Technical Bulletin No.12

GOVERNMENT OF MADHYA PRADESH
FOREST DEPARTMENT

STANDARD VOLUME TABLE
OF
BOSWELLIA SERRATA ROXB

FOR
NIMAR TRACT
IN
MADHYA PRADESH

BY

O.P. SAXENA
A.S. RAWAT & B.P. SHARMA

ISSUED BY
THE MENSURATION BRANCH (1970-71)
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PREFACE

Boswellia Serrata Roxb., locally known as Salai occurs frequently in Dry Deciduous Forests and is quite often gregarious on dry ridges and hill slopes. It is found almost all over Madhya Pradesh in varying proporhois.

It had little economic importance in the past and how it is finding ever increasing use mainly in paper pulp and packing cases industry. Paper Mills mix it up with long fibred pulp for manufacture of paper (mainly for news print). It was, felt necessary to compile volume table for this species. The Advisory board for forest research for State Forest Research Institute, Madhya Pradesh, Jabalpur, during its meeting in 1968 resolved that compilation of volume table for Salai should be taken at hand by the Mensuration Branch immediately. To start with Nimar Tract was given preference over other Salai bearing regions for collection of data as the National News Print and Paper Mills Nepanagar is supplied the required quota of Salai wood from this tract.

So far there was no volume table for Salai for Madhya Pradesh except one prepared by S.K. Seth and S.N. Dabral (1960). These tables, however, were based mainly on the collected from Palaman Division Bihar and Rajpipla Division, Saurasttra and only 35 trees from Shivpuri & Gwalior Divisions represented the northern part of Madhya Pradesh in these tables. These 35 trees constituted as little as 90% of the total data. An attempt has been made to cover the South-Western portion of Madhya Pradesh locally known as the Nimar tract and standard volume tables have been compiled which forms Part I of this bulletin. These tables can be directly applied to Nimar tract Commercial volume tables were not prepared as the limits to utilise Salai commercially (mainly for pulp) coincide with that of the standard ones. As and when sufficient data gets collected from other parts of Madhya Pradesh for the species general tables can be compiled for the whole State also utilizing this data.

From different divisions of Nimar Tract namely the forest division of East Khargone, West Khargone, North Khandwa, South Khandwa and also Harda Division (though this does not fall in geographical limits of Nimar tract) 366 representative trees in all covering different height and diameter classes have been selected cut, measured and necessary data collected in prescribed F.P.I. forms. Computation of basic data and counter checking was completed by Forest Ranger C.M. Vyas, Forest Ranger, A.J. Sharma, Forest Ranger S.K. Negi, Dy. Ranger H.D.R. Singh, Dy. Ranger J.L. Maravi and Dy. Ranger O.P. Pathak during the rains of 1969 under the direct supervision of Shri A.S. Rawat, Mensuration Officer. Their assistance is gratefully acknowledged.

The method adopted for compilation of these tables is convertional which is detailed in Silvicultural Research Code Vol.III (The tree and crop Measurement Manual) by A.L. Griffith and Jagdamba Prasad (1949 Edition). Other advanced techniques of compilation have been evolved viz. Volume basal area line method (studying regression of volume on basal area) for compilation of volume tables evolved by Humonel F.C. (British Forest Commission Bulletin No.24, 1955). This has been successfully applied for broad leaved species in India with appropriate changes. If facilities of electronic computor are available, the compilation work of Volume Tables becomes very easy and accurate at the same time. Several equations with different combinations of variables can be tested and the one which gives the

smallest sum of squares (unexplained by regression) can be selected. The conventional method has, however, been favoured as the Advisory Board in its meeting in 1969 suggested that conventional method be applied to compile the volume tables and the same be explained lucidly so that even the non gazetted staff may understand the procedure and adopt it for compilation of volume tables for various species of economic importance at divisional level which is their immediate need.

Part II of the bulletin, accordingly, pertains to a simple (conventional) procedure explaining as to how volume tables can be compiled at divisional level and easily understood even by an officer of the rank of a Forest Ranger. The procedure is more or less the same as detailed in the Silvicultural Research Code Vol.III with slight changes such as change of units into corresponding units of metric system and further elucidation of some of the steps. This was all the more nessiciatated because there were reports from various quarters that the research code was not available every where and was out of print.

It is hoped that the bulletin shall find immense use for the purpose for which is meant among the forest officers in the State. Any healthy critison or suggestions to improve upon any part of the bulletin would be welcomed gratefully.

0Jabalpur

Director
State Forest Research Institute
Jabalpur, M.P.

DEFINITIONS

1.	Standard Timber exclusive	Logs with a minimum diameter of 20 cms over bark at thin-end, volume being taken of bark.
2.	Standard bole	Length of the bole from ground level upto the point where the average diameter over bark is 20 cms.
3.	Twice bark thickness	Difference between the average diameter over and under bark.
4.	Bark percentage of total volume	Percentage of difference of sectional areas over bark and under bark devided by sectional area over bark at half height of a tree.
5.	Bark percentage in volume of logs	Percentage of difference of mid sectional area over bark and under bark divided by sectional area over bark.
6.	Branch small wood	Branches upto 5 cms dia over bark
7.	Standard small wood over diameter of 5	Anything less than 20 cms mean diameter bark down to a minimum mean cms over bark at the end.
8.	Branch small wood volume	Volume of branch small wood.
9.	Standard small wood volume	Volume of small wood on the standard definitions calculation by full basal area and including bark.
10.	Commercial stem timber in round	The volume without bark of a commercial bole in a sound tree.
11.	Commercial bole	The length of the bole which the contractor is actually prepared to convert into sawn timber.
12.	Sapwood percent in commercial timber.	Percentage of the following factor reduced from one. Factor - S1" + 2S2" + S3"/S'1 + 2S'2 + S'3 where S'1, S'2, S'3 being the sectional areas corresponding to the diameter with Sap wood at buttend section, and section and thin-end section and S"1, S"2 and S"3 are the sectional areas corresponding to these diameters without sap wood at those places.
13.	Fuel-wood	The total small wood and portion of Standard timber which is unutilisable as timber.

STANDARD VOLUME TABLES FOR *BOSWELLIA SERRATA*, ROXB. (NIMAR TRACT, MADHYA PRADESH)

BY

O.P. Saxena, A.S. Rawat & B.P. Sharma

INTRODUCTION

Boswellia Serrata Roxb. commonly known as Salai or Saler is a moderate sized to large deciduous, usually gregarious, tree with light spreading crown and some what drooping branches. It has compound imparipinnate leaves 30-45 cms long. Its bark is greenish grey to yellow or reddish, fairly thick, smooth, exfoliating in their paper flakes and resinons inside. The trees ordinarily reach a height of 15 to 18 metres and a girth of 120 cms to 150 cms at b.h. in the tract covered by these volume tables.

It is a common tree species of dry deciduous forests and usually gregarious on dry, hot and barren hills. The drier ridges of the Satpura hills are sometimes exclusively covered with Salai. It is able to thrive and to reach fair dimensions on the poorest and shallowest soil where its associates remain stunted. It is a strong light demander and does not suffer from isolation. A successful technique to regenerate Salai yet remains to be evolved.

Salai wood is quite soft as compared to other hard wood species. It is whitish, resinous with a small brown heartwood. Annual growth rings on the fresh stump are not conspicuous. Salai no more remains a secondary species and it has already established its prominence amongst the other hardwoods in commercial or industrial exploitation. In Nimar Tract of the Salai wood is exploited in bulk for feeding the National News Print and Paper Mills, Nepanagar, Madhya Pradesh (established in 1956). In other forest areas also (like Shahdol District, Madhya Pradesh where Orient Paper Mills, Amlai was established in 1964) Salai is being exploited for manufacture of paper pulp. Its fibre length, however, is comparatively small and it is mixed up with bamboo (approximately in the ratio of 1:9) for manufacture of paper pulp. It also leaves a yellow colouring matter to the pulp. Therefore it is used in very little proportions for manufacture of a better quality paper pulp. It can, however, be safely said that with the expansion of paper pulp industry demand of Salai wood shall be ever increasing and in due course of time almost all the Salai forests of the State shall come under economic exploitation. Besides this Salai wood is extensively used for manufacture of packing cases. In Match industry the wood is utilized for making splints. It is tapped for gum and oleoresin for manufacture of terpentine and resin for prints and varnishes in the northern though it is of limited economic value.

With the increasing use of Salai wood for various purposes mentioned above further studies of its Silvicultural requirements, methods of regeneration and volume production etc. are required and efforts to solve these problems are afoot.

These volume tables which form Part I of this bulletin have been compiled exclusively for Nimar Tract of the State as this whole tract falls within economically exploitable radius for exploitation of Salai wood to feed the National News Print and Paper Mills, Nepanagar. Nimar tract comprises of four forest divisions viz. East Khargone Dn., West Khargone Dn., North Khandwa Dn., and South Khandwa Dn.

Besides these four divisions data has also been collected from Harda Forest Division which lies adjacent to Nimar tract and is worked for Salai on the same lines. As per description of forests of Nimar tract by Working Plan Officers Salai is the next best associate of teak (*Tectona grandis*) the first being Saja (*Terminalia tomentosa*) occuring in Southern tropical dry deciduous Dry Teak forests (5A/CIb of Champion and Seths classification of forest types), other associates being Haldu (*Adina cordifolia*), Dhaora (*Anogciscus latifolia*), Lendia (*Lager stroemia parviflora*), Shisham (*Dalbergia latifolia*), Bija (*Pterocarpus marsupium*), Rohan (*Sovamida fabrifuga*), Kalam (*Nitragypa parvifolia*), Mahua (*Madhuca latifolia*), Dhoban (*Dalbergia paniculata*), Tendu (*Diospyros melanoxylon*), Achar (*Buchania lanzan*), Tinsa (*Ougenia dalbergiordes*), Kasai (*Bridelia retusa*) and Bauhinia spp. In very dry teak forests (type 5A/CIa) Salai becomes the major associate and proportion of Saja falls off. In Southern tropical dry mixed deciduous forests (5A/C3) where soil is found more shallow Salai is the predominent species. Other species occurring with Salai are Bija, Anjan, Saja, Kullu (*Sterculia urens*), Dhaora, Lendia, Tendu, Bel (*Aegle marmalos*), Khain (*Acacia catechu*), Galgal and Dudhi (*Holorrhena antidysentrica*) Under dry, shallow and stony soil conditions which generally exist in hill tops and higher slopes salai occurs all along forming gregarious Salai forests (5B/E2). The site quality in all these forest types generally vary from M.P.Q.III to IV b. (Height of dominant mature from trees varying from 70 feet to below 40 feet).

In all 366 trees of Salai were selected, cut, measured and necessary data was collected in metric units. A statement of the distribution of trees by diameter and height classes in different forest divisions is given in table A. In all the Working Plans prepared for the tract Salai over lapping Working Circles in each forest division. For this purpose respective Divisional Forest Officers were contacted who directed the field staff to such Salai areas. A list of compartments from where data has been collected in each division is given in Table 'B'.

The requisite data has been collected and recorded in F.R.I. Form 28 (Sample plot form 7). The conventional graphical method as described in Silvicultural Research Code Vol.III (The tree and crop measurement Manual) 1949 Edition, Chapter III has been followed to compile these volume tables. Standard definitions followed in preparing these tables are given for reference in the beginning. 5 cm diameter classes and 3 metre height classes have been adopted for grouping the data. All the tables have been prepared in metric units. Though volume was calculated in cubic metres upto four decimal places, volume (standard timber and small wood) has been read to the nearest 0.005 cu.metres as graphical method was used to prepare the tables. For standard small wood volume table of total volume (Standard timber and standard small wood) was prepared first and then substracting corresponding figures of standard timber volume tables from figures of total volume tables, small wood volume tables have been prepared.

Following set of tables have been prepared :-

Table I Total standard stem Timber in round

solid (πr^2) volume under bark

(a) by diameter and height classes

(b) by girth and height classes

Table I C - Total volume (Timber & Small wood) solid volume πr^2 in the round by diameter classes.

Table I D - Total volume (Timber & small wood) Solid volume (πr^2) in the round by girth classes.

Table II - Total standard small wood solid πr^2 volume over bark

(a) by diameter and height classes

(b) by girth and height classes

Table III - Length of standard timber bole, twice bark thickness and bark percentage by diameter classes only.

Aggregate check and height diameter class checks ,for timber and small wood volume have been applied to the tables. The average deviation and aggregate difference percentage has been recorded in the end of each table.

These tables can be directly applied to obtain volume estimates of Salai trees in Nimar tract. For other areas belonging to M.P.Q. III to IVb, the tables should be used with caution. The applicability should be tested as per procedure explained on page 33 of this bulleting.

Part II of the bulleting deals with the conventional (graphical method of compilation of volume tables which is self explantory and any forest ranger can understand the procedure. This may be very helpful to the Divisional Forest Officers to compile standard volume tables for their respective divisions for various species of economic importance.

PART I

STANDARD VOLUME TABLES

FOR

BOSWELLIA SERRATA ROXB.

