari, Visakhapatnam and Khammam districts. The general and local volume equations were also used for *Buchanania latifolia, Grewia tiliaefolia* for the same districts. The general volume equation was also used for *Lagerstroemia parviflora* in these districts.	G	$V = 0.006 + 0.328\ D^2\ H$
		L	$\log_e V = 2.2491 + 2.5206 \log_e D$
178.	East Godawari	L	$V = 0.002982 + 16.395353D^3$ ($n=23$, $R^2=.917764$)

Buchanania latifolia

General description of the species

It is a moderate sized tree almost evergreen, with a straight trunk; bark dark grey or black reddish inside, regularly divided into small rectangular plates, somewhat resembling crocodile hide.

This species occurs in deciduous forests throughout the greater part of India and Burma, except in the arid regions of north-western India. In the sub-Himalayan tract it occurs on the dry outer Himalayan and Siwalik slopes upto 900 m elevation, from the Sutlej to Nepal. It is also common in the drier types of sal forests in the sub-Himalayan tract outside the hills and in the Indian peninsula, where it is also abundant in mixed deciduous forests particularly of the drier types. In its natural habitat the absolute maximum shade temperature varies from 41° C to 46°C, the absolute minimum from -1°C to 13°C, the normal rainfall from 75 cm to 213 cm.

The tree is a moderate light-demander, very sensitive to frost, and somewhat sensitive to drought. It is not readily browsed. Silviculturally it is a useful tree for clothing dry hill sides. It produces root-suckers and coppice-shoots. The wood is of poor quality, but the tree is of some economic importance for the gum and edible fruits, which it yields.

Volume equations developed

MAHARASHTRA

179. Sondad catchment (Bhandara district) This general volume equation was also used for Wadsa catchment (Chandra Pur). The local volume equation was also used for Chitradurga, Tumkur, Bellary and Bangalore districts of Karnataka.

G $V = 0.01475 + 0.2982\ D^2\ H$ ($n=24$, $R^2=.9603$)

L $V = 0.019341 - 0.262689\ D + 4.293135 D^2$ ($n=96$, $R^2=.9886$)

180. Wadsa catchment (Chandra Pur)

L $V = -0.00767 + 0.2654\ D + 1.0383\ D^2 + 7.527\ D^3$ ($n=67$, $R^2=.9947$)

181. Uttar Pradesh The general and local volume equations were

G $V = 0.017 + 0.381\ D^2\ H$ ($n=27$, $R^2=.972$)

L $\log_e V = 2.997 + 3.093 \log_e D$

also used for G-14(65) sheets for *Grewia tiliaefolia, Pterocarpus marsupium, Terminalia chebula* and also used for G-14(65) sheet of Uttar Pradesh for *Lagerstroemia parviflora.*

MADHYA PRADESH

182.	Narayanpur Catchment	G	$V = 0.00551+0.30414\ D^2H$ ($n=36$, $R^2 = 0.8935$)
		L	$V = 0.031-0.64087\ D+6.04066\ D^2$ ($n=247$, $R^2 = 0.9621$)

Callicarpa species

General description of the species

There are about 10 species (shurbs or trees) with red flowers and more or less stellately-hairy leaves and branches. Wood white or brownish, white, even-grain. Pores usually in radial lines.

Volume equation developed

ASSAM

183.	Assam survey (15 Districts.)	L	$\sqrt{V} = -0.04506 +2.33446\ D$ ($n=61$, $R^2=.92605$)

Calophyllum inophyllum

General description of the species

It is a moderate-sized very ornamental evergreen tree with short thick,

often crooked bole, dark brown or blackish bark, handsome white flowers and dense dark green shiny foliage. This species occurs along the east and west coasts of the Indian peninsula, Burma, and the Anadamans. It is essentially a littoral species, growing down to the edge of the sea. It grows best on deep soil near the coast and will thrive on pure sand. In the Andamans, it is characteristic of the mixed forests of littoral fringe on raised beaches or deposits of sea sand.

The tree is said to be brittle and liable to damage by wind. It can be raised without difficulty from seed provided the seed is sown soon after ripening. It produces a useful timber and the seeds yield an oil used for burning.

Volume equations developed

ANDAMAN and NICOBAR ISLANDS

184. Little Andaman

G $V/D^2H = 0.05188/D^2H + 0.000038$
(dia. in cm)
($n=28$, $R^2=0.8353$)

L $V/D = 1.327/D - 0.0844 + 0.002219\ D$
(dia. in cm)
($n=28$, $R^2=0.8810$)

KARNATAKA

185. Kodagu district.

L $V = 0.14429 - 1.75632D + 10.61539D^2$

Canarium euphyllum

General description of the species

It is a large evergreen tree having very stout branchlets, youngest shoots puberulous, leaves glabrous when full grown. It occurs in South Andamans. The wood is considered suitable for aeroplane and glider structures, for making plywood, in manufacture of match boxes, joinery, cabinet, billiard tables etc.

Volume equations developed

ANDAMAN and NICOBAR ISLANDS

186.	Little Andaman. The general volume equation was also used for North Andaman.	G	V/D^2	= -0.0468/D^2 +0.000615 +0.0000139 H (dia in cm) ($n=36$, $R^2=0.4088$)
		L	V	= 1.2899 -0.06598 D +0.00175 D^2 (dia. in cm) ($n=36$, $R^2=0.9168$)
187.	North Andaman	L	V	= 0.004338 -0.007315 D +0.0011175 D^2 (dia. in cm)
188.	South and Middle Andaman	G	V/D^2H	= -0.013453/D^2H +0:28771 (dia. in cm)
		L	V/D	= 0.1751/D -2.5328+13.45 D

Canarium strictum

General description of the species

It is a large evergreen tree, occuring in Western Ghats, Assam and Khasi hills; leaflets almost glabrous; resin used to make torches. The wood is used for making canoes and oars.

Volume equations developed

ARUNACHAL PRADESH

189.	Tirap	L	V	= -0.05269+8.70702D^2 ($n=20$, $R^2=.97526$)
190.	Lohit	L	$\sqrt{V}$	= -0.21948+3.49665D ($n=20$, $R^2=.97610$)
191.	Assam Survey (15 districts)	L	V	= -0.01538 +0.62475 D -3.02099 D^2 +20.08887 D^3 ($n=52$, $R^2=.97916$)

Canarium species

General description of the species

There are about nine species, all large trees of resinous character. Three of them are from Srilanka, two from Assam, one from Sikkim and one, a very conspicuous common tree from S. India.

Volume equation developed

192. Assam survey (15 districts) L $\sqrt{V} = 0.08342 + 3.26199\ D - 0.69317\ \sqrt{D}$ ($n=42$, $R^2=.98777$)

Careya arborea

General description of the species

It is a moderate sized to large deciduous tree with large obovate leaves clustered at the ends of the branches. Bark dark grey, fissured, red and fibrous inside. The species is found sporadically throughout the greater part of India but not in the driest regions. It is very typical of savannah lands, where owing to its fire-resisting capacity, it is able to survive and to regenerate. Generally, it is characteristic of the moist types of mixed deciduous forest. The tree stands a fair amount of shade. It is drought hardy. It coppices well. It is much subject to damage by browsing. It is very fire resistant. The wood is durable, especially under water and is used for buildings, carts, furniture etc. The bark gives a good rough cordage fibre.

Volume equations developed

ASSAM

193. Assam survey (15 districts) L $\sqrt{V} = 0.23738 + 2.33289\ D + 0.48512\ \sqrt{D}$ ($n=107$, $R^2=.98393$)

GOA

194. Goa Survey L $\sqrt{V} = -0.072682 + 1.605802\ D$ (for dia. ≤ 20 cm U.B.)

			$\sqrt{V}$ = 0.276685 +1.413077 D (for small wood dia. ≤ 5 cm O.B.)
	(F.A.O. Project area)		
195.	Madhya Pradesh, Andhra Pradesh and Orissa	G	V = -0.013 +0.279 D^2 H
		L	V = 0.003 -0.848 D +7.342 D^2

Casearia species

Volume equation developed

196.	Assam survey (15 districts)	L	V = 0.14031 -2.06478 D +11.25750 D^2 (n=23, R^2=.99789)

Cassia fistula

General description of the species

It is commonly called Laburnum. It is a moderate-sized deciduous tree with a rather open crown. Bark in younger trees is smooth, light grey, reddish brown inside, in older trees reddish brown exfoliating in hard scales. This is one of the most beautiful of Indian flowering trees.

This species is common in deciduous forests throughout the greater part of India and Burma, ascending to 1200 m elevation in the Himalaya. The tree is not gregarious but is scattered in mixed deciduous forests, often of a somewhat open type; it occurs fairly frequently in sal forest. In its natural habitat the absolute maximum shade temperature varies from 38°C to 49°C, the absolute minimum from -4°C to 18°C and the normal rainfall from 50 cm to 300 cm or more. *Cassia fistula* stands a moderate amount of shade, is not frost-hardy but is drought-hardy. It is not readily browsed even by goats. It coppices vigorously and produces root-suckers freely. Wood is hard and durable used for house-posts, carts, and agricultural implements. The pulp of the pods is a strong purgative while the bark is much in demand for tanning.

Volume equation developed

(F.A.O. Project area)

197.	Kerala and Tamilnadu The general volume equation was also used for *Vitex altissima* for Kerala and Tamilnadu and for *Anogeissus latifolia* and *Xylia xylocarpa* for Kodagu district of Karnataka.	G	$V = 0.066 + 0.287\ D^2\ H$

Cassia siamea

General description of the species

It is a moderate sized evergreen tree with a dense crown, probably indigenous to Burma and the southern most part of Tamil Nadu largely planted for ornament. The yellow flowers, in large pyramidal terminal panicles, appear mainly in the hot season but the flowering period is comparatively long and flowers may often be found at various seasons. The pods ripen towards the end of the hot season; they hang in clusters and give the tree a somewhat untidy appearance. The tree grows fairly rapidly and is easy to cultivate; it grows well on moist soils provided the drainage is good.

Volume equation developed

ASSAM

198.	Assam survey (15 districts)	L	$V = 0.05159 - 0.53331\ D + 3.46016\ D^2 + 10.18473\ D^3$ ($n=42$, $R^2=.99327$)

Castanopsis hystrix

General description of the species

A very large evergreen tree. Wood grey or light greyish-brown hard. Annual rings marked by narrow belts of firmer texture. Pores moderate-sized

and large, very scanty, arranged in irregular short radial and oblique lines. Medullary rays very fine, very numerous, uniform and equidistant. It is largely available in Eastern Himalaya in Sikkim and Bhutan at 1800-2400 m, common around Darjeeling, Assam and the Khasi hills at 600-1200 m. This species in the Darjeeling forests grows to a large size, reaching 30 to 36 m in height and 3 to 6 m in girth. In Assam and Khasi hills, it is however, a much smaller tree.

The growth is moderate, about 8 rings per inch of radius. The wood is used in Darjeeling for house-building and other purposes exactly as that of *Quercus pachyphylla* which closely resembles. It gives excellent shingles and is more valuable as planking and posts whenever exposed to wet than other species of this genus. The fruit is small, edible and of good flavour. It is enclosed in a large cup with long needle-like spines, longer than those of *C.indica.*

Volume equations developed

ARUNACHAL PRADESH			
199. Tirap	L	V	= 0.13937-0.35988 $\sqrt{D}$+6.81318D^2 (n=81, R^2=.97451)
200. Lohit	L	$\sqrt{V}$	= 0.34640+3.99269D-1.64666$\sqrt{D}$ (n=35, R^2=.98954)

Castanopsis indica

General description of the species

It is a moderate-sized to large evergreen tree with elliptical oblong sharply serrate leaves and silvery grey bark. This species occurs in the Eastern Himalaya from Nepal eastwards, ascending to 1800 m altitude in Bhutan all along with outer hills up to 1200 m in Assam and Bangaladesh. It is common in the Darjeeling hills, especially on dry slopes and on abandoned cultivation. The nut, which is edible, is enclosed in a very prickly involucre. The tree coppices and pollards well. Wood largely used for shingles, as well as for building.

Volume equations developed

ASSAM			
201. Assam survey	L	$\sqrt{V}$	= 0.22234 +4.90695 D -1.5124$\sqrt{D}$ (n=25, R^2=.99083)

Castanopsis species

General description of the species

Evergreen trees with erect male catkins and nuts of the fruit wholly enclosed in the involucre,which is covered with spines or tubercles. The species of *Castanopsis* have an uniform structure which resembles that of the oaks with one class of medullary rays. Wood grey, moderately hard to hard, does not split or warp, seasons well, is durable and often shows heavy concentric lines. Pores large, in wavy radial bands and lines very prominent on a vertical section.

Volume equations developed

ASSAM

202.	Assam survey (15 districts)	L	V	= 0.05331 -0.87098 D +6.52533 D^2 +1.74231 D^3 (n=20, R^2=.99929)

SIKKIM

203.	South Western parts. The general and local volume equations were also used for *Quercus lamellosa, Quercus lineata* and for *Quercus pachyphylla* of this area.	G	V/D^2H	= 0.02305/D^2H +0.0000387 (dia. in cm) (n=38, R^2=0.8441)
		L	V/D^2	= 0.1812/D^2-0.02348/D +0.001184 (dia. in cm)

BHUTAN

204.	Central and Eastern part. General Volume equation was also used in Southern parts.	G	V/D^2H	= -0.00794/D^2H +0.34759 (n=82, R^2=.15519)
		L	$\log_e V$	= 2.319413 +2.653453 $\log_e D$ (n=165)
205.	Southern parts	L	V/D^2	= -0.02301/D^2+0.12721 /D +2.4127 + 8.12834 D (n=196, R^2=.70153)

Cedrus deodara

General description of the species

It is commonly called Himalayan Cedar, Deodar. It is a very large evergreen tree with dark green or in some cases, silvery, foliage. The form with silvery-blue foliage is conspicuous and handsome, and is fairly common in certain localities. This species occurs throughout the western Himalaya from Afghanistan to Garhwal at elevations varying from 1200 m to over 3000 m but most commonly at 1800 -2550 m. Its eastern natural limit is in the valley of the Dhauli river, a branch of the Alaknanda river in Garhwal, below the Niti pass. The altitudinal range of what may be termed the Deodar belt varies in different localities, while it is usually higher on southern than on northern aspects, this belt is a well marked one, since the tree is essentially gregarious and often forms pure crops of considerable extent. The chief Deodar forests are confined to Jaunsar, Kulu and Hazara, Kashmir, Chitral and Dir, Chamba, Bashah and Tehri Garhwal. This tree occurs naturally on mountainous country with slopes varying from moderate to precipitous, as well as on level ground in river valleys at suitable elevations. It is found on all aspects though it grows best and reaches its largest dimensions on northern aspects and in cool situations. The best growth of the species is attained on deep, fairly porous, fertile soil in cool situations, for instance along the sides of moist ravines. The great majority of the best Deodar forests are found where the rainfall varies from 100 cm to 175 cm, in these regions most of the rain falls during the south-west monsoon from June to September, while there is often considerable snow fall during the winter, from December to March. The shade temperature in the deodar zone probably varies for the most part from a minimum of -12°C to -4°C to a maximum of 27°C to 38°C. Deodar is a typically gregarious tree and is frequently found in the form of pure forests. Deodar is a light demander, drought sensitive wind firm and frost hardy. Browsing by goats is the cause of much injury to young Deodar.

Wood is moderately hard, sap-wood white, heart-wood light yellowish brown, oily and strongly scented, very durable. Deodar is the most important timber tree of the western Himalaya. The wood is extensively used for building, railway sleepers and other purposes for which durability is required, as well as for furniture, general carpentry and many other purposes. It is largely exported to the plains of India.

Volume equations developed

HIMACHAL PRADESH

206. Chamba, Lahaul Spiti	L	V/D^2	$= 0.2421/D^2 - 2.68191/D + 14.77955$

	and Kinnaur districts. The local volume equation was also used for Shimla, Rohru and Chopal districts.			- 2.63126 D (n=524, R^2=.52595)
207.	Kulu, Seraj and Kotgarh (Kulu and Shimla districts).	L	V	= 0.167174-1.735312D+12.039017 D^2 (n=423, R^2=.2664)
208.	Chir belt area-Bilaspur, Hamirpur, Kangra, Mandi, Solan and Una districts	L	V/D^2	= 0.325045/D^2 -3.533911 /D +16.818237 -5.234057 D (n=119)
209.	Rajgarh, Nahan and Sirmour districts.	L	V	= -0.0017 +8.2098 D^2 (n=221, R^2=.9393)
	JAMMU and KASHMIR			
210.	Chenab Valley catchment The general volume equation was also used for Jammu region- Udhampur Kathua, Rajaouri districts.	G	V	= 0.091531 +0.294023 D^2 H (for D^2 H ≤ 10) (n=85, R^2=.9695)
		G	V/D^2H	= 0.354658/D^2H +0.253916 (for D^2 H >10) (n=51, R^2=.0359)
	(It was also used for Shimla, Rohru, Chopal, Kulu, Seraj and Kotgarh-Kulu and Shimla Chir belt area-Bilaspur Hamirpur, Kangra, Mandi, Solan and Una districts of Himach Pradesh)	L	V	= 0.0166427 -1.756483 D +11.804879 D^2 (n=632, R^2=.2419)
211.	Jammu region-Udhampur Kathua, Rajaouri	L	$\sqrt{V}$	= 0.67872 +5.71233 D -2.95629 $\sqrt{D}$ (n=74, R^2=.9759)
212.	Kashmir Valley . These general and local equations were also used for *Pinus excelsa* of this area.	G	V	= 0.27963 D^2 H -0.54677 D^2 + 0.01393 H -0.05721
		L	V	= 15.71276 D^2 +0.17086-3.11851 D (for dia. 10-20 cm)
			V	= 11.39333 D^2 +0.37662-2.80778 D (for dia 20-60 cm)
			V	= 11.8223 D^2 +0.97629 -4.11764 D (for dia 60-150 cm)

UTTAR PRADESH

213. Bhagirathi, Bhilangana and Yamuna catchments
G V = 0.06168 +0.27696 D^2 H
(n=33, R^2=.9808)
L V = -0.00165 +8.209795 D^2
(n=221, R^2=.9393)

(F.A.O. project area)

214. Himachal Pradesh and Uttar Pradesh
G V = -0.087 +0.289 D^2 H

Chloroxylon swietenia

General description of the species

It is commonly called Satinwood. It is a moderate-sized deciduous tree with a rather short bole and a spreading light feathery crown with glaucous green, pinnate, aromatic leaves. This species occurs in the dry deciduous forests in the Indian Peninsula, extending as far north as the Satpuras and Chota Nagpur. It attains comparatively large size on sandy loam. In its natural habitat the absolute maximum shade temperature may rise to nearly 49°C, the absolute minimum being 2° C and the normal rainfall varies from 75 cm to 150 cm.

The Satinwood is a strong light demander, frost tender, and easily damaged by fire. The leaves contain an acrid oil which browsing animals and even goats, find unpalatable and this protects the plants from injury. This species is more keenly sought after than any of its associates by deer for the purpose of rubbing the velvet off their antlers, the bark of every tree being rubbed down where deer are plentiful. The tree coppices and produces root-suckers.

The tree gives the well known Satinwood of commerce used for all kinds of ornamental works

Volume equations developed

ANDHRA PRADESH

215. Mahboob Nagar Forest division. The local volume
L V = -0.003156 +2.043969 D^2
(n=204, R^2=.86)

equation was also used for *Lagerstroemia parviflora* of this area.

(F.A.O. Project area)

216.	Madhya Pradesh and Andhra Pradesh	G	V	= -0.009 +0.236 D^2 H
		L	V	= -0.094 +0.376 D +2.817 D^2

Chickrassia tabularis

General description of the species

It is a very large handsome tree with a tall straight trunk, a spreading crown and paripinnate leaves. This species occurs in Sikkim, Assam, Chittagong, the Andamans and the Indian Peninsula, chiefly in the Western Ghats. The tree is usually found scattered in moist tropical forests on hilly country. In its natural habitat the absolute maximum shade temperature varies from 36°C to 41°C, the absolute minimum from 3°C to 16°C and the normal rainfall from 175 cm - 375 cm or more. The wood is reddish brown, hard, very ornamental and suitable for furniture, if well seasoned.

Volume equations developed

ARUNACHAL PRADESH

217.	Lohit	L	V	= -0.07559+9.23051D^2 (n=13, R^2=.99962)

Cinnamomum cecidodaphne

General description of the species

A large tree. Bark 1 to 2 inch thick, dark grey, uneven, outside corky, highly scented. Wood rough pale brown, highly scented with a strong smell of camphor, soft to moderatly hard, even-grained. Annual rings marked by distinct lines.It is largley found in Eastern Himalaya in Assam, Sikkim and Bhutan, rising to 1200 m. The leaves turn red before they fall. The scent precludes the

use of the wood for tea-boxes but is good for boxes and furniture as it is not damaged by white ants. It is somewhat brittle. The growth of the tree is fast; 2 to 3 rings per inch of radius.

Volume equations developed

ARUNACHAL PRADESH

218.	Lohit	L	V	= -0.13819+2.28497D-4.27569D^2 +11.34220D^3 (n=14, R^2=.99277)

ASSAM

219.	Assam survey (15 districts) The local volume equation was also used for *Cinnamomum* spp.	L	V	= 0.14885 -1.62875 D +5.93114 D^2 +11.73286 D^3 (n=26, R^2=.97618)

Cinnamomum tamala

General description of the species

A moderate-sized evergreen tree. Bark thin, compact, brown wrinkled, with an aromatic taste. Wood reddish-grey, splits and warps, moderately hard, close-grained, slightly scented. Annual rings distinctly marked by a narrow belt of firmer wood on the outer edge with fewer pores. It is found in the Himalaya common in shady places along streams, rising to 2100 m elevation, but most common at 900 to 1500 m. It is often cultivated in gardens in North India.

When well grown, it is a handsome tree, on account of its glossy 3-nerved leaves, pink young foliage and panicles of yellowish-white flowers. The leaves are aromatic with the scent of cinnamon. They are commonly known by the name of tejpat and are used in medicine, also to flavour curries. The bark is also used as a substitute for, or an adulterant of, the true cinnamon. The wood is not used. Its rate of growth varies from 6 to 10 rings per inch.

Volume equation developed

ARUNACHAL PRADESH

220.	Debang	L	V	= 0.10970-0.88666D+6.09700 D^2 -1.62672D^3 (n=63, R^2=.92943)

Cinnamomum zeylanicum

General description of the species

It is commonly called Cinnamon tree. It is a moderate-sized to large evergreen tree with thickly coriaceous 3 or 5 veined leaves, shining above, dull beneath. Old bark rough, brown, young bark smooth, pale coloured. The bark and the leaves are very aromatic, the former yielding the cinnamon of commerce and the latter being used for flavouring. The tree is indigenous to the Western Ghat and adjoining hill ranges from the Konkan southwards ascending to 1800 m elevation.

Volume equations developed

KARNATAKA

221.	Chikmaglur, Hassan and Shimoga districts and Kerala and Tamil Nadu. The local volume equation was also used for *Hydnocarpus weightiana* and *Machilus macrantha* of these areas. (F.A.O. Project area)	L	V = 0.089 -1.242 D +9.732 D^2
222.	Kerala and Tamil Nadu. The general volume equation was also used for *Hydnocarpus wightiana Machilus and macrantha* of these areas and for *Olea dioica* of Kodagu district of Karnataka.	G	V = 0.089 +0.269 D^2 H

Cinnamomum species

Volume equations developed

WEST BENGAL

223. North Eastern and Eastern part of Kalimpong division, Singalila and Tonglu ranges of Darjeeling Division.	L	V	= 0.3353 -0.0437 D +0.0012 D^2 (for plywood) (dia. in cm)
		V	= -0.3219 +0.00073 D^2 (for total timber) (dia. in cm)
224. Singalila and Tonglu ranges of Darjeeling Division	G	V	= -0.1505 +0.0000332 D^2 H (for total timber) (dia in cm)

Cleistanthus collinus

General description of the species

It is a small tree with orbicular abovate or broadly elliptical leaves, glaucous beneath. This species is common in many parts of the Indian Peninsula as far north as the Ganga river and Chota Nagpur, especially in the Singhbhum district. It is one of the commonest trees in some of the dry types of mixed forests, and thrives on dry rocky ground, where it often becomes more or less gregarious. In Central India, it is frequently found on laterite, where it flourishes, particularly where the rock is decomposing. The tree is very hard and survives fire and grazing better than almost any other species. It is seldom browsed and is said to be poisonous, on which account it is often the commonest species on grazed area. It produces root-suckers and coppices very well. Wood is dark reddish brown, hard, durable, much used for house and fence posts.

Volume equations developed

ANDHRA PRADESH

225. Adilabad district.	G	V	= 0.00342 +0.31261 D^2 H
	L	V	= 0.011617 -0.309699 D +4.629527 D^2 ($n=484$, $R^2=.8915$)

MADHYA PRADESH

226.	Narayanpur catchment Bastar district.	G	V	$= -0.00287 + 0.38065\ D^2\ H$ $(n=100,\ R^2=.9305)$
		L	V	$= -0.03915 + 0.16295\ D + 4.09182\ D^2$ $(n=654,\ R^2=.9631)$

MAHARASHTRA

227.	Sondad catchment Bhandara district. The general volume equation was also used for Wadsa catchment Chandrapur district.	G	V	$= -0.00185 + 0.32052\ D^2\ H$ $(n=20,\ R^2=.9751)$
		L	$\sqrt{V}$	$= -0.07324 + 2.187427\ D$ $(n=223,\ R^2=.8898)$
228.	Wadsa catchment Chandrapur district.	L	V	$= -0.019404 + 3.802027\ D^2$ $(n=320,\ R^2=.8886)$
229.	Ballarshah catchment Chandrapur district.	G	V/D^2H	$= -0.00099/D^2H + 0.342201$ $(n=75,\ R^2=.004)$
		L	V/D^2	$= 0.083169/D^2 - 1.80243\ /D + 13.579193 - 15.53866\ D$ $(n=593,\ R^2=.5212)$

ORISSA

230.	Phulbani catchment (Phulbani, Ganjam and Kalahandi districts).	G	V	$= 0.005405 + 0.336072\ D^2\ H$
		L	V	$= 0.030925 - 0.567037\ D + 5.709471\ D^2$ $(n=673,\ R^2=.9275)$
231.	Koraput district	G	$\log_e V$	$= 0.594183 + 2.26738 \log_e D + 0.562626 \log_e H$ $(n=35,\ R^2=.971725)$
		L	$\sqrt{V}$	$= 0.12956 + 3.7819\ D - 1.04671\ \sqrt{D}$ $(n=350,\ R^2=.9877)$

(F.A.O. Project area)

232.	Madhya Pradesh, Andhra Pradesh and Orissa	G	V	$= 0.007 + 0.275\ D^2\ H$
		L	V	$= -0.023 + 0.163\ D + 3.006\ D^2$

Cochlospermum gossypium

General description of the species

It is a small deciduous tree with palmately lobed leaves and fibrous deeply furrowed bark. It occurs in the western sub-Himalayan tract from the Sutlej eastwards upto 900 m elevation, Chota Nagpur, Bundelkhand and the drier parts of the Indian peninsula. The tree is characteristic of dry hilly country, occupying the hottest and stoniest slopes. The tree is capable of resisting successfully the fierce, annual forest fires, it is drought resistant and a light demander.

The tree yields a gum which exudes from the fibrous deeply furrowed bark which is used as a substitute for tragacanth in calico printing. The floss covering the seeds is soft and used as substitute for Indian Kapok.

Volume equation developed

ANDHRA PRADESH

233.	Mahboob Nagar Forest division. The general volume equation was used for *Dalbergia paniculata* also.	G	$V = 0.005188 + 0.245578\ D^2\ H$

Cordia species

Volume equation developed

ASSAM

234.	Assam survey (15 districts)	L	$V = -0.49388 + 7.56417\ D - 31.45373\ D^2 + 50.93877\ D^3$ ($n=22$, $R^2=.98478$)

Cryptomeria japonica

General description of the species

It is a large evergreen tree attaining, in Japan a height of 45 m or more, bark reddish brown, peeling off in long strips. In Darjeeling hills, it has been successfully grown at elevations varying from 900 -2100 m but appears to thrive best between 1200 and 1800 m. At 2250 m on Jalapahar, the trees are stunted and the growth is slow. In the neighbourhood of Shillong, it thrives between 1200 and 1800 m on moist soils, growing far more rapidly than the indigenous pine *(Pinus khasya)*. It is planted to a certain extent in the Western Himalaya, but does not seem to grow so well as it does farther east in a moister climate. Young plants are not eaten by cattle, they succeed well in the open or under very slight shelter. Wood soft, fragrant with reddish brown heart-wood. It makes excellent tea-boxes. In Japan, it is extensively used, particularly for building casks.

Volume equation developed

WEST BENGAL

235.	Darjeeling and Kalimpong	G	V	= 0.0069 +0.08259 D^2 H +3.8946 D^2 (n=19, R^2=0.8456)
		L	V	= -0.01097 +5.30991 D^2 (n=13, R^2=0.9975)

Cryptomeria paniculata

General description of the species

A large tree with spreading crown and fluted stem. Bark pale grey or brown, exfoliating in long curled up, somewhat brittle strips, exposing a cinnamon brown surface, chocolate or reddish-brown inside. Branchlets glabrous. Leaves opposite or elliptic to ovate-lanceolate, entire, acuminate. It occurs in Lakhimpur, Kamrup, Cachar, Sibsagar, Garo hills, foot of the Khasi hills, probably also in Darrang. The wood is reddish-brown, soft, pores distant, medullary rays fine, annual rings indistinct. It is being used for railway sleepers after treatment.

Volume equation developed

ASSAM

236. Assam survey (15 districts) — L — $V = 0.15967 - 2.15871\ D + 10.80282\ D^2$ ($n=20$, $R^2=.98301$)

Cupressus species

Volume equation developed :

BHUTAN

237. North Western parts. The local volume eqaution was also used for *Junipers* of this area. — L — $\log_e V = 2.101388 + 2.418695 \log_e D$

Cyclostemon assamicus

General description of the species

A small tree found in sub Himalayan tract from the swampy forest of Dehra Dun Eastwards to the Darjeeling tract and Assam, Khasi hills, always in first under growth in damp places. Bark greyish white, granular, faintly cleft. vertically, very thin. Wood light brown, hard. Pores moderate sized, scanty, often subdivided. Medullary rays fine to moderately broad, regular, very fine, minute transverse bars numerous and regular.

Volume equation developed

ASSAM

238. Assam survey (15 districts) — L — $V = 0.05955 - 0.37223\ \sqrt{D} + 8.54890\ D^2$ ($n=54$, $R^2=.97102$)

Dalbergia latifolia

General description of the species

It is commonly called East Indian Rosewood or Bombay Black Wood. It is a large deciduous or nearly evergreen tree with a cylindrical, fairly straight bole and a full rounded crown attaining a height of 45 m. It occurs in the tropical moist deciduous forests, tropical semi-evergreen forests, and tropical dry deciduous forests.

This species is distributed from the sub-Himalayan tract of U.P. to West Bengal, Chota Nagpur, central, western and southern India and the Andaman islands.

Rosewood grows on various geological formations and thrives best on well drained, deep, moist soil, particularly in the neighbourhood of perennial streams. It grows fairly well on black cotton soil. In its natural habitat, the absolute maximum shade temperature varies from 35°C to 48°C and the absolute minimum from 0°C to 16°C. The annual rainfall ranges from 76 cm to over 500 cm. The tree, a moderate light-demander, is drought resistant. The seedlings and saplings are readily browsed by cattle and goats. It needs fire protection. It coppices well. Indian Rosewood yields good quality timber used for furniture, cabinet work, construction work, agricultural implements etc.

Volume equations developed

GUJARAT

239.	Surat circle-Dangs Surat, Valsad and Bharuch districts. This local volume equation was also used for Khargone, Khandwa, Dewas, Jhabua, Dhar districts of M.P. and Nasik, Thane, Raigarh, Dhulia districts of Maharashtra.	G	V/D^2H	$= -0.004948/D^2H + 0.361865$ $(n=70, R^2=.1905)$
		L	$\sqrt{V}$	$= -0.144504 + 2.943115\ D$ $(n=134, R^2=.98069)$

KARNATAKA

240.	Kodagu District	L	$V = 0.18945-2.46215D+10.54462D^2$

MADHYA PRADESH

241.	Balaghat, Seoni and Mandla districts. The general volume equation was also used for *Dalbergia sissoo* in Tarai region of U.P.- Saharanpur, Bijnore, Moradabad, Rampur, Bareilly, Pilibhit, Kheri, Basti, Bahraich, Gonda, Gorakhpur and Deoria districts.	G	$V = 0.044221 +2.328465\ D^2 +0.309150\ D^2H$

ORISSA

242.	Koraput district	G	$V = 0.009238 +0.376711\ D^2\ H +0.016492\ (D^2\ H)^2$ (n=39, R^2=.991984)
		L	$V/D^2 = -0.00965/D^2+0.58546\ /D-2.5605 + 24.34215\ D$ (n=27, R^2=.81141)

UTTAR PRADESH

243.	Tarai region-Saharanpur, Bijnore, Moradabad, Rampur, Bareilly, Pilibhit Kheri, Gonda, Bahraich, Basti, Gorakhpur, Deoria districts and also for *Dalbergia sissoo* for these districts. The local volume equation was also used for Dalbergia sissoo for hill regions of U.P. -Almora, Nainital, Pithoragarh and parts of Chamoli, Dehradun, Garhwal and Tehri districts.	L	$\sqrt{V} = 0.3165 +4.54751\ D -1.46921\sqrt{D}$ (n=99, R^2 = 0.9948)

(F.A.O. Project area)

244.	Madhya Pradesh, Andhra Pradesh and Orissa	G	$V = -0.010 +0.292\ D^2\ H$
		L	$V = 0.265 -3.135\ D +12.771\ D^2$

Dalbergia sissoo

General description of the species

It is commonly called Sissoo. It is a medium-sized to large, gregarious, deciduous tree with thick grey bark, attaining a height upto 30 m. It occurs throughout the sub-Himalayan tract and outer Himalayan valleys from Indus to Assam, usually up to 900 m but sometimes up to 1,500 m elevation. It has been extensively planted along roads and canals, especially in Punjab and Uttar Pradesh and in many other parts of the country. It grows well on alluvial ground and along the beds of streams and rivers, or mostly on sand or gravel along the banks of rivers or on islands, very often gregariously. The rainfall in its zone ranges from 75 cm to 450 cm.

This species is a strong light demander, frost hardy and fairly drought-resistant. It coppices vigorously. The pods are disseminated by wind and water, and natural regeneration readily springs upon riverain alluvium and elsewhere on newly exposed ground, associated with Khair. Sissoo also regenerates naturally by coppice and root suckers successfully.

The tree yields timber valued for constructional and general utility purposes e.g. in building constructions, boat building, musical instruments, in the manufacture of sports equipment. Sissoo wood is classed as an excellent fuel. Sissoo leaves are used as fodder.

Volume equations developed

ARUNACHAL PRADESH

245. Lohit and Tirap districts. The general and local volume equations were also used for *Schima khasiana, Tetrameles nudiflora, Anthocephalus cadamba* and for rest of the species for these districts and for rest of the species in East and West Kameng and Lower Subansiri districts.	G	V	= -0.1368 +0.00318 D +0.01424 H +0.0000176 D^2 H (dia. in cm)
	L	V/D^2	= 0.00331/D^2 +0.000636 (dia. in cm)

HIMACHAL PRADESH

246. Chir belt area-Bilaspur Hamirpur, Kangra, Mandi, Solan, and Una districts — L — $V = -0.013703 + 3.943499\ D^2$ (n=81)

Dalbergia species

Volume equation developed

ASSAM

247. Assam survey (15 districts) — L — $\sqrt{V} = 0.76896 + 7.31777\ D - 4.01953\ \sqrt{D}$ (n=16, R^2=.91580)

Dillenia pentagyna

General description of the species

It is a deciduous tree attaining a height of 18 m to 21 m with a rounded crown and very large leaves. It occurs in the sub-Himalayan tract from U.P. eastwards, West Bengal, Chota Nagpur, Assam, Burma, central, western and southern India. In its natural habitat the absolute maximum shade temperature is 36°C to 46°C, absolute minimum temperature is 0°C to 16 °C and the normal rainfall is 75 - 450 cm or more. The tree is a light demander. It is very sensitive to frost, but stands fire well. Its coppicing power is good. It is drought sensitive.

Volume equations developed

ASSAM

248. Assam survey (15 districts) — L — $\sqrt{V} = 0.31202 + 4.75915\ D - 1.83940\ \sqrt{D}$ (n=86, R^2=.97985)

KARNATAKA

249. Chikmaglur and Hassan districts. It was also — L — $V = 0.070 - 1.295\ D + 9.429\ D^2$

used for *Grewia tiliaefolia* in Chikmaglur and Hassan districts and for *Lagerstroemia lanceolata* in Chikmaglur, Hassan and Shimoga districts.

TRIPURA

250.	Tripura survey (F.A.O. Project area)	L	$\sqrt{V}$	=	-0.18641 +2.87919 D
251.	Kerala and Tamilnadu. The general volume equation was also used for *Grewia tiliaefolia* and *Lagerstoemia lanceolata* and *Pterocarpus marsupium* in Kerala and Tamil Nadu and for *Grewia tiliaefolia*, *Lagerstroemia lanceolata* and *Terminalia paniculata* for Kodagu district of Karnataka.	G	V	=	0.015 +0.281 D^2 H

Dillenia indica

General description of the species

It is an evergreen tree attaining a height of 9 - 12 m or more in favourable localities, with spreading branches and a rounded crown with handsome bright green shady foliage. Bark smooth, red, moderately thick, exfoliating in small hard scales. This species occurs in moist and evergreen forests of the eastern sub-Himalayan tract, Assam and Burma and the moister parts of the Indian peninsula. Often planted for ornament. Generally found along the banks of tropical forests streams and other damp places, on deep rich moist soil. In its natural habitat the tree is found in regions with an absolute maximum shade temperature of 35°-40°C, an absolute minimum of 2°C to 18°C and rainfall of 200 cm to 500 cm.

The tree is a shade bearer and frost tender. It thrives best in damp situations on deep fertile soil. The tree reproduces satisfactorily from coppice-shoots.

Volume equations developed

	ARUNACHAL PRADESH			
252.	Lohit	L	$\sqrt{V}$ =	-0.27474+3.25935D (n=17, R^2=.97009)
	ASSAM			
253.	Assam survey (15 districts)	L	$\sqrt{V}$ =	0.05376 +3.73731 D -0.79622 $\sqrt{D}$ (n=126, R^2=.97573)

Diospyros melanoxylon

General description of the species

It is a small to moderate-sized, occasionally large tree, with leaves opposite, sub-opposite, or alternate, coriaceous and varying much in size and form. Bark greyish black, exfoliating in regular rectangular scales. Wood hard, reddish brown, with irregular black heartwood, sometimes streaked with purple or brown. This species occurs in the Indian peninsula generally, extending northward to Bihar. This is one of the most characteristic trees of the dry mixed deciduous forests throughout India. It is common also in Sal forest, often replacing the Sal where the ground becomes too poor to support the latter. In the Peninsula it appears to reach its best development on metamorphic rocks. In its natural habitat the absolute maximum shade temperature varies from 41°C to 48°C, the absolute minimum from -1°C to 13°C and the normal rainfall from 50 cm to 150 cm. In the seedling and young pole stage, the tree stands moderate shade but later it requires more light. It is frost-hardy and drought resistant. The tree coppices moderately well and it pollards better. The wood is used for building, shafts, shoulder-poles and other purposes and is carved into walking-sticks, picture-frames and fancy articles. Silviculturally, the tree is of importance in clothing dry poor ground and is interesting owing to its wonderful hardiness in surviving maltreatment.

Volume equations developed

ANDHRA PRADESH

254. Adilabad district. Also used for Mysore district of Karnataka.	G	V	$= 0.01456 + 0.32613\ D^2\ H$
	L	V	$= 0.024814 - 0.578532\ D + 6.11017\ D^2$ ($n=132$, $R^2=.9203$)

GUJARAT

255. Surat circle- Dangs, Surat, Valsad, Bharuch districts. The general volume equation was also used for Southern and Eastern parts of Rajasthan. The local volume equation was also used for Chitradurga, Tumkur, Kolar, Bangalore and Bellary districts of Karnataka and Khargone, Khandwa, Dewas, Jhabua, Indore and Dhar districts of M.P. and Dadra and Nagar Haveli and also for Nasik, Thane and Raigad districts of Maharashtra.	G	V	$= -0.013104 + 0.365321\ D^2\ H$ ($n=59$, $R^2=.9595$)
	L	$\sqrt{V}$	$= -0.184139 + 2.892723\ D$ ($n=95$, $R^2=.97055$)

MADHYA PRADESH

256. Rajnandgaon and Durg districts.The general volume equation was also used for Raipur district.	G	V	$= -0.005735 + 0.39131\ D^2\ H$ ($n=28$, $R^2=.9539759$)
	L	V/D^2	$= 0.0333/D^2 - 0.93267\ /D + 8.15911 + 1.30093\ D$ ($n=707$, $R^2=.82314$)
257. Balaghat, Seoni and Mandla districts. The general volume equation was also used for Raigad district.	G	V	$= 0.019271 + 0.503674\ D^2\ H$ ($n=130$)
	L	V/D^2	$= 0.10426/D^2 - 1.69816\ /D + 12.29196$ ($n=178$, $R^2=.6887$)
258. Narayanpur catchment- Bastar district.	G	$\log_e V$	$= 0.03551 + 2.32369 \log_e D + 0.75522 \log_e H$ ($n=77$, $R^2=.9762$)

		L	V	= 0.12401 -2.00966 D +10.87747 D^2 (n=488, R^2=.989324)
259.	Raigarh district	L	V/D^2	= 0.08654/D^2-1.35447/D +10.42632 (n=107, R^2=.49955)
260.	Bilaspur district	L	V	= 0.01461 -0.11499 D +4.20147 D^2 +9.18731 D^3 (n=388, R^2=.97497)
261.	Raipur District	L	V/D^2	= -0.04233/D^2+0.492321/D-0.00858 +13.27481 D (n=227, R^2=.76395)
	MAHARASHTRA			
262.	Ballarshah catchment-(Chandrapur)	G	$\log_e V$	= 0.763456 +2.5072 $\log_e$ D + 0.583027 $\log_e$ H (n=87, R^2=.967)
		L	$\log_e V$	= 2.719783 +2.84392 $\log_e$ D (n=350, R^2=.9945)
263.	Sondad catchment-Bhandara district. The general volume equation was also used for Wadsa catchment (Chandrapur).	G	V/D^2H	= -0.00856/D^2H +0.38217 (n=34, R^2=.1127)
		L	V/D	= 0.06206/D -1.43609+9.778164 D (n=65, R^2=.9146)
264.	Wadsa catchment (Chandrapur)	L	V/D	= 0.033867/D -0.975148 +8.255412 D (n=140)
	ORISSA			
265.	Phulbani catchment (Phulbani and Ganjam district). The general volume equation was also used for Kalahandi district.	G	V/D^2H	= -0.007336/D^2H +0.400004
		L	V/D	= -0.009124/D -0.494103 +7.610416 D (n=389, R^2=.9116)
266.	Koraput district. The local volume equation was used	G	V/D^2H	= -0.007106/D^2H +0.445716 - 0.005929 D^2 H (n=67, R^2=.06206)

	for Sambalpur, Mayurbhanj and Balasore districts.	L	$\sqrt{V}$	= 0.06728 +4.06351 D -0.99816 $\sqrt{D}$ (n=168, R^2=.98717)
	(F.A.O. Project Area)			
267.	Madhya Pradesh, Andhra Pradesh and Orissa	G	V	= 0.042 +0.246 D^2 H
		L	V	= 0.043 -0.457 D +5.230 D^2
	RAJASTHAN			
268.	Southern and Eastern parts.	L	V	= 0.15581 -2.2075 D +9.17559 D^2 (n=183, R^2=.94903)

Diploknema butyracea/Madhuca butyracea

General description of the species

It is a large deciduous tree with dark grey bark. It has only been found at Tapoban in the Eastern Dun and may possibly be found in the inner hills of Tehri Garhwal. The tree is valued for its fruit, from the seeds of which a vegetable butter is extracted. It is used in making soap and candles and is said to burn without smoke or unpleasant smell. It is used as an external application for headache and for rheumatism. The oil cake, as well as the pulp of the fruit, is eaten. The sweet juice of fresh corolla is expelled and boiled into gur which is much prized in Kumaon.

Volume equations developed

ANDAMAN AND NICOBAR ISLAND

269.	Little Andaman	G	V/D^2H	= 0.14932/D^2H +0.00003091 (dia in cm) (n=22, R^2=0.0591)
		L	V/D^2	= 0.7124/D^2 -0.045735 /D +0.0015 (dia. in cm) (n=23, R^2=0.1823)
270.	North Andaman	L	$\sqrt{V}$	= 0.085958 +0.030205 D (dia. in cm) (n=9, R^2=0.92525)

Diospyros malabarica

General description of the species

It is a branching evergreen tree with large coriaceous leaves which are bright red when young, yellowish flowers and a large red velvety fruit with a viscid pulp used for paying the seams of boats. Bark dark grey, smooth, wood grey with darker streaks. It occurs in N. Circars in hill forests, chiefly along streams, in W. Coast on river banks and back waters, extending into the valleys of the Ghats. It is often cultivated.

Volume equation developed

	ASSAM		
271.	Assam survey (15 districts)	L	$\sqrt{V} = 0.13548 + 4.20022\ D - 1{:}17365\ \sqrt{D}$ ($n=60$, $R^2=.97938$)

Diospyros species

General description of the species

The structure of the wood is characteristic and the genus is usually easily recognized. The wood is normally black or grey, or greyish-brown, rarely yellowish or red. The pores are small or moderate-sized usually very scanty, single or subdivided. The medullary rays are fine, uniform, usually numerous and prominent.

Volume equation developed

	ASSAM		
272.	Assam survey (15 districts)	L	$\sqrt{V} = 0.92625 + 7.86461\ D - 4.67222\ \sqrt{D}$ ($n=39$, $R^2=.56275$)

Dipterocarpus turbinatus

General description of the species

It is a lofty evergreen tree, attaining a height of 45 m or more. It occurs in

the Andamans, Cachar and Bangaladesh. It is found in forests of the moister tropical type, evergreen or semi-evergreen, where along with a few other lofty species, it towers above the rest of the forests. In its natural habitat the absolute maximum shade temperature varies from 37°C to 43°C and the absolute minimum from 7°C to 16 °C, the rainfall varying from 150 - 500 cm. The tree is very sensitive to fire, and the tree neither coppices nor produces root-suckers. Locally the wood is used mainly for boat building, dug out canoes, and planking. The tree is sometimes tapped for wood oil.

Volume equation developed

TRIPURA

273. Tripura survey	L	$\sqrt{V}$	= -0.4464 +3.6062 D (dia in cm)

Dipterocarpus macrocarpus

General description of the species

It occurs in Arunachal Pradesh and Assam in the tropical wet evergreen forests and is the main veneer wood timber in the locality. It grows well on well drained high level alluvial plains. The wood is used in the manufacture of plywood for tea chests and for railway sleepers. The tree also yields an oleo-resin.

Volume equations developed

ARUNACHAL PRADESH

274. Lohit and Tirap districts	G	V/D^2H	= 0.03849/D^2H +0.00003608 (dia. in cm)
	L	V	= -0.096323 +0.0011645 D^2 (dia. in cm)
275. Lohit	L	$\sqrt{V}$	= -0.16526+3.3135D ($n=41$, $R^2=.97324$)
276. Tirap	L	$\sqrt{V}$	= -0.19204+3.74091D ($n=75$, $R^2=.98304$)

ASSAM

277.	Assam survey (15 districts)	L	$\sqrt{V}$	= 0.30518 +5.89533 D -2.14269 $\sqrt{D}$ (n=74, R^2=.99079)

Dipterocarpus species

Volume equations developed

ANDAMAN AND NICOBAR ISLANDS

278.	South and Middle Andaman	G	V/D^2H	= 0.042517/D^2H +0.24102
		L	V	= -0.045595 +8.576 D^2
279.	Little Andaman	G	V/D^2H	= 0.2126/D^2H +0.0000249 (dia. in cm) (n=46, R^2=0.2771)
		L	V	= 0.4723 -0.0227 D +0.00108 D^2 (dia. in cm) (n=50, R^2=0.9514)

Duabanga sonneratioides

General description of the species

It is a tall handsome tree, wood greyish brown, branchlets drooping with the weight of the flowers. It occurs in the sub-Himalayan tract from Nepal eastwards, ascending to 900 m altitude, Assam, Khasi hills, Manipur, Andaman and Nicobar Islands and Bangaladesh. Young plants are sensitive to drought and frost. The timber is used for plywood, furniture, rafters and match splints. The fruit is edible.

Volume equations developed

ARUNACHAL PRADESH

280.	Kameng and Subansiri district	G	V	= -1.8834 +0.1353 D^2 H +0.12154 H (dia in cm) (for dia class ≤ 5 cm)

		V	= -2.276 +0.0000020254 D^2 H +0.00069864 D^2 +0.59628 H (dia in cm) (for dia class ≥ 30 cm u.b.)
		V	= 0.11055 -0.000050826 D^2 +0.0000000803D^2H+0.0012955 D√H (dia in cm) (for dia class 20-30 cm u.b.)
	L	V	= -0.33276 +0.0010457 D^2 (for dia ≤ 5 cm) (dia in cm)
		V	= 0.78163 +0.00086358 D^2 (for dia ≥ 30 cm U.B.) (dia in cm)
		V	= -0.04577+0.010528 D-0.00005113 D^2 (for dia 20-30 cm U.B.)
281. Lohit	L	√V	= 0.13199+3.35856 D -0.79250√D (n=37, R^2=.99438
282. Tirap	L	√V	= -0.05931+2.63098 D (n=36, R^2=.96647)
ASSAM			
283. Assam survey (15 districts)	L	V	= 0.15564 -2.02203 D +12.79550 D^2 (n=49, R^2=.95952)
BHUTAN			
284. Southern parts	L	√V	= -0.01217 +3.39930 D -0.28981 √D (n=84, R^2=.98465)

Dysoxylum binectiferum

General description of the species

A large evergreen tree. Wood red or reddish-grey, rough, close grained, hard. Pores large and moderate-sized often subdivided. Medullary rays moderately broad, red, wavy, irregularly distributed; the distance between the rays generally larger than the transverse diameter of the pores but occasionally less when they are bent round them. Generally available in Sikkim ascending to 600 m; Assam, Khasi hills, Western Ghats, moist low country of Srilanka and Bangaladesh.

Volume equations developed

ARUNACHAL PRADESH

285.	Tirap	L	V	= -0.02919 +0.25936D +5.00028D^2 (n=74, R^2=.93709)

ASSAM

286.	Assam survey (15 districts)	L	V	= -0.04752 +0.50667 D+1.88433 D^2 +11.30632 D^3 (n=97, R^2=.99151)

Dysoxylum malabaricum

General description of the species

It is a very large evergreen tree of the evergreen forests of the Western Ghats from North Kanara southwards, Coorg, Anamalais and Travancore. Wood ivory coloured, hard, closed-grained, pores moderate-sized, numerous, evenly distributed, sometimes in fine concentric white lines, sometimes alone. Medullary rays fine numerous. A very lofty tree, wood sweet, scented; used for oil-casks.

Volume equations developed

KARNATAKA

287.	Chikmaglur and Hassan districts. The local volume equation was also used for *Hopea parviflora, Mangifera indica, Mesua ferrea* and *Vateria indica* in Chikmaglur and Hassan districts.	L	V	= 0.288 -2.913 D+13.869 D^2
	(F.A.O. Project area)			
288.	Kerala and Tamilnadu.	G	V	= 0.045+0.330 D^2 H

The general volume equation was also used for *Hopea parviflora, Mangifera indica, Mesua ferrea* in Kerala and Tamil Nadu and for *Callophyllum inophyllum* and for rest of the species in Kodagu district of Karnataka.

Ehretia laevis

General description of the species

It is a moderate sized deciduous tree with an irregularly-shaped stem and smooth light grey to whitish bark, yellow and soft inside. This tree occurs through out the greater part of India in deciduous forests, extending into dry regions. It is very common in Sal forest. The tree stands moderate shade. It is somewhat frost tender, drought resistant, good coppicer and produces root suckers.

Volume equation developed

ASSAM

289.	Assam survey (15 districts)	L	V	= -0.03844 +0.946490 D -5.40987 D^2 +33.17338 D^3 (n=38, R^2=.95558)

Elaeocarpus species

General description of the species

A large genus of about 36 species, handsome trees with white flowers and fringed petals and with drupaceous fruit resembling an olive. Wood greyish-white, soft. Pores small or moderate-sized, rather scanty, single subdivided or in short radial lines. Medullary rays numerous, fine not prominent.

Volume equation developed

ASSAM

290. Assam survey (15 districts)	L	$\sqrt{V}$	= 0.43483 +5.72522 D-2.59907 $\sqrt{D}$ (n=15, R^2=.99063)

Emblica officinalis

General description of the species

It is a moderate sized deciduous tree with feathery light green foliage and small narrow linear leaves. The bark is smooth, grey, exfoliating in irregular rounded scales. The tree occurs in mixed deciduous forests throughout the greater part of India, ascending the Himalaya to 1350 m. It is not found in the arid regions. It is a light demander. It is sensitive both to frost and to drought. The tree yields wood, red in colour, hard, apt to split, durable under water, used for agricultural implements, well construction, and inferior building and furniture. The bark, leaves and fruits are used for tanning and the tree is important as a yielder of tannin. Fruits are edible and have medicinal value.

Volume equations developed

ASSAM

291. Assam survey (15 districts)	L	V	= 0.13734 -2.49039 D+15.59566 D^2 -11.06205 D^3 (n=38, R^2=.99239)

ANDHRA PRADESH

292. Adilabad district	L	V	= -0.022635 +4.889163 D^2 (n=31, R^2=.8568)

MAHARASHTRA

293. Wadsa catchment-Chandrapur. The general volume equation was also used for Sondad catchment - Chandrapur.	G	V	= 0.01244 +0.34322 D^2 H (n=23, R^2=.8312)
	L	V/D^2	= -0.013485/D^2 +5.000428 (n=49, R^2=.1718)

294.	Sondad catchment-Bhandara district (F.A.O. Project area)	L	$\sqrt{V}$	= -0.042212 +2.352940 D ($n=45$, $R^2=.9495$)
295.	Madhya Pradesh, Andhra Pradesh and Orissa	G	V	= -0.038 +0.344 D^2 H
		L	V	= -0.406 +3.540 D-3.231 D^2

Engelhardtia spicata

General description of the species

It is a moderate-sized to large deciduous tree with grey bark and leaves usually paripinnate. This tree produces root-suckers in abundance and is thus useful for binding unstable hill sides. Wood reddish grey, moderately hard, used for tea boxes and carving. It is common and sometimes almost gregarious in the outer Himalaya up to 1800 m, usually on rather dry situations, also in Assam, Manipur, Bangaladesh and Burma.

Volume equations developed

BHUTAN

296.	Central and Eastern parts. General Volume equation was also used in Southern parts.	G	$\log_e V$ =	-0.14969 +2.15320 $\log_e$ D +0.76463 $\log_e$ H ($n=40$, $R^2=.994$)
		L	$\log_e V$ =	2.535662 +2.519379 $\log_e$ D ($n=84$)
297.	Southern parts	L	$\log_e V$ =	2.47635 +2.51046 $\log_e$ D ($n=66$, $R^2=.99348$)

Erythrina species

General description of the species

A middle sized tree growing in dry locality with spine on the stem and bipinnate leaves and red flowers. The leaves, flowers, bark and root are used in medicine.

Volume equation developed

ASSAM

298.	Assam survey (15 districts)	L	V	= -0.07803 +1.70258 D-9.16180 D^2 +33.91455D^3 (n=280, R^2=.98172)

Eucalyptus species

General description of the species

An Australasian genus consisting of about 140 species, most of which are found in Australia and some in Tasmania, New Guinea and other islands. The Eucalyptus are evergreen trees, all more or less aromatic and containing oil-glands in the leaves; the oil distilled from the leaves of some species is of value in medicine. The great utility of these trees is in supplying fast-growing timber and fuel as well as oil, tannin, and other products, their swamp-draining capacity and their direct anti-malarial value. Eucalyptus, as a rule, are intolerant of shade. Many species coppice well. Eucalyptus are generally wind-firm.

Volume equations developed

KARNATAKA

299.	Chitradurg, Tumkur, Bangalore, Kolar and Bellary districts. The local volume equation was also used for Tarai region of U.P.-Saharanpur, Bijnore, Moradabad, Rampur, Bareilly, Pilibhit, Kheri, Bahraich, Gonda, Basti, Gorakhpur, Deoria districts and for Hill region of U.P.- Almora, Nainital, Pithoragarh and parts of Chamoli, Dehra Dun, Garhwal and Tehri districts.	L	V	= 0.02894 -0.89284 D+8.72416 D^2 (n = 198, R^2=.9892)

UTTAR PRADESH

300.	Tarai region-Saharanpur, Bijnore, Moradabad, Rampur, Bareilly, Pilibhit, Kheri, Bahraich, Gonda, Basti, Gorakhpur and Deoria districts.	G	V =	$-0.0015 + 0.2401\ D^2\ H$

Eugenia cymosa

General description of the species

It is a shrub or a small tree, leaves thinly coriaceous or elliptic-lanceolate. It occurs in Khasi hills, Cachar, Andaman and Nicobar Islands, Uttar Pradesh, Western Ghats in the Anamalai ranges, Tirunelveli and Kerala upto 1200 m. The wood is used for rafters, scantlings, posts, boards, ship building, tool handles etc. The bark is a source of black dye.

Volume equation developed

TRIPURA

301.	Tripura survey	L	$\sqrt{V}$ =	$-0.08008 + 2.39257\ D$ (dia in cm)

Eugenia species

Volume equations developed

ARUNACHAL PRADESH

302.	Debang	L	V =	$0.22468 - 2.41386D + 9.74543D^2$ ($n=53$, $R^2=.93334$)

ASSAM

303.	Assam survey (15 districts)	L	V =	$-0.02792 + 0.92933\ D - 5.56465\ D^2 + 25.77488\ D^3$ ($n=24$, $R^2=.98868$)

Euphoria longana

General description of the species

Euphoria longana is a middle sized tree, attaining a height of 15 m. Leaflets coriaceous, 2-5 pair, shining above, glaucous and often slightly pubescent beneath . The seed is entirely enclosed by the succulent, sweet edible arils. It occurs in the Western side of the peninsula in the evergreen forests, from the Konkan southwards and in the Khasi hills. It is cultivated in Northern India. Fruit is edible, the wood is used for posts, agricultural implements, furniture and building purposes. Leaves, flowers and fruits are of medicinal value.

Volume equation developed

	ASSAM		
304.	Assam survey (15 districts)	L	$V = 0.04030 - 0.79053\ D + 8.30601\ D^2$ ($n=77$, $R^2=.99075$)

Ficus species

Volume equation developed

	ASSAM		
305.	Assam survey (15 districts)	L	$\sqrt{V} = 0.03629 + 3.95389\ D - 0.84421\ \sqrt{D}$ ($n=149$, $R^2=.98126$)

Garuga pinnata

General description of the species

It is a large deciduous tree with compound imparipinnate leaves, which are often covered with red galls. Bark thick, soft, greyish brown, exfoliating in large irregular hard flakes, red inside. Sapwood large and white, heartwood reddish brown, moderately hard.

This species is widely distributed throughout India and Burma,chiefly in mixed deciduous forests. It is a common associate of Teak and Sal,. It is a

typically sporadic species and does not occur gregariously, except in patches of limited extent. In the miscellaneous hilly forests of drier regions, it is most prevalent on cool aspects and in ravines, but elsewhere it is not particular as to aspect. In its natural habitat the normal rainfall varies from 92 cm to 250 cm. *Garuga pinnata* is a strong light-demander, frost-tender and sensitive to drought. It is one of the most fire-resisting species. It coppices well and produces root-suckers. Wood is not very durable, used for inferior building and other purposes.

Volume equations developed

306.	Assam survey (15 districts)	L	$V = 0.08486 - 1.28721\ D + 8.29412\ D^2$ ($n=57$, $R^2=.95299$)
	GUJARAT		
307.	Surat circle-Dangs, Surat, Valsad and Bharuch districts.The local volume equation was also used for Khargone, Khandwa, Dewas, Jhabua and Dhar districts of Madhya Pradesh, Dadra and Nagar Haveli and also for Dhulia, Nasik, Thane and Raigad districts of Maharashtra.	L	$\sqrt{V} = 0.0533434 + 3.53035D - 0.810548\ \sqrt{D}$ ($n=150$, $R^2=.94861$)
	ORISSA		
308.	Phulbani catchment (Phulbani, Ganjam and Kalahandi districts).	G	$V = -0.014212 + 0.390288\ D^2\ H$
		L	$V/D = 0.077965/D - 1.481043 + 9.797028\ D$ ($n=139$, $R^2=.9453$)
309.	Koraput district	G	$\log_e V = 0.262489 + 2.277143\ \log_e D + 0.686807\ \log_e H$ ($n=61$, $R^2=.99236$)

		L	$V/D^2 = -0.09144/D^2 +1.48588/D -5.53172 -24.04851\ D$ ($n=77$, $R^2=.89345$)
	(F.A.O. Project area)		
310.	Madhya Pradesh, Andhra Pradesh and Orissa	G	$V = -0.002 +0.256\ D^2\ H$
		L	$V = 0.034 -0.901\ D +6.898\ D^2$

Gmelina arborea

General description of the species

It is a moderate-sized to large deciduous tree with numerous spreading branches, which form a large shady crown. It occurs scattered in deciduous forests throughout the greater part of Indian sub-continent and the Andamans upto an altitude of 1,500 m. It is found in all the states but is nowhere common. In its natural habitat the absolute maximum shade temperature varies from 38°C to 48°C, the absolute minimum from 1°C to 16 °C and the normal rainfall from 75 cm to 450 cm or more. It reaches its largest dimensions in the mixed forests of moist regions, as in the eastern sub-Himalayan tract, Assam and elsewhere. It shows a preference for moist fertile valleys. The tree is a light demander, moderately frost-hardy, and does not stand excessive drought. It coppices very well, saplings are readily browsed by deer and other cattle. *Gmelina* yields timber used for construction work, planking furniture, cabinet work, panelling, carriage, boxes, boat building, agricultural implements, musical instruments, etc. Leaves form fodder for cattle. Wood is used in plywood manufacture also.

Volume equations developed

ARUNACHAL PRADESH

311.	Debang	L	$V = -0.17300+3.56208D+12.20271D^2 +25.45583D^3$ ($n=59$, $R^2=.97084$)
312.	Tirap	L	$V = -0.02688+0.78270D+4.04195\ D^2$ ($n=32$, $R^2=.98366$)
313.	Lohit	L	$V = 0.01156 +0.21230D +5.10448D^2$ ($n=27$, $R^2=.96923$)

ASSAM

314.	Assam survey (15 districts)	L	V	= 0.25058 -3.55124 D+16.41720 D^2 -8.32129 D^3 (n=128, R^2=.98699)

TRIPURA

315.	Tripura survey	L	$\sqrt{V}$	= -0.00189 +2.10033 D (dia in cm)

Grewia tiliaefolia

General description of the species

A moderate sized tree, bark grey on young and dark brown on old trees. Sapwood white, heartwood small, brown, close grained, hard. Annual rings marked by a line. Pores moderate sized, numerous, uniformly distributed. Medullary rays fine, prominent on a radial section, giving a handsome silver grain. It is found in the sub-Himalayan tract from the Yamuna to Nepal ascending to 1200 m; Central and South India, upper Burma and in low country of Sri Lanka.

It is a moderate-sized tree with large oblique leaves, common in Chota Nagpur, Central and Southern India. The wood is tough and elastic and is used for shafts, shoulder-poles and similar purposes. The fruit is eaten and the inner bark made into cordage. The growth of young coppice shoots is very-rapid.

Volume equations developed

ANDHRA PRADESH

316.	East Godavari	L	V	= .018620+13.916741D^3 (n=37, R^2=.92929)

ASSAM

317.	Assam survey (15 districts)	L	V	= 0.05858 -1.20414 D+9.80167 D^2 (n=116, R^2=.96828)

KARNATAKA

318.	Kodagu district	L	V	$= -0.01611+4.90810D^2$

MAHARASHTRA

319.	Melghat Forest division	G	$\log_e V$	$= 0.676394 +2.409476 \log_e D +0.596175 \log_e H$ ($n=95$, $R^2=.9768$)
		L	V	$= 0.0418481 -1.140567 D +9.817616 D^2$ ($n=95$, $R^2=.7155$)

(F.A.O. Project area)

320.	Madhya Pradesh, Andhra Pradesh and Orissa. The general volume equation was also used for *Grewia* species in H.P., U.P. and Haryana.	G	V	$= -0.035 +0.307 D^2 H$ ($n=52$, $R^2=.909$)
		L	V	$= 0.775 -7.787 D+22.748 D^2$

Grewia species

General description of the species

A large genus of plants of forest interest, containing about 34 species, of which 12 are trees or small trees and the rest shrubs or climbers. *G.oppositifolia* is found up to 2000 m in the North-West Himalaya, and one or two shrubby or semiscandent species rise to nearly that height in the hills of South India. There are 7 species in Northern India, 8 in the North-East, 17 in Western and 18 in South India. Some species of *Grewia* have edible fruits and the wood of some is strong, tough and elastic.

Volume equation developed :

ASSAM

321.	Assam survey (15 districts)	L	V	$= -0.44075 +7.49221 D-36.09962 D^2 +71.91238 D^3$ ($n=78$, $R^2=.9765$)

Hardwickia binata

General description of the species

It is a moderate-sized to large tree, leafless for a short time or nearly evergreen, with drooping slender branchlets and greyish green coriaceous bifoliate leaves. Almost everywhere the trees have been much mutilated by pollarding for the sake of fodder, manure or bast fibre and in most localities, the larger trees are old pollards. This species occurs in the drier parts of the Indian peninsula, extending as far north as the Banda district of U.P.

The wood is perhaps the hardest and heaviest in India. The sapwood is small and white, the heartwood dark reddish brown streaked with purple, close grained, very durable, used for bridge and house construction, agricultural implements, carts, wheelwork etc. The bast yields a strong fibre largely employed for ropes and the branches are much lopped for manure and cattle fodder.