NIMAR TRACT, MADHYA PRADESH

Table I (a) *Boswellia serrata*

Total timber in the round solid (πr^2) volumes under bark (From curve No.1)

Diam. class (b.h.) O.B.in C.M.	Height class in Metres			
	61-90	91-120	121-150	151-180
	Volume in cubic metres			
15.1-20.0	0.020	0.040	-	-
20.1-25.0	0.050	0.100	0.125	-
25.1-30.0	0.075	0.150	0.190	(0.240)
30.1-35.0	(0.100)	0.210	0.265	0.330
35.1-40.0	-	0.290	0.360	0.435
40.1-45.0	-	0.400	0.480	0.580
45.1-50.0	-	0.525	0.645	(0.765)

Note : 1. Figures in brackets are based on less number of trees or an Extrapotation of curves.

2. On application of aggregate check the difference between the actual volume of trees measured and the total volume read off from the final curves for actual average diameter and interpolated actual average height has found to be ± 1.4% and the average difference to be 5.4%

Table I (b) *Boswellia serrata*

Total timber in the round solid (πr^2) volumes under bark

Girth class (b.h.) over bark in cms.	Height class in metres 6.1-9.0	9.1-12.0	12.1-15.0	15.1-18.0
	Volume in cubic metres			
45.1-60.0	(0.020)	(0.040)		-
60.1-90.0	0.055	0.100	0.145	-
90.1-120.0	0.105	0.220	0.280	0.345
120.1-135.0	-	0.350	0.430	0.520
135.1-150.0	-	0.475	0.575	0.690

Note : Figures in brackets are based on less number of trees or can extrapolation of curves.

Table I (c)

Species : ***Boswellia serrata***

Total volume (Timber + small wood) Solid volume (πr^2) in the round

Diam.class (b.h.) O.B.in cms.	Height class in Metres 6.1-9.0	9.1-12.0	12.1-15.0	15.1-18.0
10.1-15.0	(0.010)	(0.060)	-	-
15.1-20.0	0.050	0.105	-	-
20.1-25.0	0.095	0.165	0.225	-
25.1-30.0	0.140	0.225	0.290	-
30.1-35.0	(0.185)	0.300	0.370	0.445
35.1-40.0	-	(0.385)	0.475	0.565
40.1-45.0	-	(0.510)	0.615	0.725
45.1-50.0	-	(0.650)	0.815	(0.945)

Note : Figures in brackets are based on less number of trees or an extrapolation of curves.

Table I (d) Species : *Boswellia serrata*

Total volume (Timber + small wood) Solid volume (πr^2) in the round

Girth class in cms.	Height class in Metres 6-9	9-12	12-15	15-18
	Volume in cubic metres			
20.1-45.0	(0.005)	(0.015)	-	-
45.1-60.0	0.065	0.100	-	-
60.1-90.0	0.135	0.190	0.235	-
90.1-120.0	(0.240)	0.330	0.385	0.425
120.1-135.0	-	0.475	0.565	0.660
135.1-150.0	-	0.615	0.755	0.885

Note : Figures in brackets are based on less number of trees or on extrapolation of curves.

Table II (a)

Total small wood volume solid (πr^2) volumes over bark

Diam.class (b.h.) O.B. in cms.	Height class in Metres 6.1-9.0	9.1-12.0	12.1-15.0	15.1-18.0
	Volume in cubic metres			
10.1-15.0	(0.010)	(0.060)	-	-
15.1-20.0	0.030	0.065	-	-
20.1-25.0	0.045	0.065	0.100	-
25.1-30.0	0.065	0.075	0.100	-
30.1-35.0	(0.085)	0.090	0.105	0.115
35.1-40.0	-	(0.095)	0.115	0.130
40.1-45.0	-	(0.110)	0.135	0.145
45.1-50.0	-	(0.125)	0.170	(0.180)

Note : 1. Figures in brackets are based on less number of trees or an extrapolation of curves.

2. On application of aggregate check the difference between the actual volume of the trees measured and the total read off from the final curves for actual average diameter and interpolated actual average height was found to be ± 3.7% and average difference to be 7.8%.

Table No.II (b)

Boswellia Serrata

Total volume (Small wood) solid volume πr^2 in the round

Girth class in cms.	Height class in Metres 6.1-9.0	9.1-12.0	12.1-15.0	15.1-18.0
	Volume in cubic metres			
20.1-45.0	(0.005)	(0.015)	-	-
45.1-60.0	0.010	(0.060)	-	-
60.1-90.0	0.030	0.090	0.90	-
90.1-120.0	-	0.110	0.105	0.080
120.1-135.0	-	0.125	0.135	0.140
135.1-150.0	-	0.140	0.180	0.195

Note : Figures in brackets are based on less number of trees or on extrapolation of curves.

Table No.III

Boswellia serrata

Data of Twice bark thickness, bark percentage and length of standard timber bole

Diam.class (b.h.) over bark in cms.	Twice bark thickness in cms.	Bark per-centage	Length of standard timber bole in meters	Number of observation
10.1-15.0	(2.2)	(40.5)	-	5
15.1-20.0	2.6	36.8	2.8	17
26.1-25.0	3.0	33.4	3.6	60
25.1-30.0	3.5	30.4	4.2	73
30.1-35.0	3.8	28.0	4.7	87
35.1-40.0	4.1	25.8	5.1	67
40.1-45.0	4.3	24.2	5.4	27
45.1-50.0	4.5	23.2	5.6	21
50.1-55.0	4.6	22.4	5.7	8
55.1-60.0	(4.7)	(22.0)	-	1

Note : Figures in bracket are based on less number of trees or extrapolation of curves.

TABLE A

TABLE SHOWING DISTRIBUTION OF SALAI TREES OF DIFFERENT DIAMETER AND HEIGHT CLASSES IN VARIOUS DIVISIONS OF NIMAR TRACT M.P. FOR PREPARATION OF STANDARD VOLUME TABLES

Height Class	6.1 to 9.0										9.1 to 12.0										
Diameter Class / Name of Division	10.1 to 15.0	15.1 to 20.0	20.1 to 25.0	25.1 to 30.0	30.1 to 35.0	35.1 to 40.0	40.1 to 45.0	45.0 to 50.0	50.1 to 55.0	55.1 to 60.0	10.1 to 15.0	15.1 to 20.0	20.1 to 25.0	25.1 to 30.0	30.1 to 35.0	35.1 to 40.0	40.1 to 45.0	45.0 to 50.0	50.1 to 55.0	55.1 to 60.0	Trees
Khandwa Dn.	2	4	2	-	-	-	-	-	-	-	3	7	21	9	6	2	-	-	-	-	56
Khandwa Dn.	-	-	-	-	-	-	-	-	-	-	-	-	1	8	5	4	-	2	-	-	20
Khargone Dn.	-	-	-	1	-	-	-	-	-	-	-	-	1	2	8	2	-	2	1	-	17
Khargone Dn.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harda Dn.	-	-	-	-	-	-	-	-	-	-	-	1	2	5	8	2	1	-	1	-	20
Total	2	4	2	1	-	-	-	-	-	-	3	8	25	24	27	10	1	4	2	-	113
Exact Total										9										104	

Height Class	12.1 to 15.0										15.1 to 18.0										
Diameter Class / Name of Division	10.1 to 15.0	15.1 to 20.0	20.1 to 25.0	25.1 to 30.0	30.1 to 35.0	35.1 to 40.0	40.1 to 45.0	45.0 to 50.0	50.1 to 55.0	55.1 to 60.0	10.1 to 15.0	15.1 to 20.0	20.1 to 25.0	25.1 to 30.0	30.1 to 35.0	35.1 to 40.0	40.1 to 45.0	45.0 to 50.0	50.1 to 55.0	55.1 to 60.0	Trees
Khandwa Dn.	-	5	28	16	12	4	1	-	-	-	-	-	-	-	-	-	1	-	-	-	67
Khandwa Dn.	-	-	-	6	13	11	6	6	2	-	-	-	-	1	4	3	4	2	1	1	60
Khargone Dn.	-	-	-	5	3	6	3	4	-	-	-	-	-	1	3	2	4	4	1	-	37
Khargone Dn.	-	-	-	3	7	3	1	1	-	-	-	-	-	-	3	11	12	6	-	-	47
Harda Dn.	-	-	3	5	8	9	-	2	-	-	-	-	-	-	3	1	1	2	2	-	38
Total	-	5	31	35	43	33	11	13	2	-	-	-	2	13	17	22	14	3	4	1	249
Exact Total										173										76	

Height Class	12.1 to 15.0										
Diameter Class / Name of Division	10.1 to 15.0	15.1 to 20.0	20.1 to 25.0	25.1 to 30.0	30.1 to 35.0	35.1 to 40.0	40.1 to 45.0	45.0 to 50.0	50.1 to 55.0	55.1 to 60.0	Trees
Khandwa Dn.	-	-	-	-	-	-	-	-	-	-	-
Khandwa Dn.	-	-	-	-	-	-	-	-	-	-	-
Khargone Dn.	-	-	-	-	-	-	-	-	1	-	1
Khargone Dn.	-	-	-	-	-	-	2	1	-	-	3
Harda Dn.	-	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	2	1	1	-	4
Exact Total										4	366

Table - B

Statement showing Range and Compartmentwise distribution of Sample trees in various forest divisions.

S.No.	Name of Forest Division	Range	Comptt.No.	No.of trees collected
1.	South Khandwa	Asirgarh	169	43
		Barhanpur	170	7
		Nepanagar	60	25
		Nepanagar	-	48
			Total	**123**
2.	North Khandwa	Singhoji	269	20
		W.Kalibhit	477	10
		E.Kalibhit	478	10
		Bolodi	410	8
		Bolodi	382	12
		Aonlia	360	10
		Chandgarh	487	10
			Total	**80**
3.	Harda	Mogardha	49	14
		Mogardha	45	11
		Rahatgaon	176	15
		Rahatgaon	153	10
		Makdai	-	9
			Total	**59**
4.	East Khargone	Badwaga	309	20
		Bisthon	F.S.Satpura	30
			Total	**50**
5.	West Khargone	Warla	F.S. Satpura	54
			Total	**54**
			G.Total	**366**

PART - II

A SIMPLE PROCEDURE OF COMPILATION OF VOLUME TABLES

A volume table shows for a given species the average contents of trees of given sizes

(i) OBJECTS :

1. To estimate the volume of an average tree of known linear dimensions. (The estimate may be based on diameter and height measurements together, or on diameter alone in the latter case. Some knowledge of quality class of locality may be necessary, and may require height measurement and age determination of selected trees).

2. To estimate the volume of a given crop, or marked trees in it. (This estimate of aggregate volume may similarly be based on diameter and height measurements, or on diameter and quality class data. The figure obtained may be used by a Divisional Forest Officer as a basis for estimates of a marked coupe, or by a Working Plan Officer for standing volume of a whole felling series and hence for calculating stocking and prescribed yield.

(ii) KIND OF VOLUME TABLES

Two main types of volume table require to be differentiated, viz. General Volume Tables which cover the whole natural range of dimensions for species and Local Volume Tables which are applicable to the more restricted range of dimensions occurring in a given coupe, compartment, or felling series and can be derived from the general tables. Both kinds of table can be expressed in varying units and may include volume down to any desired diameter limit. For use, it is generally a necessary preliminary to determine whether the tables are applicable to the specific instance, the method being given subsequently under head 'Applicability of General Volume Tables'. It is probable that well defined types within a species will require separate general volume tables.

(A) General Volume Tables :

These tables are compiled for successive diameter classes of convenient range (2 cm., 5 cm. and 10 cm are most usual), sub divided into convenient height classes (generally 3 m to 6 m.) or quality classes (taken from yield tables). The chief use of these tables is for the derivation of local tables as described below.

General volume tables may be compiled in a number of forms as described in the following paragraphs :

(1) **Standard Volume Tables** : Here volume is recorded down to the standard limits for timber 8" (20 cm in metric system) overbark at the thin end, with stump included and like wise for small wood is below 8" overbark and upto 2" overbark (in metric system below 20 cm. over bark to 5 cm over bark) if necessary. These tables are mainly of use as a basis for reference.

(2) **Commercial Volume Tables (Outturn in round) :**

The actual diameter limit down to which conversion is done or is customary, is applied instead of the standard limit, stump volume being ommitted. The tables are for use only in areas over which the closeness of

conversion is the same.

Note : These tables are subject to the limit-actions that in practice utilization varies with time (often depending on market conditions) and place. They have much less permanent value than the standard tables, and their chief use is as the basis for preparation of purely local (and usually temporary) tables for individual coupes etc. This value will further vary considerably with the stability of local conditions as regards market requirements in kind and amount. Particularly for the lower diameter classes, violent fluctuations are possible which may throw estimates badly out if these classes form a large proportion of the whole. Whether poles (infact or axe trimmed), or small sized scantling sawn from small trees are saleable or not, will decide in indivisual cases between 0 to 100 percent utilization. In such circumstances, it is advisable to estimate separately for the diameter classes concerned. The wastage in conversion may thus be appreciably affected by the nature of the market demands.

(3) **Sawn outturn tables** : The volume of sawn timber actually sawn from trees of different size classes is given. These tables are comparable with (2) above.

(4) **Assortment Tables** : These given volumes in the round which are included in trees of given height and diameter classes down to various stated this end diameters, so that (1) and (2) above are really special cases of assortment tables.

(5) **Sawn Outturn Assortment Tables** : These tables are similar to (4) above, but give sawn outturn in standard sized pieces instead of volume in the round.