Volume equation developed

ANDHRA PRADESH

322.	Mehboob Nagar Forest division. The local volume equation was also used for *Madhuca latifolia* of this area.	G	$V = -0.023583 + 0.279452\ D^2\ H$
		L	$V = 0.063632 + 5.355486\ D^3$ (n=386, $R^2 = 0.86$)

Holarrhena antidysenterica

General description of the species

It is a small deciduous tree, bark greyish brown, scaly, is a useful accessory species in clothing the ground and acting as a nurse to more valuable species.The tree is important for reclothing waste lands. This species is distributed throughout India, in deciduous forests and open waste lands. It ascends the outer Himalayan valleys to 1200 m elevation and is abundant in the Sal and mixed deciduous forests of the sub-Himalayan tract. It is common throughout the Indian peninsula down to Malabar and Travancore. The tree stands a slight amout of shade but develops best in full light. It is drought hardy, is sensitive to frost, not readily browsed, even by goats. It coppices well and shoots up readily after severe damage by fire. It produces root-suckers in abundance.

Wood is white soft, even grained, used for carving into picture frames, and fancy articles. The bark and seeds have medicinal use.

Volume equation developed

ASSAM

323. Assam survey (15 districts). The local volume equation was also used for *Kydia calycina.*	L	V	=	0.17994 -2.78776 D+14.44961 D^2 (n=97, R^2=.98269)

Hydnocarpus kurzii

General description of the species

It is a moderate-sized evergreen tree common in some of the tropical forests in Assam, Bangaladesh and Burma. The seeds of which give the well known Chaulmugra oil, which is valuable for the treatment of cutaneous diseases and also in dysentery and leporosy.

Volume equation developed

ASSAM

324. Assam survey (15 districts)	L	V	=	-0.10582 +0.90158 D+4.05744 D^2 (n=76, R^2=.95478)

Hymenodictyon excelsum

General description of the species

It is a large deciduous tree, with a straight cylindrical bole and a rounded crown. Bark greyish brown, thick, soft, corky and furrowed on stems of older trees, smooth on poles and branches. This species occurs scattered throughout the greater part of India in dry mixed deciduous forests. The tree

is common on loose dry deposits of boulders and debris along the base of the outer hills in sub-Himalayan tract and is one of the characteristic trees of the Bhabar tract of U.P. It is also found on sandy or stony soils on alluvial ground near rivers, in Savannah lands and in the Sal forests of northern India. It is a strong light demander. The wood is white when fresh, turning darker, soft, light, used for planking, boxes, toys and excellent for match manufacture.

Volume equation developed

325.	Assam survey (15 districts)	L	$V/D^2 = 0.15698/D^2-2.75681\ /D+14.19521$ ($n=12$, $R^2=.96447$)

Juglans regia

General description of the species

It is commonly called Walnut. It is a large deciduous tree with imparipinnate leaves. In the Himalaya, it occurs indigenously usually at 1350-3300 m elevation extending in west to Afghanistan and east to Bhutan. In the west, it grows either in pure groups or in mixture with other broad leaved species such as Maples, Oaks, Horse chestnut and Bird cherry or with conifers, particularly Spruce, Silver Fir, Blue Pine, and Yew. It occurs chiefly on deep well drained fertile soil, often containing boulders, in sheltered situations such as moist ravines or depressions on the hill sides. The walnut tree is a light demander, wind firm and good coppicer. The wood is even-grained, greyish brown with dark brown streaks, often beautifully mottled,used for furniture, cabinet-making, carving and gunstocks. The burrs are particularly valuable and are used for veneer. As a fruit tree the walnut is well known, its bark is used for cleaning teeth.

Volume equation developed

HIMACHAL PRADESH

326.	Kulu, Seraj and Kotgarh (Kulu and Shimla districts)	L	$\sqrt{V} = -0.207299 + 3.254007\ D$ ($n=42$, $R^2=.9649$)

Kydia calycina

General description of the species

It is a moderate-sized deciduous tree with grey bark exfoliating in irregular flakes or long strips. This species is common throughout India and Burma, chiefly in mixed deciduous forests, not in arid regions and in the sub-Himalayan tract it is abundant in many of the mixed forests and in Sal forests. The tree is a light demander, fairly frost hardy and is a useful nurse for Sal. It coppices well and produces root suckers. The tree has soft white wood, of little value commercially, but important owing to its abundance in certain types of forests.

Volume equations developed

ARUNACHAL PRADESH

327.	East and West Kameng districts. These general and local volume equation were also used for Upper and Lower Subansiri districts.	G	$V = -0.49425 + 0.276\ D^2\ H + 0.0286\ H$ (dia in cm) (for dia. $\leq$ 5 cm)
		L	$V = 0.72892 + 0.0015117\ D^2 - 0.25727\ \sqrt{D}$ (dia in cm) ((for dia $\leq$ 5 cm) ($n = 48$, $R^2 = 0.935$)
328.	Kameng and Subansiri district	G	$V = 0.1239 - 0.0316\ H + 0.000034\ D^2\ H$ (dia in cm) (for dia upto 30 cm U.B.)
		L	$V = 0.96221 + 0.0011095\ D^2$ (dia in cm) (for dia upto 30 cm U.B.)
329.	Lohit	L	$\sqrt{V} = -0.02297 + 2.68423D$ ($n=53$, $R^2=.98825$)
330.	Tirap	L	$\sqrt{V} = -0.04241 + 1.31895D + 0.65065\sqrt{D}$ ($n=45$, $R^2= .93177$)

Lagerstroemia lanceolata

General description of the species

It is commonly called Benteak. Benteak is a moderate-sized to large deciduous tree attaining a height of upto 30 m with a large crown. It occurs along and below the Western Ghats from the Dangs southwards to Kerala, ascending the hill ranges of Karnataka, the Nilgiris and parts of Tamil Nadu in moist mixed deciduous forests. The tree occurs upto an elevation of 1,200 m but grows best between 300 m and 900 m. Benteak prefers deep, moist soils. In its natural habitat, the absolute maximum shade temperature varies from 35°C to 45°C and the absolute minimum from 3°C to 18°C. The normal rainfall varies from 75 cm to 450 cm or more. This species is a light demander, it coppices freely and is moderately fire-hardy. Benteak timber is used for boat-building as it is very durable, it is also used for house building, furniture,bridges, carts, coffee boxes, oil casks, agricultural implements, constructional works and general carpentry.

Volume equations developed

GOA

331.	Goa survey. The local volume equations were also used for the rest of species.	L	$\sqrt{V}$	= - 0.238101 + 2.9997947 D (for dia ≤ 20 cm)
		L	$\sqrt{V}$	= - 0.054867 + 2.968427 D (for dia ≤ 5 cm)

KARNATAKA

332.	Kodagu District	L	V	= $0.23839-2.48071D+10.14106D^2$

Lagerstroemia parviflora

General description of the species

It is a large (in poor localities a small) deciduous tree. Bark light grey to reddish, thin, smooth, exfoliating in narrow longitudinal flakes, light brown inside.

This species occurs in sub-Himalayan tract from the Yamuna eastwards,

ascending to 900 m, West Bengal, Assam, Chota Nagpur, Central India and the Indian peninsula southwards to the Nilgiris and Upper Burma. Generally the tree is not gregarious, though often plentiful. The tree is a light demander, fairly frost-hardy, it coppices and pollards vigorously. Wood very hard, durable, used for building, agricultural implements, carts, boats, shafts, axe-handles etc.

Volume equations developed

ARUNACHAL PRADESH

333.	Lohit	L	V	= -1.25621+24.09007D-135.30588D^2 +258.26669D^3 (n=9, R^2=.9477)

ANDHRA PRADESH

334.	Adilabad and East Godavari districts.	L	V	= 0.066188-1.334512 D+9.403257 D^2 (n=119, R^2=.97850
335.	East Godavari	L	V	= .711565-9.9435 D+417245D^2-37.1728 D^3 (n=29, R^2=.9545)

GUJARAT

336.	Surat Circle- Dangs, Surat, Valsad and Bharuch districts. The local volume equation was also used for Dadra and Nagar Haveli and for Khargone, Khandwa, Dewas, Jhabua Indore and Dhar districts of M.P. The general volume equation was used for Mewasi Forest Division, Dhulia, Nasik, Thane and Raigarh districts of Maharashtra and also for Dadra and Nagar Haveli.	G	V	= -0.00867 +0.398711 D^2 H (n=64, R^2=.9822)
		L	$\sqrt{V}$	= 0.027366 +3.668008 D -0.718475 $\sqrt{D}$ (n=115, R^2=.98575)

MADHYA PRADESH

337.	Rajnandgaon and Durg districts	G	V/D^2H	= 0.001512/D^2H +0.396093 +0.015448 D^2 H (n=18, R^2=.228980)
		L	V/D^2	= -0.02984/D^2 +0.47398 /D-0.22056 +14.75467 D (n=445, R^2=.71020)
338.	Balaghat, Seoni and Mandla districts. The general volume equation was also used for Raigarh district.	G	V	= 0.01636 +4.605476 D^2 +0.21389 D^2 H (n=114)
		L	V	= 0.01617 -0.66446 D+9.71038 D^2 (n=262, R^2=.99531)
339.	Bilaspur District	L	V	= 0.06913 -1.37605D+11.89119 D^2 (n=113, R^2=.98935)
340.	Raipur District	L	V	= 0.0568 -1.19611 D+9.11319 D^2 (n=124, R^2=.95318)

MAHARASHTRA

341.	Ballarshah catchment-(Chandrapur)	G	$\log_e V$	= -1.699443 +1.912497 $\log_e D$ +1.15776 $\log_e H$ (n=44, R^2=.936)
		L	V/D^2	= 0.06466/D^2 -1.371984/D +9.629971 (n=127, R^2=.7061)
342.	Sondad catchment-Bhandara district. The general volume equation was also used for Wadsa catchment (Chandrapur)	G	V/D^2H	= -0.00088/D^2H+ 0.35949 (n=26, R^2=.0033)
		L	V	= 0.044315-1.013939D+8.510299 D^2 (n=83, R^2=.9891)
343.	Wadsa catchment (Chandrapur)	L	$\sqrt{V}$	= -0.13034 +2.824203 D (n=39, R^2=.9666)
344.	Melghat Forest division	G	V	= -0.002101 +0.393065 D^2 H (n=102, R^2=.136)
		L	V	= 0.030595 -1.025799 D+10.41355 D^2 (n = 102, R^2=.7602)

	ORISSA		
345.	Phulbani catchment (Phulbani, Ganjam and Kalahandi districts). The general volume equation was also used for Tarai region of Uttar Pradesh.	G	$V = -0.010442 + 0.385687\ D^2 H$
		L	$\sqrt{V} = -0.153687 + 2.975938\ D$ (n=185)
346.	Koraput district	G	$V = 0.009491 + 0.352882\ D^2 H + 0.015283\ (D^2 H)^2$ (n=45, R^2=.9968)
		L	$V/D^2 = 0.07199/D^2 - 1.25923\ /D + 9.28416$ (n=89, R^2=.60572)
	TRIPURA		
347.	Tripura survey	L	$\sqrt{V} = -0.19901 + 2.89643\ D$ (dia in cm)
	UTTAR PRADESH		
348.	Tarai region-Saharanpur Bijnore, Moradabad, Rampur, Bareilly, Pilibhit, Kheri, Bahraich and Gonda districts.	L	$V/D^2 = -0.1649/D^2 + 2.42518\ /D - 8.60085 + 28.48599\ D$ (n=51, R^2=.67148)
349.	Southern region- Agra, Etawah, Jalaun, Jhansi, Lalitpur, Hamirpur, Banda and Allahabad districts. The general volume equation was also used for *Shorea robusta* of this area and for rest of the species in Balaghat, Seoni and Mandla districts of Madhya Pradesh.	G	$V/D^2H = 0.002565/D^2H + 0.489814 - 0.00552\ D^2 H$ (n=147)
		L	$V = 0.10529 - 1.68829\ D + 10.29573\ D^2$ (N=90, R^2=.98428)
	(F.A.O.Project area)		
350.	Madhya Pradesh, Andhra Pradesh and Orissa	G	$V = 0.009 + 0.270\ D^2H$
		L	$V = 0.023 - 0.546\ D + 6.274\ D^2$

Lagerstroemia species

Volume equation developed

ASSAM

351.	Assam survey (15 districts)	L	$V = 0.11740 - 1.58941\ D + 9.76464\ D^2$ ($n=223$, $R^2=.96970$)

Lannea coromandelica

General description of the species

It is a large deciduous tree with a white sapwood. The heartwood is scanty. Leaves imparipinnate, leaflets 3-4 pair, opposite, entire. It is common in deciduous forests throughout India in the sub-Himalayan tract extending to the Indus and ascending to 1200 m in the outer hills. The trees are leafless from January to June but on the eastern side of the peninsula (Sriharikota, Madras, Javadis) in leaf almost throughout the year. A handsome tree when in full foliage. It is easily grown from cuttings.

Volume equations developed

ANDHRA PRADESH

352.	Mehboob Nagar Forest Division	L	$V = -0.027403 + 3.069449\ D^2$ ($n=126$, $R^2=.94$)
353.	Adilabad District	G	$V = 0.00370 + 0.34594\ D^2\ H$
		L	$V = 0.091153 - 1.66153\ D + 10.24624\ D^2$ ($n=140$, $R^2=.9199$)

ASSAM

354.	Assam survey (15 districts)	L	$\sqrt{V} = -0.32985 + 2.21152\ D + 0.78769\ \sqrt{D}$ ($n=67$, $R^2=.97814$)

BIHAR

355.	South West Bihar-Chapra, Kodarma, Giridih, Mugher	G	$V = 0.021968 - 0.393047\ D + 0.598833\ D^2\ H$

	Shahabad, Gaya, Daltonganj, Garwa, Latehar, Hazaribagh and Ranchi Forest division.		
	GUJARAT		
356.	Surat Circle -Dangs Surat, Valsad, Bharuch districts. The local volume equation was used for Dadra and Nagar Haveli and Dhulia district of Maharashtra and Khargone, Khandwa, Dewas, Jhabua, Indore and Dhar districts of M.P..	G	$\log_e V = -0.005687 + 2.394468 \log_e D + 0.791548 \log_e H$ (n=76, R^2=.9928)
		L	$\sqrt{V} = 0.404153 + 5.555051 D - 2.545525 \sqrt{D}$ (n=174, R^2=.98502)
	HIMACHAL PRADESH		
357.	Chir belt area- Bilaspur Hamirpur, Kangra, Mandi Solan and Una districts. The general volume equation was also used for Jammu region, Shiwalik region of Haryana and Punjab-Ambala, Ropar, Hoshiarpur and Gurdaspur districts, Udaipur Forest division and Southern and Eastern parts of Rajasthan.	G	$V = -0.004511 + 0.377131 D^2 H$ (n=87, R^2=.9665)
		L	$V/D^2 = -0.017639/D^2 + 0.132337/D + 1.336264 + 9.315146 D$ (n=44)
	JAMMU and KASHMIR		
358.	Jammu region	L	$\sqrt{V} = -0.13498 + 2.57874 D$ (n=34, R^2=.96425)
	MADHYA PRADESH		
359.	Narayanpur catchment-Bastar district.	G	$V = -0.00716 + 0.34669 D^2 H$ (n=41, R^2=.9519)

	L	V	= -0.09390 +0.37008 D +4.99237 D^2 (n=166, R^2=.95827)
360. Rajnandgaon and Durg districts. The general volume equation was also used for Raipur district of Madhya Pradesh and Tarai region of Uttar Pradesh.	G	$\log_e V$	= 0.571345 +2.491134 $\log_e D$ +0.640547 $\log_e H$ (n=24, R^2=.916812)
	L	V/D^2	= 0.01858/D^2 -0.39871 /D+3.07785 + 11.10529 D (n=561, R^2=.95008)
361. Balaghat,Seoni and Mandla districts. The general volume equation was also used for Bilaspur and Raipur districts.	G	V/D^2H	= 0.007683/D^2H +0.547179
	L	V/D^2	= 0.07432/D^2 -1.75673 /D+13.6934 -3.31887 D (n=265, R^2=.7904)
362. Indore catchment-Mandsaur Ratlam,Ujjain, Shajapur and Raigarh districts. The local volume equation was also used for Udaipur Forest division of Rajasthan.	L	V	= 0.046731-0.962906 D+7.301883 D^2
363. Raipur district	L	V	= -0.05957 +0.93959 D-4.04701 D^2 +22.239 D^3 (n=215, R^2=.98999)
364. Bilaspur district	L	V/D^2	= -0.10634/D^2 +1.73515 /D-7.34938 +32.75369 D (n=118, R^2=.80826)
365. Raigarh district	L	$\sqrt{V}$	= -0.11751 +2.86874 D (n=58, R^2=.96823)
MAHARASHTRA			
366. Sondad catchment-Bhandara district	G	V	= -0.000001+0.35751D^2H (n=33, R^2=.9311)
	L	V	= 0.093318 -1.531417 D+9.011590 D^2 (n =82, R^2=.5750)

367. Wadsa catchment (Chandrapur)	L	$\sqrt{V}$	= -0.138286 +2.729368 D (n=44, R^2=.9504)
368. Melghat Forest division	G	$\log_e V$	= 0.319645 +2.432517 $\log_e$ D +0.728293 $\log_e$ H (n=165, R^2=.9903)
	L	$\log_e V$	= 2.960505 +2.958718 $\log_e$ D (n=165, R^2=.9860)
MEGHALAYA			
369. Meghalaya survey. The general and local volume equations were also used for *Toona ciliata* for Meghalaya	G	V	= 0.20577 +0.00035623 D^2 + 0.0000181 D^2 H (dia in cm) (n=37, R^2=0.9409)
	L	V	= -1.391 -0.14129 D+0.001645 D^2 +0.90411 $\sqrt{D}$ (dia in cm) (n=51, R^2=0.9801)
ORISSA			
370. Phulbani catchment- (Phulbani and Ganjam districts). The general and local volume equations were also used for *Ougeinia dalbergioides* for these areas and Kalahandi district.	G	V	= 0.017028 -0.243413 D + 0.415072 D^2 H
	L	V	= 0.057424 -1.153088 D+8.542648 D^2 (n=252)
371. Koraput district	G	V	= -0.055367 +0.422394 D +0.338742 D^2 H (n=65, R^2=.986545)
	L	V/D^2	= -0.01071/D^2 -0.66528 /D+9.54478 -4.58876 D (n=124, R^2=.89815)
RAJASTHAN			
372. Southern and Eastern parts.	L	V	= -0.00146 -0.39953 D+5.33895 D^2 (n=278, R^2=.93634)
TRIPURA			
373. Tripura survey	L	$\sqrt{V}$	= -0.21972 +2.86603 D

UTTAR PRADESH

374. Lansdowne Forest division and parts of Yamuna, Tehri and Garhwal Forest division (Balance area of Tehri and Garhwal Circle). The local volume equation was also used for hill region of UP.	G	V/D^2H	$= -0.00768/D^2H + 0.54718$
	L	V	$= 0.19381 - 0.83928\sqrt{D} + 10.32053\ D^2$ ($n=227$, $R^2=.97367$)
375. Tarai region	L	V/D^2	$= 0.14004/D^2 - 2.35990/D + 11.90726$ ($n=45$, $R^2=.92985$)
376. Southern U.P. -Agra, Etawah, Jalaun, Jhansi, Lalitpur Hamirpur, Banda, and Allahabad districts. (F.A.O. Project area)	L	V	$= 0.0446 - 0.91313\ D + 6.65224\ D^2$ ($n=144$, $R^2=.97065$)
377. Madhya pradesh, Andhra Pradesh, and Orissa	G	V	$= -0.057 + 0.292\ D^2\ H$
	L	V	$= 0.155 - 2.153\ D + 9.471\ D^2$

Larix griffithii

General description of the species

It is commonly called Sikkim Larch. It is a moderate sized or large deciduous tree attaining a height of 18 m with a pyramidal shape and long pendulous branches. Bark is brown. The tree occurs in the Himalaya in eastern Nepal,Sikkim, and Bhutan at 2400-3600 m elevation. It grows on dry rocky ancient moraines formed by glaciers and also grows on grassy slopes where the drainage is good. It regenerates freely in pure crops on fresh debris in the open, particularly on the taluses formed at the base of precipices, on new ground exposed by landslips on snow slides or on the diluvial cones, formed by mountain torrents where they issue into the valleys. The wood is soft to moderately hard with a red, durable heart-wood.

Volume equations developed :

BHUTAN

378. North Western parts. The general volume	G	$\log_e V$	$= -1.409685 + 1.846742 \log_e D + 1.045675 \log_e H$ ($n=122$)

equation was also used for *Tsuga dumosa* in Western parts of Sikkim and for *Tsuga brunoniana* in North Western and Southern parts of Bhutan.	L	V	= 0.055312 -1.379780 D+11.394329 D^2

Lyonia (Pieris) ovalifolia

General description of the species

It is a small deciduous tree. Bark is brown, thick, fibrous, exfoliating in long narrow strips, deeply furrowed longitudinally, the furrows often proceeding spirally up the stem. It occurs in the Western Himalaya at an elevation of 1200 m to 2400 m chiefly on grassy slopes. Also found in the Eastern Himalaya descending to 1500 m in the Tista valley and Khasi hills. The tree is fire resistant, good coppicer and not browsed by cattle. The wood is of little value as timber or fuel but the tree is useful in covering hill slopes and in Western Himalaya, acts as a nurse to Deodar.

Volume equations developed

ARUNACHAL PRADESH

379. Debang	L	V	= 0.14560-2.10543D+11.81097 D^2 - 6.56089D^3 (n=117, R^2=.97305)

UTTAR PRADESH

380. Alaknanda catchment - Major portion of district Chamoli and parts of Pauri Garhwal and Almora districts. The local volume equation was also used for Nainital, Pithoragarh, Dehradun and Tehri districts.	L	V	= 0.03468 -0.56878 D+4.72282 D^2

Macaranga denticulata

General description of the species

It is a soft wooded moderate sized evergreen tree attaining a height of 18 m or more with a smooth light grey stem and peltate broadly ovate acuminate leaves. The natural habitat of the tree is in the sub-Himalayan tract from Sikkim eastwards, ascending occasionally to 1500 m altitude in Assam and Bangaladesh. It needs a moist warm climate. The tree coppices well and does not tolerate frost or drought. Young plants are browsed by deer. It is very sensitive to fire.

Volume equations developed

ARUNACHAL PRADESH

381.	Debang	L	V	= -0.10251+1.67509D-0.31323D^2 ($n=114$, $R^2=.7899$)

ASSAM

382.	Assam survey (15 districts) The local volume equation was also used for *Macaranga indica* and *Macaranga peltata* for these areas.	L	V	= 0.13333 -2.18825 D+13.12678 D^2 ($n=34$, $R^2=.99848$)

Machilus gammicana

General description of the species

It is found in Sikkim Himalaya at 1500-2400 m. A common tree in the Darjeeling forests. The tree grows moderately fast. A large tree with brown bark. Wood reddish brown, moderately hard, even-grained. Pores moderate-sized, surrounded by loose tissue and grouped in obliquely concentric patches often filled with resin. Medullary rays fine to moderately broad, rather scanty. The wood is used for planking, tea-boxes etc.

Volume equations developed

WEST BENGAL

383.	North Eastern and Eastern part of Kalimpong division, Singalila and Tonglu ranges of Darjeeling division and Darjeeling district.	L	V	= -0.3417 +0.0055 D+0.0006 D^2 (for ply wood) (dia in cm)
		L	V	= -0.0672 +0.00063 D^2 (for total timber) (dia in cm)
384.	Singalila and Tonglu ranges of Darjeeling division	G	V	= -0.0762 +0.0000272 D^2 H (for ply wood) (dia in cm)
		G	V	= 0.0659 +0.0000275 D^2 H (for total timber) (dia in cm)

Machilus odoratissima

General description of the species

It is a moderate sized evergreen tree with oblong lanceolate leaves. Bark dark brown, wood grey, moderately hard apparently not used as timber. It occurs in outer Himalayan valleys and hill slopes from Sutlej eastwards at 600-2100 m elevation. The tree is found mainly in moist ravines and shady places. The tree is a shade bearer. It is not browsed by cattle.

Volume equations developed

WEST BENGAL

385.	North Eastern and Eastern Parts of Kalimpong division, Singalila and Tonglu ranges of Darjeeling division. and Darjeeling district.	L	V	= -1.3359 +0.0565 D (for ply wood) (dia in cm)
		L	V	= -3.511 +0.0915 D+35.411 /D (for total timber) (dia in cm)
386.	Singalila and Tonglu ranges of Darjeeling districts	G	V	= -0.2856 +0.0000303 D^2 H (for ply wood) (dia in cm)
		G	V	= 0.0303 +0.0000308 D^2 H (for total timber) (dia in cm)

Machilus species

Volume equations developed

ARUNACHAL PRADESH

387.	Debang	L	V/D^2	= 4.84009-0.02402 $/D^2$ (n=149, R^2=.267451)

ASSAM

388.	Assam survey (15 districts)	L	V	= -0.70958+13.03244 D-72.25358 D^2 +147.43033 D^3 (n=23, R^2=.95226)

BHUTAN

389.	Central and Eastern parts. The general volume equation was used for Southern parts, Gedu and Chengekha area of Western Bhutan and also Western parts of Nepal.	G	$\log_e V$	= -0.56664 +2.03335 $\log_e$ D + 0.87279 $\log_e$ H (n=122, R^2=.989)
		L	V/D^2	= 0.136186/D^2 -2.126400 /D + 12.734067 (n=324)
390.	Southern parts	L	V/D^2	= 0.07116/D^2 -1.33867 /D+9.8397 +2.29781 D (n=414)

NEPAL

391.	Western parts	L	V	= -0.08130 +2.54747 D

Madhuca latifolia

General description of the species

It is a large deciduous tree distributed in most parts of the mainland India. The young parts are pubescent, bark grey or blackish, with shallow wrinkles and vertical cracks. Heartwood scanty, reddish-brown, very hard, close and

even-grained, tough, durable, and seasons well. But the tree is so much prized for its flower and fruit that it is rarely felled. The flowers are eaten raw or cooked, or made into sweetmeats. A coarse and strong spirit is also distilled from them. The fruit is eaten and gives, when pressed, a thick oil which is eaten, burned in Chirags and is also used to adulterate Ghee, the oil cake is used to poison fish.

Volume equations developed

ANDHRA PRADESH

392.	Mehboob Nagar Forest division. The general volume equation was also used for *Terminalia crenulata* and *Zizyphus xylocarpa* of this area.	G	V	$= -0.002557 + 0.260114\ D^2\ H$
393.	Adilabad District	L	V	$= 0.046883 - 0.894379\ D + 7.220441\ D^2$ ($n=53$, $R^2=.9826$)

MADHYA PRADESH

394.	Narayanpur catchment Bastar District.	G	V/D^2	$= -0.02616/D^2 + 2.75128 + 0.21872\ H$ ($n=38$, $R^2=.6114$)
		L	V	$= -0.00092 - 0.55547\ D + 7.34460\ D^2$ ($n=173$)

MAHARASHTRA

395.	Ballarshah catchment (Chandrapur)	G	V/D^2	$= -0.009571/D^2 + 0.726397 + 0.311692\ H$ ($n=35$, $R^2=.670$)
		L	V/D^2	$= 0.025091/D^2 - 0.185618/D + 3.561089 + 10.801390\ D$ ($n=119$, $R^2=.7731$)
396.	Sondad catchment Bhandara district. The general volume equation was also used for Wadsa catchment- (Bhandara district)	G	V/D^2H	$= -0.00951/D^2H + 0.36089$ ($n=43$, $R^2=.0866$)
		L	V/D	$= -0.058016/D + 0.352354 + 2.92291\ D + 3.624110\ D^2$ ($n=125$, $R^2=.8789$)

397.	Wadsa catchment (Chandrapur)	L	$V = 0.074069 - 1.230020\ D + 7.726902\ D^2$ ($n=78$, $R^2=.9058$)
398.	Melghat Forest division	G	$\log_e V = 0.482167 + 2.479672 \log_e D + 0.697683 \log_e H$ ($n=101$, $R^2=.9866$)
		L	$\log_e V = 2.990552 + 2.972433 \log_e D$ ($n=101$, $R^2=.9802$)
	ORISSA		
399.	Koraput district	G	$V = 0.001526 + 0.391284\ D^2 H$ ($n=32$, $R^2=.96372$)
		L	$V = 0.10423 - 1.38429\ D + 8.39379\ D^2$ ($n=66$, $R^2=.98135$)
	(F.A.O. Project area)		
400.	Madhya Pradesh, Andhra Pradesh and Orissa	G	$V = -0.014 + 0.275\ D^2 H$
		L	$V = -0.051 - 0.034\ D + 4.542\ D^2$

Mallotus philippinensis

General description of the species

It is a small, much branched evergreen tree with a short and often fluted bole. Bark is thin and dark grey. It occurs in the sub-Himalayan tract and outer hills from the Indus eastwards, to nearly 1500 m elevation into West Bengal, Chota Nagpur, Indian peninsula, and Burma. It is a very common tree in Sal forests as an underwood. Within the Sal forests it often appears in advance of the Sal, helping to kill out the grass, protecting the young Sal from frost.

The tree stands a considerable amount of shade. It coppices very well and produces root suckers, it is frost hardy and drought resistant, it is not readily browsed by goats and cattle. Wood is hard and close grained, useful for bobbins, a dye known as Kamela, used for dyeing silk, is obtained from the red glands on the surface of the capsules.

Volume equation developed :

ASSAM

401.	Assam survey (15 districts)	L	V	= 0.14749 -2.87503 D+19.61977 D^2 -19.11630 D^3 (n=78, R^2=.96106)

Mansonia dipikae

General description of the species

It is large evergreen tree attaining a height of 25-35 m, bark greyish white with longitudinal fissures. It occurs in Assam at an altitude of 150 m to 210 m. It is a good timber tree with durable heartwood and takes a good polish.

Volume equations developed

ARUNACHAL PRADESH

402.	Lohit and Tirap districts. The general volume equation was also used for *Shorea assamica* of this area.	G	V/D^2H	= 0.04367/D^2H +0.000039 (dia in cm)
		L	V	= 0.0942-0.0643 $\sqrt{D}$ +0.00129D^2 (dia in cm)

ASSAM

403.	Assam survey (15 districts)	L	V	= 0.06337-1.46052 D+ 12.05817 D^2-5.52238 D^3 (n=21, R^2=.99598)

Manilkara littoralis

General description of the species

It occurs in little Andaman and North Andaman. It is a constituent of the littoral forests that forms a thin border almost all along the coast line.

Volume equations developed

ANDAMAN and NICOBAR ISLAND

404. Little Andaman	G	V/D^2H =	0.08632/D^2H +0.000029 (dia in cm) ($n=27$, $R^2=0.8070$)
	L	V =	0.0245 -0.00497 D +0.000719 D^2 (dia in cm)

Melia azadirachta

General description of the species

A large tree. Bark is grey. Wood hard, closed-grained; sapwood grey, heartwood red.It is only found in avenues and gardens and about villages in Northern and Western India. A very important Indian tree held in great esteem by the people. Indeed almost every part of the tree has its use. The wood is durable; it is used for construction of carts, in ship-building and for agricultural implements and in south India for furniture.

Volume equations developed

ARUNACHAL PRADESH

405. Lohit	L	V =	-0.03510+5.32981D^2 ($n=18$, $R^2=.94124$)

Mesua ferrea

General description of the species

It is commonly called - Iron wood tree. It is a moderate sized to large handsome, evergreen tree attaining a height of 45 m or more, often buttressed at the base, sometimes spirally twisted, with a dense crown. This species

occurs in evergreen and semi-evergreen forests of West Bengal, Assam, Meghalaya, Arunachal Pradesh, Nagaland, Maharashtra, Karnataka, Kerala, Tamil Nadu and Andamans. In the States of Maharashtra, Karnataka, Kerala and Tamil Nadu, it is a constituent of the tropical rain forests in the Western Ghats from South Konkan downwards. In Andamans, it is found in the evergreen forests especially on hills. It thrives in a variety of soils, but it prefers deep moist, fertile and well drained soils. It also prefers granite sand and sandy alluvium. It occurs mostly at elevations from about 60 -1200 m, although its altitudinal range extends upto 1500 m. In its natural habitat, the climate is generally warm, moist and equable. It is a pronounced shade-bearer, very sensitive to drought, easily killed by fire and very sensitive to frost. It is a good coppicer.

The timber is primarily used for railway sleepers, bridges, as posts and beams in building construction, boat-building and agricultural implements. Seed kernels yield oil. Dried flowers, alongwith other aromatics, are used in the preparation of perfumed ointments.