B. Local Volume Tables :

From any of the above five forms of tables, simplified tables can be derived which are applicable to a restricted locality of more or less uniform quality. Classification by height as well as diameter classes is avoided as with uniform quality each diameter class will have a fairly uniform average height. This height is estimated from measurements on a restricted number of typical trees. It must be repeated that it may be necessary to demonstrate that the general tables are applicable to the locality in question vide the heading (Applicability of General Volume Tables).

Note : In view of the value of local tables for practical application to individual coupes it is inadvisable to attempt to make these tables cover to a wide field. It is better to derive local volume tables for each set of conditions encountered, especially as very little work is needed, from given good general tables.

(C) Form Quotient Volume Tables :

All the above tables, both general and local, can be based on form quotients as well as diameters and heights.

Note : In India, Form quotient tables have not been compiled for any species. In item 'A' & 'B' (General Volume Tables and local volume tables) also, standard volume tables and commercial volume tables are mostly prepared as these tables find wide use. A method to compile such tables is given below :

(iii) COMPILATION OF GENERAL STANDARD AND COMMERCIAL VOLUME TABLES :

(A) **General** : The following information

should be recorded with all the volume tables :

(a) Species, Common & Scientific name.

(b) State, detailed locality, quality class of locality, etc. in which the data have been collected.

(c) Units of measurements used, and the portion of the trees measured. (These should whenever possible be the standard ones).

(d) Number of trees measured by d.b.h. and height classes, separately when necessary for each important set of data.

(e) Method of computation (preferably standard).

(f) Checks applied and results.

(g) Relation to other existing volume or yield tables.

(h) By whom the measurements made.

The object of recording these items of information is to make the data available for combination with further data collected on the same lines either previously or in future. Data collected on the standard procedure and definitions are of the widest application.

In the first meeting of the Advisory Board for State Forest Research Institute, Madhya Pradesh, Jabalpur hel at Jabalpur on 26th November 1964, emphasis was laid on compilation of volume tables for miscellaneous species occurring in Madhya Pradesh, preference being given to *Terminalia tomentosa, Acacia catechu* and *Boswellca serrata*.

(B) Field Work :

(a) **Selection trees :**

(1) Trees of typical height and development should be selected in crops covering the range of distribution to which the results are to be applied. They should be evenly distributed over the range of type or quality class concerned.

(2) Trees with defects other than these which would be regarded as average for crops under study such as fork, broken top etc. should not be selected.

(3) Separate sets of trees may be required for different methods of thinning, origin of crops etc.

Note : More discrimination is required in selection of trees to be measured than has been given to it in the past. A smaller number of trees suitably selected will give better results that a much larger number taken with no selections or with conscious or unconcious selection of trees of one type. Generally, trees above the average trend to be selected. A very common error is to take the trees from too restricted a portion of the area to which it is intended to apply the tables, an error often aggrevated by the absence of check or record that the restricted area is in any way typical of the whole.

(b) **Number of trees :**

(4) The number of trees required as a basis for a satisfactory table depends upon :

(i) The grouping adopted

(ii) The precision required

(iii) The deviations of individual

tree volumes from the mean in each group.

It should be determined for each set of tables. 100 trees can be regarded as a satisfactory number for a division provided that the whole range of diameter and heights is fairly evenly covered and that the standard deviation is not too high with the grouping adopted. A method of determining whether an adequate number of trees has been taken is given by the formula :

$$SE = \frac{S.D.}{\sqrt{r}} \quad \text{whence} \quad n = \left(\frac{S.D}{S.E.}\right)^2$$

where

S.E. - denotes standard error
S.D. - denotes standard deviation
n - denotes number of observations

Example : From the commercial measurements of 9 trees of a certain timber species in one diameter and height class, the volumes are computed; required number of trees necessary for measurement so that the volume of the average tree of the class may be accurate within 0.5, cft. would be as under :

Commercial volume (9 trees) = 29.9, 32.8, 26.8, 29.8, 29.3, 29.5, 28.8, 27.3, 30.2 (Cft.)

Total volume of 9 trees = 263.8 (Cft.) (Total)

Average volume $= \frac{263.8}{9} = 29.3$ (Cft.)

Sum of squares $(29.9)^2 + (32.8)^2 + (30.2)^2 = 7757.44$

Correction factor $= \frac{(\text{Total})^2}{\text{number of observation}} = \frac{T^2}{n} = \frac{(263.8)^2}{9}$

$= 7732.27$

Standard Deviation $= \sqrt{\frac{\text{Sum of squares - correction factor.}}{\text{No. of observations-1}}}$

$= \sqrt{\frac{7757.44 - 7732.27}{9-1}}$

$= \sqrt{\frac{25.17}{8}} = 1.774$

Standard error $= \frac{\text{Accuracy required}}{2}$

$= \frac{0.5}{2} = 0.25$

Number of trees required for one diameter and one height class $= \left(\frac{S.A.}{S.E.}\right)^2 = \left(\frac{1.774}{25}\right)^2 = 50$

Therefore in that particular diameter and height class at least 50 trees shall be required if the volume of the average tree of the class is desired to be accurate within 0.5 cft.

It must be stressed again that the resultant figure is of no use if the condition that the trees are reasonably representative of the whole area concerned, is not satisfied.

(C) Measurements :

(5) For standard volume tables, measurements should be collected on standard line. For ready reference 'General Rules For Measurement of Trees' are given in Appendix I. Standard volumes should be recorded whenever possible, even if commercial volumes are primarily required. The extra work involved in recording standard measurements as well as local

commercial volume data is almost always justified, and opportunities of adding in this way to the body of information of general application should not be missed, above all for species concerning which there are few statistical data at present available.

(6) For commercial volume tables the measurements should be collected in prescribed form under General Rule 24, Appendix I.

(7) Measurements should be recorded on the standardised forms F.R.I.139 and 76 for commercial timber and on S.P. forms 7 & 4 for standard timber. A copy of each of these four forms is attached with the appendices.

(C) Computations :

(a) The Individual Tree Volume :

(1) Sectional area corresponding to the average mid-diameter of each section should be read from sectional area tables to 5 decimal places. See Appendix II.

(2) Volume of each section should be calculated by multiplying sectional area by length of section correct to 3 decimal places.

(3) Timber or small wood volume should be obtained by totalling the volumes of the sections measured.

(4) Derived units : If in addition to $\pi r2$ volumes, volumes in other units are required, they should be derived from the final tables based on $\pi r2$ volumes, i.e. derived unit tables should not be obtained independently from the original individual tree volumes measured in such units.

(b) Grouping, Averaging and Tabulating :

(A) By hight and diameter classes :

(5) The following diameter and height intervals are convenient as grouping units (groups or classes) :

Diameter interval 10 cms - For trees usually attaining maturity at 50 cms - d.b.h. & over

Diameter interval 5 cms - For trees usually attaining maturity at 30 cms to 50 cms d.b.h.

Diameter interval 2 cms - For trees usually attaining maturity at height of 24 metres or more.

Height interval 6 metres - For trees usually attaining maturity below 24 metres.

(6) All available data are collected by the selected height and diameter classes on the standardised S.P. Form No.4 an example being reproduced in Appendix III.

(7) For each diameter-height group, the following diameter-height averages should be computed :

1. Diameter B.H.
2. Total height
3. Length of bole (standard or commercial)
4. Timber volume (Standard or commercial)
5. Small wood volume (standard only and only if required)
6. Form factors (any required)
7. Miscellaneous data as required (e.g., thinend diameter, outturn, conversion factor etc.)
8. For each height class (group), average height should be calculated.
9. The diameter-height averages, together with the number of trees on which they are based, should be recorded on a form such as that reproduced in Appendix IV.

This will be referred to as the "table of basic averages" by diameter and height.

10. When no marked correlation with height has been observed in these compilations under Rule 6 above, or the differences by height classes are relatively small, than further compilation should be done by diameter groups only. This is found in the case of bark R.C. calculations.

Note : Preparation of volume tables by diameter class only and by diameters and quality classes' is now out of date. Therefore as far as possible volume tables should be compiled by height and diameter classes as this method gives more accuracy than the other two.

(C) Curves :

(A) Smoothing of basic averages by diameter and height

(17) Values recorded in the table of basic averages Appendix IV. by diameter and height should be smoothed graphically in three successive steps given below :

Step 1 : Diameter height averages of different values (volumes etc.) should be plotted against corresponding diameter height averages of d.b.h., separately for each height groups (class), using distinctive height group marks such as O + Δ / × ϕ etc. The number of measurements forming the basis of each average should be noted against the point.

Smooth curves should be drawn for each height group and then harmonised with reference to one another. Values against the middle of each diameter interval should be read from the curves and tabulated.

Note : Smoothing of curves - The principle "Nature non facitsallus" is accepted in drawing growth curves sharp turns and double inflections are to be avoided unless reasonably explicable by physical factors. Curves should be drawn with the maximum radius of curvature continued over the longest possible stretch. The two processes known as smoothing and harmonising are utilised to help towards this end.

1. Smoothing : By smoothing is meant graduatic of the values of the dependent variable for a given series of values of the independent variable. If the observational errors are considerable, or the data scanty, then it is enstrmay to draw smooth curves, not actually through the points, but evenly among them and as closely as possible to them, on the assumption that the actual function has no very rapid fluctations. In smoothing, the weight of each point should be taken as the square root of the number of observations it represents.

2. Harmonising : By harmonising is meant the graduating relatively to one another, of corresponding values in different classes into which a set of data is divided. In harmonising, the central portion of the central curve-being based on most observations - is taken as the basis, and portion of the curve next to this which is generally based upon scanty data, corrected accordintly, this process being continued to the remotest curve.

The difference between smoothing and harmonising should be noticed; the former relates to values belonging to a

single class and so to a single curve, the latter to values as between class and class, and so to a family of curves.

Step 1 : The average height should be plotted against corresponding average diameter (d.b.h.), using distinctive marks for each height group and noting the number of measurements against the point as in Step 1. Smooth curves should be drawn for each height group. The average heights against the middle of each diameter interval should be read from the curves and tabulated.

Step 2 : The average values tabulated in Step 1 should next be plotted against corresponding average heights tabulated in Step 1.a, separately for each diameter group, using distinctive marks for each group. Smooth curves, which will usually approximately to straight lines should be drawn and harmonised.

Values should then be read from the lines or curves against the middle of each height interval.

Step 3 : The values read from the curves in Step 2 should again be plotted against the middle of diameter intervals and smooth harmonised curves drawn. Final values are read from these curves and tabulated. (This is reproduced in curve No.1 of standard timber volume in Part I).

(d) Tables :

(18) When subordinate tables in units of measurements which are of local or secondary importance are required in addition to tables in standard units which are of wide use and application, the former should always be derived from the latter by use of the conversion factors. In some cases, a factor can be applied to the whole tables.

Example :

	Principle Table Curve	Subordinate Table	Conversion factor
1.	Standard volume/ diam.	Table of πr^2 volume by girths	Girth/diameter
2.	-do-	Table of volume by quarter girth	Girth/diameter and quarter girth volume/πr^2 volume

In other cases, the conversion factor will vary in the several diameter or diameter-height classes. In such cases, curves and tables for the conversion factor against diameter of diameter-height should be derived, and applied to the table in question :

Example :

	Principle Table Curve	Subordinate Table	Conversion factor
3.	Standard volume/ diam.	Commercial volume/ diameter	Calculated percentage of commercial volume to standard volume by diam. classes.
4.	Commercial volume/ diameter	Heartwood/diam.	Calculated percentage of heart wood in commercial volume by diameter classes.

(D) Checks :

(19) The following checks should be made :

(a) **Aggregate check** : The actual volume of the trees measured should be checked against the total volume read from the final curves for actual average diameter and interpolated actual average height, both available from the table of basic data.

The difference should not exceed one percent.

Example :

Standard volume by totalling data	Volume obtained from tables	Volume derived difference	Percentage field
	Cft.		
1. Timber	1,27,923	1,28,509	+ 0.46
2. Small wood	2,637	2,596	- 1.55

The timber is thus well within prescribed limits; for the small wood, a larger variation is permissible and is to expected; the agreement found is close enough.

(b) **Height/diameter class check :** This is merely a further analysis of the aggregate check described above, applied to each diameter and height class. The difference between the total volume obtained from the field data and corresponding value read from the curve against actual average diameter and interpolated actual average height, multiplied by the number of trees in the class, should be differ by more than 5 percent. At the same time, there should be not less than 20 trees in the class for the check to be reliable.

(c) **Relative check** : When two or more tables are derived independently from the same data, they should be checked against each other, e.g. volume directly from field data, and volume as the product of cylinders and form factors.

Note : Detailed procedure to apply relative check is not being given here as such cases are expected to be dealt with in the Research Institute and not by the territorial staff.

(d) **Average deviation check** : The average deviation of actual indivisual tree volumes from these read from the curves (with interpolation for height as necessary) may be computed. The utility of this step is explained in the next paragraph. As, however, this check is very laborious, it need only be applied in the case of tables which are considered of importance from the point of view of their possible wide application.

(E) Applicability of General Volume Tables :

When volume tables are available for a species, the point which is first to be decided is whether or not these tables are directly applicable in a given locality or to a given coupe. For this purpose a small number of trees, 4 to 5 in each diameter height class, i.e. 20 to 25 felled trees in the locality should be selected as prescribed earlier under Rules 1 to 3 of the subhead (B) Field work, then measurements (standard or commercial as the case may be)

carefully recorded, and the corresponding volumes read from the curves. The differences (without regard to sign) of the comparable values of these two series should be averaged (average deviation), and also their algebric sum determined (aggregate difference).