Volume equations developed

ARUNACHAL PRADESH

406.	East and West Kameng, Upper and Lower Subansiri and Kameng districts.	G	$V = 0.0996 - 0.80\ D + 0.40\ D^2\ H$ ($n=19$, $R^2=0.9840$)
		L	$V = 0.39401 - 0.045276\ D + 0.0016769\ D^2$ (dia in cm) ($n=27$, $R^2=0.9860$)
407.	Lohit	L	$V = -0.30694 + 3.97443D - 10.57969D^2 + 23.00092D^3$ ($n=460$, $R^2=.99797$)
408.	Tirap	L	$V = 0.056750 - 1.98386\ \sqrt{D} + 14.02203D^2$ ($n=121$, $R^2=.97801$)

ASSAM

409.	Assam survey (15 districts)	L	$V = 0.09252 - 1.95124\ D + 13.51055\ D^2$ ($n=74$, $R^2=.97591$)

Michelia champaca

General description of the species

It is commonly called Champ. The Champ is a tall, handsome, evergreen tree, attaining a height of 35 m or more, with a clean, long cylindrical bole. The tree occurs from Nepal eastwards, along the foothills upto 900 m altitude including West Bengal and Assam, in the Western Ghats from Kanara to Kerala, it is occasionally seen in the deep valleys of the forests of south Bihar. It is extensively cultivated in almost all parts of India. Champ is a tree of hot humid climate. The maximum temperature in its habitat goes upto 48°C and annual rainfall upto 500 cm. It does not stand sub-zero temperatures or rainfall below 200 cm. It grows on rich, moist deep, well drained, preferably sandy loam soil. The tree is light-demander, frost hardy, generally sensitive to fire. It is subject to damage by animals. Champ yields an excellant timber used for light furniture, plywood, tea-chests, heavy packing cases, carving and ship building. A variety of camphor is extracted from the wood by distillation. The fragrant fresh flowers yield, on distillation "Champaca oil" of commerce which is chiefly used in Jasmine flower perfumes. They also yield a yellow textile dye. The bark contains alkaloids and tannins and is chewed with betel and also used as an adulterant of cinnamon. A variety of silkworm is sometimes reared on the tree. The leaves, bark, roots, flowers and fruits are used medicinally.

Volume equations developed

ARUNACHAL PRADESH

410. Tirap	L	V	= -0.11391+1.06784D+5.36178D^2	(n=27, R^2=.99588)

ASSAM

411. Assam survey (15 districts)	L	$\sqrt{V}$	= 0.37142 +5.64184 D-2.27448 $\sqrt{D}$	(n=45, R^2=.9880)

Michelia excelsa

General description of the species

It is a tall deciduous tree attaining a height of 30-36 m usually with a straight clean bole and a compact or only moderately spreading crown. Bark of young trees whitish, that of old trees light ash grey with numerous small pits.

This species occurs in Eastern Himalaya at 1500 -2400 m elevation in Khasi and Naga hills. In the Darjeeling forests, it occurs mixed with Oaks, Maples, Laurels, and other trees. It grows on well drained hill sides or ridges, preferring the lighter moist deep loamy soils, it also grows fairly well when planted on moderate clay soils,but bad drainage and excessive soil moisture are injurious, retarding the development of the tree and producing a stunted growth. In the natural habitat of the tree the climate is temperate and very wet. The absolute maximum shade temperature varies from 27°C to 32°C, the absolute minimum from -7°C to -1°C and the normal rainfall from 225-500 cm or more.

The tree is a light demander, frost hardy, good coppicer and does not produce root-suckers. It suffers much if exposed to fire and is more subject to the attack of animals than almost any other tree of its regions. This is one of the most important timber trees of the Darjeeling hills, where the wood is in great demand for building and other purposes.

Volume equations developed

SIKKIM

412. South Western parts

G $V/D^2H = 0.02692/D^2H + 0.00003503$ (dia in cm) ($n=24$, $R^2=0.9693$)

L $V/D^2 = 0.002517/D + 0.0002138 + 0.00001064\ D - 0.00000004\ D^2$ (dia in cm) ($n=42$, $R^2=0.3510$)

WEST BENGAL

413. North Eastern and Eastern parts of Kalimpong division, Singalila and Tonglu ranges of Darjeeling division

L $V = -2.1537 + 0.0745\ D$ (for plywood)

L $V = -3.4152 + 0.0902\ D + 32.4791/D$ (for total timber)

414. Singalila and Tonglu ranges of Darjeeling division	G	V =	-0.1458 +0.0000248 D^2 H (for plywood) (dia in cm)
	G	V =	-0.0205 +0.0000263 D^2 H (for total timber) (dia in cm)

Michelia species

Volume equations developed

ARUNACHAL PRADESH

415. East and West Kameng, and Lower Subansiri districts.	G	V =	0.13904 +0.30787 D^2 H ($n=33$, $R^2=0.9702$)
	L	V =	0.62818 -0.063197 D +0.0020932 D^2 (dia in cm) ($n=52$, $R^2=0.9293$)

ASSAM

416. Assam survey (15 districts)	L	V =	0.23057 -3.51494 D+17.62619 D^2 ($n=22$, $R^2=.99698$)

BHUTAN

417. Central and Eastern parts	G	V/D^2H=	0.00667/D^2H +0.32947 ($n=94$, $R^2=.0084$)
	L	$\sqrt{V}$ =	-0.280741 +3.515265 D ($n=208$)
418. Southern parts	L	V =	0.53034 -1.84392 $\sqrt{D}$+11.29170 D^2

Miliusa species

Volume equation developed

ASSAM

419. Assam survey (15 districts)	L	$\sqrt{V}$ =	0.66382 +7.03093 D -3.68133 $\sqrt{D}$ ($n=22$, $R^2=.98611$)

Mitragyna parviflora

General description of the species

It is a large deciduous tree with full rounded crown and a bole often short, fluted, and buttressed. Bark grey, smooth exfoliating in scales which leave shallow depressions. This species occurs throughout the greater part of India and Burma, ascending to 1200 m elevation in the outer Himalaya. Within its habitat the tree is scattered in deciduous forests. It reaches its best development on well-drained ground with deep soil. In the Tarai and plains of the sub-Himalayan tract, it occurs freqently in low-lying somewhat swampy grounds. In such places, however, its development suffers and as a rule it remains stunted. In the peninsular region, it is often found on black cotton soil and on alluvial ground near rivers.

In its natural habitat the absolute maximum shade temperature varies from 38°C to 48°C, the absolute minimum from -1°C to 13°C and the normal rainfall from 88 cm to 325 cm.The tree is light demander, drought hardy and good coppicer. Wood light pinkish brown, even grained, used for building, furniture, agricultural implements, bobbins, combs, cups, spoons and other carved and turned articles.

Volume equations developed

GUJARAT

420.	Surat circle - Dangs, Surat, Valsad and Bharuch districts. The local volume equation was also used for Khargone, Khandwa, Dewas, Jhabua, Indore, Dhar districts of M.P., and for Dhulia, Nashik, Thane and Raigarh districts of Maharashtra.	G	$\log_e V = -1.574644+1.986771 \log_e D +1.135213 \log_e H$ (n=76, R^2=.9923)
		L	$V/D^2 = 0.099768/D^2-1.744274/D+10.086934$ (n=156, R^2=.82990)

MADHYA PRADESH

421.	Rajnandgaon and Durg districts. The general volume equation was also used for Raigarh district.	G	V/D	$= 0.001269/D - 0.029158 + 0.337067\ D\ H$ ($n=27$, $R^2=.946453$)
		L	V	$= 0.16015 - 0.64021\ \sqrt{D} + 7.19062D^2$ ($n=87$, $R^2=.95503$)
422.	Balaghat, Seoni and Mandla districts. The general volume equation was also used for Raigarh district.	G	V/D^2H	$= 0.00932/D^2H + 0.42472$ ($n=142$)
		L	V/D^2	$= 0.04778/D^2 - 1.17815/D + 10.68031$ ($n=142$, $R^2=.72011$)
423.	Raigarh district	L	V	$= -0.111271 + 1.11342\ D + 2.30514\ D^2$ ($n=10$, $R^2=.8817$)
424.	Raipur district	L	V/D^2	$= -0.02394/D^2 + 4.49414$ ($n=46$, $R^2=.54408$)

MAHARASHTRA

425.	Melghat Forest division	G	$\log_e V$	$= -1.234937 + 2.030024 \log_e D + 1.042554 \log_e H$ ($n=98$, $R^2=.9885$)
		L	V	$= 0.048795 - 1.241364D + 9.496613\ D^2$ ($n=98$, $R^2=.7575$)

ORISSA

426.	Koraput district. The local volume equation was also used for Sambalpur, Mayurbhanj and Balasore districts.	G	$\log_e V$	$= -0.097172 + 2.050903 \log_e D + 0.678458 \log_e H$ ($n=40$, $R^2=.98453$)
		L	V	$= 0.08444 - 1.26801\ D + 8.75274\ D^2$ ($n=28$, $R^2=.99915$)

Monsonia species

General description of the species

A tree with hard brown heart wood which has an unpleasent smell when felled green, while the heart wood of trees which have died naturally and have

remained a long time in the forest gradually become scented. In structure, the wood somewhat resembles Sandal wood.

Volume equation developed

ASSAM

427.	Assam survey (15 districts)	L	$\sqrt{V} = 0.24672+5.30687D-1.86171\sqrt{D}$ ($n=27$, $R^2=.99270$)

Myristica malabarica

General description of the species

It is found in Western Coast from the Konkan southwards, in the evergreen forests. The wood is said to be used for building. The seeds give an oil which is used in lamps and as an ointment. A large tree wood reddish grey, moderately hard. Annual rings doubtful, reddish distant concentric lines like annual rings conspicuous. Pores moderate-sized, oval, usually subdivided, arranged in short radial strings in echelon, not numerous, uniformly distributed medullary rays fine, not prominent.

Volume equation developed

KARNATAKA

428.	Kodagu district	L	$V = 0.79131-10.40359D+45.56029D^2 -37.81912D^3$

Olea dioica

General description of the species

A moderate-sized tree. Wood light reddish-brown, hard, rather rough; annual rings indistinct. It is found in Eastern Himalaya in the Darjeeling lower hills, Assam and in Western Ghats from Konkan southward.

Volume equation developed

KARNATAKA

429.	Kodagu district	L	$V = -0.03001+5.75523D^2$

Ougeinia dalbergioides

General description of the species

It is a small to moderate-sized deciduous tree, often with a crooked stem. Crown full and rounded in well developed tree. Bark is ash grey or light brown with regular longitudinal and horizontal cracks, exuding a red gum when cut. This species occurs in the sub-Himalayan tract and outer Himalayan valleys and slopes upto 1500 m altitude from Punjab to Bhutan, Chota Nagpur, Central India, Orissa and the Circars, M.P. and Maharashtra. In the peninsula, it is found in mixed deciduous forests, where it is some times abundant and almost gregarious. It is very characteristic of landslips, banks, the sides of ravines, and other exposed places. In its natural habitat, the absolute maximum shade temperature varies from 38°C to 46°C and the absolute minimum from -1°C (sometime less) to 7°C and the normal rainfall from 88 cm (rarely less) to 175 cm.

The tree is a shade bearer when young. Although in early youth, it is tender both to drought and to frost, it is afterwards hardy. Wood hard, close grained, strong and durable, much in demand for agricultural implements, wheel work, house posts and other purposes.

Volume equations developed

GUJARAT

430.	Surat circle - Dangs, Surat, Valsad and Bharuch districts. The local volume equation was also used for Dadra and Nagar Haveli and Mewasi Forest division of Mahashtra and	G	$\log_e V = -0.657789+2.053096 \log_e D +0.870996 \log_e H$ ($n=58$, $R^2=.9889$)
		L	$\sqrt{V} = -0.469152+1.403410 D+1.42555 \sqrt{D}$ ($n=88$, $R^2=.97998$)

	Khargone, Khandwa, Dewas, Jhabua, Indore and Dhar districts of M.P..			
	MADHYA PRADESH			
431.	Balaghat, Seoni and Mandla districts. The general volume equation was also used for Raigarh and Bilaspur districts.	G	V/D^2H	= 0.037269/D^2H+0.459791
		L	V	= 0.13806-0.52699 $\sqrt{D}$+ 9.22165 D^2 (n=332, R^2=.93703)
432.	Rajnandgaon and Durg districts. The general volume equation was also used for Raipur district.	G	$\log_e V$	= -1.979103+1.775664 $\log_e D$ +1.246994 $\log_e H$ (n=18, R^2=.9812)
		L	V	= 0.13824-2.55636 D+ 16.52029 D^2-15.59244 D^3 (n=456, R^2=.92567)
433.	Raigarh district	L	V/D^2	= -0.0107/D^2+5.16668 (n=31, R^2=.20555)
434.	Bilaspur district	L	V	= 0.23448-3.14419D+16.34645D^2 (n=134, R^2=.98689)
435.	Raipur district	L	V	= -0.10715+0.25684 $\sqrt{D}$+ 4.68486 D^2 (n=67, R^2=.94428)
	MAHARASHTRA			
436.	Melghat Forest division	G	V	= -0.001676+0.355166D^2H (n=99, R^2=.0872)
		L	V	= 0.025941-0.832619D+ 8.285841D^2 (n=99,R^2=.9405)
	ORISSA			
437.	Koraput district	G	V	= 0.00398+0.384313 D^2H (n=39, R^2=.9919)
		L	$\sqrt{V}$	= 0.03456+3.8192D-0.80884 $\sqrt{D}$ (n=69, R^2=.98177)

UTTAR PRADESH

438. Lansdowne Forest division and parts of Yamuna, Tehri and Garhwal Forest division (Balance area of Tehri Garhwal circle). The local volume equation was also used for Hill region of U.P. for Almora, Nainital, Pithoragarh, Chamoli and Dehradun districts.	G	V/D^2H =	$0.03727/D^2H+0.45979$ (n=104)
	L	$\sqrt{V}$ =	$0.41563+5.14405D -2.11832 \sqrt{D}$ (n=94, R^2=.98579)

Pajanelia longifolia

General description of the species

It is a tree attaining a height of 9–18 m. It occurs in Silhet, Khasi hills, Andamans and Malabar, common upto 600 m elevation. The wood is used for canoes, house building and planking.

Volume equations developed

ANDAMAN and NICOBAR ISLANDS

439. Little Andaman. The general volume equation was also used for North Andaman.	G	V =	$0.4257+0.0000205D^2H$ (dia in cm) (n=37, R^2=0.9104)
	L	V =	$-0.4406+0.0158D+ 0.00083D^2$ (dia in cm) (n=32, R^2=0.9544)
440. North Andaman	L	V/D =	$0.0547/D-0.0029157 + 0.0000727 D - 0.00000045D^2$ (dia in cm)

Phoebe cooperiana

General description of the species

It is a large timber tree, bark greyish, exfoliating in flakes, shallowly and reticulately furrowed. It occurs in Arunachal Pradesh and Assam. The tree yields valuable timber used for building works, planking and also for furniture.

Volume equation developed

ASSAM

441.	Assam survey (15 districts)	L	$\sqrt{V} = 0.05613+4.53383D-1.03039\sqrt{D}$ ($n=24$, $R^2=.99515$)

Phoebe goalparensis

General description of the species

It is a tall timber tree, stem buttressing at base, branches ultimately minutely puberulous, blackish. It occurs in Assam in the district of Goalpara, Darrang, Nowgong and Sibsagar. Tree yields valuable timber known as "Bonsum" or 'Assam Teak' used for building structure, planking, furniture and all kinds of cabinet work.

Volume equations developed

BHUTAN

442.	Central and Eastern parts. The general volume equation was also used for Southern parts.	G	$V = -0.04320+0.36220\ D^2H$ ($n=34$, $R^2=.970$)
		L	$\sqrt{V} = -0.253366+3.567924\ D$ ($n=76$)
443.	Southern Parts and Gedu and Changekha area of Western Bhutan.	L	$\sqrt{V} = -0.65767+3.21650\ D +0.80684\sqrt{D}$ ($n=86$, $R^2=.97914$)

Phoebe species

Volume equations developed

WEST BENGAL

444.	North Eastern and Eastern parts of Kalimpong division, and Singalila and Tonglu ranges of Darjeeling division.	L	V = -0.5193 +0.0252 D (for plywood) (dia in cm)
445.	Singalila and Tonglu ranges of Darjeeling.	G	V = -0.334+0.0000324 D^2H (for plywood) (dia. in cm)
		G	V = -0.2763+0.0000355D^2H (for total timber) (dia. in cm)

Picea smithiana

General description of the species

It is commonly called West Himalayan Spruce. It is a very tall evergreen tree with conical crown, horizontal or drooping branches and slender pendulous tassel-like branchlets. Bark grey to greyish brown, exfoliating in small thin rounded scales. This species occurs throughtout the western Himalaya from Afghanistan eastwards as far as Kumaon at elevation of 2100- 3300 m. It grows in the cool, temperate regions of the Himalaya, where there is comparatively heavy snowfall between December and April. The maximum shade temperature seldom reaches 32°C while the rainfall varies between 100 cm and 250 cm.

Spruce is a moderate light demander and fire sensitive, tree is not wind firm, it is not subject to snow-break. Wood used for tea boxes, match manufacture and wood pulp.

Volume equations developed

HIMACHAL PRADESH

446.	Rohru- Chopal, Shimla, Chamba, Lahaul-Spiti and Kinnaur districts.	G	V/D^2H= 0.28318+0.0337/D^2H
		L	V/D^2= 0.26072/D^2-3.29692 /D+14.71246 (n=427)

	The general volume equation was also used for Chir belt area of H.P.		
447.	Chir belt area-Bilaspur, Hamirpur, Mandi, Solan, Kangra & Una districts.	L	$V/D^2 = 11.770869+0.163269/D^2-2.232068/D +1.06041\ D$ (n=1976)
	UTTAR PRADESH		
448.	Alaknanda catchments - major portion of district Chamoli and parts of Garhwal and Almora districts. The general volume equation was also used for western parts of Nepal.	G	$V = 0.033695+0.283177D^2H$
	(F.A.O. Project area)		
449.	Himachal Pradesh, Uttar Pradesh, Haryana	G	$V = 0.151+0.232D^2H$
	NEPAL		
450.	Western parts	L	$V/D^2 = -0.03431/D^2+0.47368\ /D +3.15807+7.55719D$

Picea spinulosa

General description of the species

It is commonly called East Himalayan or Sikkim Spruce. It is a tall evergreen tree attaining a height of over 60 m. Its bark is rough scaling off in small quadrangular plates. Young branchlets slender, glabrous, yellowish, grey; leaves are in an imperfect radial arrangement, covering the upper side of the

branchlets. The tree is indigenous to Sikkim in the inner valleys at elevation of 2400 m and above and has been recorded from Chumbi valley at 2700 - 3000 m. In Sikkim it occurs with *Tsuga brunoniana* at 2400 - 3300 m, with *Abies webbiana* at 2700-3300 m and sometimes with *Larix griffithii.*

Volume equations developed

BHUTAN

451. North Western parts	G	$\log_e V$ =	-1.074891+1.893688 $\log_e D$ +0.973121 $\log_e H$ (n=93)
	L	$\sqrt{V}$ =	-0.238455+3.757776D (for D> 75cm) (n=268)
	L	$\log_e V$ =	2.611759+2.487319$\log_e D$ (for D ≤ 75cm) (n=268)
452. Central and Eastern parts. The local volume equation was also used for Southern parts.	G	$\log_e V$ =	-1.29816+1.86384 $\log_e D$ +1.03333 $\log_e H$ (n=154, R^2=.996)
	L	$\log_e V$ =	2.763193 +2.605962 $\log_e D$ (n=263)

Pinus wallichiana

General description of the species

It is commonly called the Blue Pine. It is a tall tree attaining a height of 45 m, bark smooth, slate coloured on young trees, rough with shallow fissures on mature trees, foliage bluish-green, at higher elevation greyish-green. It occurs at high elevations upto 3750 m where it forms extensive forests with the Himalayan Spruce and Silver Fir. As the seed comes up in open grasslands without shelter and as it is readily carried about by wind, there is abundant second growth of it at lower elevations down to 1500 m.

Volume equations developed

ARUNACHAL PRADESH

453. East and West Kameng district. The general and local volume equations were also used for Lower Subansiri district.	G	V =	$-0.26434+6.7823D^2+0.08789D^2H$ (dia in cm)
	L	V =	$0.22736-0.027394D+0.0012413D^2$ (dia in cm)
454. Debang	L	V/D^2 =	$3.88801+1.00147/D-0.07019/D^2$ (n=204, R^2=.32198)

HIMACHAL PRADESH

455. Shimla, Rohru, Chopal Lahul-Spiti and Chamba districts.	L	V/D^2 =	$0.28497/D^2-3.32891/D+16.51904-3.7314D$ (n=630, R^2=.59225)
456. Kulu, Seraj and Kotgarh-Kulu and Shimla districts.	L	V =	$0.251311-2.683081D+13.484565D^2$ (n=541, R^2=.4238)
457. Chir belt area- Bilaspur Hamirpur, Kangra, Mandi, Solan and Una districts	L	V/D^2 =	$0.291006/D^2-3.542277/D+16.894379-4.678466D$ (n=97)
458. Rajgarh and Nahan - Sirmour district	L	V =	$0.2232-2.3509D+11.9067D^2$

JAMMU AND KASHMIR

459. Chenab valley catchment. The general volume equation was also used for Shimla, Rohru and Chopal-Shimla district, Kulu, Seraj and Kotgarh-Shimla and Kulu districts and Chir belt area - Bilaspur, Hamirpur, Kangra, Mandi, Solan and Una districts of Himachal Pradesh.	G	V =	$0.070572+0.296062\ D^2H$ for $D^2H \leq 10$ (n=63, R^2 =0.9539)
	G	$V/D^2\ H$ =	$0.724684/D^2\ H+0.239729$ for $D^2H>10$ (n=30, R^2 =0.1444)
	L	V/D^2 =	$0.213315/D^2+12.631292-2.519227/D$ (n=583, R^2=.4027)
460. Jammu Region-Kathua, Udhampur, Rajouri.	L	V =	$0.2072-2.24612D+12.50978D^2$ (n=57, R^2=.67346)

UTTAR PRADESH

461.	Bhagirathi, Bhilangana and Yamuna catchment	G	$V/D^2H = 0.03085/D^2H+0.30649$ ($n=35$, $R^2=.1013$)
		L	$V = 0.223139-2.35096D+11.90669D^2$ ($n=86$, $R^2=.9627$)
	(F.A.O. Project area)		
462.	Himachal Pradesh, Uttar Pradesh, Haryana	G	$V = -0.166+0.304D^2H$

BHUTAN

463.	North Western parts. The general volume equation was also used in Western parts of Nepal.	G	$\log_e V = -1.049334+1.926332\log_e D +0.967612 \log_e H$ ($n=218$)
		L	$\log_e V = 2.697278+2.659289 \log_e D$ ($n=270$, $R^2=.9855$)
464.	Central and Eastern parts	L	$V/D^2 = 0.185555/D^2-3.040264 /D +16.183975$ ($n=119$)
465.	Southern parts	L	$V/D^2 = 0.20188/D^2-3.21761 /D+16.61531$ ($n=143, R^2=.8479$)

NEPAL

466.	Western parts.	L	$V = 0.09222+4.29192D-1.08566D^2$

Pinus roxburghii

General description of the species

It is commonly called Chir or Chir Pine. Chir is a large evergreen tree attaining a height upto 55 m. Chir pine occurs in the outer ranges and principal valleys of the Himalayas and on the ridges of the Siwalik hills flanking the Himalayas, from about 450-2300 m. Its distribution in India is confined to Jammu & Kashmir, Himachal Pradesh and Uttar Pradesh. In the pure Chir zone, the absolute maximum temperature varies from 30°C to 38°C. The absolute minimum shade temperature within most parts of the region of the pine falls below freezing point, and ground frosts often occur in winter. The mean annual temperature lies between 15°C and 20°C. The normal rainfall varies from about 90 cm to 300 cm. Chir requires good drainage, prefers hilly country and is

often found on steep slopes. Chir pine is a strong light demander, drought hardy, frost hardy. Chir timber is used expensively for house building, packing cases, boat building, tea chests, sporting requisites, railway sleepers, electric poles etc. The oleo-resin extracted from Chir yields, on distillation, turpentine and resin, two products of great industrial importance.

Volume equations developed

HIMACHAL PRADESH

467. Chir belt area - Bilaspur, Hamirpur, Kangra, Mandi, Solan and Una districts. The general volume equation was also used for Shivalik region of Haryana and Punjab - Ambala, Ropar, Hoshiarpur and Gurudaspur districts.

G $V = 0.034529+0.284662D^2H$

L $V/D^2 = 0.167095/D^2-2.085944/D+9.929936$ (n=563)

468. Shimla district.

L $\sqrt{V} = -0.17399+2.89718D$ (n=104, R^2=.96809)

469. Kulu-Seraj Kotgarh-Kulu and Shimla districts.

L $\log_e V = 2.435237+2.560689 \log_e D$ (n=159, R^2=.9477)

470. Rajgarh and Nahan -Sirmour district

L $V/D^2 = 0.2283/D^2-1.7288 /D+9.05$ (n=388, R^2=.4945)

471. Chamba, Lahaul Spiti and Kinnaur district.

L $V = 0.167091-2.08594D+9.92994D^2$

JAMMU AND KASHMIR

472. Chenab valley catchment. The general volume equation was also used for Jammu region - Jammu, Udhampur, Kathua and Rajouri of J & K, and Kulu, Seraj and Kotgarh - Kulu and Shimla districts of Himachal Pradesh.

G $V/D^2H = 0.019541/D^2H+0.29711$ (n=36, R^2=.0086)

L $V/D^2 = 0.128812/D^2-2.285176 /D +11.950158$ (n=97, R^2=.5004)

473.	Jammu Region - Kathua, Udhampur, Rajouri.	L	$V = 0.07565-1.11851D+7.07064D^2+3.85072D^3$ ($n=455$, $R^2=.73324$)
	UTTAR PRADESH		
474	Bhagirathi, Bhilangana and Yamuna catchments. The general volume equation was also used for Lansdowne Forest division - parts of Yamuna, Tehri and Garhwal Forest divisions (Balance area of Tehri and Garhwal circle), Alaknanda catchment - Major parts of Chamoli district and parts of Pauri Garhwal and Almora districts of Uttar Pradesh and Shimla, Rohru and Chopal - Shimla district of Himachal Pradesh.	G	$V/D^2H = 0.27408+0.00249\ /D^2H$ ($n=31$, $R^2=.0307$)
		L	$V = 0.276739-3.068630D+12.409920D^2$ ($n=928$, $R^2=.9663$)
475.	Lansdowne forest division, parts of Yamuna, Tehri and Garhwal forest division (Balance area of Tehri and Garhwal Circle).The local volume equation was also used for Hill region- Almora, Nainital etc.	L	$\sqrt{V} = 0.05131+3.9859D-1.0245\ \sqrt{D}$ ($n=874$, $R^2=.98288$)
476.	Alaknanda catchment - Major part of Chamoli district and parts of Pauri Garhwal and Almora districts.	L	$= 0.12844-2.23711D+11.78506D^2-0.56094D^3$ ($n=873$, $R^2=.5722$)

(F.A.O. Project area)

477.	Himachal Pradesh, Uttar Pradesh and Haryana, Parts of Madhdya Pradesh, Andhra Pradesh, Kerala, Orissa and Tamil Nadu	G	$V = -0.116+0.297D^2H$
	BHUTAN		
478.	North Western parts	G	$\log_e V = -1.251652+1.964424 \log_e D$ $+1.003778 \log_e H$ (n=80)
		L	$\log_e V = 2.609513+2.844257 \log_e D$ (n=84, R^2=.9565)
479.	Central and Eastern parts. The local volume equation was used for Southern parts and areas of Western parts.	G	$V/D^2H = -0.00156/D^2H+0.32159$ (n=154, R^2=.01232)
		L	$\sqrt{V} = 0.291801+6.041763\ D-2.430993\ \sqrt{D}$ (n=272)
	NEPAL		
480.	Western parts	G	$V/D^2H = 0.002489/D^2H+0.274078$
		L	$V/D^2 = 0.14329/D^2-2.12457\ /D$ $+9.91557+2.24684\ D$

Pinus khasiya

General description of the species

It is a tall tree attaining a height of 30 - 45 m. It occurs in the Khasi and Naga hills and Manipur and Bangaladesh and Burma. Branches more or less whorled, bark thick, deeply cracked, resin ducts numerous in the outer and middle belt of each annual ring.

A large evergreen tree. Wood very resinous, moderately hard, pale brown to red. Annual rings very distincts.

Volume equations developed

ASSAM

481.	Assam survey (15 districts)	L	$V = -0.01523+5.65779\ D^2$ ($n=38$, $R^2=.97648$)

MANIPUR

482.	Manipur survey	G	$V = -0.013767+0.254694\ D^2H$
		L	$\sqrt{V} = -0.200251+2.927166\ D$

MEGHALAYA

483.	Meghalaya survey	G	$V = 0.02356+0.0004842\ D^2 +0.0000164\ D^2\ H$ (dia. in cm) ($n=36$, $R^2=0.8281$)
		L	$V = 0.0232-0.011613\ D+0.0011549\ D^2$ (dia. in cm) ($n=51$, $R^2=0.8100$)

Planchonia andamanica

General description of the species

It is an evergreen tree of the Andamans, occuring in evergreen or semi-deciduous forests. The wood is hard, durable, and of good quality and forms an important timber.

Volume equations developed

ANDAMAN AND NICOBAR ISLANDS

484.	North Andaman	G	$V/D^2H = 0.37271/D^2H+0.0000215$ (dia. in cm) ($n=38$, $R^2=0.3087$)

	L	$V = 0.0000029+0.000768\ D^2$ (dia. in cm) ($n=32$, $R^2=0.5339$)

Premna species

Volume equation developed

ASSAM

485. Assam survey (15 districts)	L	$\sqrt{V} = -0.59983+0.72994D+2.12551\ \sqrt{D}$ ($n=70$, $R^2=.94301$)

Pterocarpus dalbergioides

General description of the species

It is commonly called Andaman Padauk. Padauk is a very large, semi-deciduous or practically evergreen tree attaining a height of upto 45 m. With ascending branches, often with very large buttresses at the base. It occurs only in the Andamans, though sparingly cultivated in the eastern and western peninsula and is found scattered in mixed deciduous or semi-evergreen forests from near sea level upto 90 m elevation. It grows best on alluvial soils. The mean rainfall of its habitat, is 310 cm and the mean daily maximum temperature varies from 28° to 32°C. Padauk is a strong light demander and a good coppicer, it is very sensitive to suppression by weeds in the seedling stage. Andaman Padauk yields high quality timber, it is a first class cabinet wood and a fine, strong constructional timber. It is suitable for heavy carpentry and high class furniture. It makes an attractive plywood.

Volume equation developed

ANDAMAN AND NICOBAR ISLANDS

486. South and Middle Andaman	G	$V/D^2H = -0.016861/D^2H+0.38978$
	L	$V = -0.068871+11.011\ D^2$

Pterocarpus marsupium

General description of the species

It is commonly called Kino tree, Gum Kino Tree or Bijasal. Bijasal is a tall deciduous tree attaining a height of 31 m with spreading branches, forming a large rounded crown. Bark rough, thick, dark grey, longitudinally fissured with the outer softer corky layer exfoliating in small pieces of irregular shape and size, inner bark reddish-brown, fibrous.

This species is distributed throughout the Indian peninsula in deciduous forests, its northern limit being Saurashtra and Mount Abu in the West, the Santhal Parganas in the east and Bundelkhand in the centre. It is also found to a limited extent in sub-Himalayan tract from Haldwani eastwards to Gorakhpur. It is quite common in Madhya Pradesh, Gujarat, Maharashtra, Andhra Pradesh, West Bengal, Orissa, Karnataka, Kerala and Tamil Nadu. It prefers a soil with a fair proportion of sand and is often found on red loam with a certain percentage of clay. In its natural habitat, the absolute maximum shade temperature varies from 35°C to 48°C and the absolute minimum from 0°C-18°C. The normal rainfall varies from 76 -190 cm.

Bijasal is a moderate light demander and good coppicer. The tree produces root suckers sparingly. Young plants are frost tender and require careful protection from fire, frost and grazing.

The timber is used in south India for furniture and constructional purposes, in railways carriages and wagon building, sleepers, ship building and for joinery work. Bijasal bark is the source of an important gum, the Kino which has medicinal value. The leaves are used as fodder for cattle.

Volume equations developed

ANDHRA PRADESH

487.	Adilabad district	L	V/D=	-0.018208 /D -0.145889 +5.03522 D+5.91151 D^2 ($n=91$, $R^2=.9353$)
488.	Mehboob Nagar Forest division	G	V	= 0.013437+0.217379 D^2H
489.	East Godavari	L	V	= 0.477930-5.9792D+24.5798D^2 -16.7699D^3 ($n=47$, $R^2=.933156$)

GUJARAT

490. Surat circle-Dangs, Surat, Valsad and Bharuch districts. The local volume equation was also used for Dadra and Nagar Haveli, Chitradurg, Tumkur Kolar, Bangalore and Bellary districts of Karnataka, Khargone, Khandwa, Dewas, Indore, Dhar, districts of M.P. and for Mewasi Forest division, Dhulia, Nashik, Thane and Raigarh districts of Maharashtra.