For the tables to be directly applicable, it is necessary that :

(i) Average deviation (A.D.) of test trees should be of the same order of magnitude as that of the basic data of the table.

(ii) The aggregate difference should not exceed $\frac{2 \times A.D.}{\sqrt{n}}$

Example :

Commercial measurements of 12 trees of a particular species covering a fairly wide range of diameters were made in a certain area; test is required whether the existing volume tables of the said species are applicable or not. The average deviation of the basic data of the tables is taken as 7 percent.

The measurements of the test trees, the actual calculated volumes, the corresponding table volumes obtained by interpolation to exact height and necessary computations are given in the following table :

Tree No.	D.b.h. ins.	Total Ht. (ft)	Commercial Volume			Computations
			Actual	From the curved	Difference	
1.	15.1	98	25.8	33.0	7.2	Aggregate difference
2.	19.6	80	51.0	45.8	5.2	$= \frac{1852.9-1772.2}{1772.2}$
3.	22.2	93	65.1	70.0	4.9	
4.	23.6	116	111.9	100.4	11.5	= 4.6 percent
5.	24.5	128	130.7	120.0	10.7	Average deviation =
6.	26.8	112	127.5	123.9	3.6	$\frac{120.1}{1772.2} \times 100 = 6.8$
7.	27.7	125	165.3	149.1	16.2	Average deviation of basic data = 7%
8.	27.9	131	191.2	181.1	10.1	$\frac{2 \times A.D.}{n} = \frac{2 \times 7\ ^{3}/_{4}}{n}$ 4.0%
9.	30.4	115	176.2	165.5	10.8	
10.	35.4	129	248.3	255.9	7.6	(This quality 4.0% measures) the maximum permissible sampling error of the difference of the mean of the table values and the test trees.
11.	32.4	132	233.5	219.0	14.5	
12	37.3	140	326.3	308.5	17.8	
Total	-	-	1852.9	1772.2	120.1	

From the above computation, it would be seen that :

(i) The average deviation of the trees from the curved values is 6.8 percent and so is not appreciably different from that of basic data (7 percent).

(ii) Aggregate difference is 4.6 percent which only slightly exceeds the quantity $\frac{2 \times A.D}{n}$ or 4.0% Hence existing be directly applied, special tables not being necessary. The small discripancy may be due to different tree shape, etc. or to a different standard of conversion which may be suspected of influencing mainly the lower diameter classes.

(iii) Had the average deviation of the basic data of the general tables been 3 percent instead of 7 percent, this sample would have shown a significant difference, and the table could not be applied with confidence that the total volume obtained would agree with that calculated from the tables; within the limits of the sampling error of the difference between the data on which the tables are based over the local test data.

Note : The calculations involved in finding out average deviation of table volume with the actual volume of the individual tree are laborious and time consuming. In divisional practice, therefore, average deviation from the average of the concerning height diameter class may be taken multiplied by the number of trees in the height diameter class and averaged for all the height diameter classes. This has been termed as average difference in the volume tables produced in Part I and can be used in place of average deviation.

METHOD OF COMPILATION OF LOCAL VOLUME TABLES (STANDARD OR COMMERCIAL) FROM GENERAL VOLUME TABLES (STANDARD OR COMMERCIAL) :

(1) GENERAL :

Local volume curves and tables should be derived from the general ones for application to individual felling series.

The general object is to estimate height so that the enumeration or marking lists can be directly, converted into volumes and to have a table for use for the particular average quality class prevailing in the felling series instead of for the middle of the standard quality classes from General volume tables. If such local volume tables are prepared it will be possible to draw estimates of outturn from a coupe to a greater accuracy than with the help of such conversion factors which are either based on scanty data or applied arbitrarily in adjoining divisions.

The Research Staff will usually collect data for and compile general volume tables and it will fall on the territorial staff to derive local curves and tables for local use.

(B) FIELD WORK

(1) Each type of locality should be separately dealt with whenever the difference is appreciable.

(2) When compartments have been allotted to different quality classes by the working plan, sufficiently close estimates may be obtainable by use of the corresponding curve, but in view of the variation within a quality class, a local curve may still be preferable.

(3) The total height and d.b.h. of four or more typical trees in each 10 cm diameter classs should be measured, the selected trees conforming with the following specifications :

(a) They should have, as rearly as can be judged the average height of the trees of their diameter class standing within their immediate vicinity and

(b) They should be as widely and as regularly distributed as possible over the whole area in question.

(C) COMPUTATION :

(1) Height and d.b.h. measurements should be averaged for each diameter class and the averages so obtained plotted for a height/diameter curve. If the points do not easily fit a smooth curve, further measurements should be taken if this can be done; if it can not, the individual heights should be scrutinized for possible abnormalities which can be excluded.

(2) Height for any convenient diameters such as the middle of the usual 10 cm class, i.e. at 25 cm, 35 cm, 45 cm and so on..... should be read from this curve.

(3) These heights should be interpolated between the general volume curves at the corresponding diameters and smooth curve drawn through the points (In the present tables curve No.I or II can be used as the data is required for standard timber or total volume).

(4) The volumes corresponding to the middle of diameter classes should be read from this curve and tabulated as the local volume table.

APPENDIX - I

GENERAL RULES FOR MEASUREMENT OF TREES

(i) Breast Height

1. Breast height should be measured by means of a measuring stick on the standing tree at 1.37 m (4 1/2') above ground level.
2. On sloping ground, breast height should be measured on the uphill side, after removal of any dead leaves and needles lodged there.
3. The breast height point should be marked by intersecting vertical and horizontal lines (12 cm long) when ever possible, painted with white paint. This is referred to as cross mark.
4. Breast height measurements should not be taken at 1.37 m if the stem is abnormal at that level, but the cross mark should be shifted up or down as little as possible to a more normal portion of the stem.
5. When the tree is forked below breast height, each fork should be treated as though it were a separate tree. If the forking renders the measurements at 1.27 m level abnormal, the foregoing rule 4 should be applied, the tree counting as one or two according as to whether more acceptable measurements are obtainable above or below 1.37 m.
6. When butress formation is characteristic of a species and is known or is likely to extend upwards with development of the trees, the cross-mark should be pointed at the lowest level above which abnormal formation is not likely to extend. This height must be standardised for the species and the relationship between diameter at 1.37 m and at this standard height must be separately worked out in divisional practice.

   Note : 10 ft. has been standardised for *Holoptelea integrifolia* in Uttar Pradesh, 12 ft. for *Heritera minor* in the Sunderbans of Bengal and 10 ft. for *Bruguinea gymporhiza* in Andamans. In Madhya Pradesh no such height has been standardised for any species. Fluting in teak is common but in most of the cases the bole is normal at 1.37 m.
7. The height above ground level of the cross mark should always be recorded for each tree measured.

(ii) Diameter measurements

8. When callipers are used, two measurements should be taken at right angles to each other whenever possible. Diameter is there understood to imply the average of the two measurements. The first diameter, should always be read off with the scale of the calliper touching the cross mark and the second diameter with one of the calliper arms touching the same point.
9. Before taking overbark measurements, moss, lichen and loose bark should be removed by hand or with a rough stick.
10. Diameter at breast height should be measured at the cross mark on the standing tree.
11. Under bark measurements should be taken after removing a narrow strip (8 cm to 10 cm wide) of bark all round the stem care being required to ensure that the bark is entirely removed but none of the outer wood in it.

12.A Diameter should be measured and recorded in centimetre trees and decimals to the nearest fifth of a centimetre (2 mm).

12B. If instead of callipers measuring tapes are used for measurement of g.b.h., then the girth measurements should be recorded near to 0.5 cms. Girth should be measured at the cross mark with steel tape of standard make.

(iii) Height measurements

13. Total height of a standing tree should be measured vertically from the ground level to the tip of the leader or to the highest point of the crown above ground level when no leader exists.

14. The total height of a felled tree should be measured by tape in a straight line, no allowance being made for the curvature of stem or any other defect. The stump must be included.

15. Total height should be measured to the nearest whole decimetre, half or more being counted as one i.e. to the first decimal place when recorded in metres.

(iv) Age :

16. For species with annual rings are should be determined by counting the rings on the stump, with an allowance for the number of years required to reach the height at which the count is made.

17. The height of the stump should be measured vertically from the point at which the pith is cut, to the ground level on the uphill side.

18. The number of years required for seedling to reach stump height should be determined by measurements of seedlings growing under similar conditions. Tree growing seedlings should be selected for this purpose and the data should be standardised for each species, quality-class and method of regeneration. The stan dardised stump allowances for important timber species, such as **Sal, Teak**, Khair, Kardhai, Saja, Semal **etc. have** been worked out in the past. Therefore seedline height data for these species may not be necessarily collected.

19. When hollowness or knot is encountered at the centre of stumps, the procedure for meeting this difficulty is also available. However, such stumps should be rarely chosen for age datermination.

(v) Timber and small wood volume :

20. Timber volume should be measured under bark with full sectional area. (πr^2).

21. Small wood should be measured as volume over bark with full sectional area (πr^2).

22. All length measurements should be made to the nearest whole decimetre.

(vi) Standard measurements :

23. Standard measurements include the following :

(a) Diameter at breast height over and under bark. In case of species with pronouned buttresses (notably semal) girth should be measured at 1.37m; girth and diameter should also be measured at the standardised height for the cross mark (see Rule 6 above).

(b) Total height to the nearest whole decimetre.

(c) Standard timber bole which comprises the length of the stem from ground level upto point where the average diameter over bark is 20 centimetres.

Note : This should be measured in a straight line from end to end should not follow curves or bends.

In practice the cross mark provides a datum point for taking the measurement.

(d) Standard timber comprises the volume including stumps but excluding bark, down to the limiting diameter of 20 cm.

Over bark : For buttressed trees, a diameter measurement should be taken at the lowest acceptable point clear of the buttresses and at the nearest multiple of 1.5 metre from the ground level which is above it and not less than 1.5 metre. The taper between these two points should be considered to continue evenly downwards to ground level and the upper part of the tree measured in 3 metres length as usual.

The following treatment for forked trees should be applied.

Any tree forked at a height of less than 1.37 m from ground level should be measured as two trees.

For trees forked below the living crown the larger arm should be treated as the stem and the volume of the other arm should be recorded separately from the branch wood.

(e) Standard small wood comprises the volume including bark between the limiting diameters of 20 cm and 5 cm over bark.

N.B. when callipers are in use fixed iron callipers of 20 cm and 5 cm diameter may be used with advantage to locate timber and small wood limits on a felled tree.

(f) Timber and small wood volumes of a felled tree should be measured by dividing the total length of each into as nearly as possible equal sections, and by taking the following measu rements.

(1) Length of each section. The length of the sections should preferably be 3 metres odd metres being included in the last section which should not exceed 4.5 m.

(2) Under bark diameter at the middle of each timber section.

(3) Over bark diameter at the middle of each small wood section.

These tree measurements are not required for branch small wood of teak and Sal for which sufficient data are already available.

Where the middle of any section is abnormal the measurements should be taken at equal short distances on both sides of the abnormal point.

Timber and small wood in branches should be dealt with in the same way when branch wood data required. Dead branches are not measured.

Standard timber and small wood volume of branches, when required should be measured and recorded separately from those of the stem.

(g) Diameter over and underbak at a point half way between breast height and the top of the tree for form quotient.

(h) Ring countings on the stump and height of the cut pith above ground level on uphill side.

(i) An estimate of the quality of locality on any acceptable standard.