G $\log_e V = 0.097741+2.293041 \log_e D +0.710614 \log_e H$ (n=73, R^2=.9434)

L $\sqrt{V} = 0.175068+4.598243 D-1.500562 \sqrt{D}$ (n=102)

MADHYA PRADESH

491. Narayanpur catchment - Bastar district.

G $V/D^2H = 0.00163/D^2H+0.36188$ (n=34)

L $V = -0.00116-0.56934D+7.8153D^2$ (n=238, R^2=.97636)

492. Rajnandgaon and Durg districts. The general volume equation was also used for Raipur district.

G $\log_e V = -2.194977+1.932216 \log_e D+ 1.430576 \log_e H$ (n=27, R^2=.996469)

L $V/D^2 = 0.07747/D^2-1.64857 /D+11.33719$ (n=531, R^2=.67744)

493. Raigarh district. The general volume equation was also used for Bilaspur district.

L $V/D^2 = -0.04659/D^2+8.06901$ (n=65, R^2=.54428)

494. Bilaspur district.

L $V = 0.06801+0.14032D+1.43895D^2 +18.34982 D^3$ (n=129, R^2=.98519)

495. Raipur district.

L $V/D^2 = 0.04482/D^2-1.14471/D+9.39716$ (n=156, R^2=.70711)

496.	Balaghat, Mandla and Seoni. The general volume equation was also used for Raigarh and Bilaspur districts.	G	$V = 0.07055+0.471211D^2H$ (n=131)
		L	$\sqrt{V} = 0.47558+5.17895\ D-2.10308\ \sqrt{D}$ (n=184, R^2=.9676)
	MAHARASHSTRA		
497.	Ballarshah catchment-(Chandrapur).	G	$V/D^2H = -0.006412/D^2H+0.341324$ (n=39, R^2=.116)
		L	$V/D^2 = 0.028252/D^2-0.833643/D+8.033788$ (n=116, R^2=.7651)
498.	Sondad catchment - Bhandara District. The general volume equation was also used for Wadsa catchment (Chandrapur).	G	$V = 0.03611+0.33714\ D^2H$ (n=42, R^2=.9022)
		L	$V = -0.029600+6.552826\ D^2$ (n=116, R^2=.9839)
499.	Wadsa catchment - (Chandrapur).	L	$V = 0.107059-1.010240\ D+7.685670\ D^2$ (n=59, R^2=.9716)
	ORISSA		
500.	Phulbani catchment (Phulbani, Ganjam and Kalahandi districts).	G	$V/D^2H = -0.007399/D^2H+0.382499$
		L	$V = 0.058424-1.233468\ D+9.433633\ D^2$ (n= 400, R^2=.9612)
501.	Koraput district. The local volume equation was also used for Sambalpur, Mayurbhanj and Balasore districts.	G	$V = -0.01439+1.33284\ D^2 +0.328477\ D^2H$ (n=69, R^2=.97746)
		L	$\sqrt{V} = -0.16276+2.82002D+0.04034\ \sqrt{D}$ (n=184, R^2=.98602)
	(F.A.O. Project area)		
502.	Kerala, Tamilnadu Andhra Pradesh, M.P. and Orissa	L	$V = 0.70 -1.295\ D + 9.429\ D^2$

Pterocymbium tinctorium (Sterculia companulata)

General description of the species

It is a tree attaining a height of 15 m - 18 m, bark brownish, leaves cordate, ovate and 5 nerved. A large trees of the tropical forests of Andamans and Burma. Wood generally light soft often spongy. Pores large, Medullary rays moderately broad or broad, very prominent on a radial section.

Volume equations developed

ANDAMAN AND NICOBAR ISLANDS

503.	South and Middle Andaman	G	$V/D^2H = 0.37127/D^2H+0.23259$
		L	$V = 0.019795-0.99448D+10.101D^2$
504.	Little Andaman. The general volume equation was also used in North Andaman.	G	$V/D^2 = 0.02059/D^2-0.000036+$ 0.0000268 H (dia. in cm) ($n=29$, $R^2=0.6566$)
		L	$V = 0.00999-0.0154D+0.0012D^2$ (dia. in cm) ($n=32$, $R^2=0.9336$)
505.	North Andaman	L	$V/D^2 = 0.00026+0.00001759D-$ $0.0000001D^2$

Pterospermum acerifolium

General description of the species

It is a large handsome evergreen tree with thin grey smooth bark and large round somewhat variable deeply cordate or peltate leaves, dark green above and white tomentose beneath. It occurs in the sub-Himalayan tract and outer Himalayan valleys and hills upto 1200 m elevation, often planted for ornament. The tree is a moderate shade bearer, fairly frost hardy, the tree coppices well and produces root-suckers. The wood is moderately hard,

reddish, of good quality, suitable for carpentry, and sometimes used for planking.

Volume equations developed

ARUNACHAL PRADESH

506.	Lohit	L	$\sqrt{V}$ = -0.14844+3.16395D (n=23, R^2=.99608)
507.	Tirap	L	$\sqrt{V}$ = -0.13394+3.23371D (n=6, R^2=.99664)

ASSAM

508.	Assam survey (15 districts).	L	$\sqrt{V}$ = 0.21596+4.14881D-1.38264 $\sqrt{D}$ (n=22, R^2=.98863)

Pterospermum species

General description of the species

Twelve species of which two are found in North-Western India, three in North-East India, Seven in South India five in Burma and only one in Sri Lanka. These are all handsome plants, good for garden and park and avenue cultivation.

It occurs in Khasi hills, Manipur and in Bangaladesh. It is a large tree, young shoots and under side of leaves are sometimes grey tomentose. Leaves and lanceolate are from a rounded nearly equal sided base.

Volume equation developed

ASSAM

509.	Assam survey (15 districts).	L	$\sqrt{V}$ = -0.08150+2.48467D (n=22, R^2=.9870)

Quercus dilatata

General description of the species

It is comonly called green Oak or Moru Oak. It is a large evergreen tree with a dense crown of shining green foliage. This species occurs in Western Himalaya from Nepal westwards, chiefly at 2100 - 2700 m elevation, but descending in some localities to about 1650 m particularly in cool moist situations. It is very common in the Kumaon hills and from Jaunsar to Kulu. It prefers moist, cool localities and northern aspects. Its best development is attained on deep rich, moist, well drained soil. The habitat of this oak is in temperate regions, where there is usually a fairly heavy winter snowfall. The maximum shade temperature seldom exceeds 32°C, and the minimum is often below -6°C. The normal railfall including equivalent snowfall, varies for the most part from 112 - 238 cm.It stands more shade, its coppicing power is uncertain, it is much subjected to lopping. Young plants and coppice-shoots are readily browsed, particularly by goats. Wood of the tree is very hard, used for building and agricultural implements as well as for fuel and charcoal.

Volume equations developed

HIMACHAL PRADESH

510. Shimla, Rohru, Chopal- Shimla District. The general volume equation was also used for Bhagirathi, Bhilangana and Yamuna catchment and Alakhnanda catchment of U.P. It was also used for *Quercus semecarpifolia* for Shimla, Rohru and Chopal- Shimla district.

G $V = 0.03560+0.31504D^2H$

L $V/D^2 = 0.21126/D^2-2.54947/D+11.92346$ ($n=103$, $R^2=.7697$)

511. Rajgarh and Nahan- Sirmour district. The local volume equation was also used for Chamba, Lahual Spiti and Kinnaur districts.

L $V/D^2 = 0.0988/D^2-1.5547/D+10.1631$ ($n=335$, $R^2=.6686$)

Also for Bhagirathi, Bhilangana and Yamuna catchment, Alkananda catchment- major portion of district Chamoli and parts of Pauri Garhwal and Almora districts of U.P. and Western parts of Nepal.

UTTAR PRADESH

512. Lansdowne Forest division and parts of Yamuna, Tehri and Garhwal Forest divisions. The local volume equation was also used for Almora, Nainital, Pithoragarh and parts of Chamoli district, Dehra Dun, Garhwal and Tehri districts. The general volume equation was also used for *Quercus incana* (Ban Oak) for Chir Belt area-Bilaspur, Hamirpur, Kangra, Mandi, Solan and Una, Shimla, Rohru, Chopal-Shimla district, Rajgarh, Nahan Sirmour districts of H.P. and Jammu region of J and K, Bhagirathi, Bhilangana and Yamuna catchment, Lansdowne Forest division and parts of Yamuna, Tehri and Garhwal Forest division

G $V = 0.01480+0.31906D^2H$ ($n=19$, $R^2=0.9984$)

L $\sqrt{V} = 0.47511- 4.93282D-2.450475 \sqrt{D}$ ($n=127$, $R^2=.99106$)

	of U.P. and Western parts of Nepal. This was also used for *Quercus semecarpifolia* for Alkananda catchment, Lansdowne Forest division of U.P.		
513.	Alaknanda catchment, major portion of district Chamoli and parts of Pauri Garhwal and Almora districts.	G	$V = 0.0356 + 0.31504\ D^2H$ ($n=21$, $R^2=.9294$)
		L	$\sqrt{V} = 0.65735 + 5.35636\ D - 2.86435\ \sqrt{D}$ ($n=294, R^2=.94618$)
	NEPAL		
514.	Western parts	L	$V = 0.34302 + 4.35585D - 1.74481D^2$

Quercus incana

General description of the species

It is commonly called Grey oak or Ban Oak. It is a moderate-sized to large evergreen tree attaining a height of 12-18 m with massive gnarled branches and a rounded crown. This species occurs in Western Himalaya, extending eastward to Nepal, at an elevation of 1200 -2400 m, but occasionally descending lower in moist situations. It grows on a variety of geological formations. It attains its largest dimensions on cool northern aspects with deep moist soil, on hot aspects with shallow rocky soil it is stunted. It is a very useful nurse to Deodar on hot slopes. In the normal habitat of this Oak the climate is a temperate one, the shade temperature seldom exceeds 35°C, while it occasionally descends to below -6°C. The normal rainfall varies ordinarily from 100 - 238 cm. The Ban Oak is a moderate light demander, the tree is wind firm, moderate coppicer, in its younger stages this Oak suffers much from goat browsing, and cattle also eat the young shoots, it is also lopped for fodder, this Oak resists ordinary frost. It suffers severely from fire. Wood of the tree is very hard, apt to warp and split, much used for fuel and charcoal, and employed to some extent for building and agricultural implements.

Volume equations developed

HIMACHAL PRADESH

515.	Chir Belt area - Bilaspur, Hamirpur, Kangra, Mandi, Solan and Una districts	L	$\sqrt{V} = 0.240157+3.820069\ D -1.394520\ \sqrt{D}$ (n=239)
516.	Shimla, Rohru, Chopal-Shimla district	L	$V = 0.08519-1.24724D+7.94479D^2$ (n=143, R^2=.95451)
517.	Rajgarh and Nahan - Sirmour district	L	$V/D^2 = 0.0854/D^2-1.2582\ /D+7.703$ (n=600, R^2=.6028)
518.	Chamba, Lahaul and Spiti and Kinnaur districts	L	$V = 0.24016+3.82077D-1.39452D^2$ (n=239)

JAMMU AND KASHMIR

519.	Jammu Region. The local volume equation was also used for *Quercus* species for Kashmir Valley and for Jammu region.	L	$V = 0.04430- 0.84266D+ 6.36239D^2 +2.27556D^3$ (n=471, R^2=.96665)

UTTAR PRADESH

520.	Bhagirathi, Bhilangana and Yamuna catchment and Lansdowne Forest division.	L	$V/D^2 = 0.085356/D^2-1.258189\ /D +7.702984$ (For dia. >20 cm) (n=600, R^2=.6028)
521.	Alaknanda catchment-Major portion of district of Chamoli and parts of Pauri Garhwal and Almora district. The general volume equation was also used for Western parts of Nepal.	G L	$V = 0.014796+0.319061D^2H$ $V = 0.06839-0.95816D+6.06105D^2 +2.66635D^3$ (n=439, R^2=.4525)

522. Lansdowne and parts of Yamuna, Tehri and Garhwal forest divisions (Balance area of Tehri and Garhwal circle).	L	V/D^2 =	0.03484/D^2-0.461 /D+4.15846 +3.04122 D (n=1101, R^2=.54603)
NEPAL			
523. Western parts	L	V/D^2 =	0.04712/D^2-0.70584 /D+5.27042+ 2.48078 D

Quercus lamellosa

General description of the species

It is a large evergreen tree attaining a height of 30-36 m forming in the open a massive spreading crown and a short, often crooked bole, but producing in a close crop a tall clean straight bole. It occurs in the Eastern Himalaya from Nepal eastwards at elevation of 1800-2700 m. It thrives best on northern slopes with deep, well drained, fairly moist soil. The tree is a shade bearer. It is hardy to frost and drought, but is very susceptible to damage by fire. It is a good coppicer and does not produce root-suckers. The wood of the tree is very hard, durable and is used for building and fuel. This is the most important oak of the Darjeeling hills.

Volume equations developed

WEST BENGAL

524. North Eastern and Eastern parts of Kalimpong division. The local volume equations were also used for Darjeeling district.	L	V =	-3.7287+0.1431D-0.0005D^2 (dia. in cm) for Plywood
	L	V =	-9.246+0.165D+134.00/D (dia.in cm) for total timber
525. Singalila and Tonglu Ranges of Darjeeling Division	G	V =	-0.366+0.0000359D^2H (dia.in cm) for Plywood
	G	V =	-0.1922+0.0000373D^2H (dia. in cm) for total timber

Quercus lineata

General description of the species

It is a large evergreen tree with thick brown rough bark. It occurs in the Eastern Himalaya at 1800 -2700 m elevation in Khasi and Naga hills. This is an important tree of the Darjeeling hills and is a common companion of the Buk *(Q. lamellosa)*.

Volume equations developed

WEST BENGAL

526.	North Eastern and Eastern parts of Kalimpong Division and Darjeeling district.	L	$V = 0.3129-0.036\ D+0.0009D^2$ (dia. in cm) (for Plywood)
		L	$V = 1.4402+0.00082\ D-0.3431\ \sqrt{D}$ (dia. in cm) (for total timber)
527.	Singalila and Tonglu ranges of Darjeeling division.	G	$V = -0.1902+0.0000227D^2H$ (dia. in cm) (for Plywood).
		G	$V = 0.0270+0.0000225D^2H$ (dia. in cm) (for total timber)

Quercus semecarpifolia

General description of the species

It is commonly called Brown Oak or Kharshu Oak. It is a large tree, evergreen or nearly so, forming in favourable localities a long clean bole, but at its upper limit and on exposed ridges often stunted and gnarled. This species is found throughout the Himalaya from Bhutan westwards, chiefly at 2400 -3600 m elevation and on the Burma–Manipur frontier at 2400 - 3000 m. It decends occasionally to 1950 m but is seldom found in abundance below 2400 m. Within its zone it is gregarious, forming pure forests along the tops and upper slopes of ridges. It is found on deep rich moist soil and on poor rocky ground on the crests of ridges, where it is usually stunted. The Kharshu Oak forests occur in regions of heavy snowfall and at least moderate rainfall, they do not extend into the driest parts of the inner Himalaya. This Oak is a light demander. It coppices and pollards fairly well. The leaves, particularly when young, are

readily eaten by goat and sheep. The tree is not so liable to be thrown by wind but sometimes suffers from snow break. Bark dark grey, rough, with small quadrangular or irregular scales, yields tannin. Wood of the tree is very hard, of good quality but not much used as timber, though locally employed for building and agricultural implements, an excellent fuel and charcoal wood.

Volume equations developed

HIMACHAL PRADESH

528.	Chamba, Lahaul Spiti and Kinnaur districts	L	$V = 0.098800-1.55471D+10.16317D^2$
529.	Shimla, Rohru and Chopal-Shimla district.	L	$V/D^2 = 0.13581/D^2-1.84908/D+10.82341 - 0.6276\ D$ ($n=291$, $R^2=.6061$)
530.	Chir belt area - Bilaspur, Hamirpur, Kangra, Mandi, Solan and Una districts	L	$\sqrt{V} = 0.381357+4.448446D-1.956996\ \sqrt{D}$ ($n=101$)

UTTAR PRADESH

531.	Alaknanda catchment-Major portion of district Chamoli and parts of Pauri Garhwal and Almora district	L	$V = 0.08355-1.28586\ D+8.76867\ D^2 +1.12150D^3$ ($n=751$, $R^2=.34032$)
532.	Hill region - Almora, Nainital, Pithoragarh and parts of Chamoli district, Dehra Dun, Garhwal and Tehri districts.	L	$V/D^2 = 0.08875/D^2-1.34258\ /D+8.57555$ ($n=184$, $R^2=.59878$)
533.	Lansdowne Forest division and parts of Yamuna, Tehri and Garhwal Forest division (Balance area of Tehri and Garhwal circles).	L	$\sqrt{V} = 0.34696+4.54678D-1.98637\ \sqrt{D}$ ($n=88$, $R^2=.9911$)

NEPAL

534.	Western parts	L	V = -0.19983+3.02906D

Quercus species

General description of the species

Oaks, a large genus, are one of the most important genus of these forests, not only in India and Europe but also in North America, Japan and other parts of world. The genus contains about 300 species of which 31 are found in India and Burma. These 31 belong to 6 sub–genera.

Wood brown, very hard to extremely hard, heavy, generally with a distinct, darker coloured heartwood. The wood of most Indian species warps and splits in seasoning.

Volume equations developed

ARUNACHAL PRADESH

535.	Debang	L	$V/D^2 = 5.09470+0.00563/D$ (n=1670, R^2=.06501)
536.	Tirap	L	$V = -0.04378+6.23420D^2$ (n=95, R^2=.98624)

ASSAM

537.	North Cachar hills	G	$V/D^2H = -0.023684/D^2H+0.000033712$ (Dia. in cm)
		L	$V/D^2 = 0.000295/D^2-0.0079835/D$ +0.000862 (Dia.in cm)
538.	Assam survey (15 Districts)	L	$V = 0.14153-2.27358D+12.90490D^2$ (n=180, R^2=.98263)

HIMACHAL PRADESH

539.	Kulu-Seraj and Kotgarh (Kulu and Shimla districts).	L	$\sqrt{V} = 0.682380+5.049937D-2.770924\sqrt{D}$ (n=585,R^2=.9392)

	The general volume equation was also used for rest of species for Shimla, Rohru and Chopal disticts.		
540.	Udhampur, Jammu Kathua and Rajouri district (F.A.O. Project area)	L	$V = .04430-.84266D+6.362390D^2 +2/27556D^3$ (n=471. $R^2 = .96665$
541.	Uttar Pradesh and Himachal Pradesh.	G	$V = 0.013+0.296D^2H$
	BHUTAN		
542.	North Western parts. General Volume equation was also used in Southern parts.	G L L	$V/D^2H = 0.00211/D^2H+0.392382$ (n=148) $\sqrt{V} = -0.227181+3.498873D$ (n=1116) for $D > 0.79$ m. $\log_e V = 2.435867+2.436696 \log_e D$ for $D \leq 0.79$ m. (n=1116)
543.	Central and Eastern parts	L	$\sqrt{V} = 0.020144+4.292089D-0.894675 \sqrt{D}$ (n=1420)
543.a	Southern parts	L	$V = 0.20699-3.13612D+15.76557D^2 -1.95718D^3$ (n=426, R^2=.96625)

Rhododendron arboreum

General description of the species

It is a small evergreen tree, often with a somewhat crooked or gnarled trunk. Bark soft, easily cut through with a pocket knife. The tree occurs in the western Himalaya at 1500 -2400 m elevation.This species extends to the eastern Himalaya, where however, it is less common, it is also found in the Khasi hills and the hills of southern India. The tree stands a fair amout of shade, thrives best on moist loam and coppices well. The wood is of inferior quality, but is used both as timber and as fuel.

Volume equations developed

UTTAR PRADESH

544.	Alaknanda catchment- Major portion of district Chamoli and parts of Pauri Garhwal and Almora districts. Also in Nainital, Pithoragarh Dehra Dun and Tehri districts.	L	$V = 0.06007-0.21874 \sqrt{D}+3.63428D^2$ (n=546, R^2=.91132)

NEPAL

545.	Western parts	L	$V = -0.02861+2.3069\ D-0.23517D^2$

Rhododendron species

General description of the species

A genus of beatiful trees and shrubs, found in the Himalaya and the mountains which connect it with Burma and run down in to the Malay peninsula. One species only occurs in south India and Srilanka.

Volume equations developed

ARUNACHAL PRADESH

546.	Debang	L	$V = -0.08934+0.70730D+2.13941D^2$ (n=365, R^2=.95629)

BHUTAN

547.	Central and Eastern parts.	L	$\sqrt{V} = 0.306492+4.315360D-1.749908 \sqrt{D}$ (n=746)

Salmalia (Bombax) insignis

Volume equations developed

ANDAMAN AND NICOBAR ISLANDS

548. Little Andaman

G $V/D^2 = -0.000000084/D^2+0.0001964 +0.0000187\ H$ (dia.in cm) ($n=48$, $R^2=0.5283$)

L $V = -0.404+0.0126D+0.000669D^2$ (dia. in cm)

Sapium eugenifolium

General description of the species

Found as a glabrous tree of the Central and Eastern Himalaya from Kumaon (900-1200 m) to Sikkim, Assam and the Khasi hills. Wood is soft and spongy.

Volume equation developed

ARUNACHAL PRADESH

549. Debang

L $V = -0.06440+0.48094\ D+4.61818D^2$ ($n=79$, $R^2=.98883$)

Saurinia nepalensis

General description of the species

Small tree or large shrubs, wood soft, spongy, branches ending in tufts of leaves among which are the flower panicles. It is found in outer Himalaya (800-2100 m) from the Yamuna eastward in Khasi hills, Manipur and Sikkim.

Volume equations developed

ARUNACHAL PRADESH

550. Debang

L $V = 0.03006-0.77786D+6.72270D^2 -4.87608D^3$ ($n=88$, $R^2=.97772$)

Schima khasiana

General description of the species

It is an evergreen tree, leaves strongly serrate, veins distinctly rectiulate between tertiary nerves. It occurs in the Khasi hills.

Volume equation developed

ASSAM

551.	Assam survey (15 districts)	L	$\sqrt{V} = 0.04671+4.35546D-0.99408\sqrt{D}$ ($n=94$, $R^2=.98970$)

Schima wallichii

General description of the species

It is a large handsome evergreen tree attaining a height of 24-30 m. This species occurs in the eastern Himalaya and sub-Himalayan tract from Nepal eastwards in Assam, Khasi hills and Manipur. It is often more or less gregarious. In the eastern Himalaya it ascends to about 1500 m elevation or slightly higher. In the Duars, it is common in places mixed with Sal on deep rich soil. In its natural habitat the absolute maximum shade temperature ordinarily varies from 32°C to 38°C the absolute minimum from -1°C to 4°C, and the normal rainfall from 137 to 500 cm. The tree is a moderate light demander, it coppices well. Wood is used for building and other purposes, but apt to warp and split.

Volume equations developed

ARUNACHAL PRADESH

552.	Tirap	L	$V = -0.01637+6.08487D^2$ ($n=31$, $R^2=.97952$)

ASSAM

553.	Assam survey (15 districts)	L	$V = 0.27609-3.68443D+15.86687D^2$ ($n=265$, $R^2=.98449$)

TRIPURA

554. Tripura survey — L — $\sqrt{V} = -0.11242+2.54133D$

BHUTAN

555. Southern parts — L — $\sqrt{V} = 0.28069+4.61980D-1.65381\sqrt{D}$ ($n=162$, $R^2=.9924$)

Schleichera trijuga

General description of the species

It is a large deciduous(nearly evergreen) tree with a fluted comparatively short trunk and a shady spreading crown. This species occurs in the sub-Himalayan tract from Sutlej to Nepal, Chota Nagpur, Central India and the peninsula generally, apparently absent from Assam. The tree is typical of mixed deciduous forests, often of a somewhat dry type. In general it thrives best on a light well drained gravelly or loamy soil. In its natural habitat the absolute maximum shade temperature varies from 38°-48°C, the absolute minimum from --1°C to 16°C and the normal rainfall from 75 cm to 250 cm or more. *Schleichera trijuga* is a shade-bearer and frost and drought hardy, it is subject to damage by grazing. It produces root-suckers freely and its pollarding and coppicing power is good. The wood is very hard, reddish brown,used for oil and sugar mills, rice pounders, agricultural implements, and other purposes. The fruit is edible and the seeds yield an oil of some value. One of the chief uses of the tree is for the propagation of lac, the quality of which is considered better than that produced on any other tree.

Volume equations developed

KARNATAKA

556. Chikmaglur, Hassan and Shimoga districts. The local volume equation was also used for *Tetrameles nudiflora* for Chikmaglur and Hassan districts. — L — $V = 0.010-0.912D+11.396D^2$

(F.A.O.Project area)

557.	Kerala and Tamil Nadu. The general volume equation was also used for *Tetrameles nudiflora* for Kerala and Tamil Nadu.	G	$V = 0.41+0.322D^2H$

Semecarpus anacardium

General description of the species

It is commonly called Marking Nut tree. It is a moderate sized deciduous tree with rough dark brown bark yielding an acrid juice. The tree has large ovate leaves and typical fruits, consisting of an oblique drupe,black when ripe, situated on fleshy orange coloured receptacle, the black pericarp contains a corrosive juice used as marking ink. The tree occurs in the sub-Himalayan tract chiefly in Sal forests in West Bengal, Assam, Chota Nagpur and throughout the greater part of the Indian peninsula and in Bangaladesh. The tree is a moderate shade bearer, a good coppicer and the seedlings are rather sensitive to frost.

Volume equation developed

ASSAM

558.	Assam survey (15 districts)	L	$\sqrt{V} = 1.67477+14.83747D-9.43386\sqrt{D}$ ($n=14$, $R^2=.97862$)

Shorea assamica

General description of the species

It is a very large tree with a long clean bole and rough brown bark. This species occurs in Upper Assam at the foot of the Naga hills in the Sibsagar and Lakhimpur districts in evergreen forests. In Assam, it occurs sporadically mixed with many other kinds of large trees, or occasionally it is found growing more or less gregariously in patches of varying extent. In its natural habitat the absolute maximum shade temperature is about 30°C to 39°C, the absolute

minimum about 4°C, and the normal rainfall varies between 200 cm - 400 cm. This species belongs to the hygrophilous type of Dipterocarps. The wood is light brown, handsome, open, grained, much softer than *Shorea robusta* and of good quality.

Volume equations developed

ARUNACHAL PRADESH

559.	Lohit	L	$\sqrt{V} = -0.24358+3.58273D$ ($n=22$, $R^2=.99631$)
560.	Tirap	L	$V = 0.46380-5.05368D+18.96318D^2$ ($n=67$, $R^2=.99045$)

Shorea robusta

General description of the species

It is a large gregarious tree attaining a height of 36 m with rounded crown and shining foliage, the mature leaves are somewhat coriaceous, and ovate-oblong.

This species occurs in two main regions separated by the Gangetic plain namely, the northern and the central Indian regions. The main and almost continuous stretch of sal forests in the northern region commences with the Kalesar forest in the Ambala District, on the right bank of the Yamuna, and stretches along the sub-Himalayan tract as far east as the Darrang district of Assam. In places the Sal extends some distance out into the plains, it also runs into the outer Himalayan valleys, and ascends the outer hills to 1200 m. South of the Brahmaputra river in Assam it is found in the Garo hills, Nowgong, Kamrup, and the Khasi and Jaintia hills. In the central Indian region the Sal commences near the Ganga in the Santhal Parganas and extends southwards through Chota Nagpur and Orissa. To the west there are considerable areas of Sal forest in Madhya Pradesh.

In its natural habitat, the absolute maximum shade temperature varies from about 34°C at high elevations to about 47°C in the hottest part of Chota Nagpur, and the absolute minimum varies from under -1°C to about 7°C while the normal rainfall varies from 100 to 450 cm. Sal forests occur both in hilly country and on flat ground. The Sal is found on a variety of geological formations. The most favourable soil for its growth is a well drained moist deep sandy loam with good subsoil drainage. Sal forests can be separated into two

extreme types, the dry and the moist types. The dry type is well represented in the central Indian region and the western part of the northern region. The moist type is seen in West Bengal and Assam, where the Sal is associated with various evergreen species. Intermediate types, may be found in many parts of the Uttar Pradesh and in Chota Nagpur.

Sal is light demander, good coppicer, wind firm, does not produce root-suckers and withstands frost better than many of its associates and is one of the most fire resistant of all the species of its regions. The sap wood is small, pale coloured, heartwood brown, hard, cross grained, very strong and durable, seasoning slowly. This is one of the most important timber trees of India, the wood is extensively used for building construction of all kinds, railway sleepers, wagons, and a large number of other purposes. The tree when tapped yields a whitish resin which is burnt as incense and used for caulking boats.

Volume equations developed

ASSAM

561. Assam survey (15 districts).
L $V = 0.16019 - 2.81861\ D + 16.19328\ D^2$ ($n=202$, $R^2=.98325$)

BIHAR

562. South West Bihar-Chapra Kodarma, Giridih, Munger, Shahabad, Gaya, Daltonganj Garhwa, Latehar, Hazaribagh and Ranchi Forest divisions. The local volume equation was also used for Singhbum district.
G $V = -0.004092 + 0.375132\ D^2\ H$
L $\sqrt{V} = -0.046597 + 2.227173\ D$

563. Ranchi district. These general and local volume equations were also used for Santhal Parganas and parts of Bhagalpur districts, besides for Purlia and Midnapur districts of West Bengal.
G $V/D^2H = 0.0041834/D^2H + 0.37802$ ($n=78$, $R^2=0.1678$)
L $V/D^2 = 0.022585/D^2 - 0.70158\ /D + 8.714$ ($n=504$, $R^2=0.5225$)

564. West Champaran District
The general volume equation was also used for Narayanpur catchment- (Bastar district) of M.P. and also for western parts of Nepal.

G $\log_e V = -1.85614 + 1.99578 \log_e D + 1.21786 \log_e H$ (n=195, R^2 =.9749)

L $V/D^2 = 0.1563/D^2 - 2.45104 /D + 11.90581$

HIMACHAL PRADESH

565. Rajgarh and Nahan- (Sirmour district.
The general volume equation was also used for Shivalik region of Punjab and Haryana (Ambala, Ropar, Hoshiarpur, Gurdaspur districts).

G $V = 0.118 + 0.257 D^2 H$

L $V/D^2 = 0.1919/D^2 - 2.7070 /D + 11.7563$ (for dia. ≥ 120 mm)

MADHYA PRADESH

566. Narayanpur catchment- Bastar district.

L $V = 0.17279 - 2.54241 D + 13.08048 D^2 - 3.49087 D^3$ (n=1354, R^2=.96238)

567. Rajnandgaon and Durg districts. The general volume equation was also used for Raipur district.

G $\log_e V = 0.506446 + 2.464189 \log_e D + 0.658978 \log_e H$ (n=36, R^2=.99404)

L $\sqrt{V} = 0.30205 + 5.63243 D - 2.25440 \sqrt{D}$ (n=1446, R^2=.98847)

568. Raigarh district.

L $V = 0.05823 - 1.22994 D + 10.51982 D^2$ (n=889, R^2=.94356)

569. Bilaspur district.

L $V = 0.10715 - 1.82058D + 11.91792D^2 + 0.49058D^3$ (n=1306, R^2=.95471)

570. Raipur district.

L $V = 0.48104 - 6.28923D + 24.48398D^2 - 9.20515D^3$ (n=626, R^2=.98394)

571. Balaghat Mandla-Seoni districts. The general volume equation was also used for Lansdowne Forest

G $V/D^2H = 0.006094/D^2H + 0.43047 + 0.00249 D^2H$ (n=98)

L $V = 0.32542 - 1.27173\sqrt{D} + 11.74767D^2$ (n=1070, R^2=0.9648)

division and parts of Yamuna, Tehri and Garhwal Forest division (Balance area of Tehri and Garhwal circle).

MEGHALAYA

572. The general volume and local equations were also used for *Tectona grandis.*

G $V = -2.2086+0.12879\ H +0.0000247D^2H$ $(n=43, R^2=0.9216)$

L $V = -0.27862+0.0010882D^2$ $(n=55, R^2=0.9216)$

ORISSA

573. Phulbani catchment (Phulbani and Ganjam and Kalahandi districts). The general volume equation was also used for Tarai region of Uttar Pradesh.

G $\log_e V = -0.595479+2.181665 \log_e D +0.877344 \log_e H$

L $V/D = 0.109884/D-1.804754 + 10.297714D$ $(n=1545, R^2=.9405)$

574. Koraput district. The local volume equation was also used for Sambalpur, Mayurbhanj and Balasore districts.

G $V/D^2H = -0.001775/D^2H+0.338574$ $(n=77, R^2=.056025)$

L $\sqrt{V} = 0.19994+4.57179D-1.56823\ \sqrt{D}$ $(n=599, R^2=.97384)$

TRIPURA

575. Tripura survey.

L $\sqrt{V} = -0.22388+3.29474D$

UTTAR PRADESH

576. Tarai region-Saharanpur Bijnor, Moradabad, Rampur, Bareilly, Pilibhit, Kheri, Bahraich, Gonda, Basti, Gorakhpur and Deoria districts.

L $\sqrt{V} = 0.16306+4.8991D-1.57402\ \sqrt{D}$ $(n=1045, R^2=.9884)$

577. Southern U.P.- Agra, Etawah, Jalaun, Jhansi,

L $V = -0.17763+0.54602\ \sqrt{D}+3.62682D^2$ $(n=128, R^2=.8954)$

	Lalitpur, Hamirpur, Banda, Allahabad, Mirzapur and Varanasi districts. The general volume equation was also used for rest of species for this area and also for Balaghat, Seoni, Mandla, Rajgarh, Bilaspur and Raipur districts of M.P.		
578.	Lansdowne Forest division and part of Yamuna, Tehri and Garhwal Forest disivions. Local volume equation was also used for Hill region-Almora, Nainital, Pithoragarh and part of Chamoli, Dehra Dun and Tehri districts.	L	$V = 0.03085-0.77794\ D+8.42051D^2 + 5.91067D^3$ ($n=710$, $R^2=.96135$)
	WEST BENGAL		
579.	Bankura district.	G	$V/D^2H = -0.0040134/D^2H+0.36701$
		L	$V/D^2 = 0.00389/D^2-0.27516\ /D+6.90733$
580.	Darjeeling and Kalimpong divisions.	G	$V/D^2 = -0.0331556/D^2+0.02924\ H +8.7781$ ($n=49$, $R^2=0.7011$)
		L	$V/D^2 = -0.32546/D^2+9.78645$ ($R^2=0.9618$)
	(F.A.O. Project area)		
581.	Madhya Pradesh, Andhra Pradesh, Orissa, Himachal Pradesh, U.P. and Haryana.	L	$V = 0.148-1.025D+8.380D^2$
	NEPAL		
582.	Western parts	L	$V = 0.15215+3.54561D-1.13708D^2$

Sideroxylon longepetiolatum

General description of the species

It is an evergreen tree, occurs in Andaman forests.

Volume equations developed

ANDAMAN AND NICOBAR ISLANDS

583.	Little Andaman	G	$V/D^2H = 0.11295/D^2H+0.0000264$ (dia. in cm) ($n=40$, $R^2=0.1452$)
		L	$V/D^2 = -0.03189/D^2+0.005964\ /D +0.0005834$ (dia in cm) ($n=38$, $R^2=0.7074$)
584.	North Andaman	L	$V/D^2 = 0.001098-0.00001344\ D + 0.000000019D^2$ (dia. in cm) ($n=5$, $R^2=0.6486$)

Spondias pinnata

General description of the species

It is a deciduous tree with smooth grey bark, every part of which has a characteristic aromatic smell. Leaves are alternate and imparipinnate. This species is fairly common in Uttar Pradesh, Western Ghats and Assam. The tree can be most easily propagated by cuttings. The wood is soft, light grey, with large pores. The fruit is eaten when ripe, or pickled or made into curries when green and tender.

Volume equation developed

ASSAM

585.	Assam survey (15 districts)	L	$\sqrt{V} = 0.49487+6.18662D-2.95076\ \sqrt{D}$ ($n=25$, $R^2=.97310$)

Sterculia villosa

General description of the species

It is a large deciduous tree with grey or brown bark covered with corky nodules and branches showing large leaf-scars. The species is common in deciduous forests throughout India. A light sandy soil is most favourable for the establishment of seedlings. The tree is a good coppicer. The bast yields a strong fibre which is much used for rough cordage. The cortex yields a white gum.

Volume equations developed

ASSAM

586.	Assam survey (15 districts).	L V	= 0.27909-3.26515D+13.46829D^2 (n=78, R^2=.99032)

BHUTAN

587.	Central and Eastern parts. The general volume equation was also used for Southern parts of Bhutan.	G V/D^2H=	0.00231/D^2H+0.34018 (n=75, R^2=.0052)
588.	Southern parts. The local volume equation was also used for Gedu and Changekha area of Western Bhutan.	L $\sqrt{V}$	= 0.35895+4.99513D-2.14135 $\sqrt{D}$ (n=114, R^2=.97182)

Stereospermum personatum

General description of the species

It is a large deciduous straight-stemmed tree, in unfavourable situations a small tree. This species occurs in sub-Himalayan tract from Uttar Pradesh eastwards to Assam, common upto 600 m elevation in the eastern Himalaya and in Bangladesh, in mixed deciduous forests, ascending

to 1200 m in the Shan hills. In the Indian peninsula it is found chiefly on the western side, rare in Chota Nagpur and Orissa, fairly common in valleys in the Madhya Pradesh also in moist forests of the Konkan. In its natural habitat the absolute maximum shade temperature varies from under 38°C to 46°C, the absolute minimum from 2°C to over 15°C and the normal rainfall from 100 to 375 cm. The tree is a good coppicer and produces root-suckers freely. The wood is hard, grey,used for building, furniture, tea-boxes, canoes, etc.

Volume equations developed :

ARUNACHAL PRADESH

589. Lohit — L — $\sqrt{V} = -0.24440+3.26068\sqrt{D}$ ($n=30$, $R^2=.96201$)

ASSAM

590. Assam Survey (15 districts). — L — $V = 1.38791-12.52739D+30.51466D^2-9.65242D^3$ ($n=122$, $R^2=.96201$)

Stereospermum suaveolens

General description of the species

It is a large deciduous tree. Dark grey, exfoliating in large flat scales. Wood hard with a small yellowish brown handsomely mottled heartwood. This species occurs throughout the greater part of India in mixed deciduous and Sal forests. It is common in the sub-Himalayan tract, ascending the outer hills to 1200 m, but is rare west of the Yamuna. It occurs also in Rajasthan, Chota Nagpur, Madhya Pradesh and in many other parts of the Indian peninsula, chiefly in valleys on plateau and plains. It becomes gregarious on clayey ground. In the Siwalik hills, it is characteristic of the dry upper slopes and ridges.

The tree is a moderate light demander, frost hardy and produces root-suckers. It resists fire well. It is not readily browsed by cattle or goats.

Volume equation developed

ASSAM

591. Assam survey (15 districts) — L — $\sqrt{V} = 0.49746+5.98454D-2.84986\sqrt{D}$ ($n=27$, $R^2=.99158$)

Symplocos spicata

General description of the species

A small evergreen tree. Bark is light grey, thin, smooth. Wood is white, soft and even-grained. Annual rings marked by few pores in the autumn wood. It occurs throughout the greater part of India in the hilly country in evergreen forests, ravines and Sholas, in Himalaya from Kumaon to Assam, ascending to 1500 m; Assam, Khasi hills, Cachar, Western Ghats from the Konkan southwards, very common in the Nilgiris Sholas above 900 m and in Bangladesh and Bhutan.

Volume equations developed

BHUTAN

592.	Central and Eastern parts. General Volume equation was also used for Southern parts.	G	$V = 0.00155+0.34028D^2H$ ($n=69$, $R^2=.977$)
		L	$\sqrt{V} = -0.212798+3.288996\ D +0.046417\ \sqrt{D}$ ($n=84$)
593.	Southern parts. The local volume equation was also used for Gedu and Changekha areas of Western Bhutan.	L	$\sqrt{V} = -0.2433 +2.44627\ D +0.48232\ \sqrt{D}$ ($n=131$, $R^2=.97479$)

Symplocos theaefolia

General description of the species

It is a middle sized tree with glabrous leaves. It occurs in Kumaon, Nepal, Sikkim, Assam, Khasi hills at an elevation from 1500 -3000 m. Leaves serve the purpose of an axilliary in dyeing. The wood is used for making rough house posts and as a fuel.

Volume equations developed

SIKKIM

594.	Southern Western parts	G	$V = -0.005398+0.0000718D^2 +0.00003255D^2H$ (dia. in cm) ($n=18$, $R^2=0.7185$)

	L	$V = -0.03754+0.000587D^2$ (dia. in cm) ($n=190$, $R^2=0.9592$)

Syzygium cumini

General description of the species

A tall evergreen tree found in moist ground, waste lands, along river banks, Nala banks and valleys. There are three varities according to the size of the fruit. It has a fairly wide distribution and the wood is particularly useful for underwater conditions.

Volume equations developed

ARUNACHAL PRADESH

595.	Tirap	L	$V = -0.00094+6.15921D^2$ ($n=30$, $R^2=.98201$)

ASSAM

596.	Assam survey (15 districts).	L	$\sqrt{V} = -0.05923 +2.33654\ D$ ($n=104$, $R^2=.92740$)

BIHAR

597.	Ranchi district. The general and local volume equations were also used for Singhbhum, Santhal Pargana and parts of Bhagalpur districts of Bihar and Purulia district of West Bengal.	G	$V/D^2H = 0.0077689/D^2H-0.001154/D^2 +0.375$ ($n=47$, $R^2=0.9179$)
		L	$V/D^2 = 0.016042/D^2-0.49647\ /D+6.2214$ ($n=25$, $R^2=0.5301$)

ORISSA

598.	Phulbani catchment (Phulbani, Ganjam and Kalahandi districts).	G	$V = -0.002043+0.361337D^2H$
		L	$\log_e V = 2.132776+2.479397 \log_e D$ ($n=221$, $R^2=.97$)

599. Koraput district.	G	$\log_e V$ =	0.842866+2.412125 $\log_e D$ +0.521065 $\log_e H$ (n=41, R^2=.98654)
	L	$\sqrt{V}$ =	0.30706+5.12731D-2.09870 $\sqrt{D}$ (n=85, R^2=.99384)
UTTAR PRADESH			
600. Tarai region-Saharanpur, Bijnore, Moradabad, Bareilly, Pilibhit, Kheri, Bahraich, Gonda, Basti, Gorakhpur and Deoria districts.	L	V =	0.08481-1.81774 D+12.63047 D^2 -6.69555D^3 (n=305, R^2=.915)
601. Hill region - Almora, Nainital, Pithoragarh and part of Chamoli district, Dehra Dun, Garhwal and Tehri districts.	L	V/D^2 =	0.09809/D^2-1.94468 /D+13.36728 - 6.33263D (n=171, R^2=.6452)

Syzygium species

Volume equation developed

ASSAM			
602. Assam survey (15 districts).	L	V =	-0.13284+1.88944 D-4.96385 D^2 +21.41051D^3 (n=78, R^2=.93485)

Taxus baccata

General description of the species

It is commonly called Yew. It is an evergreen shrub or tree, sometimes attaining large dimensions in the Himalaya, usually much branched, with spreading branches and dense foliage. This species is widely distributed throughout the northern hemisphere. In India it is indigeneous to the Himalaya

at 1800-3300 m elevation, but chiefly above 2100 m the Khasi hills. It is particularly common in the forests of Hazara, where it reaches a large size. It is found as a rule in moist, shady places, often as an underwood to broad leaved species or other conifers. The Yew is a pronounced shade bearer. The wood is hard, close and even grained, requiring long seasoning.

Volume equation developed

HIMACHAL PRADESH

603.	Kulu, Seraj and Kotgarh (Kulu and Shimla districts).	L	$V = 0.487126+3.698924D-1.856459\sqrt{D}$ ($n=102$, $R^2=.9567$)

Tectona grandis

General description of the species

It is commonly called Teak. It is a large deciduous tree with a rounded crown, and under favourable conditions, a tall clean cylindrical bole. The heartwood is dark golden yellow, turning brown with age, oily, with a characteristic odour extremely durable, seasons well, and does not warp or split. Teak is indigenous throughout the greater part of the Indian peninsula. In the peninsula the northern limit of teak is in the western Aravallis in Rajasthan thence eastward through Central India to the Jhansi district, entering the Banda district thence in a south easterly direction to the Mahanadi river. From the northern limit it extends southward to Tirunelveli and Travancore. In the Indian peninsula, it is by no means continuous within the limits mentioned, but is confined to tracts of greater or less extent separated by other tracts where it is absent or of very local occurence. Teak has been planted in many localities outside its natural region.

Teak thrives best and reaches its largest dimensions in a fairly moist, warm, tropical climate. It thrives best with a normal rainfall varying from 125-375 cm. In the Indian peninsula it experiences in places absolute maximum shade temperatures upto about 48°C, and absolute minimum shade temperatures down to about 2°C, but these extremes denote a drier climate than is favourable to its development. In the moist parts of the West Coast, where it reaches larger dimensions than in the drier parts of its Indian peninsular region, the climate is much more equable, the absolute maximum shade temperature varying from 30°C - 38°C, and the absolute minimum from 13°C - 17°C. Teak sometimes occurs remarkably pure, and attains large dimensions on well

drained deep alluvial soil, but along dry ridges and on shallow soil, it becomes stunted. It requires good subsoil drainage and occurs on a variety of geological formations.

Teak is a pronounced light demander, is sensitive to frost and drought, coppices and pollards vigorously, has greater power of resisting the effect of fire than the majority of its associates. It is not readily browsed.

Teak is the most important timber tree of India. It is extensively used for ship building, house building, bridge and wharf construction, piles, furniture and cabinet work, railway carriages and wagons, carving, ordinance work, wheel spokes and felloes, general carpentry, and numerous other purposes.

Volume equations developed

ANDHRA PRADESH

604. Mehboobnagar Forest division.

G $V = 0.003027+0.295446D^2H$

L $V = -0.085926+5.640754D^2$ ($n=51$, $R^2=.96$)

605. Adilabad district.

G $V = 0.01103+0.31458D^2H$

L $V = 0.023613-0.531006\ D+6.731036D^2$ ($n=1445$, $R^2=.9403$)

ASSAM

606. Assam survey (15 districts).

L $V = 0.19112-3.25372\ D+17.9194\ D^2-1.66117\ D^3$ ($n=133$, $R^2=.99588$)

GUJARAT

607. Surat circle- Dangs Surat, Valsad and Bharuch districts. The general and local volume equations were also used for Mewasi Forest division, Nasik, Thane and Raigarh districts of Maharashtra. The local volume equation was also used for Khargone, Khandwa, Dewas, Jhabua, Indore and Dhar districts of M.P.

G $V = -0.013110+0.360062\ D^2H-0.003649\ (D^2H)^2$ ($n=94$, $R^2=.9836$)

L $\sqrt{V} = -0.405890+1.98158\ D+0.987373\ \sqrt{D}$ ($n=925$)

KARNATAKA

608.	Chickmaglur, Hassan and Shimoga districts.	L	$V = 0.086+5.641D^2$
609.	Kodagu district	G	$V = -0.001384+0.363126D^2H$
		L	$V = -0.27773+3.10419D-6.12739D^2 +15.16993D^3$

MADHYA PRADESH

610.	Balaghat, Seoni and Mandla districts. The general volume equation was also used for Tarai region of Uttar Pradesh.	G	$V = 0.00600+2.661999D^2+0.280538D^2H$ (n=146)
		L	$V = 0.04346-0.26352\ \sqrt{D}+8.79334D^2$ (n=817, R^2=.97332)
611.	Rajnandgaon and Durg districts. The general volume equation was also used for Raipur district.	G	$V = 0.005011+0.355606D^2H$ (n=29, R^2=.982936)
		L	$V/D^2 = 0.045181/D^2-0.91863\ /D+8.18261 + 1.95661D$ (n=621, R^2=.76031)
612.	Bilaspur districts	L	$V = -0.01682+5.39426D^2$ (n=20, R^2=.97341)
613.	Raipur district	L	$V/D^2 = 0.12591/D^2-2.45212\ /D +16.52336 -7.57135\ D$ (n=124, R^2=.85328)

MAHARASHTRA

614.	Ballarshah catchment-(Chandrapur)	G	$\log_e V = -0.895849+2.048538\ \log_e D +0.945216\ \log_e H$ (n=59, R^2=.977)
		L	$V/D^2 = 0.074892/D^2-1.406473/D+10.1161$ (n=186, R^2=.8239)
615.	Sondad catchment Bhandara district. The general volume equation was also used for Wadsa catchment (Chandrapur)	G	$V/D^2H = -0.0023/D^2H+0.30446$ for $D^2H \leq 1.5$ (n=37, R^2=.009)
		G	$V = 0.08758+0.24432D^2H$ for $D^2H > 1.5$ (n=37, R^2=.956)
		L	$V = -0.003673-0.379175D+6.368282D^2$ (n=58, R^2=.9858)

616.	Wadsa catchment (Chandrapur)	L	$\sqrt{V}$ = -0.106720+2.562418D (n=30, R^2=.9768)
617.	Melghat Forest division	G	V/D^2H= -0.001384/D^2H+0.363126 (n=302, R^2=.0548)
		L	V = 0.032011-0.995414 D+9.911290D^2 (n=301, R^2=.7601)
	RAJASTHAN		
618.	Udaipur Forest division. The general volume equation was also used for Southern and Eastern Rajasthan. The local volume equation was also used for Indore catchment - Mandsour, Ratlam, Ujjain, Shajapur and Raigarh districts of Madhya Pradesh.	G	V = 0.008690+0.323051D^2H (n=94, R^2=.9123)
		L	V = 0.062108-0.927983D+ 6.613031D^2
619.	Southern and Eastern Rajasthan.	L	V = -0.01066+0.18542D+1.9554D^2 (n=223, R^2 =.90484)
	UTTAR PRADESH		
620.	Tarai Region-Saharanpur, Bijnore, Moradabad, Rampur, Bareilly, Pilibhit, Kheri, Bahraich, Gonda, Basti, Gorakhpur and Deoria districts. The general volume equation was also used for Balaghat. Seoni Mandla and Bilaspur districts of M.P.	L	V = 0.08847-1.46936D+11.98979 D^2 +1.970560D^3 (n=275, R^2 = 0.9958)
	WEST BENGAL		
621.	Darjeeling and Kalimpong divisions.	G	V/D^2H = 0.00176/D^2H+0.22875 (n=53, R^2=0.0045)

		L	$V/D = 0.00341/D-0.65623+7.881D$ ($n=34$, $R^2=0.9533$)
	(F.A.O. Project area)		
622.	Part of Andhra Pradesh, and Madhya Pradesh, The local volume equation was also used for Kerala, Orissa, Tamil Nadu, and Orissa.	L	$V = -1.123+6.532D-2.536D^2$

Terminalia belerica

General description of the species

It is a large deciduous tree attaining a height of 37 m often buttressed at the base. The species is found in deciduous forests throughout the greater part of India. It is a common associate of Sal, Teak, and other important trees, occuring more or less scattered. In its natural habitat the absolute maximum shade temperature varies from 36°C - 46°C, the absolute minimum from -1°C to 16°C and the normal rainfall from 102 cm to 305 cm. The tree is a light demander, frost sensitive, drought hardy, and a good coppicer. The tree is yellowish grey, hard, not durable, but lasts fairly well under water, and is used for planking, packing cases, boats, and other purposes. The fruits are used for tanning.

Volume equations developed

ARUNACHAL PRADESH

623.	Tirap	L	$\sqrt{V} = -0.14325+3.07937D$ ($n=98$, $R^2=.99051$)
	ASSAM		
624.	Assam survey (15 districts)	L	$V = 0.26454-3.05249D+12.35740D^2$ ($n=124$, $R^2=.96927$)
	GOA		
625.	Goa survey	L	$\sqrt{V} = -0.0233308 +2.803750 D$ (total volume OB for dia >20 cm)
		L	$\sqrt{V} = -0.23519+2.672250D$ (Total volume OB for dia >5 cm)

GUJARAT

626. Surat Circle - Dangs, Surat, Valsad and Bharuch districts. The local volume equation was also used for Dadra and Nagar Haveli, Mewasi Forest division, Dhulia, Nasik, Thane and Raigarh districts of Maharashtra and Khargone,Khandwa, Dewas, Jhabua, Indore and Dhar districts of M.P.

G $V = -0.005564+0.365874D^2H$ (n=66, R^2=.9593)

L $V = 0.074706-1.430082\ D +10.181971D^2$ (n=107, R^2=.97959)

MADHYA PRADESH

627. Balagaht, Seoni and Mandla districts

G $V = -0.042473+6.996762\ D^2 +0.137468D^2H$ (n=125)

L $\sqrt{V} = -0.14017+3.36423D$ (n=125, R^2=.957)

628. Rajnandgaon and Durg districts

G $V/D^2H = 0.009254/D^2H+0.388757 +0.002718(D^2H)$ (n=18, R^2=.278278)

L $\sqrt{V} = -0.15683+3.01055D$ (n=46, R^2=.96798)

ORISSA

629. Phulbani catchment (Phulbani, Ganjam and Kalahandi districts).

G $V/D^2H = 0.000342/D^2H+0.339402$

L $V/D = 0.103171/D -1.684599 +10.107586\ D$ (n=575, R^2=.9178)

630. Koraput district. The local volume equation was also used for Sambalpur, Mayurbhanj and Balasore districts.

G $V = -0.093639+7.384277D^2 +0.070648D^2H$ (n=31, R^2=.990142)

L $V = -0.14823 +2.44138\ D-6.86434\ D^2 +18.05444\ D^3$ (n=40, R^2=.96163)

TRIPURA

631. Tripura survey — L — $\sqrt{V} = -0.00598+2.28626D$

Terminalia bialata

General description of the species

It is a large deciduous tree of Andamans, attaining a height of 30 m. In the Andamans it is one of the chief species in the semi-deciduous forests. It also occurs sometimes in the evergreen forests. The wood of this tree is strong, elastic, straight, grained and of good quality and forms an important timber.

Volume equations developed

ANDAMAN AND NICOBAR ISLANDS

632. Little Andaman. The general volume equation was also used in North Andaman.

G — $V/D^2H = 0.1597/D^2H+0.0000249$ (dia. in cm) ($n=36$, $R^2=0.2035$)

L — $V = 0.62603-0.04926D+0.001733D^2$ (dia. in cm) ($n=28$, $R^2=0.2402$)

633. North Andaman — L — $V/D = 0.014256+0.00017769\ D+0.0000069D^2$ (dia. in cm) ($n=24$, $R^2=0.8625$)

Terminalia chebula

General description of the species

It is a moderate sized to large deciduous tree with a rounded crown spreading branches, and usually a short trunk. This species occurs throughout the greater part of India, in mixed deciduous forests, extending into forests of comparatively dry types. It ascends to elevations, upto 1500 m in the outer Himalaya, upto 1800 m in Kerala in localities where the rainfall is light. It is found on variety of geological formations, and on clayey as well as on sandy soil.

In its natural habitat the absolute maximum shade temperature varies from 36°C - 48°C, the absolute minimum from -1°C to 15°C, and the normal rainfall from 75 -325 cm. The tree is a light demander, it is fairly frost and drought hardy. It withstands fire well and is a good coppicer.

The wood is very hard, fairly durable, used for building, agricultural implements, and other purposes. The tree is important because of its fruits, which are the best of the commercial mayrabalans used for tanning.

Volume equations developed

MADHYA PRADESH

634. Narayanpur catchment Bastar district

G $V/D^2H = -0.00652/D^2H+0.41369$ (n=34, R^2=.0209)

L $V = -0.05004-0.03440D+6.35715D^2$ (n=180, R^2=.953059)

Terminalia citrana

General description of the species

A large deciduous tree. Bark light grey, exfoliating with few large flakes, wood grey, with an irregular dark heart-wood of small size, not always present. It is found in the Eastern Himalaya in the lower hills from Nepal to Assam; Andamans and Bangladesh.This tree greatly resembles *T. chebula*. The fruit is also used similarly. The wood is used for planking and general building purposes in Assam.

Volume equation developed

ARUNACHAL PRADESH

635. Lohit

L $\sqrt{V} = -0.05527+2.59229D$ (n=19, R^2=.98954)

Terminalia tomentosa

General description of species

It is commonly called Laurel. *Terminalia tomentosa* is a large, deciduous

tree with a long clean bole, spreading branches and heavy crown, attaining a height of 30-36m. It has a very thick dark-coloured bark, deeply cracked longitudinally, resembling very much the back of a crocodile. This species occurs from Kangra (H.P.) in the west to Goalpara (Assam) in the east and southwards throughout the peninsula from sea level upto 1200 m. The tree attains its largest dimensions on deep, rich alluvial soil. In its natural habitat, the absolute maximum shade temperature varies from 35°C - 48°C and the absolute minimum from 0°C to 18°C and the rainfall ranges from 130 cm to 250 cm. It is a common associate of Sal and teak in their respective zones. Laurel is a light demander, drought tender, frost resistant, good coppicer and tolerant of waterlogging. It is fairly tolerant to damage by fire and is readily browsed by animals, especially deer. The timber of Laurel is used for building and contruction works, for making furniture, oil mills, electric casing, rough carpentry, railway wagon, floor boards and doors. It is also used for agricultural implements and for veneers and plywood. Bark is used for tanning.

Volume equations developed

ANDHRA PRADESH

636.	Adilabad district	G	$V = 0.00785+0.33165D^2H$
		L	$V = 0.051812-1.076790\ D+7.991280\ D^2$ ($n=241$, $R^2=.9445$)
637.	Mehboobnagar Forest division.	L	$V = 0.012763+9.281920D^3$ ($n=179$, $R^2=.86$)

BIHAR

638.	Ranchi district. The general volume equation was also used for Purulia, Bankura and Midnapur districts of West Bengal.	G	$V/D^2H = -0.002149/D^2H+0.42823$ ($n=60$, $R^2=0.0168$)

639. West Champaran district. The general volume equation was also used for Narayanpur catchment Bastar district, M.P. and for Western parts of Nepal.

G $V = 0.00962+0.28661D^2H$

L $V/D^2 = 0.08565/D^2-1.51685/D+10.24871$

GUJARAT

640. Surat Circle-Dangs Surat, Valsad and Bharuch districts. The local volume equation was also used for Dadra and Nagar Haveli, Mewasi Forest division, Dhulia, Nasik, Thane and Raigarh districts of Maharashtra and for Southern U.P. The local volume equation was also used for Khrgone, Khandwa, Dewas, Jhabua, Indore and Dhar districts of M.P.

G $V/D^2H = -0.004409/D^2H+0.348579$
$-0.001412\ D^2H$
$(n=80, R^2=.12627)$

L $\sqrt{V} = -0.203947+3.159215D$
$(n=215, R^2=.97596)$

KARNATAKA

641. Kodagu district

L $V = 0.06517-0.21738D+3.96894D^2$
$+4.63954D^3$

MADHYA PRADESH

642. Narayanpur catchment-Bastar district

G $V/D^2H = 0.00962/D^2H+0.28661$
$(n=138, R^2=.1032)$

L $V = 0.12646-1.57183D+8.35611D^2$
$(n=942, R^2=.9749)$

643. Rajnandgaon and Durg districts. The general volume equation was also used for Raipur district.

G $V/D^2H = -0.00684/D^2H+0.369361$
$(n=30, R^2=.352926)$

L $V = 0.07851-1.59610\ D+11.33106\ D^2$
$+2.39723D^3$
$(n=1382, R^2=.95704)$

644.	Balaghat, Seoni and Mandla districts. The general volume equation was also used for Raigarh and Bilaspur districts.	G	$V = 0.028856+0.462852D^2H$ (n=170)
		L	$V = 0.33695-1.23004\sqrt{D} +11.86676D^2$ (n=998, R^2=.95634)
645.	Raigarh district	L	$V/D^2 = 0.17367/D^2-2.9171/D +19.940708-16.01855\ D$ (n=205, R^2=.36006)
646.	Bilaspur district	L	$V/D^2 = 0.01149/D^2+0.01899\ /D+4.09643 + 11.077995\ D$ (n=451, R^2=.48955)
647.	Raipur district	L	$V = 0.00376-0.77604D+8.35533D^2$ (n=458, R^2=.97007)
	MAHARASHTRA		
648.	Ballarshah catchment (Chandrapur)	G	$V = -0.003885+0.313861D^2H$ (n=120, R^2=.036)
		L	$\log_e V = 2.343936+2.616301 \log_e D$ (n=477) (for dia ≥ 38 cm)
		L	$V/D^2 = 0.048532/D^2-1.05615\ /D+8.204564$ (for dia. < 38 cm)
649.	Sondad catchment - Bhandara district The general volume equation was also used for Wadsa catchment (Chandrapur)	G	$V = -0.00012+0.29302D^2H$ (n=41, R^2=.9782)
		L	$V/D = 0.08383/D-1.610568 +10.522\ D -3.72837\ D^2$ (n=224, R^2=.9062)
650.	Wadsa catchment - (Chandrapur)	L	$V/D = 0.011283/D-0.39734 +4.7047\ D+2.36964\ D^2$ (n=226, R^2=.9114)
651.	Melghat Forest division	G	$V = -0.001546+0.377718D^2H$ (n=109, R^2=.0324)
		L	$V = 0.060344-1.569539D+ 12.090296D^2$ (n=109, R^2=.7572)

ORISSA

652. Koraput district. The local volume equation was also used for Sambalpur, Mayurbhanj and Balasore districts.

G $V/D^2H = 0.001254/D^2H+0.361631 + 0.001864\ D^2H$ (n=98, R^2=.11191)

L $V = 0.05061-1.11994D+8.77839D^2$ (n=289, R^2=.97943)

UTTAR PRADESH

653. Tarai Region - Saharanpur, Bijnore, Moradabad, Rampur, Bareilly, Pilibhit, Kheri, Bahraich, Gonda, Basti, Gorakhpur and Deoria districts.

L $V/D^2 = 0.18149/D^2-2.85865\ /D+18.60799$ (n=76, R^2=.7628)

654. Lansdowne forest division, (parts of Yamuna catchment).

L $V/D^2 = 0.08658/D^2-2.04096\ /D +13.28405 -3.58047D$ (n=88, R^2=.8251)

655. Hill Region. The local volume equation was also used for rest of species for the area,

L $V = 0.3845-3.45596D+10.98759D^2$

656. Southern U.P.- Agra, Etawah, Jalaun, Jhansi, Lalitpur, Hamirpur, Banda, and Allahabad districts

L $\sqrt{V} = 0.41071+5.51319D-2.59952\sqrt{D}$ (n=77, R^2=.96188)

WEST BENGAL

657. Purulia, Bankura and Midnapur districts.

L $V/D^2 = 0.022389/D^2-0.84158\ /D+9.4721$

(F.A.O. Project area)

658. Part of Andhra Pradesh, Madhya Pradesh,

G $V = -0.042+0.290D^2H$

L $V = -0.033-0.526D+6.396D^2$

Uttar Pradesh,
Kerala, Orissa
and Tamilnadu.

659. G-14 (65) sheet
Special survey — G — $V = 0.23+0.306D^2H$

NEPAL

660. Western parts — L — $\log_e V = 1.93554+2.34815 \log_e D$

Terminalia myriocarpa

General description of the species

It is a very large evergreen tree with pendulous branches. Bark greyish brown rough, exfoliating in vertical flakes. This species occurs in Eastern Himalaya from Nepal eastwards,in valleys and lower hills upto 1500 m elevation in Assam. It is very plentiful in some localities, often coming up in gregarious patches on newly exposed ground, forming pure even-aged groups underneath which evergreen species appear. *Terminalia myriocarpa* is a tree of moist situations and rich soils, and in Assam is often found associated with *Bischoffia javanica.* In its natural habitat the absolute maximum shade temperature varies from 32°C to 39°C, the absolute minimum from 2°C to 7°C and the normal rainfall from 200 -500 cm or possibly more. The tree is a shade bearer and is exacting as regards moisture. It does not produce root-suckers. The wood is dark brown, hard, used for house building, canoes, furniture, and other purposes.

Volume equations developed

ARUNACHAL PRADESH

661. East and West Kameng districts. The general and local volume equation were also used for Lower and Upper Subansiri districts.

G — $V = -0.04433+9.0475D^2 +0.04031D^2H$ ($n=35$, $R^2=0.9820$)

L — $V = -0.096981+0.001065D^2$ (dia in cm) ($n=51$, $R^2=0.9662$)

662.	Upper Subansiri.	G	$V = -0.04433+0.00090475D^2 +0.000004031D^2H$ (dia in cm)
	ASSAM		
663.	Assam survey (15 districts)	L	$\sqrt{V} = 0.30858+4.35664D-1.64694\sqrt{D}$ ($n=39$, $R^2=.99013$)
	BHUTAN		
664.	Central and Eastern parts.	G	$V = 0.00635+0.35936D^2H$ ($n=59$, $R^2=.966$)
665.	Southern parts.	L	$\log_e V = 2.52144+2.31085 \log_e D$ ($n=65$, $R^2=.9894$)

Terminalia paniculata

General description of the species

It is a large to very large deciduous tree. Bark thick, dark brown, rough, with numerous shallow longitudinal and transverse fissures. The lower part of the bole is often much fluted. This species occurs in the western regions of the Indian peninsula from Maharashtra southwards, and in southern India. It is one of the commonest trees of the North Kanara mixed deciduous forests. It extends southwards through South Kanara and Malabar to Kerala, and occurs in the Nilgiris, Anamalais, and other hill ranges of southern India. It attains its largest dimensions in the deciduous forests of the Western Ghats. It is also found throughout the eastern forests, but here it reaches smaller dimensions. Throughout its region it is often the most plentiful species of the mixed forests. The tree is found in valleys and on lower slopes, preferring fairly moist situations. It requires a well drained soil. In its natural habitat the absolute maximum shade temperature varies from 35°C - 39°C, the absolute minimum from 13°C to 18°C and the normal rainfall from 100 cm to 450 cm. The tree is a light demander and a good coppicer. The heartwood is light brown, very hard, wood is used chiefly for planking, agricultural implements, and canoes, but not quite so much in demand as that of *T. tomentosa.* The bark contains much tannin.

Volume equations developed

KARNATAKA

666.	Kodagu district	L	$V = 0.13100-1.87132D+9.47861D^2$

GOA

667.	Goa survey	L	$\sqrt{V} = -0.351539+3.215392D$ (UB upto 20 cm dia.)
		L	$\sqrt{V} = -0.199035+3.21011D$ (OB upto 5 cm dia.).

Terminalia procera

General description of the species

It is commonly called Indian Almond. It is a large handsome deciduous tree with whorled branches and large glabrous leaves. Bark smooth, grey, stem often buttressed. This species is a native of the Andamans. In the Andamans it occurs in the littoral forests on raised beaches and deposits of sea-sand above high tide. It also extends into the Padauk forests, where it is confined to sandy soil not far from the sea. It is extensively planted in tropical India for ornament and for the sake of its fruits, the kernels of which are eaten.