(j) Sapwood thickness should be measured for all the species in which differentation of heart wood is or is likely to be important. For this purpose it should be measured at both ends of one callipered diameter at the middle of the first (1.5 metre) and

(32A)

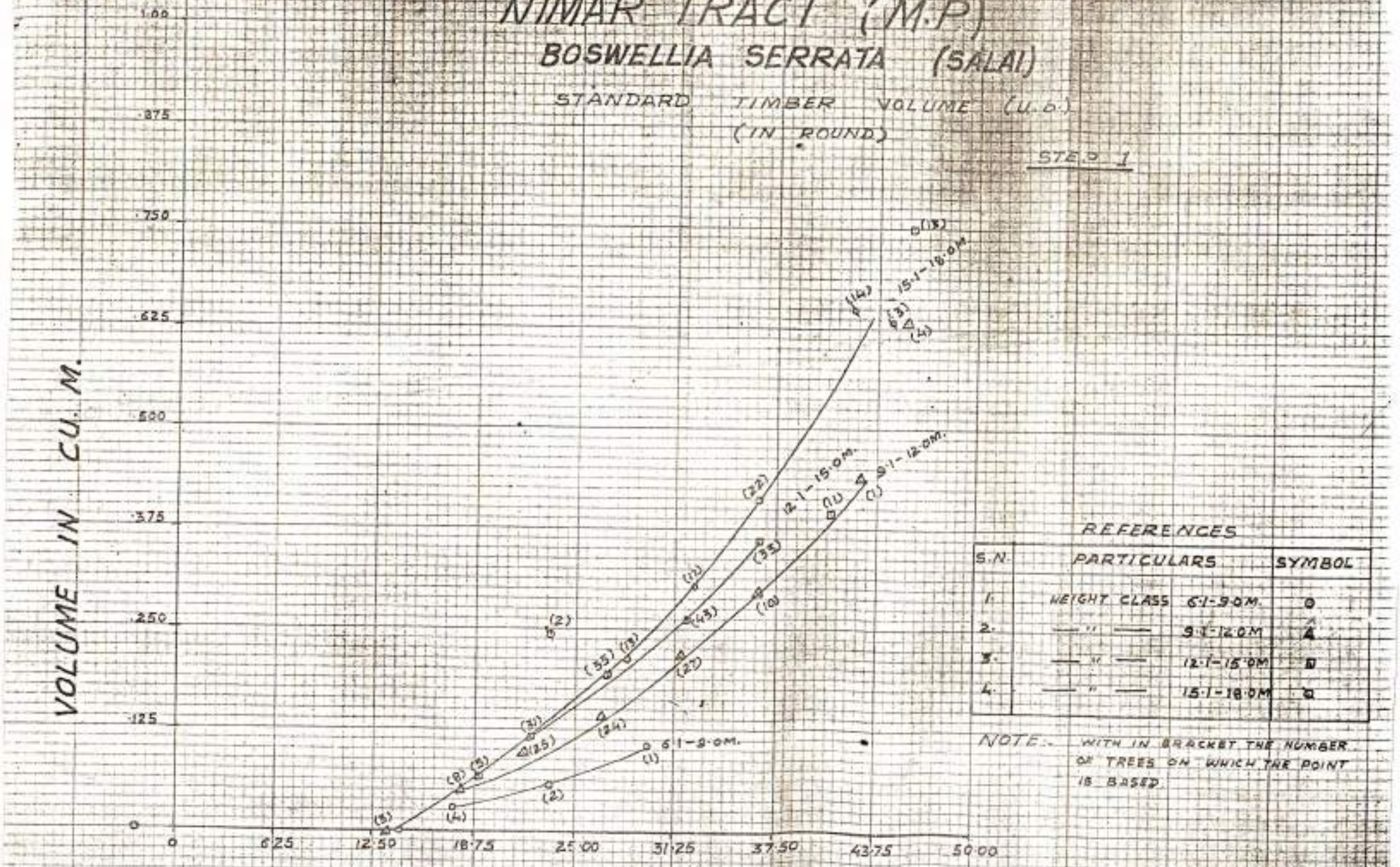
NIMAR TRACT (M.P.)

BOSWELLIA SERRATA (SALAI)

STANDARD TIMBER VOLUME (U.B.)

(IN ROUND)

STEP 1



REFERENCES

S.N.	PARTICULARS	SYMBOL
1.	HEIGHT CLASS 6.1-9.0M.	○
2.	—"— 9.1-12.0M	△
3.	—"— 12.1-15.0M	□
4.	—"— 15.1-18.0M	◇

NOTE:- WITH IN BRACKET THE NUMBER OF TREES ON WHICH THE POINT IS BASED.

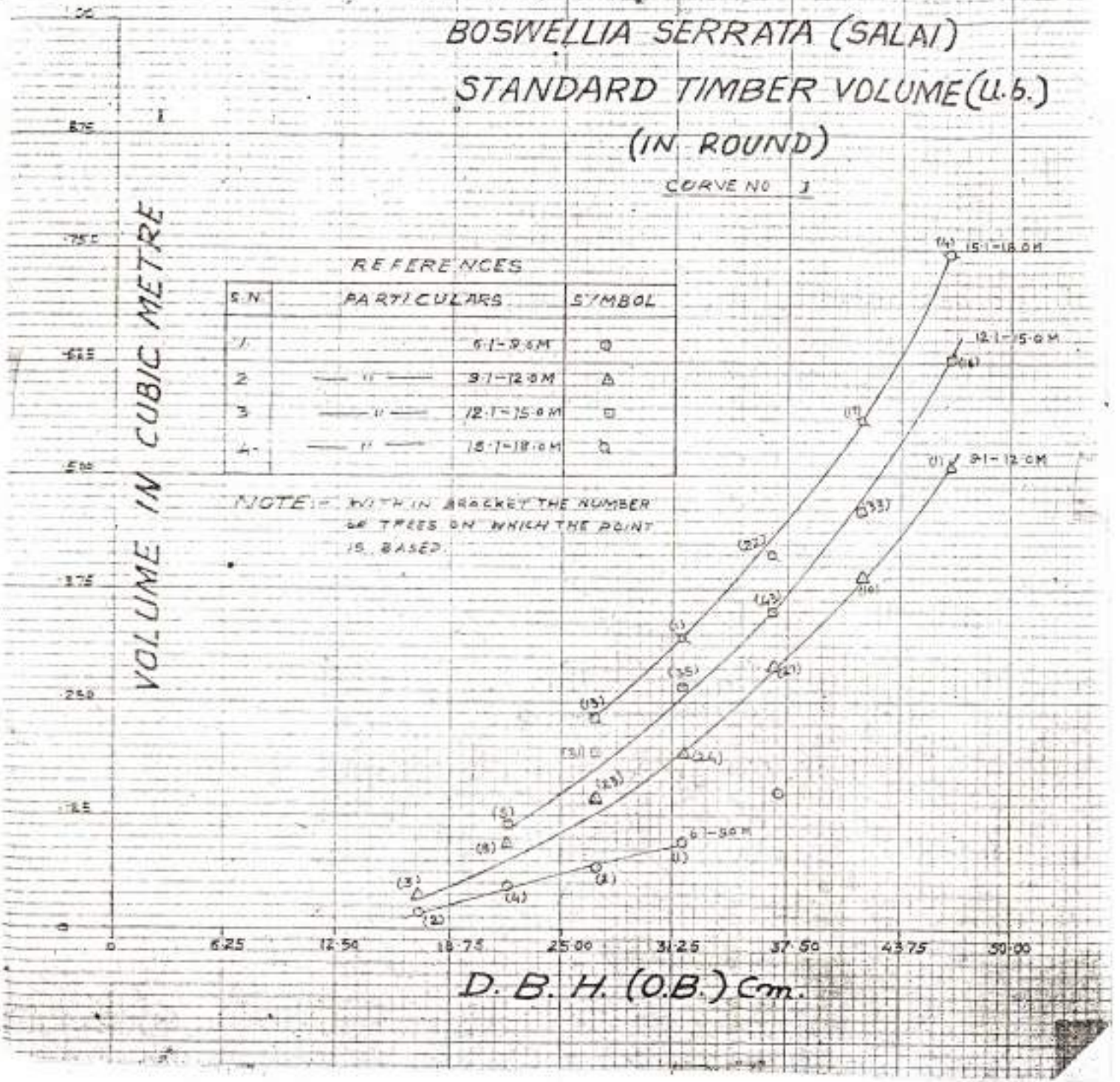
NIMAR TRACT M.P.

BOSWELLIA SERRATA (SALAI)

STANDARD TIMBER VOLUME (U.B.)

(IN ROUND)

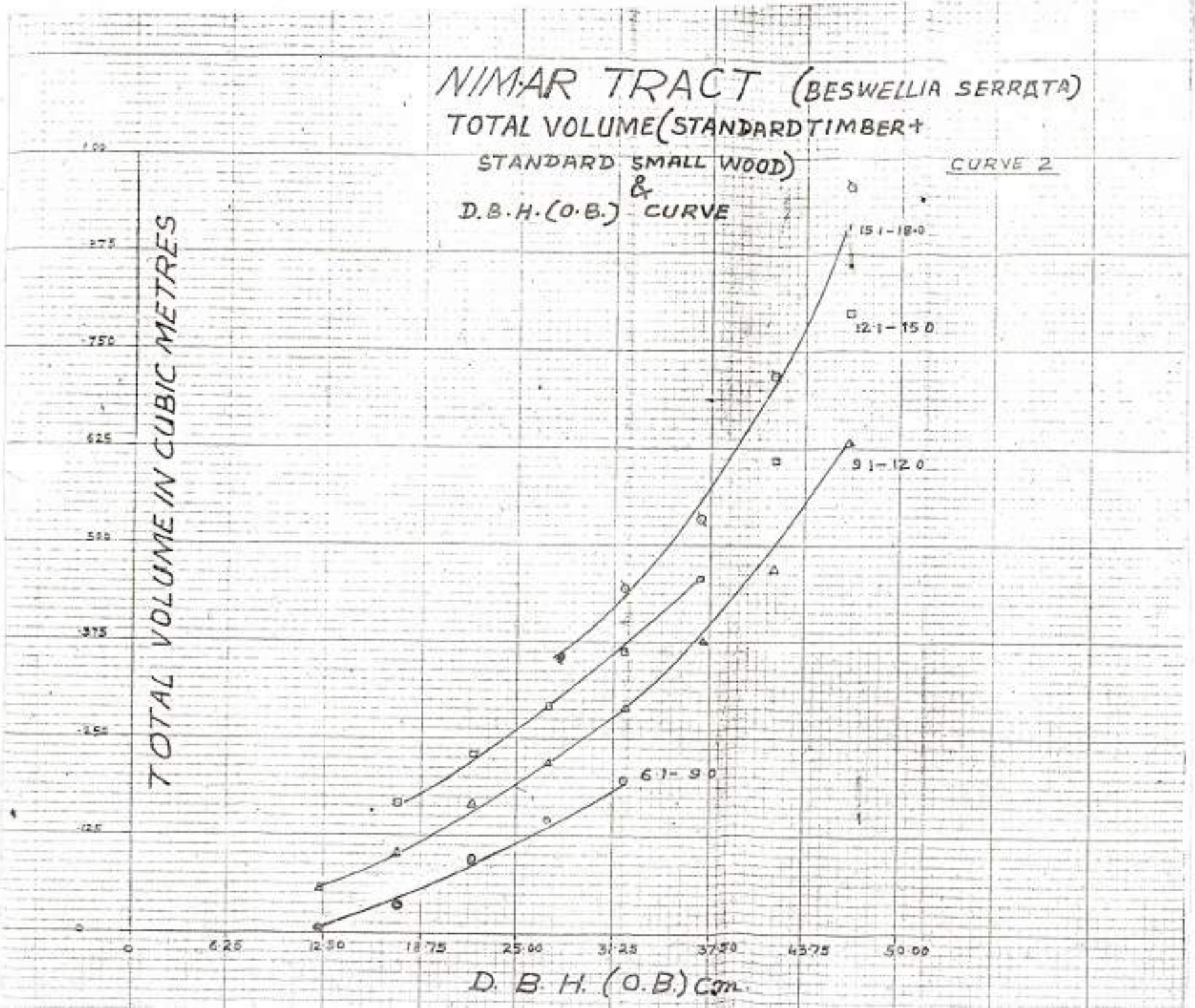
CURVE NO 1



REFERENCES

S.N.	PARTICULARS	SYMBOL
1.	6.1-9.0 M	○
2.	9.1-12.0 M	△
3.	12.1-15.0 M	□
4.	15.1-18.0 M	◇

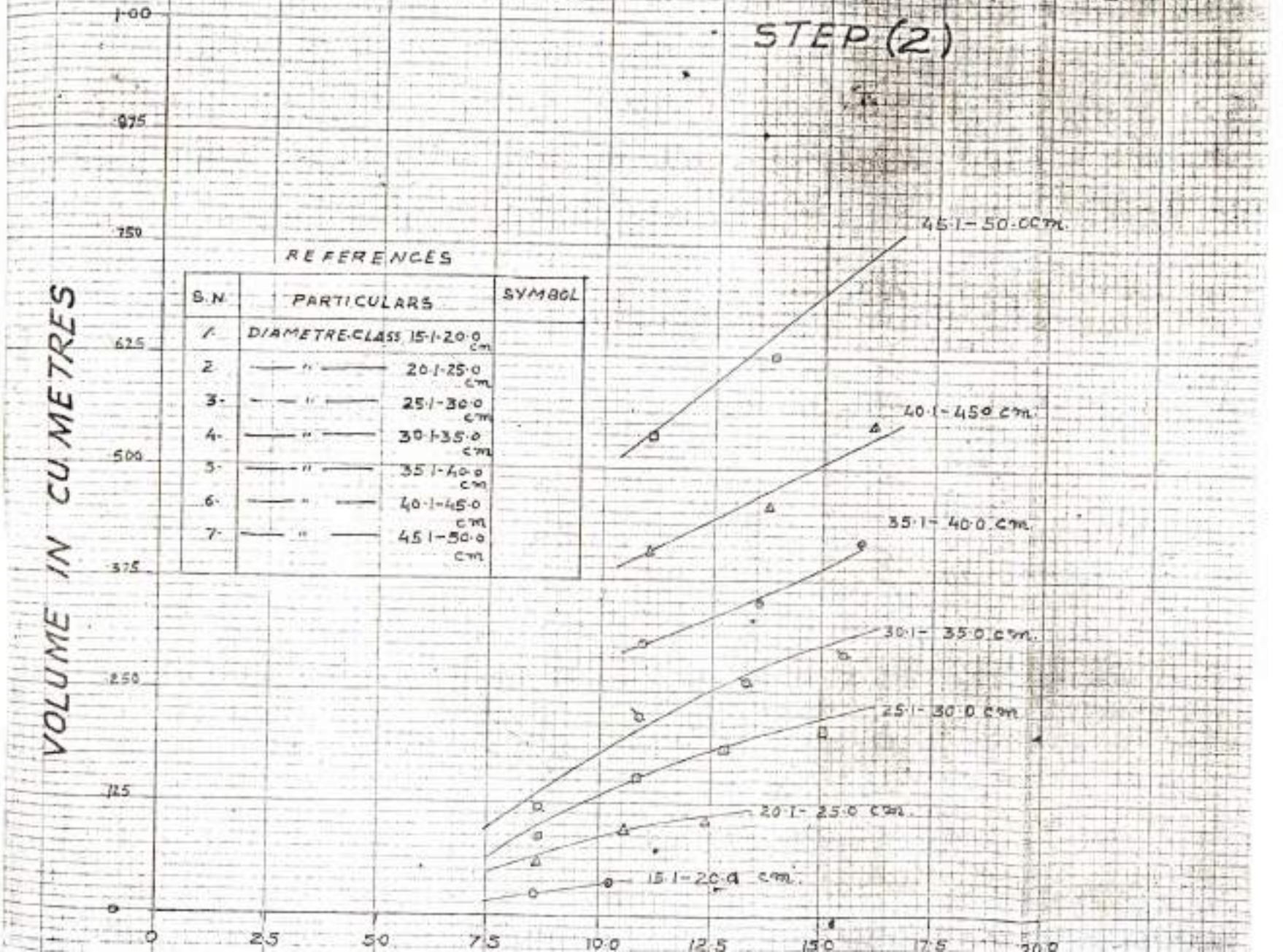
NOTE:- WITHIN BRACKET THE NUMBER OF TREES ON WHICH THE POINT IS BASED.


NIMAR TRACT (BESWELLIA SERRATA)
TOTAL VOLUME (STANDARD TIMBER + STANDARD SMALL WOOD) & D.B.H. (O.B.) CURVE
CURVE 2
TOTAL VOLUME IN CUBIC METRES
1·00
·875
·750
·625
·500
·375
·250
·125
0
15·1 – 18·0
12·1 – 15·0
9·1 – 12·0
6·1 – 9·0
0
6·25
12·50
18·75
25·00
31·25
37·50
43·75
50·00
D. B. H. (O.B.) Cm.

BOSWELLIA SERRATA

HEIGHT/STANDARD TIMBER VOLUME

STEP (2)



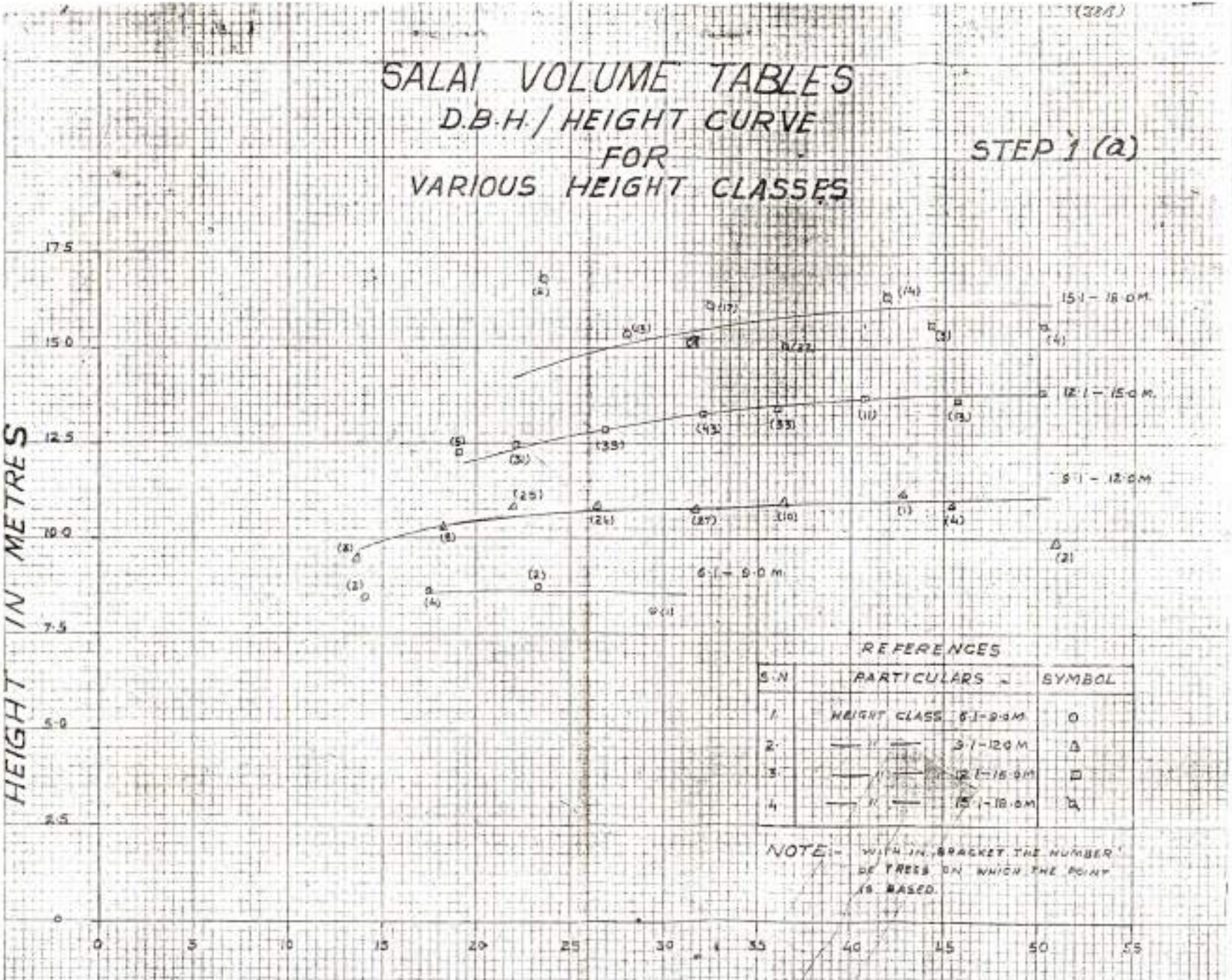
REFERENCES

S.N.	PARTICULARS	SYMBOL
1.	DIAMETRE CLASS 15·1-20·0 cm.	
2.	" 20·1-25·0 cm.	
3.	" 25·1-30·0 cm.	
4.	" 30·1-35·0 cm.	
5.	" 35·1-40·0 cm.	
6.	" 40·1-45·0 cm.	
7.	" 45·1-50·0 cm.	

SALAI VOLUME TABLES

D.B.H / HEIGHT CURVE FOR VARIOUS HEIGHT CLASSES

STEP 1 (a)



(38F)

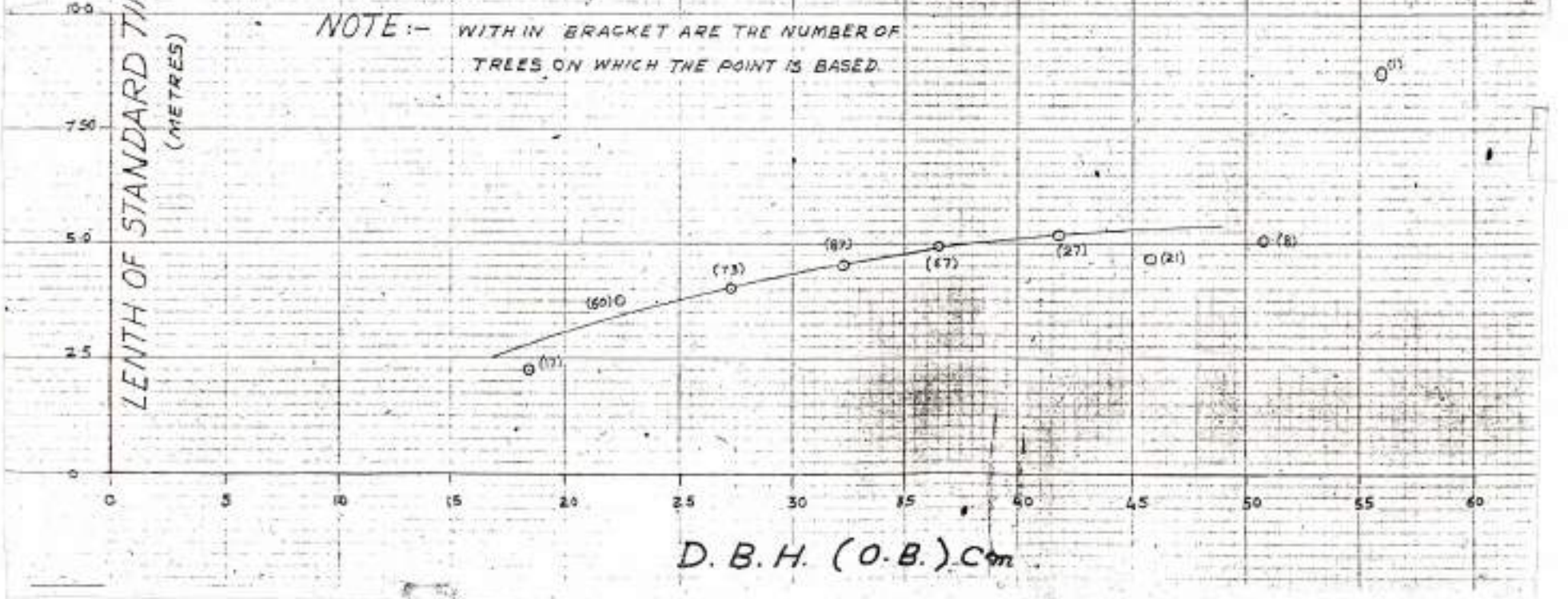
NIMAR TRACT M.P.

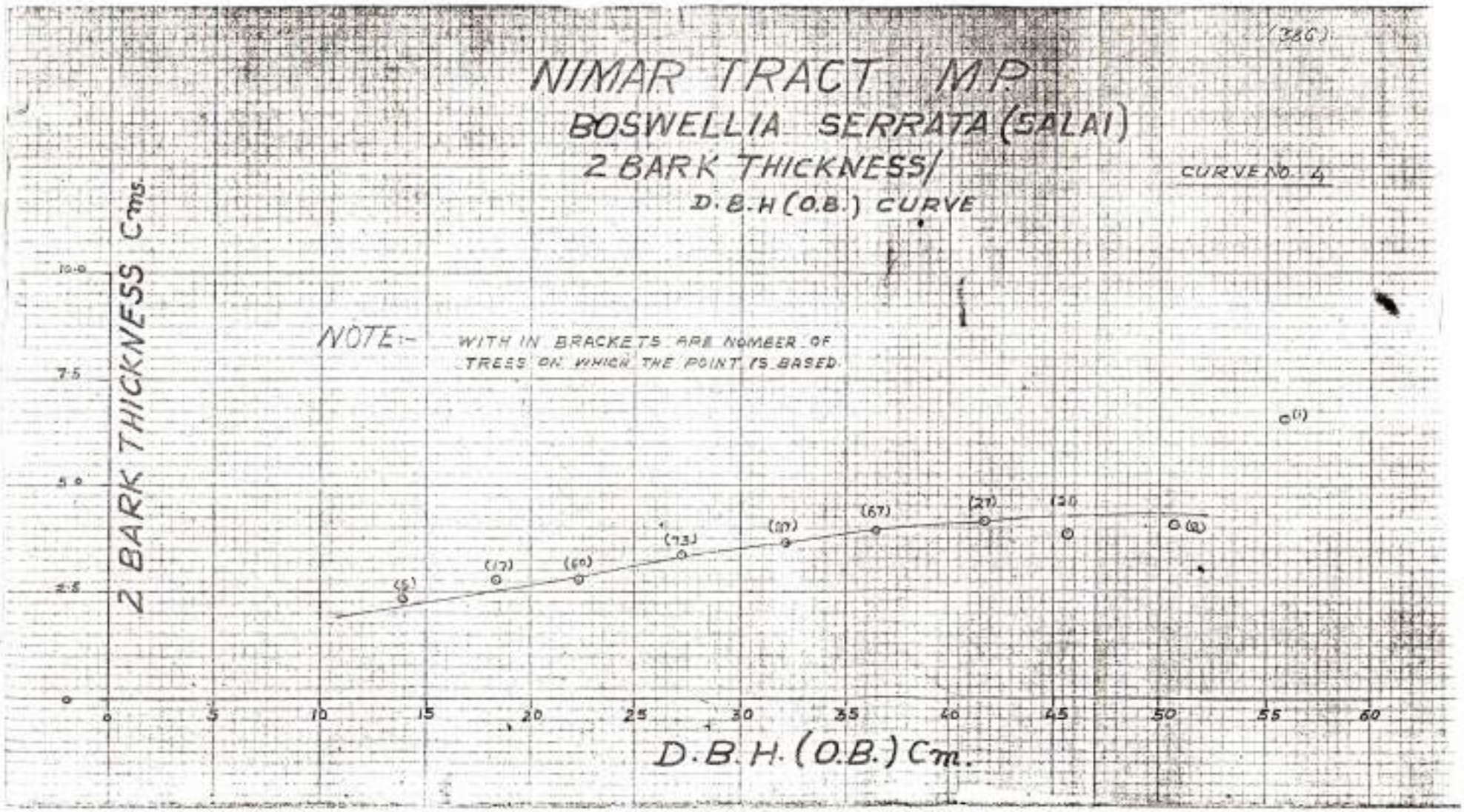
BOSWELLIA SERRATA

D.B.H. (O.B) / LENTH OF STANDARD TIMBER BOLE CURVE

CURVE NO. 3

NOTE :- WITH IN BRACKET ARE THE NUMBER OF TREES ON WHICH THE POINT IS BASED.