Volume equations developed

ANDAMAN AND NICOBAR ISLANDS

668.	South and Middle Andaman	G	$V = -0.13889+6.1052D^2+0.10503D^2H$
		L	$V = 0.0040216+8.6257D^2$
669.	Little Andaman The general volume equation was also used in North Andaman.	G	$V/D^2 = -0.02415/D^2 +0.0005 +0.0000148$ H (dia in cm) ($n=40$, $R^2=0.2252$)
		L	$V = -0.1843+0.00198D+0.000936D^2$ (dia. in cm) ($n=32$, $R^2=0.9788$)
670.	North Andaman.	L	$V/D = 0.008968+0.001124D-0.0000001D^2$ (dia. in cm)

Terminalia species

Volume equation developed

ASSAM

671.	Assam survey (15 districts)	L	$V = 0.50603-6.64203D+25.23882D^2-9.19797D^3$ ($n=24$, $R^2=.99828$)

Tetrameles nudiflora

General description of the species

It is a lofty deciduous tree attaining a height of 46 m with a long clean bole and immense plank buttresses at the base. Bark greyish white, fairly smooth. This species occurs in moist tropical and evergreen forests in the eastern sub-Himalayan tract and outer hills, Eastern Ghats and Nilgiris. The wood is whitish, soft, rather coarse, and not durable. In southern India, it is used for dug-out canoes, after treatment with fish oil to increase its durability. It is also used for rough packing cases.

Volume equations developed

ASSAM

672.	Assam survey (15 districts)	L	$V/D^2 = 0.12914/D^2-2.50478/D+15.25108$ ($n=24$, $R^2=.92720$)

BHUTAN

673.	Central and Eastern parts	G	$\log_e V = -1.33610+1.75959 \log_e D +0.99492 \log_e H$ ($n=86$, $R^2=.991$)
674.	Southern Parts	L	$\sqrt{V} = -0.50980+2.41166D+1.12639 \sqrt{D}$ ($n=144$)

Toona ciliata/Cedrela toona

General description of the species

It is commonly called Toon or Red Cedar. It is a large deciduous tree, with a heavy crown, attaining a height of 30 m. It has a dark grey or reddish-brown bark. This species occurs in the forests of the sub-Himalayan tract and valleys of the outer Himalaya upto an elevation of 1200 m and in most of plains of India. In south India, it is mainly found in evergreen and semi-evergreen forests. It is commonly cultivated as an avenue and ornamental tree. It grows in deep, rich, moist, well drained, loamy soil. In its habitat the average rainfall varies from 110 cm to 400 cm, maximum temperature from 38°C to 48°C and the minimum temperature from -1°C to 18°C. Toon is a moderate light demander, frost hardy, drought and fire sensitive. Toon timber is used for furniture, in house-construction, well construction, carving, musical instruments, carts, etc. It is fairly suitable for match boxes. The bark has medicinal value.

Volume equations developed

ARUNACHAL PRADESH

675.	Lohit	L	$\sqrt{V} = -0.05514+2.67753D$ ($n=26$, $R^2 = .95658$)
676.	Tirap	L	$V = 0.21869-2.04074D+10.41713D^2+1.85232D^3$ ($n=74, R^2=.99642$)

ASSAM

677.	Assam survey (15 districts)	L	$V = 1.10314-3.52579\sqrt{D}+15.50182\,D^2$ ($n=63$, $R^2=.98009$)

TRIPURA

678.	Tripura survey	L	$\sqrt{V} = -0.27525 +3.0319\,D$

Trewia nudiflora

General description of the species

It is a moderate-sized to large deciduous tree, often with a short bole and

spreading branches, but under favourable conditions producing a long clear bole, often much buttressed at the base. This species occurs in the sub-Himalayan tract from west of the Yamuna eastwards, West Bengal, Assam, Chota Nagpur, in the peninsula, cheifly in moist forest and particularly along streams and in moist and swampy situations. This is one of the most characteristic trees of the swamp forests of the western sub-Himalayan tract. It is also common in moist places along the foot-hills of the eastern sub-Himalayan tract. The tree is a moderate light demander, good coppicer and produces root-suckers. It is fairly frost hardy, but is sensitive to drought. Wood white, soft,not durable, used for drums, planking, carved images and is suitable for match manufacture.

Volume equation developed

ASSAM

679.	Assam survey (15 districts)	L	$\sqrt{V} = -0.45312-0.41426D+2.10913\sqrt{D}$ ($n=21$, $R^2=.91962$)

Tsuga dumosa

General description of the species

It is commonly called Hemlock Fir. It is a tall tree upto 36 m high with a massive trunk,bark thick rough, branches drooping. It occurs in Eastern Kumaon through Nepal, Sikkim, Bhutan to Arunachal Pradesh at 2400-3000m. The timber is used for shingles, packing cases, bobbins and reels. The bark is used for thatching.

Volume equations developed

ARUNACHAL PRADESH

680.	Debang	L	$\sqrt{V} = -0.09154+2.37257D$ ($n=101$, $R^2=.96725$)

SIKKIM

681.	South Western parts	G	$V = 0.0008056+0.00003283D^2H$ (dia. in cm) ($n=26$, $R^2=0.9431$)

L V/D^2 = -0.00055+0.00716/D
+0.000029D -0.00000012D^2
(dia. in cm)
(n=26, R^2=0.7752)

NEPAL

682. Western parts. L $\log_e V = 2.32244+2.37411 \log_e D$

Tsuga brunoniana

General description of the species

It is commonly called Himalayan Hemlock Spruce. It is a large, handsome evergreen tree attaining a height of 30-36 m with a pyramidal outline and spreading branches which droop gracefully. It occurs in Central and Eastern Himalaya from Kumaon to Bhutan, chiefly at 2400-3000 m elevation but ascending to about 3300 m and descending to 1950 m elevation. The bark is thick and rough. Wood is whitish, soft,not of very good quality, used for shingles. In Sikkim the bark is used for roofing.

Volume equations developed

BHUTAN

683. North Western parts. L $V = 0.055312-1.37978 D + 11.394329D^2$ (n=274, R^2=.3476)
The local volume equation was also used for *Larix Griffithii* of this area.

684. Central and Eastern parts L $\sqrt{V} = -0.480494+2.738112 D + 0.948655 \sqrt{D}$ (n=420)

685. Southern parts L $\sqrt{V} = -0.09173+3.25878D$ (n=58, R^2=.96764)

Vateria indica

General description of the species

It is commonly called Piney Varnish or Indian Copal tree. It is a large handsome evergreen tree attaining a height of 45 m with a smooth grey bark and a cylindrical stem. It occurs in Western India from North Kanara to Travancore, upto 1050 -1200 m elevation chiefly in evergreen forest, but occasionally along rivers in deciduous forests. In the natural habitat of the tree the climate is humid, the absolute maximum shade temperature varies from 35°C - 38°C, the absolute minimum from 13°C to 18°C, and the normal rainfall from 200 cm to 500 cm or more. It is a pronounced shade bearer. The tree yields a gum resin of excellent quality. It has been extensively planted as an avenue tree in Karnataka and Kerala.

Volume equations developed

ASSAM

686.	Assam survey (15 districts)	L	$\sqrt{V} = -0.15493+3.11190D$ ($n=19$, $R^2=.98831$)

KARNATAKA

687.	Kodagu district	L	$V = -0.39452+2.73920D+6.03205D^2$

Vitex peduncularis

General description of the species

It is a moderate sized to large tree with trifoliate leaves, the petioles being winged in young plants and coppice shoots. This species occurs in eastern sub-Himalayan tract, Assam, Chota Nagpur, Orissa and the Circars and is common in upper mixed and tropical forests.

Volume equations developed

ASSAM

688.	Assam survey (15 districts)	L	$V = -0.16386+2.23116\ D -7.00969D^2+22.13099D^3$ ($n=37$, $R^2=.98649$)

TRIPURA

689. Tripura survey — L — $\sqrt{V} = -0.26502 + 3.01933\ D$

Wrightia tinctoria

General description of the species

It is a small deciduous tree. It occurs in the Indian peninsula, extending northward to Rajasthan and Banda (U.P.),in the Deccan in open deciduous forests, often on trap, it extends southwards to Kerala, and is found most commonly on dry sandy soil and on hilly ground. The tree stands moderate shade and it produces root-suckers.

Volume equations developed

ASSAM

690. Assam survey (15 districts) — L — $\sqrt{V} = 0.23229+4.41646D-1.55989\sqrt{D}$ ($n=175$, $R^2=.96970$)

GUJARAT

691. Surat circle - Dangs Surat, Valsad and Bharuch districts. The local volume equation was also used for Khargone, Khandwa, Dewas, Jhabua, Indore and Dhar districts of M.P. Mewasi Forest division and Nasik, Thane, Raigarh districts of Maharashtra and for Dadra and Nagar Haveli. — L — $\sqrt{V} = 0.050294+3.115497\ D -0.687813\ \sqrt{D}$ ($n=162$)

MAHARASHTRA

692. Melghat Forest divsion — G — $V = -0.00915 +0.159602\ D +0.333868D^2H$ ($n=113$, $R^2=.9388$)

L — $V = -0.009510+4.149345D^2$ ($n=113$, $R^2=.4166$)

Xerospermum glabratum

General description of the species

It is a middle sized aromatic tree, leaves glabrous, leaflets two pairs, lanceolate. It occurs in Khasi hills.

Volume equation developed

ASSAM

693.	Assam survey (15 districts)	L	$V = 0.12248-2.08874D+12.24355D^2$ ($n=159$, $R^2=.98631$)

Xylia xylocarpa

General description of the species

It is a moderate sized to large deciduous tree attaining a height of 18 m. This species occurs in the Indian peninsula, extending as far north as Bombay in the west, Orissa in the east, and the Balaghat district of Madhya Pradesh in the centre. It extends southwards to Travancore, but is absent from the south of that area. It is not found in the dry districts of the Indian peninsula. It is plentiful throughout the deciduous forests of the Western Ghats. It is a typical gregarious tree, often forming nearly pure crops. The tree is found on various geological formations. In its natural habitat the absolute maximum shade temperature varies from 35°C to 40°C, the absolute minimum from 3°C to 17°C. The tree is a shade bearer, it withstands fire better than most species. The tree coppices and pollards well and produces root-suckers in abundance. The wood is very hard, reddish brown, durable, liable to split in seasoning. It is used for house and bridge construction.

Volume equations developed

KARNATAKA

694.	Kodagu district	L	$\sqrt{V} = 0.01631+2.20921D$

GOA

695.	Goa survey	L	$\sqrt{V} = -0.244801 +2.876594$ D (for dia ≤ 20 cm for total timber O.B.)
		L	$\sqrt{V} = -0.121927+2.955949$ D (for dia ≤ 5 cm for total wood O.B.)

ANDHRA PRADESH

696.	East Godawari	L	$V = -0.000039+3.34636D^2+3.18889D^3$ ($n=239$, $R^2=.929296$)

MAHARASHTRA

697.	Ballarshah catchment (Chandrapur)	G	$V = 0.143109+0.199878\ D^2H +0.222392\ (D^2H)^2$ ($n=30$, $R^2=.970$)
		L	$V = 0.264709-4.122856\ D +19.1317\ D^2$ ($n=103$, $R^2=.9452$)
	(F.A.O. Project area)		
698.	Parts of Andhra Pradesh, Kerala, Orissa and Tamil Nadu.	G	$V = -0.014+0.289D^2H$ ($n=113$, $R^2=.867$
		L	$V = 0.098-1.52D+8.963D^2$

Zanthoxylum rhetsa

General description of the species

It is an erect, deciduous tree attaining a height of 30 m. Main stem armed with stout, straight long prickles. This species occurs in India ascending upto 300-500 m in the Western Peninsula, Himalayas, Andhra Pradesh and Bihar. Sometimes descending as low as 90 m. The unripe carpels and seeds are used as condiments in South India. The cork from the base of the prickles of the trunk is made into beads and other ornaments. Young leaves are edible. An essential oil obtained from the fruit is used in medicines. The wood is used for house posts and for looms.

Volume equation developed

ASSAM

699.	Assam survey (15 districts)	L	$V = -0.04521+0.45290D +5.18275D^2$ ($n=21$, $R^2=.98417$)

Zizyphus xylopyra

General description of the species

It is a small deciduous tree or large shrub with straggling branches, the branchlets armed with prickles, or often unarmed, especially in the case of old trees or on good soil; bark greyish brown, smooth, or rough with small oblong exfoliating scales. This species occurs in the sub-Himalayan tract and outer hills upto 900 m from the Sutlej eastwards, Bihar, Chota Nagpur, Rajasthan, central and southern India, the Deccan and the peninsula generally. In its natural habitat the absolute maximum shade temperature varies from 38°C - 48°C., the absolute minimum from -1°C to 15°C and the rainfall from 50 -188 cm.

The tree is light demander, drought hardy and frost tender. It is browsed by goats and has considerable power of recovery from injury, and is thus capable of surviving in areas over run by fire. It coppices and pollards well. The wood is used for agricultural implements, fuel, and charcoal. The bark is used for tanning; the fruits are rich in tannin, and are employed for tanning and for dyeing leather. The leaves are used for fodder. One of the chief uses of the tree, however, is for the propagation of lac. It is a useful tree for clothing certain types of poor dry ground or clay soil where little else will grow.

Volume equations developed

ANDHRA PRADESH

700.	Mehboob Nagar Forest division.	G	$V = -0.002557+0.260114D^2H$
		L	$V = 0.027354+4.663714D^2$ (n=142, R^2=.93)

Rest of species of the inventoried area for which common equations were used

Volume equations developed

ANDAMAN AND NICOBAR ISLANDS

701.	South and Middle Andaman	G	$V/D^2H = 0.022593/D^2H+0.2805$ (dia. in cm)

	L	V/D=	0.014989/D-0.59317 +9.2123D (dia. in cm)
702. Little Andaman. The general volume equation was also used for North Andaman.	G	V/D^2H=	0.19915/D^2H+0.000022 (dia. in cm)
	L	V =	1.0405-0.0589D+0.001505 D^2 (dia. in cm)
703. North Andaman.	L	V =	-0.004339+0.0007688D^2 (dia. in cm)
ANDHRA PRADESH			
704. East Godavari	L	V =	0.184105-3.07474D+16.448494D^2 -12.38362D^3 (n=624, R^2=.9428)
705. East and West Godavari, Visakhapatnam and Khammam districts	G	V =	0.001+0.333D^2H
	L	$\log_e$ V =	2.1795+2.5045 $\log_e$ D
706. Adilabad district	L	V =	0.088183 -1.490948 D +8.984266D^2 (n=1160, R^2=.9481)
707. Mehboob Nagar Forest division.	G	V =	0.003446+0.243906D^2H
	L	V =	0.058237+4.597986D^3 (n=443, R^2=.96)
ARUNACHAL PRADESH			
708. Debang.	L	V =	0.00978-0.21005D+5.62160D^2 (n=2078, R^2=.95441)
709. Lohit.	L	V =	0.15958-1.57976D+8.25014D^2 -0.48518D^3 (n=1753, R^2=.97252)
710. Tirap.	L	$\sqrt{V}$ =	-0.17114+2.00564D+0.54361$\sqrt{D}$ (n=1350, R^2=.95708)
ASSAM			
711. Assam survey (15 districts)	L	V =	0.11079-1.81103 D+11.4132 D^2 +0.38528D^3 (n=2720, R^2=.95575)

BIHAR

712. Ranchi district, Santhal Parganas and parts of Bhagalpur districts. The general and local volume equations were also used in Puralia, Bankura and Midnapur districts of West Bengal.

G $V/D^2 = 0.0078117/D^2H-0.0019764/D^2 +0.50894$ (n=50, R^2=0.0052)

L $V/D^2 = 0.025584/D^2-0.89224\ /D+9.5879$ (n=113, R^2=0.7800)

713. South West Bihar - Chhapra, Kodarma, Giridih, Mongher, Shahabad, Gaya,Daltonganj, Garwa, Latehar, Hazaribagh and Ranchi Forest divisions and Singhbum district.

G $V = 0.014507+0.40361D^2H$

714. West Champaran district.

G $V/D^2H = 0.008169/D^2H+0.298862$ (dia in cm)

L $V = 0.05396-0.82031D+6.17975D^2$

GUJARAT

715. Surat Circle-Dangs, Surat, Valsad and Baruch districts. The general and local volume equations were also used for Mewasi Forest division, Dhulia, Nasik, Thane and Raigarh districts of Maharashtra and also for Dadra and Nagar Haveli. The local volume equation was also used for Khargone, Khandwa, Dewas, Jhabua, Indore and Dhar districts of M.P.

G $V/D^2H = -0.003013/D^2H+0.351923$ (n=85, R^2=.09743)

L $\sqrt{V} = -0.153973+2.724109D$ (n=629, R^2=.95684)

HIMACHAL PRADESH

716.	Chir belt area-Bilaspur, Hamirpur, Kangra, Mandi, Solan and Una districts.	L	$V/D^2 = 0.007602/D^2-0.033037/D +1.868567 +4.483454\ D$
717.	Shimla, Rohru and Chopal - Shimla district.	L	$V/D^2 = 0.16587/D^2-1.7541\ /D+9.20497$ $(n=160,\ R^2=.40535)$
718.	Kulu, Seraj and Kotgarh-Kulu and Shimla districts	L	$V = 0.193297-2.267002\ D +10.679492D^2$ $(n=340,\ R^2=.9565)$
719.	Rajgarh and Nahan	L	$V = 0.3846 -3.4559\ D+10.9878\ D^2$

JAMMU AND KASHMIR

720.	Kashmir valley	G	$V = 0.01052+0.30039D^2H$
		L	$V = 0.23781-2.09431\ D +7.78268D^2$
721.	Chenab valley. The general volume equation was also used for Shimla, Rohru and Chopal - Shimla district, Kulu, Seraj and Kotgarh-Kulu and Shimla districts of Himachal Pradesh.	G	$V/D^2H= 0.05026/D^2H+0.296846$ $(n=39,\ R^2=.4194)$
		L	$V/D^2 = 0.253546/D^2-2.358187\ /D +9.872098$
722.	Jammu Region-Udhampur, Rajouri, Kathua and Jammu districts.	L	$V = -0.03316 +0.77262\ D -0.50833D^2+11.50107D^3$ $(n=499,\ R^2=.30916)$

KARNATAKA

723.	Chikmagalur, Hassan and Shimoga districts.	L	$V = 0.058+4.598D^2$
724.	Kodagu district	L	$V = 0.16948-1.85075D+10.63682D^2$

MADHYA PRADESH

725.	Rajnandgaon and Durg districts.	G	$V/D^2H = -0.006595/D^2H+0.410357$ (n=32, R^2=.239374)
		L	$V = 0.01488-0.60281\ D+6.39518\ D^2 +3.68801D^3$ (n=4506, R^2=.96785)
726.	Balaghat, Seoni and Mandla districts. The local volume equation was also used for Rajgarh, Bilaspur and Raipur districts.	L	$V/D^2 = 0.0697/D^2-1.4597\ /D +11.79933-2.35397D$ (n=2478, R^2=.7101)
727.	Narayanpur catchment -Bastar district.	G	$V/D^2H = 0.00322/D^2H+0.33866$ (n=294, R^2=.0165)
		L	$V = 0.25057-3.35375\ D+14.84406\ D^2 -4.41292D^3$ (n=1946, R^2=.9763)
728.	Rajgarh district.	L	$V = 0.04935-1.026608\ D +8.89721\ D^2$ (n=988, R^2=.98021)
729.	Bilaspur district.	L	$V/D^2 = 0.05886/D^2-1.22835\ /D +10.43005-1.55502\ D$ (n=1577, R^2=.58493)
730.	Raipur district.	L	$V/D^2 = 0.03646-0.91545/D+7.71869 +1.15753\ D$ (n=2684, R^2=.73337)

MAHARASHTRA

731.	Ballarshah catchment (Chandrapur).	G	$V/D^2H = -0.000044/D^2H+0.329134$ (n=269, T^2=.000004)
		L	$V/D = 0.040841/D-0.88376 +7.25224\ D+1.34817\ D^2$ (For dia. < 40 cm) (n=1153)
		L	$\sqrt{V} = -0.135764+2.756043D$ (For dia. ≥ 40 cm)
732.	Sondad catchment-Bhandara district.	G	$V/D^2H = 0.00042/D^2H+0.33352$ (n=111, R^2=.0004)

	The general volume equation was also used for Wadsa catchment (Chandrapur).	L	$V/D = 0.076856/D-1.359767 +8.72548D-0.591440D^2$ ($n=605$, $R^2=.8915$)
733.	Wadsa catchment-(Chanda Priority-I).	L	$V/D = 0.020853/D-0.610255 +6.108230D+0.637781D^2$ ($n=402$, $R^2=.9005$)
734.	Melghat Forest division.	G	$V = 0.000114+0.357503D^2H$ ($n=278$, $R^2=.002$)
		L	$V = 0.042264-1.098756\ D +9.231891\ D^2$ ($n=279$, $R^2=.6768$)
	MEGHALAYA		
735.	Meghalaya survey.	G	$V= -0.63783+0.05150H+ 0.000027956D^2H$ (dia. in cm) ($n=150$, $R^2=0.9025$)
		L	$V= -0.081297+0.0010659D^2$ (dia. in cm) ($n=172$, $R^2=0.8836$)
	ORISSA		
736.	Phulbani catchment-Phulbani and Ganjam districts. The general and local volume equations were also used for Kalahandi district. The general volume equation was also used for Tarai Region of U.P.	G	$V= -0.004119+0.346750D^2H$
		L	$V/D= 0.088074/D-1.449236 +8.760534D$ ($n=1359$, $R^2=.927$)
737.	Koraput district	G	$V = -0.002909+0.376517D^2H$ ($n=77$, $R^2=.986142$)
		L	$\sqrt{V} = 0.06063+3.43666D-0.75571\ \sqrt{D}$ ($n=1786$, $R^2=.97531$)
	RAJASTHAN		
738.	Udaipur Forest division. The general volume	G	$V = 0.012804+0.327792D^2H$ ($n=190$, $R^2=.9351$)

	equation was also used for Southern and Eastern Rajasthan and Jammu region -Udhampur, Rajouri, Kathua and Jammu. The local volume equation was also used for Chitradurga, Tumkur, Kolar, Bellary and Bangalore districts of Karnataka and Indore catchment - Mandsour, Ratlam, Ujjain, Shajapur and Raigarh districts of Madhya Pradesh,	L	$V = 0.081467-1.063661\ D + 6.452918\ D^2$ (n=242)
739.	Southern and Eastern parts. The local volume equation was also used for *Wrightia tinctoria* of this area.	L	$V = 0.00471+1.79326D^2$ ($n=1060$, $R^2=.9041$)
	SIKKIM		
740.	Sikkim survey.	G	$V = 0.024659+0.00003492D^2\ H$ (dia. in cm) ($n=20$, $R^2=0.8987$)
		L	$V = 0.3555-0.037D+0.001259D^2$ (dia. in cm) ($n=283$, $R^2=0.9366$)
	TRIPURA		
741.	Tripura survey. The local volume equation was also used for rest of the species of Manipur survey.	L	$\sqrt{V} = -0.226400+2.935870D$ (dia. in cm)
	UTTAR PRADESH		
742.	Tarai Region- Saharanpur, Bijnore, Moradabad, Rampur, Bareilly, Pilibhit, Kheri, Bahraich, Gonda, Basti, Gorakhpur and Deoria districts.	L	$V/D^2 = -0.00342/D^2-0.0922\ /D +2.28178 +9.46641\ D$ ($n=1211$, $R^2=.66156$)

743.	Alaknanda catchment-Major portion of district Chamoli and parts of Pauri Garhwal and Almora districts. The general volume equation was also used for western parts of Nepal.	L	$\sqrt{V} = 0.60124+5.32265D-2.92195\sqrt{D}$ (n=773, R^2=.9336)
744.	Lansdowne Forest division and parts of Yamuna, Tehri and Garhwal Forest divisions.	G	$V = 0.00855+0.4432\ D^2+0.28813D^2H$ (n=221, R^2=.976)
		L	$V = 0.03843-0.36982\ D+2.62185\ D^2 +7.68659\ D^3$ (n=3825, R^2=.9543)
745.	Southern Uttar Pradesh-Agra, Etawah, Jalaun, Jhansi, Lalitpur, Hamirpur, Banda, Allahabad, Mirzapur and Varanasi districts.	L	$V = 0.17553-0.71434\sqrt{D}+7.94663D^2$ (n=804, R^2=.97086)
746.	Bhagirathi, Bhilangana and Yamuna catchment.	L	$V = 0.384595-3.455960D+10.987590D^2$
	WEST BENGAL		
747.	North Eastern and Eastern parts of Kalimpong division. The general and local volume equations were also used as local volume equations for Darjeeling district.	L	$V = -3.1373+0.0926D+0.000082D^2$ (for plywood) (dia. in cm)
		L	$V = -4.0496+0.1003D+39.727\ /D$ (for total timber) (dia in cm)
748.	Singalila and Tonglu ranges of Darjeeling division.	G	$V = 0.6334+0.00004D^2H-0.0323D$ (for plywood) (dia. in cm)
		G	$V = -0.1748+0.00003D^2H$ (for total timber) (dia in cm)

749. G-14(65) Sheet
Special Survey

L $\log_e V = 2.194+2.503 \log_e D$

BHUTAN

750. North Western parts.

L $V/D^2 = 0.041566/D^2-1.075224\ /D$
$+9.402206$ (n=800)

751. Southern parts.
The local volume.
equation was also used
for Gedu and Changekha
areas of Western Bhutan.
Central Bhutan and for
Larix grifithii of this area.

L $\sqrt{V} = 0.12404+4.00303D-1.09844\ \sqrt{D}$
(n=4314)

NEPAL

752. Western parts.

L $V = 0.14288+3.59548D-1.09591D^2$

CHAPTER II

Regional volume equations for Tropical Rain Forest Tree species of Karnataka
This was done between 1976 and 1980 (Rai 1980). The stem timber volume of trees above 15 cm dbh is given by these equations.

Aphanamixis polystachya/Amoora Canarana

General description of the species

It is a tree of the forest of the Western Ghats from North Kanara to the Anamalai Hills. The wood is hard, close-grained, red, with a darker coloured heart wood.

Volume equation developed

KARNATAKA

1. Sagar Forest division — $V = -0.0263+0.40113\ D^2H$ ($n=33$, $R^2=0.9660$)

Callophyllum elatum/tomentosum

General description of the species

Callophyllum elatum is a species of southern tropical wet evergreen forest of India. A large tall evergreen tree, bark with longitudinal cracks. Wood reddish-brown, moderately hard, streaked on the vertical sections by the dark concentric lines and the pores.

Volume equation developed

KARNATAKA

2. Sagar Forest division — $V = 0.02492+0.43282\ D^2H$ ($n=48$, $R^2=0.9767$)

Canarium strictum

General description of the species

A very large deciduous tree. Bark grey, roughish, wood moderately hard, heart wood pink, sapwood greyish-white. It is found in the evergreen forests of the western coast up to about 1500 m. This is a handsome tree and is one of the most conspicuous trees in the forests of the Western Ghats, especially when coming into new leaf, for the young leaves are of a bright crimson colour, very hairy, and like red velvet.

Volume equation developed

KARNATAKA

3.	Sagar Forest division	$V = 0.0147+0.5225\ D^2H$ ($n=30$, $R^2=0.9773$)

Dipterocarpus indicus

General description of the species

Dipterocarpus indicus is a species of Southern Tropical Wet evergreen forest of India. It is also found in Sri Lanka and Malaysia. It is a lofty tree, wood dark reddish-grey and hard. Pores moderate sized to large and scanty. The timber is open in the grain and not durable. Timber is soft but useful for building purposes.

Volume equation developed

KARNATAKA

4.	Sagar and Kodagu Forest divisions.	$V = 0.0303+0.4444D^2H$ ($n=56$, $R^2=0.9797$)

Dysoxyllum malabaricum

General description of the species

(Please refer to the notes in the previous chapter)

Volume equation developed

KARNATAKA

5. Sagar Forest division $V = 0.0795+0.457\ D^2H$ ($n=30$, $R^2=0.8926$)

Euphoria longana

General description of the species

(Please refer to the notes in the previous chapter)

Volume equation developed

KARNATAKA

6. Sagar Forest division $V = -0.0287+0.48016\ D^2H$ ($n=40$, $R^2=0.9856$)

Ficus nervosa

General description of the species

Ficus nervosa is a species of Southern Tropical Wet evergreen and semi evergreen forests of India.

Volume equation developed

KARNATAKA

7. Sagar Forest division $V = 0.0153+0.3856D^2H$ ($n=34$, $R^2=0.9078$)

Garcinia cambogia

General description of the species

It is a species of Southern Tropical Wet evergreen forests of India. It is a small evergreen tree, wood grey, sometimes patched with red, shining, hard,

close grained, smooth, concentric bands forming transverse, bars, very numerous, white and prominent.

Volume equation developed

8. Sagar Forest division — $V = 0.0028+0.43309D^2H$ ($n=46$, $R^2=0.9394$)

Garcinia morella

General description of the species

Garcinia morella is a species of Southern Tropical Wet evergreen forests of India. The latex of the tree yields Gamboge dye of commerce. An evergreen tree wood yellow, hard mottled, with numerous wavy concentric bands of soft texture. Pores large, subdivided.

Volume equation developed

KARNATAKA

9. Sagar Forest division — $V = -0.0213+0.46517D^2H$ ($n=30$, $R^2=0.9703$)

Holigarna beddomei

General description of the species

Holigarna beddomei is a species of Southern Tropical Wet evergreen forests of India. An enormous tree. Wood soft reddish-grey. Pores large scanty, medullary rays moderately broad, not numerous, reddish, giving a pretty silver-grain.

Volume equation developed :

KARNATAKA

10. Sagar Forest division — $V = -0.0175+0.4521\ D^2H$ ($n=30$, $R^2=0.9413$)

Holigarna grahmii

General description of the species

Holigarna grahmii is a species of Southern Tropical Wet evergreen forests of India. Wood soft greyish. Pores large, prominent on a vertical section. Medullary rays fine, short, not prominent.

Volume equation developed

KARNATAKA

11. Sagar Forest division — $V = -0.013+0.411076\ D^2H$ ($n=40$, $R^2=0.8968$)

Kingiodendron pinnatum/Hardwickia pinnata

General description of the species

Kingiodendron pinnatum is a species of Southern Tropical Wet evergreen forest of India. It also occurs in Sri Lanka. A very large tree, wood moderately hard, sapwood large; heart-wood dark red or reddish-brown, exuding a red, sticky resin. Pores moderate-size and large, often sub divided and scanty.

Volume equation developed

KARNATAKA

12. Kodagu Forest division — $V = -0.01855+0.44803D^2H$ ($n=34$, $R^2=0.8122$)

Lansium anamallayanum

General description of the species

A medium sized tree. Bark thin grey, lenticellate wood hard, pink, close-grained. Pores small regularly distributed. Medullary rays extermely fine and numerous, giving a satiny silver-grain on a radial section. It is found in the forests of Western Ghats at 450-900 m up to Kerala.

Volume equation developed

KARNATAKA

13. Sagar and Kodagu Forest divisions. $V = 0.036+0.38947D^2H$ ($n=43$, $R^2=0.9288$)

Mastixia arborea

General description of the species

Mastixia arborea is a species of Southern Tropical Wet evergreen and semi evergreen forests of India. A large tree, wood greenish grey, soft, pores small, numerous evenly distributed. Medullary rays fine and very fine, numerous and short.

Volume equation developed

KARNATAKA

14. Sagar Forest division $V = -0.0232+0.3809D^2H$ ($n=33$, $R^2=0.922$)

Myristica magnifica

General description of the species

Myristica magnifica is a species of Southern Tropical Wet evergreen forests of India. A very large evergreen tree with large butresses to the stem. Bark dark redish brown. Wood light reddish-brown, streaked, soft with many prominent brown concentric lines like annual rings pores moderate-sized, in short radial strings of two and three. Medullary rays very fine, brown and numerous.

Volume equation developed

KARNATAKA

15. Sagar Forest division $V = 0.0196+0.4315D^2H$ ($n=30$, $R^2=0.8433$)

Palaquim ellipticum

General description of the species

Palaquim ellipticum is a tree of Southern Tropical Wet evergreen forests of India and Malaysia.

Volume equation developed

KARNATAKA

16.	Sagar and Kodagu Forest division.	$V = 0.02245+0.47522D^2H$ ($n=40$, $R^2=0.9555$)

Persia macrantha/ Machilus macrantha

General description of the species

Persia macrantha is a species of Southern Tropical Wet evergreen and semi evergreen forests of India. It is found in the Western Ghats from the Konkan southwards to Travancore ascending to 2100 m. A large evergreen tree. Wood orange brown and moderately hard. Pores moderate sized and often sub-divided.