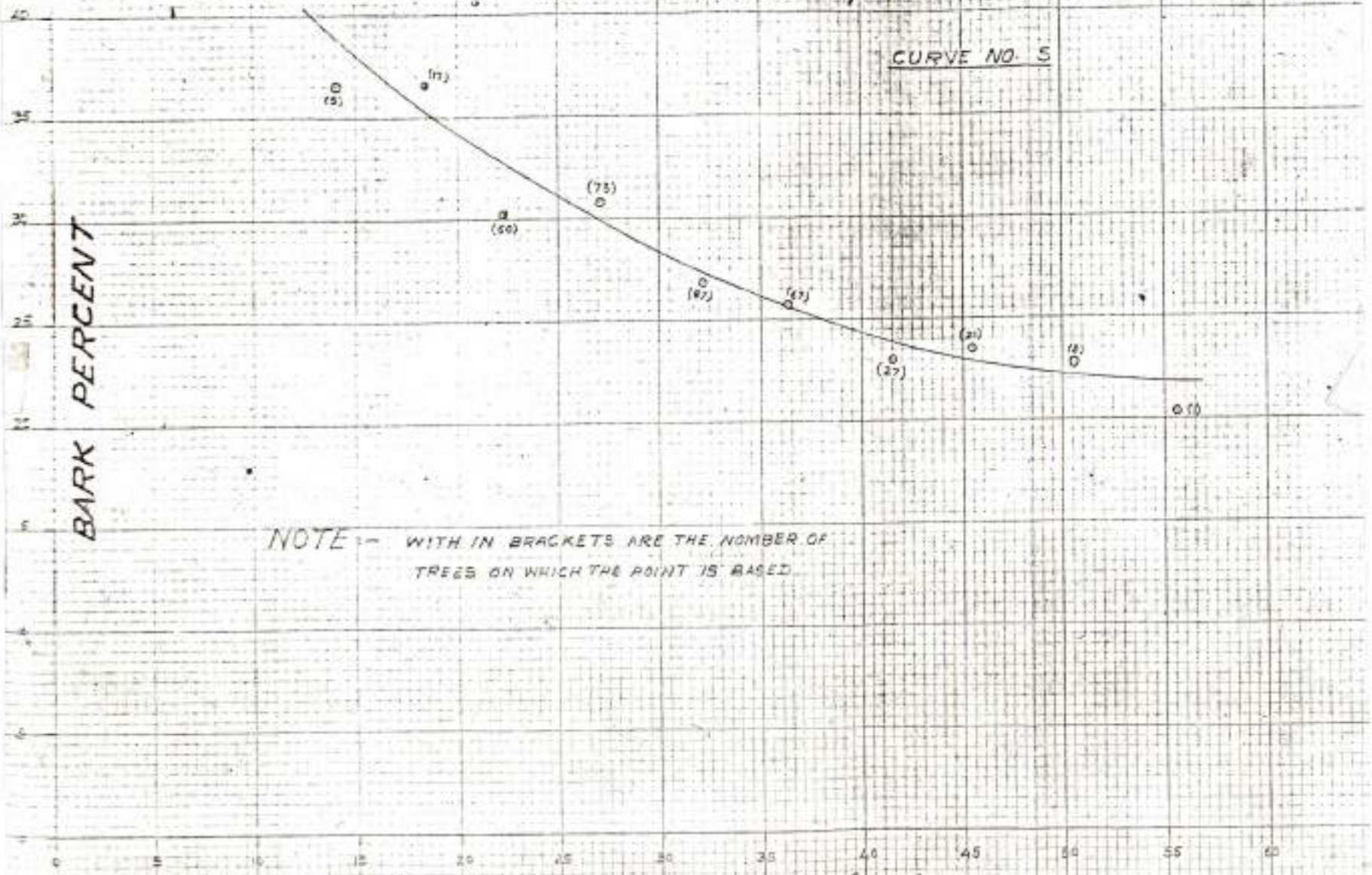



NIMAR TRACT M.P.
BOSWELLIA SERRATA (SALAI)
2 BARK THICKNESS/
D.B.H (O.B.) CURVE
CURVE NO. 4
(386)
NOTE:- WITH IN BRACKETS ARE NOMBER OF TREES ON WHICH THE POINT IS BASED.
2 BARK THICKNESS Cms.
D.B.H. (O.B.) Cm.
10.0
7.5
5.0
2.5
0
0
5
10
15
20
25
30
35
40
45
50
55
60
(5)
(17)
(60)
(73)
(37)
(67)
(27)
(20)
(8)
(1)

NIMAR TRACT M.P.

BOSWELLIA SERRATA (SALAI)

D.B.H. (O.B.)/BARK PERCENT CURVE



NOTE :- WITH IN BRACKETS ARE THE NOMBER OF TREES ON WHICH THE POINT IS BASED.

last timber sections and at the middle of the section nearest mid timber. This may be done by cutting a notch to the heartwood or with the use of an increment borer. Sapwood data are most urgently needed for *Shorea robusta, Dalbergia sissoo, Tectona grandis, Acacia catechu* and *Dalbergia latifolia.*

(vii) Commercial measurements :

24. Commercial measurements include the following.

(a) Diameter overbark at breast height (Rule 8 to 12).

(b) Total height to the nearest whole decimetre (Rule 13 to 15).

(c) Commercial timber bole comprising the length of the stem from the butt as far up as the wood is utilized or to any limit accepted for the purpose.

Commercial timber comprising the volume excluding bark from the butt as far up as the wood is utilized, or to any limit accepted for the purpose.

Commercial timber should be measured by dividing the commercial timber hole into as nearly equal sections as possible and taking on each section the following measurements.

(1) Length of section. This should not exceed 6 metres.

(2) Under bark diameters at the middle of the section. In the case of species with pronounced, buttresses, the lowest log should be taken so that its mid point is free from buttress effect. Ordinarily, trees forked below 4 metres should not be measured but when such trees have to be taken, Rule 23(d) for standard measurements should be followed.

(e) Diameter over and under bark at the middle of the commercial bole.

(f) Ring counting on the stump, and the height of the cut pith above ground level on the up hill side (stump height).

(g) An estimate of the quality of locality based on any accepted standard.

(h) Sapwood thickness should be measured for all species in which differentiation of heart wood is or is likely to be important. For this purpose it should be measured at both ends of one callipered diameter, at both ends of the commercial bole, and at the middle.

N.B. Address of firms from where aluminium callipers graduated upto 2 mm can be obtained are given below, suitable size for the purpose shall be of 75 cms.

1. M/S Devco
   Nemi Mansions
   Amrit Kaur Road,
   Dehra Dun, (U.P.)
2. M/S J. Qumarjee & Company
   3, Hanuman Chowk,
   P.O.Box No.88, Dehra Dun, (U.P.)
3. Mr. J.U. Jain
   3, Hanuman Chowk
   Dehra Dun, (U.P.)

Appendix - 11

Area of Circles of Diameters 1.0 Centimetres to 120.0 Centimetres

Meter in Centimetres	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	Area of Circle in Square Metres									
1.	0.000 08	0.000 10	0.000 11	0.000 13	0.000 15	0.000 18	0.000 20	0.000 23	0.000 25	0.000 28
2.	.000 31	.000 35	.000 38	.000 42	.000 45	.000 49	.000 53	.000 57	.000 62	.000 66
3.	.000 71	.000 75	.000 80	.000 86	.000 91	.000 96	.001 02	.001 08	.001 13	.001 19
4.	.001 26	.001 32	.001 39	.001 45	.001 52	.001 59	.001 66	.001 73	.001 81	.001 89
5.	.001 96	.002 04	.002 12	.002 21	.002 29	.002 38	.002 46	.002 55	.002 64	.002 73
6.	.002 83	.002 92	.003 02	.003 12	.000 22	.003 32	.003 42	.003 53	.003 63	.003 74
7.	.003 85	.003 96	.004 07	.004 19	.004 30	.004 42	.004 54	.004 66	.004 78	.004 90
8.	.005 03	.005 15	.005 28	.005 41	.005 54	.005 67	.005 81	.005 94	.006 08	.006 22
9.	.006 36	.006 50	.006 65	.006 79	.006 94	.007 09	.007 24	.007 39	.007 54	.007 70
10.	0.007 85	0.008 01	0.008 17	0.008 33	0.008 49	0.008 66	0.008 82	0.008 99	0.009 16	0.009 33
11.	.009 50	.009 68	.009 85	.010 03	.010 21	.010 39	.010 57	.010 75	.010 94	.011 12
12.	.001 31	.011 30	.011 69	.011 88	.012 08	.012 27	.012 47	.012 67	.012 87	.013 07
13.	.013 27	.013 48	.013 68	.013 89	.014 10	.014 31	.014 53	.014 74	.014 96	.015 17
14.	.015 39	.015 61	.015 84	.016 06	.016 29	.016 51	.016 74	.016 97	.017 20	.017 44
15.	.017 67	.017 91	.018 15	.018 39	.018 63	.018 87	.019 11	.019 36	.019 61	.019 86
16.	.020 11	.020 36	.020 61	.020 87	.021 12	.021 38	.021 64	.021 90	.022 17	.022 48
17.	.022 70	.022 97	.023 24	.023 51	.023 78	.024 05	.024 33	.024 61	.024 88	.025 16
18.	.025 45	.025 73	.026 02	.026 30	.026 59	.026 88	.027 17	.027 46	.027 76	.028 06
19.	.028 35	.028 65	.028 95	.029 26	.029 56	.029 86	.030 17	.030 48	.030 79	.031 10
20.	0.031 42	0.031 73	0.032 05	0.032 37	0.032 69	0.033 01	0.033 33	0.033 65	0.033 98	0.034 31

Contd.

21.	.034 64	.034 97	.035 30	.035 63	.035 97	.036 31	.036 64	.036 98	.037 33	.037 67
22.	.038 01	.038 36	.038 71	.039 06	.039 41	.039 76	.040 11	.040 47	.040 83	.041 19
23.	.041 55	.041 91	.042 27	.042 64	.043 01	.043 37	.043 74	.044 12	.044 49	.044 86
24.	.045 24	.045 32	.046 00	.046 38	.046 76	.047 14	.047 53	.047 92	.048 31	.048 70
25.	.049 09	.049 48	.049 88	.050 27	.050 67	.051 07	.051 47	.051 87	.052 28	.052 69
26.	.053 09	.053 50	.053 91	.054 33	.054 74	.055 15	.055 57	.055 99	.056 41	.056 83
27.	.057 26	.057 68	.058 11	.058 53	.058 96	.059 40	.059 83	.060 26	.060 70	.061 14
28.	.061 58	.062 02	.062 46	.062 90	.063 35	.063 79	.064 24	.064 69	.065 14	.065 80
29.	.066 05	.066 51	.066 97	.067 43	.067 89	.068 35	.068 81	.069 28	.069 75	.070 22
30.	0.070 69	0.071 16	0.071 63	0.072 11	0.072 58	0.073 06	0.073 54	0.074 02	0.074 51	0.074 99
31.	.075 48	.075 96	.076 45	.076 94	.077 44	.077 93	.078 43	.078 92	.079 42	.079 92
32.	.080 42	.080 93	.081 43	.081 94	.082 45	.082 96	.083 47	.083 98	.084 50	.085 01
33.	.085 53	.086 05	.086 57	.087 09	.087 62	.088 14	.088 67	.089 20	.089 73	.090 26
34.	.090 79	.091 33	.091 86	.092 40	.092 94	.093 48	.094 02	.094 57	.095 11	.095 66
35.	.096 21	.096 76	.097 31	.097 87	.098 42	.098 98	.099 54	.100 10	.100 66	.101 22
36.	.101 79	.102 35	.102 92	.103 49	.104 06	.104 63	.105 21	.105 78	.106 36	.106 94
37.	.107 52	.108 10	.108 69	.109 27	.109 86	.110 45	.111 04	.111 63	.112 22	.112 82
38.	.113 41	.114 01	.114 61	.115 21	.115 81	.116 42	.117 02	.117 63	.118 24	.118 85
39.	.119 46	.120 07	.120 69	.121 30	.121 92	.122 54	.123 16	.123 79	.124 41	.125 04
40.	0.125 66	0.126 29	0.126 92	0.127 56	0.128 19	0.128 82	0.129 46	0.130 10	0.130 74	0.131 38
41.	.132 03	.132 67	.133 32	.133 96	.134 61	.135 27	.135 92	.136 57	.137 23	.137 89
42.	.138 54	.139 20	.139 87	.140 53	.141 20	.141 86	.142 53	.143 20	.143 87	.144 55
43.	.145 22	.145 90	.146 57	.147 25	.147 93	.148 62	.149 30	.149 99	.150 67	.151 36
44.	.152 05	.152 74	.153 44	.154 13	.154 83	.155 53	.156 23	.156 93	.157 63	.158 34
45.	.159 04	.159 75	.160 46	.161 17	.161 88	.162 60	.163 31	.164 03	.164 75	.165 47
46.	0.166 19	0.166 91	0.167 64	0.168 36	0.169 09	0.169 82	0.170 55	0.171 20	0.172 02	0.172 76
47.	.173 49	.174 23	.174 97	.175 72	.176 46	.177 21	177 95	.178 70	.179 45	.180 20

Contd.