Volume equation developed

KARNATAKA

17.	Sagar Forest division	$V = 0.0901+0.41355D^2H$ ($n=30$, $R^2=0.9807$)

Symplocos spicata

General description of the species

(Please refer to the notes in the previous Chapter)

Volume equation developed

KARNATAKA

18. Sagar Forest division

$V = 0.0381+0.42144D^2H$
$(n=30, R^2=0.9681)$

Syzygium cumini

General description of the species

(Please refer to the notes in the previous Chapter)

Volume equation developed

KARNATAKA

19. Sagar Forest division

$V = 0.0238+0.41681D^2H$
$(n=37, R^2=0.81191)$

Vateria indica

General description of the species

(Please refer to the notes in the previous Chapter)

Volume equation developed :

KARNATAKA

20. Kodagu Forest division

$V = 0.00761+0.37655D^2H$
$(n=40, R^2=0.9815)$

Combined volume equation for overwood species

The data of volume production by individual trees of the below mentioned species has been combined together.

Aphanamixis polystachya
Carallia brachiata

Canarium strictum.
Dipterocarpus indicus.
Dysoxyllum malabaricum.
Eugenia utilis
Euphoria longana
Ficus nervosa
Holigarna beddomei
Holigarna grahmii
Kingiodendron pinnatum
Mastixia arborea
Palaquinm ellipticum.
Persia macrantha
Vateria indica

The observed range of diameter was from 3.4 to 107.0 cm and height was from 4.8 to 47 m. The equation is based on the measurement of 510 trees of the above species.

Volume equation developed :

KARNATAKA

21.	Kodagu and Sagar Forest divisions.	V	= 0.0547+0.4172D^2H (n=510, R^2=0.9232)

Combined volume equation for underwood

The data of volume production by individual trees of the below mentioned species has been combined together.

Drypets alata
Garcinia morella
Garcinia cambogia
Lansium anamallayanum
Myristica magnifica
Olea dioica
Symplocos laurina

The observed range of diameter was 2.3 to 54.9 cm and height was from 6.0 to 33.0 m. The equation is based on the measurement of 239 trees.

Volume equation developed

KARNATAKA

22.	Kodagu and Sagar Forest divisions	$V = 0.2304+0.3807D^2H$ ($n=239$, $R^2=0.9563$)

Combined volume equation for tree species of tropical rain forests

The preceding two volume equations have been constructed from the data of fifteen overwood and seven underwood species. In all volume measurements of 749 trees have been considered for the above two volume equations. By combining the data of all the trees together a volume equation has been developed which can be applied for the assessment of growing stock of a Tropical Rain forest for prediction of stem timber volume.

The observed range of diameter and height for the volume equation is 2.3 cm to 107 cm and 4.8cm to 47 m, respectively.

Volume equation developed

23.	Tropical Rain Forests of Karnataka.	$V = 0.0790+0.4149D^2H$ ($n=749$, $R^2=0.9303$)

CHAPTER III

Other Volume Equations available in the Forest Research Institute (published in *Indian Forest Records* and in the *Indian Forester)*

Acacia auriculiformis

General description of the species

An exotic from Australia, has been planted in a number of states of India such as Bihar, Karnataka, Orissa and West Bengal under various afforestation schemes. It is commonly known as "Australian Acacia". Its wood is suitable for paper pulp and for making charcoal. However, presently as the price of conventional timber is quite high, more and more use is being made of this wood for building construction and for agricultural implements. The tree is also suitable for avenue planting. It is a promising species and grows well even under poor soil conditions.

Volume equations developed

1. Orissa

$$V = 0.187693-2.825587D+0.054763DH+12.164775D^2-0.004788/D$$
$$(n=64, R^2=0.9924)$$

2. Orissa

$$V/D = 1.991576-35.923234D+1.397779DH+146.683991D^2-5.75817D^2H-0.069569/D+3.389547/H$$
$$(n=64, R^2=0.9835)$$

3. Orissa

$$V/H = 0.01547-0.326002D+0.00028333H+1.77926DH+0.0070975D^2-0.0492556D^2H+0.00620429/D+0.0381795/H$$
$$(n=64, R^2=0.9855)$$

4. Orissa

$$V/BA = 5.281671-255.915553D+1.590848H+1177.771744DH-29.363841D^2H-0.740995/D+72.19644/H$$
$$(n=64, R^2=0.9266)$$

5. Orissa

$$\sqrt{V} = -0.0105973+3.02847D$$
$$(n=64, R^2=0.9518)$$

6. Orissa

$V = 0.100961+4.03861D-56.387D^2+362.638D^3-668.176D^4$
(n=64, R^2=0.9761)

7. Orissa

$V/D^2H = -2.103648+0.246118H-1.861666DH-46.4771139D^2+15.074647D^2H-0.040471/D+11.892896/H$
(n=64, R^2=0.9972)

Acacia catechu

General description of the species

(Please refer to the notes in Chapter I)

Volume equations developed

HARYANA

8. Morni hills, Pinjore division.

$\text{Log } V = -0.4649+2.1141\text{Log } D+0.9175 \text{ Log } H$
(n=56, R^2=0.9862)

9. Morni hills, Pinjore division.

$VOB = -0.003667+4.373288D^2+0.073788D^2H$
(n=111, R^2=0.9385)

10. Morni hills, Pinjore division.

$VOB = -1.072253+4.3693\ 1D+0.076683\ 1/D$
(n=111, R^2=0.91259))

11. Morni hills, Pinjore division.

$VUB = -0.013071+3.554539D^2+0.065378D^2H$
(n=111, R^2=0.9354)

12. Morni hills, Pinjore division.

$VUB = -0.909144+3.640653D+0.064592\ 1/D$
(n=111, R^2=0.9072)

Adina cordifolia

General description of the species

(Please refer to the notes in Chapter I)

Volume equation developed

13. Bihar and U.P. $V = -0.378691+0.200954D^2H+0.021702H$ (n=148)

Adina cordifolia and *Lannea caromandelica*

Volume equations developed

14. North-Eastern States
VUB $V = -0.258095+0.300616D^2H$ ($n=11$, $R^2=0.9750$)
VUB $\sqrt{V} = -0.469497+3.698566D$ ($n=11$, $R^2=0.9831$)

Albizia procera and *Gmelina arborea*

Volume equations developed

15. North Eastern State
VUB $V = -0.315083+0.309355D^2H$ ($n=13$, $R^2=0.9738$)
VUB $\sqrt{V} = -0.335225+3.565933D$ ($n=13$, $R^2=0.9677$)

Alnus nepalensis

General description of the species

(Please refer to the notes in Chapter I)

Volume equations developed

Total wood volume (TWV)

WEST BENGAL

16. Darjeeling and Kalingpong Forest division
$V = 0.230953-4.036943D+11.920988D^2+0.100151DH$ ($n=220$, $R^2=0.9035$)

17. Darjeeling and Kalingpong Forest division — $V/D = 0.249487+0.334007DH$ ($n=220$, $R^2=0.5383$)

18. Darjeeling and Kalingpong Forest division — $V = 0.04013+0.340941D^2H$ ($n=220$, $R^2=0.9033$)

19. Darjeeling and Kalingpong Forest division — $V = 0.054916+41.54263D^3-36.681433D$ ($n=220$, $R^2=0.8892$)

20. Darjeeling and Kalingpong Forest division — $\sqrt{V} = -0.136676+3.60113D$ ($n=220$, $R^2=0.8958$)

Total Timber volume (TTV)

WEST BENGAL

21. Darjeeling and Kalingpong Forest division — $V= 18.06226-84.262672D-0.281692H +114.242398D^2+1.83548DH -2.492093D^2H-1.090281/D$ ($n=220$, $R^2=0.9761$)

22. Darjeeling and Kalingpong Forest division — $V/D= 64.427935-283.331362D -0.939499H+366.791043D^2 +6.27554DH-8.827523D^2H 4.302552/D$ ($n=220$, $R^2=0.9428$)

23. Darjeeling and Kalingpong Forest division — $V= 2.37378-18.3844D-0.0994406H +0.668218DH-0.777854D^2H +32.7813D^2$ ($n=220$, $R^2=0.9730$)

24. Darjeeling and Kalingpong Forest division — $V = -0.377355+11.53351D^2$ ($n=220$, $R^2=0.9653$)

25. Darjeeling and Kalingpong Forest division — $\sqrt{V} = -0.688879+4.8732D$ ($n=220$, $R^2=0.9157$)

Amoora wallichii

General description of the species

(Please refer to the notes in Chapter I)

Volume equations developed

26. Assam State.

VUB V = -0.0651082+0.27376393D^2H
(n=9, R^2=0.9986)
VUB $\sqrt{V}$ = -0.3692+3.4775D
(n=9,R^2=0.9837)

Bombax insigne

General description of the species

A large tree, trunk without prickles. Wood structure similar to that of *B. malabaricum,* but pores smaller and more scanty. It is found in the deciduous forests of North Kanara and Andaman Islands. The wood is more durable than that of ordinary Semal.

Volume equations developed

27. Maharashtra and U.P.

VUB V = 0.3873+0.2634D^2H
(n=874, R^2=0.9275)
$\sqrt{V}$ = -0.0695+2.9613D
(n=874,R^2=0.8404)

Broussonetia papyrifera

General description of the species

Indigenous to China and Upper Burma, this tree was introduced in the Northern India (Saharanpur) in 1880 and it has done well wherever tried, provided it can get sufficient supply of moisture. It is likely in time to become common in the sub-Himalayan tract as well as in the more heavily irrigated portions of the plain but has scarcely had time to spread very much as yet. The wood is soft greyish white, rather perishable. The inner fiber of the bark is used to make paper in Japan and cloth in the South sea Islands. The growth is exceedingly rapid on good mosit soil. It would probably be a useful tree for villagers to grow and lop for fodder in moist tracts such as the Kangra district. The tree is remarkable for the variety of climates in which it can be grown. A fairly large deciduous tree, bark smooth grey, shoots pubescent when young. Leaves are opposite and alternate.

Volume equation developed

28. Punjab

$\sqrt{V} = -0.10185087+3.0746775D(OB)$
$(n=109, R^2=0.9824)$

Careya arborea

General description of the species

(Please refer to the notes in Chapter I)

Volume equations developed

29. Goa

VUB V $= 0.014502+0.225928D^2H$
$(n=56, R^2=0.8286)$

VUB $\sqrt{V}$ $= 0.072682+1.6058023D$
$(n=56, R^2=0.6968)$

Cedrus deodara

General description of species

(Please refer to the notes in Chapter I)

Volume equations developed

30. Himachal Pradesh, Jammu & Kashmir, and U.P.

VUB V $= -0.0789+0.2836D^2H$
$(n=2243, R^2=0.9824)$

$\sqrt{V} = -0.4893+4.0603D$
$(n=2243, R^2=0.9572)$

Chir-pine (Pinus roxburghii

General description of the species

(Please refer to the notes in Chapter I)

Volume equation developed

31. Uttar Pradesh. VUB V = 6.995627(5.459120+0.033044BH +0.005604BH(.029074D+1.0)) (n=161, R^2=0.979)
where BH= Basal area/ha
V = Total stemwood/ha
H = Top height in m

Cleistanthus collinus

General description of the species

(Please refer to the notes in Chapter I)

Volume equation developed

ORISSA

32. Angual, Athmallick, Balangir, Barapahar, Dhenkand, Gangpur, Ghumsur North, Ghumsur south, Nayagarh, Rairakhal and Sambalpur Forest divisions.

V = (0.010987-0.014616H)+ (0.03659+0.4432H) $D^2 x 10^{-4}$
Standard Timber volume (πr^2) (U.B.)
(n=461)

Cryptomeria japonica

General description of the species

(Please refer to the notes in Chapter I)

Volume equations developed

33. West Bengal VUB V = -0.1084+0.3163D^2H
(n=296, R^2=0.9772)
$\sqrt{V}$ = -0.5241+4.0030D
(n=296, R^2=0.9535)

Dalbergia latifolia

General description of species

(Please refer to the notes in Chapter I)

Volume equations developed

34.	Maharashtra and Orissa combined.	V/H	= -0.00829+0.43960(B.A.) (n=292)
35.	Karnataka	VUB V	= -0.0808723+0.282803D²H (n=64, R^2=0.9817)
		VUB √V	= -0.434178+3.22769D (n=64, R^2=0.9400)

Dalbergia sissoo

General description of the species

(Please refer to the notes in Chapter I)

Volume equations developed

36.	U.P., West Bengal, Punjab and Haryana	V	= -0.0721+0.2293D²H (n=1146, R^2=0.9518)
		√V	= -0.3238+3.0077D (n=1146, R^2=0.9358)

Dipterocarpus indicus

General description of the species

(Please refer to the notes in Chapter I)

Volume equations developed

37.	Karnataka	Log V	= -0.4649+2.1141 Log D+0.9175 LogH (n=56, R^2=0.9862)

38. Manipur VOB V = -0.041378+0.417864D^2H
(n=24, R^2=0.9918)

Duabanga sonneratioides and Sterculia alata

Volume equations developed

39. North-Eastern States VUB V = -0.067131+0.266551D^2H
(n=11, R^2=0.9636)

VUB $\sqrt{V}$ = -0.224055+3.274590D
(n=11, R^2=0.9671)

Duabanga sonneratioides

General description of the species

(Please refer to the notes in Chapter I)

Volume equation developed

40. Manipur VOB V = 0.081671+0.319025D^2H
(n=26, R^2=0.9938)

Eucalyptus camaldulensis

General description of species

Eucalyptus camaldulensis is a fast growing handsome tree native to Australia. It has been planted in different states of India such as Punjab, Haryana, Karnataka, Kerala, Madhya Pradesh and Uttar Pradesh.

Volume equations developed

41. New Forests Plantation Dehra Dun. VOB = -0.00458+0.0000361D^2H
(n=40, R^2=0.99)

42.	New Forests Plantation Dehra Dun.	Log(VOB)	= -10.7334+1.05565 log (D^2H) (n=40, R^2=0.986)
43.	New Forests Plantation Dehra Dun	VOB	= 0.02341-0.009753D+0.00117189D^2 (n=40, R^2=0.984)
44.	New Forests Plantation Dehra Dun.	VOB	= -0.046176+0.00087438D^2 (n=40, R^2=0.978)
45.	New Forests Plantation Dehra Dun.	√VOB	= -0.12509+0.0333731D (n=40, R^2=0.980)
46.	New Forests Plantation Dehra Dun.	VUB	= -0.006313+0.0000291D^2H (n=40, R^2=0.984)
47.	New Forests Plantation Dehra Dun.	Log(VUB)	= -11.3035+1.09417 log D^2H (n=40, R^2=0.982)
48.	New Forests Plantation Dehra Dun.	VUB	= 0.02612-0.009235D+0.00098603D^2 (n=40, R^2=0.979)
49.	New Forests Plantation Dehra Dun.	VUB	= -0.039766+0.00070432D^2 (n=40, R^2=0.971)
50.	New Forests Plantation Dehra Dun.	√VUB	= -0.12058+0.0301648D (n=40, R^2=0.974)

Eucalyptus globulus

General description of the species

A lofty tree, attaining 30 m height has, highly aromatic, young shoots. In Austrialia the wood is brown, hard, tough, durable. The wood of the tree grown in the Nilgiris is grey, with darker streaks and moderately hard. Pores small to moderate-sized, round in groups or in radial or oblique lines; closely packed in concentric belts in the annual rings. Medullary rays fine, very numerous.

Volume equations developed

51.	Nilgiri hills, Tamil Nadu	VOB	= 0.00183+0.00003309D^2H (n=165, R^2=0.995)

52. Nilgiri hills, Tamil Nadu

$VUB = -0.000174+0.00002685D^2H$
$(n=165, R^2=0.994)$

53. Nilgiri hills, Tamil Nadu

$\sqrt{VOB} = -0.121986+0.0344338D$
$(n=165, R^2=0.979)$

54. Nilgiri hills, Tamil Nadu

$\sqrt{VUB} = -0.115412+0.0312191D$
$(n=165, R^2=0.977)$

Eucalyptus grandis

General description of the species

Eucalyptus grandis has been planted extensively in Kerala and also in parts of Tamilnadu. The species has proved fast growing and has been found suitable for pulping. In the lower altitudes it is attacked by the 'pink disease' caused by *Corticium salmonicolor* but has done well in higher ranges.

Volume equations developed

55. Kerala and Tamilnadu

$VOB\ V = -0.0009+0.3360D^2H$
$(n=149, R^2=0.9946)$

$VOB\ \sqrt{V} = -0.1480+3.6992D$
$(n=149, R^2=0.9668)$

$VUB\ V = -0.0030+0.2941D^2H$
$(n=149, R^2=0.9930)$

$VUB\ \sqrt{V} = -0.1476+3.4805D$
$(n=149, R^2=0.9634)$

56. Kerala and Tamilnadu

$V = -74.684814+17.624124x+2.131032x^2$
$(n=38, R^2=0.9314)$

$V = -62.453599+13.488326x+1.972164x^2$
$(n=38, R^2=0.9228)$

where x=Top height of crop x (no. per ha)$^{1/6}$x10 $^{-1}$

57. Kerala and Tamilnadu

$VUB\ V = -0.0345911+0.211996D^2H+0.0271027D^2H \log A+0.0024646H$
$(n=230, R^2=0.969)$

VOB V = -0.037728+0.216865D^2H
+0.039256D^2H log A+0.003188H
(n=230, R^2=0.977)

where A = Age in years

Eucalyptus hybrid (Mysore Gum)

General description of the species

Mysore Gum has been extensively planted in most of the states in India. It is popularly known as *Eucalyptus hybrid* and is belived to be *E.tereticornis* by some.

Volume equations developed

Total wood Volume (TWV)

UTTAR PRADESH

58. Muzaffarnagar district. VOB = 0.001188+0.00003108D^2H (n=85, R^2=.990)

59. Muzaffarnagar district. Log(VOB) = -10.3877+1.00085 log (D^2H) (n=85, R^2=.984)

60. Muzaffarnagar district. VOB = -0.02081-0.006597D+0.000943D^2 (n=85, R^2=.968)

61. Muzaffarnagar district. VOB = -0.090281+0.0080164D^2 (n=85, R^2=.964)

62. Muzaffarnagar district. $\sqrt{VOB}$ = -0.18364+0.0325332D (n=85, R^2=.966)

Total wood

63. Muzaffarnagar district. VUB = -0.007001+0.00002498D^2H (n=85, R^2=.986)

64. Muzaffarnagar district. Log VUB = -10.9709+1.03535 log (D^2H) (n=85, R^2=.983)

65. Muzaffarnagar district. VUB = 0.00538-0.008022D+0.00081276D^2 (n=84, R^2=.952)

66.	Muzaffarnagar district.		VUB	= -0.079093+0.0006409D^2 (n=85, R^2=.950)
67.	Muzaffarnagar district.		√VUB	= -0.17926+0.293601D (n=85, R^2=.958)
68.	Andhra Praesh, Bihar Haryana, Kerala, M.P., Tamil Nadu, Mysore, U.P. and West Bengal States	VOB	V	= -2.4726+0.4354BxH(m^3/ha) (n=125, R^2=0.9956)
		VUB	V	= -2.2920+0.3232BxH (n=125, $R^2$0.9899)
69.	Tamilnadu	VOB	V	= 0.0026+0.3296D^2H (n=121, R^2=0.9788)
		VUB	V	= 0.0002+0.2715D^2H (n=121, R^2=0.9727)
70.	Bihar, Haryana, West Bengal, Punjab, U.P., M.P., Kerala and Tamilnadu.		V	= -0.0001+0.31145D^2H (n=580, R^2=0.9855)
			V	= -0.0015+0.2401D^2H (n=580, R^2=0.9826)
			√V	= -0.0868+2.8335D (n=280, R^2=0.978)
			√V	= -0.0840+.25110D (n=580, R^2=0.9710)

Eucalyptus species

General description of the species

(Please refer to the notes in Chapter I)

Volume equations developed

Total Wood Volume (TWV)

71.	Punjab	√V	= -0.1545+0.3537D (n=37, R^2=0.972)

Total Timber Volume (TTV)

72. Punjab

$\sqrt{V} = -0.2582+0.03606D$ (n=32, R^2=0.964)

Gmelina arborea

General description of the species

(Please refer to the notes in Chapter I)

Volume equations developed

73. Assam, West Bengal, Bihar and U.P.

$V = -0.1559+0.2707D^2H$ (n=98, R^2=0.9526)

$\sqrt{V} = -0.6013+3.9822D$ (n=98, R^2=0.9354)

74. Tripura

VUB $V = -0.118644+0.236705D^2H$ (n=38, R^2=0.8521)

Holoptelia integrifolia

General description of the species

A large deciduous tree distributed throughout the greater part of India up to an altitude of 600 m. It is somtimes grown on the road side. Bark grey, pustular exfoliating in somewhat corky scales, leaves elliptic-ovate, acuminate. The bark when cut and the leaves and twigs when crushed emit an unpleasant odour. *H.integrifolia* thrives in deep porous soil with good drainage but becomes stunted and crooked on poor shallow soil. It is a moderate light demander and is not frost hardy.The wood is light yellow with an unpleasant odour when freshly cut, lustrous, somewhat interlocked grained, medium and even textured, moderately heavy and strong.

The timber is used for indoor building puposes, furniture, cabinet work, carving, ploughs, yokes, carts etc.

Volume equation developed

75.	Based on the data from Bihar and U.P.	V	= -0.182942+0.196873D^2H +0.008401H ($n=276$, $R^2=0.9446$)

Lagerstroemia lanceolata

General description of the species

(Please refer to the notes in Chapter I)

Volume equations developed

76.	Goa	VUB V	= 0.049772+0.282077D^2H ($n=54$, $R^2=0.9558$)
		VUB $\sqrt{V}$	= -0.238101+2.997947D^2 ($n=54$, $R^2=0.9568$)

Lagerstroemia parviflora

General description of the species

(Please refer to the notes in Chapter I)

Volume equations developed

77.	Assam	VUB V	= -0.152267+0.3194D^2H ($n=9$, $R^2=0.9575$)
		VUB $\sqrt{V}$	= -0.396250+3.669093D ($n=9$, $R^2=0.9938$)

Lannea coromandelica

General description of the species

(Please refer to the notes in Chapter I)

Volume equations developed

78.	Andhra Pradesh, Bihar, Maharashtra and Orissa.	$V = -0.06927-1.0343x10^{-4}D^2+0.00138H +0.3385x10^{-4}D^2H$ (n=252)
	HARYANA	
79.	Morni Hills, Pinjore division.	$VOB = -0.387939+0.357845D^2H -0.0263911\ (D^2H)^2$ (n=111, R^2=0.9485)
80.	Morni Hills, Pinjore division.	$VOB = -0.872228+3.582583D+0.0612263/D$ (n=111, R^2=0.9447)
81.	Morni Hills, Pinjore division.	$VUB = -0.00684856+0.259017D^2H -0.0104249\ (D^2H)^2$ (n=111,R^2=0.9405)
82.	Morni Hills, Pinjore division.	$VUB = -1.565084+4.062855D+0.23381/D -0.012245/D^2$ (n=111, R^2=0.9508)

Melanorrhoea usitata

General description of the species

A large deciduous tree, up to 18m in height and 2.7 m in girth, with a straight cylindrical bole up to 9 m long, found in Manipur. Young branches villous, bark dark grey, exfoliating in small angular thin flakes, leaves oblong or obovate-cuneate.

The tree is a light demander, but appears to benefit from slight shade when young. Natural regeneration is good in areas where trees are not subjected to heavy tapping for lacquer. Good seed years, however, are irregular. A natural varnish, known as Burmese lacquer or Thitsi, is obtained by tapping trees through V-shapped incisions in the bark. This is widely used in Manipur, Burma and Siam as a water proofing paint for boats and household vessels.

The tree yields a hard and durable timber. The timber is used for building purposes for furniture, bridge construction etc.

Volume equation developed

83. Based on the data from Manipur — VOB V = $0.098912+0.309411D^2H$ ($n=19$, $R^2=0.9773$)

Pinus caribaea and Pinus patula

General description of the species

To augment the meagre resource of long fibred pulping material in the country the researches led to the introduction of exotic conifers. The choice fell on tropical conifers because of their adaptability to considerable climatic and edaphic variations, less exacting nature both with regards to soil moisture and soil fertility and its high rate of growth.

Tropical pines have been tried in several states in varying proportions. *Pinus patula* and *Pinus caribaea* have shown success but the performances are not uniform.

Volume equations developed

84. Based on the data from New Forest, Dehra Dun — VUB TV = $0.40279D^2H+0.03684/2 \cosh 4.2 (0-D^2H)-0.01837$ ($n=60$, $R^2=0.986$)

85. Based on the data from New Forest, Dehra Dun — VUB TVs = $0.34489D^2H-0.02487/2 \cosh 8.3 (0-D^2H)+0.01424$ ($n=110$, $R^2=0.9741$)

86. Based on the data from New Forest, Dehra Dun.

VUB Log h = $1.0186+0.089171 \log d$ ($n=13$, $R^2=0.0081$)

VUB V = $0.013693+0.34659D^2H$ ($n=13$, $R^2=0.8877$)

VUB Log h = $0.06592+0.85211 \log d$ ($n=12$, $R^2=0.7293$)

VUB = $0.013693+0.34659D^2H$ ($n=12$, $R^2=0.9702$)

Pinus wallichiana

General description of the species

(Please refer to the notes in Chapter I)

Volume equations developed

87.	Jammu & Kashmir, U.P. and Himachal Pradesh	V	= -118.1167+0.4034XBAxHC (n=198, R^2=0.9605)

Pinus khasiya

General description of the species

(Please refer to the notes in Chapter I)

Volume equations developed

88.	Orissa, U.P., West Bengal and Tamil Nadu.	VOB	= 0.006267414+0.344573D^2H (n=152, R^2=0.99)
89.	Orissa, U.P., West Bengal and Tamil Nadu.	VUB	= -0.0008966476+0.280998D^2H (n=126, R^2=0.98)
90.	Koraput-Orissa	√VOB	= -0.09794292+2.677145D (n=50, R^2=0.93)
91.	Koraput-Orissa	√VUB	= -0.1009729+2.419254D (n=50, R^2=0.92)
92.	Balliguda division of Orissa	√VOB	= -0.1325421+3.205593D (n=57, R^2=0.97)
93.	Balliguda division of Orissa	√VUB	= -0.1399898+2.953166D (n=57, R^2=0.97)
94.	Manipur	VOB V	= 0.007118+0.360313D^2H (n=16, R^2=0.9580)

Poplar (Populus deltoides)

General description of the species

The poplar is being raised in Uttar Pradesh as a fast growing species capable of yielding high volume at a relatively low age. Amongst the various exotics tried, *Populus deltoides* has the most promising result and is being raised on large scale in the plains of U.P. between 26°N to 30°N latitude. Poplar wood is well suited to industries such as matchs, pulp and paper, fibre board etc.

Volume equations developed

95.	Based on the data from U.P.	VOB V	$= 0.2728+0.0052D^2H$ ($n=130$, $R^2=0.9787$)
		VOB $\sqrt{V}$	$= 2.6513-0.0929D$ ($n=130$, $R^2=0.9696$)
96.	Based on the data from U.P. state	VUB V	$= -0.001099+0.216548D^2H$ ($n=22$, $R^2=0.9571$)

Populus ciliata

General description of the species

A large deciduous tree. Bark greenish-grey smooth when young, brown with deep vertical fissures when old. Wood grey or brownish-grey and soft. Annual rings marked by smaller and fewer pores in the autumn wood.

This is a common and conspicuous tree in the western Himalaya, from Kashmir to Bhutan at 1200-3,050 m in mixed forests, with the Ban and Moru Oaks, the Deodar and Blune pine. It grows fairly fast, quicker at first more slowly as it gets old, 8 to 9 rings per inch of radius being about an average.

The wood is used for cattle trough and the leaves as fodder for goats. The wood would do well, where there is a demand, for planking, boxes, match wood and various other purposes.

Volume equations developed

97.	Uttar Pradesh	VOB	$= 0.004529+0.286131D^2H$ ($n=425$, $R^2=0.97$)

98. Uttar Pradesh — VUB = $-0.003241+0.250658D^2H$ ($n=425$, $R^2=0.96$)

99. Uttar Pradesh — $\sqrt{VOB} = -0.143393+3.040067D$ ($n=425$, $R^2=0.97$)

Pterocarpus marsupium

General description of the species

(Please refer to the notes in Chapter I)

Volume equation developed

Standard Timber Volume (πr^2) (U.B.) in cubic metre

100. Andhra Pradesh, Bihar Maharashtra and Orissa.

$$V = -0.178097+0.000457H+0.261731\times10^{-4}HD^2+1.660792\times10^{-4}D^2$$ ($n=728$)

Shorea robusta

General description of the species

(Please refer to the notes in Chapter I)

Volume equations developed

101. U.P. and West Bengal

$V = -0.0894+0.2605D^2H$ ($n=4010$, $R^2=0.9580$)

$\sqrt{V} = -0.2736+3.3241D$ ($n=1241$, $R^2=0.7801$)

102. U.P., Orissa and Bihar

VUB $V = -54.1068+0.3237\times BA\times HC$ ($n=172$, $R^2=0.81543$)
where BA = Basal area in m^3/ha
HC = Crop height in m

(Silver Fir)/*Abies densa*

General description of the species

(Please refer to the notes in Chapter I)

Volume equation developed

103.	Seraj Forest division of H.P.	V	= -389.6969+16.2356xBA(m^3/ha) (n=27, R^2=0.9066)

(Silver Fir)*Abies pindrow*

General description of the species

(Please refer to the notes in Chapter I)

Volume equations developed

104.	H.P., Jammu and Kashmir and U.P.	V	= 0.1196+0.2558D^2H (n=804, R^2=0.9688)
		$\sqrt{V}$	= -0.4643+3.9759D (n=804, R^2=0.9567)

Syzygium cumini

General description of the species

(Please refer to the notes in Chapter I)

Volume equations developed

105.	Satara and Savantwadi of Maharashtra. Porahat, Latehar and Gumla Forest divisions of Bihar.	V	= -0.17369+2.5591x$10^{-4}D^2$ +0.0061H+0.1020x$10^{-4}D^2H$ (n=341)
106.	U.P.	VUB V	= -0.123477+0.279115D^2H (n=988, R^2=0.9368)
		VUB $\sqrt{V}$	= -0.372495+3.026064D (n=988, R^2=0.9239)

Tectona grandis

General description of the species

(Please refer to the notes in Chapter I)

Volume equations developed

107.	Kerala, M.P., Karnataka, Orissa, Tamil Nadu and U.P.	VUB	V	$= -0.0645+0.2322D^2H$ ($n=2021$, $R^2=0.8602$)
			$\sqrt{V}$	$= -0.5514+3.8590D$ ($n=2012$, $R^2=0.9569$)

Local volume equation

108.	All India		$\sqrt{V}$	$= -0.1163+2.8013D$ ($R^2=0.9999$)
109.	All India		V	$= 0.1657-1.1235D+8.0855D^2$ ($R^2=0.9999$)
110.	M.P., Maharashtra, Karnataka, Kerala and Tamilnadu.	VUB	V_1	$= 0.19601K_1+0.25659D^2H-0.10787$ ($n=660$, $R^2=0.9781$)
		VUB	V_2	$= 0.20416K_1+0.25514D^2H+0.10375$ ($n=660$, $R^2=0.9741$)

where K_1 = Dummy variable
V_1 = Total tree volume (Standard Timber in m^3)
V_2 = Total tree volume in m^3

Terminalia belerica

General description of the species

(Please refer to the notes in Chapter I)

Volume equations developed

111.	Goa	VUB V	= -0.032786393+0.27396617D^2H (n=39, R^2=0.9749)
		VUB $\sqrt{V}$	= -0.233307+2.803750D (n=39, R^2=0.9649)

Terminalia tomentosa

General description of the species

(Please refer to the notes in Chapter I)

Volume equation developed

112.	Bihar M.P., Karnataka, Orissa, U.P. and West Bengal.	V/D^2	= 1.856495+0.218882H -0.196202/D^2 (n=594,R^2=0.7137)

Terminalia paniculata

General description of the species

(Please refer to the notes in Chapter I)

Volume equations developed

113.	Goa	VUB V	= -0.103241+0.307142D^2H (n=69, R^2=0.9870)
		VUB $\sqrt{V}$	= -0.351539+3.215392D (n=69, R^2=0.9488)

Tetrameles nudiflora

General description of the species

(Please refer to the notes in Chapter I)

Volume equations developed

114. Assam

VUB V = -0.129836+0.281525D^2H (n=11, R^2=0.9710)

VUB $\sqrt{V}$ = -0.552325+3.808665D (n=11, R^2=0.9508)

Toona ciliata

General description of the species

(Please refer to the notes in Chapter I)

Volume equation developed

115. West Bengal and U.P.

V = -0.124830+0.284996D^2H (n=83, R^2=0.9764)

Trewia nudiflora

General description of the species

(Please refer to the notes in Chapter I)

Volume equation developed

116. Pilibhit, Haldwani, Dehra Dun and Bahraich forest divisions of U.P.

V2 = -0.07042+0.289D^2H (n=352, R^2=0.9702) (V2=Standard Timber volume in m^3)

Xylia xylocarpa

General description of the species

(Please refer to the notes in Chapter I)

Volume equations developed

117. Goa

VUB V = -0.033109+0.269456D^2H (n=96, R^2=0.883)

VUB $\sqrt{V}$ = -0.244801+2.8765594D (n=96, R^2=0.9110)

Zanthoxylum rhetsa

General description of the species

(Please refer to the notes in Chapter I)

Volume equations developed

118. Assam	VUB V	$= -0.200493+0.314713D^2H$ $(n=9, R^2=0.9902)$
	VUB $\sqrt{V}$	$= -0.518911+3.815328D$ $(n=9, R^2=0.9868)$

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