48.	.180 96	.181 71	.182 47	.183 22	.183 98	.184 75	.185 51	.186 27	.187 04	.187 81
49.										
50	.188 57	.189 84	.190 12	.190 89	.191 67	.192 44	.193 22	.194 00	.194 78	.195 56
51.	0.196 35	0.197 14	0.197 92	0.198 71	0.199 50	0.200 30	0.201 09	0.201 89	0.202 68	0.203 48
52.	.204 28	.205 08	.205 89	.206 69	.207 50	.208 31	.209 12	.209 93	.210 74	.211 50
53.	.212 37	.213 19	214 01	.214 83	.215 65	.216 48	.217 30	.218 13	.218 96	.219 79
54.	.220 62	.221 45	.222 29	.223 12	.223 96	.224 80	.225 64	.226 48	.227 33	.228 17
55.	.229 02	.229 87	.230 72	.231 57	.232 43	.232 28	.234 14	.235 00	.235 86	.236 72
56.	.237 57	.238 45	.239 31	.240 18	.241 05	.241 92	.242 79	.243 67	.244 54	.245 42
57.	.246 30	.247 18	.248 06	.248 95	.249 83	.250 72	.251 61	.252 50	.253 39	.254 20
58.	.255 18	.256 07	.256 97	.257 87	.258 77	.259 67	.260 58	.261 48	.262 39	.263 30
59.	.264 21	.265 12	.266 03	.266 95	.267 86	.268 78	.269 70	.270 62	.271 55	.272 47
60.	.273 40	.274 32	.275 25	.276 18	.277 12	.278 05	.278 99	.279 92	.280 86	.281 80
61.	0.282 74	0.283 69	0.286.63	0.285 58	0.286 53	0.287 48	0.288 43	0.289 38	0.290 33	0.291 29
62.	.292 25	.293 21	.294 17	.295 13	.296 09	.297 06	.298 02	.298 99	.299 96	.300 83
63.	.301 91	.302 88	.303 86	.304 84	305 82	.306 80	.307 78	.308 76	.309 75	.310 74
64.	.311 72	.312 71	.313 71	.314 70	.315 70	.316 69	.317 69	.318 69	.319 69	.320 69
65.	.321 70	.322 71	.323 71	.324 72	.325 73	.326 75	.327 76	.328 77	.329 79	.330 81
66.	.331 83	.332 85	.333 88	.334 90	.335 93	.336 96	.337 99	.339 02	.340 05	.341 08
67.	.342 12	.343 16	.344 20	.345 24	.346 28	.347 32	.348 37	.349 41	.350 46	.351 51
68.	.352 57	.353 62	.354 67	.355 73	.356 79	.357 85	.358 91	.359 97	.361 03	.362 10
69.	.363 17	.364 24	.365 31	.366 38	.367 45	.368 53	.369 61	.370 68	.371 76	.372 84
70.	.373 93	.375 01	.376 10	.377 19	.378 28	.379 37	.380 46	.381 55	.382 65	.383 75
71.	0.384 85	0.385 95	0.387 05	0.388 15	0.389 26	0.390 36	0.391 47	0.392 58	0.393 60	0.394 80
72.	.395 92	.397 04	.398 15	.399 27	.400 39	.401 52	.402 64	.403 76	.404 98	.406 02
73.	.407 15	.408 28	.409 42	.410 55	.411 69	.412 82	.413 96	.415 11	.416 25	.417 39
74.	.418 54	.419 69	.420 84	.421 99	.423 14	.424 29	.425 45	.426 60	.427 76	.428 92

Contd.

75.	.430 08	.431 25	.432 41	.433 58	.434 75	.435 92	.437 09	.438 26	.439 43	.440 61
76.	.441 79	.442 97	.444 15	.445 33	.446 51	.447 70	.448 88	.450 07	.451 26	.452 45
77.	.453 65	.454 84	.456 04	.457 23	.458 43	.459 63	.460 84	.462 04	.463 25	.464 45
78.	.465 66	.466 87	.468 08	.469 30	.470 51	.471 73	.472 95	.474 17	.475 39	.476 61
79.	.477 84	.479 06	.480 29	.481 52	.482 75	.483 98	.485 22	.486 45	.487 69	.488 93
80.	.490 17	.491 41	.492 65	.493 90	.495 14	.496 39	.497 64	.498 89	.500 14	.501 40
81.	0.502 65	0.503 91	0.505 17	0.506 43	0.507 69	0.508 96	0.510 22	0.511 49	0.512 76	0.514 03
82.	.515 30	.516 57	.517 85	.519 12	.520 40	.521 68	.522 96	.524 24	.524 53	.526 81
83.	.528 10	.529 39	.530 68	.531 97	.533 27	.534 56	.535 86	.537 16	.538 40	.539 76
84.	.541 06	.542 37	.543 67	.544 98	.546 29	.547 60	.548 91	.550 23	.551 54	.552 86
85.	.554 18	.555 50	.556 82	.558 14	.559 47	.560 79	.562 12	.563 45	.564 78	.566 12
86.	.567 45	.568 79	.570 12	.571 46	.572 80	.574 15	.575 49	.576 83	.578 18	.579 53
87.	.580 88	.582 23	.583 59	.584 94	.586 30	.587 65	.589 01	.590 38	.591 74	.593 10
88.	.594 47	.595 84	.597 20	.598 57	.599 95	.601 32	.602 70	.604 07	.605 45	.606 83
89.	.608 21	.609 00	.610 98	.612 37	.613 75	.615 14	.616 53	.617 93	.619 32	.620 72
90.	.622 11	.623 51	.624 91	.626 31	.627 72	.629 12	.630 53	.631 94	.633 35	.634 76
91.	0.636.17	0.637 59	0.639 00	0.640 42	0.641 84	0.643 26	0.644 68	0.646 11	0.647 53	0.648 96
92.	0.650 39	0.661 82	0.653 25	0.654 68	0.656 12	0.657 55	0.658 99	0.660 48	0.661 87	0.663 38
93.	.664 76	.666 21	.667 65	.669 10	.670 55	.672 01	.678 46	.674 .92	.676 37	.677 83
94.	.679 29	.680 75	.682 22	.683 68	.685 13	.686 61	.688 08	.689 56	.691 03	.692 50
95.	.693 98	.695 46	.696 98	.698 41	.699 90	.701 38	.702 87	.704.35	.705 84	.707 33
96.	.708 82	.710 31	.711 81	.713 31	.714 80	.716 30	.717 80	.719 31	.720 81	.722 32
97.	.723 82	.725 38	.726 84	.728 35	.729 87	.731 38	.732 90	.734 42	.736 94	.737 46
98.	.738 98	.740 51	.712 08	.743 56	.745 09	.746 62	.748 16	.749 69	.751 22	**.752** 76
99.	.754 30	.755 84	.757 38	.758 92	.760 47	.762 01	.763 56	.765 11	.766 68	**.768**.21
100.	.769 77	.771 32	.772 88	.774 44	.776 00	.777 56	.779 16	.780 69	.782 26	**.783** 85
101.	0.785 40	0.786 97	0.788 34	0.790 12	0.791 69	0.793 27	0.794 85	0.796 43	0.798 01	0.**799** 60

Contd.

102.	.801 18	.802 77	.804 36	.805 95	.807 54	.809 14	.810 73	.812 33	.813 93	.815 53
103.	.817 13	.818 73	.820 34	.821 94	.823 55	.825 16	.826 77	.828 38	.830 00	.831 61
104.	.833 23	.834 85	.836 47	.838 09	.839 71	.841 34	.842 96	.844 59	.546 22	.847 85
105.	.849 49	.851 12	.852 76	.854 39	.856 03	.857 67	.859 32	.860 96	.862 61	.864 25
106.	.865 90	.867 55	.869 20	.870 86	.872 51	.874 17	.875 83	.877 49	.879 15	.880 81
107.	.882 47	.884 18	.885 81	.887 48	.889 15	.890 82	.892 49	.894 17	.895 84	.897 52
108.	.899 20	.900 88	.902 57	.904 25	.905 94	.907 63	.909 31	.911 01	.912 70	.914 39
109.	.916 09	.917 79	.919.48	.921 18	.922 89	.924 59	.926 30	.928 00	.929 71	.931 42
110.	.933 13	.934 84	.936 56	.938 27	.939 99	.941 71	.943 43	.945 16	.940 88	.948 60
111.	0.950 33	0.952 06	0.953 79	0.955 52	0.957 26	0.958 99	0.960 73	0.962 47	0.964 20	0.965 95
112.	0.967 69	0.969 43	0.971 18	0.972 93	0.974 68	0.976 43	0.978 18	0.979 93	0.981 69	0.983 44
113.	.985 20	.986 96	.988 72	.990 49	.992 25	.994 02	.995 79	.997 56	.999 33	1.001 10
114.	1.002 87	1.004 65	1.006 43	1.008 21	1.009 99	1.011 77	1.013 55	1.015 34	1.017 12	1.018 91
115.	1.020 70	1.022 49	1.024 29	1.026 08	1.027 88	1.029 68	1.031 48	1.033 28	1.036 08	1.036 88
116.	1.038 69	1.040 50	1.042 30	1.044 12	1.045 93	1.047 74	1.049 56	1.051 37	1.053 19	1.055 01
117.	1.056 83	1.058 85	1.060 48	1.062 30	1.064 13	1.065 96	1.067 79	1.069 62	1.071 46	1.073 29
118.	1.075 13	1.076 97	1.078 81	1.080 65	1.082 60	1.084 34	1.086 19	1.088 03	1.089 88	1.091 74
119.	1.093 59	1.095 44	1.097 80	1.099 16	1.101 01	1.102 88	1.104 74	1.106 60	1.108 47	1.110 33
120.	1.112 20	1.114 07	1.115 94	1.117 82	1.119 69	1.121 57	1.123 45	1.125 33	1.127 21	1.129 09
121.	1.130 97	1.132 86	1.134 75	1.136 64	1.138 53	1.140 42	1.142 31	1.144 21	1.146 10	1.148 03

South Agni FS
F.R.I.28 ,
Coupe No.3
Comptt.No.269

(Sample form)

Step - I

MEASUREMENT OF SAMPLE TREES

Singaji Range, N. Khandwa Dn.
Species : *Boswellia serrata*

Initials sd/- **C.M. Vyas**
Crown Class Dia.... Date
Sample Tree No.1

Age in Years	Total ht.	Diameter in Cms and decimals At		At right angles	Average	Basal area at 1.37 m .09787 Sq.metres
	11.2m	1.37m	OB 35.2	35.3	35.3	Volume of cylinder - 1.00125 Cu.m.
			UB 32.0	32.0	32.0	
		Mid ht.	OB 22.1	22.0	22.05	Bark thickness at 1.37m-1.65cm
			UB 20.0	20.0	20.0	Bark percent 17.3% O.B.- 0.566
		1/2 ht. above 1.37 m	OB 20.0	20.0	20.0	Form quotient U.B. - 0.562
			UB 18.0	18.0	18.0	
Height of first green branch 3 m		Height of green bran - 5.6m ches alround		With of crown stump - 8.00m allowance		Average crown ht - 4.3 m Length of crown - 6.9 m
Number of rings on Stumps - 42		Height of Stump - 10cm				

Form factors (To three places of decimals)	Timber		Small wood		Sapwood % in stem timber
	Stem	Branch	Stem	Branch	
	.228	-	.034	.039	-

Volume measurements

Timber down to diameter O.B. 20 cms small wood down to dia O.B. 5 cms

Thickness of sapwood (at middle of sections Cms & Dec.)	Length meter	Mid diams U.B. At right angle cm. & dcm	Average cm. & Deci.	Volume cu.m & cu.dcm.	Length cm. & Deci.	Mid diams U.B. At right angle cm. & dcm	Average cm. & Deci.	Volume cu.m & cu.dcm.
		Stem				Stem		
1st section	3m	32.0 33.0	32.5	0.24838	2.80 m	13.2 13.0	13.1	.03774
			Total	0.24888			Total	0.03774
						Branch		
Section nearest mid timber					2.0 m	12.0 12.2	12.1	0.02300
		Branch						
Last section	-	- -	-		2.50 m	10.0 10.0	10.0	.01962
							Total	10.04262

Note : Only items in roman type to be filled in the field.

Instructions for sample tree calculations

The following computations are made and noted on S.P. Form No.7

(a) All pairs of diameters are averaged to one decimal place for diameters of volume section 0.05 is taken alternately as 0.1 and nil.

(b) Sectional areas required are read from tables (Appendix II) to 5 decimal places.

(c) The volume of the cylinder is obtained by multiplying the basal area at B.H. by the total height and the volumes of the sections are obtained by multiplying sectional areas by lengths of sections all volumes are calculated correct to 5 decimal places.

(d) Volume of timber and small wood sections are separately totalled.

(e) Form factors for timber and small wood are obtained by dividing the volume of each by the volume of cylinder (above)

(f) Total age is determined by adding to the recorded numbers of rings on the stumps the allowance corresponding to the stump height as standardise for the species.

(g) Bark percent when required is obtained by multiplying the difference between sectional area O.B. & U.B. at half height by 100 and dividing by sectional area O.B. at the same height.

(h) Bark thickness at 1.37 m is half the difference between the average diameters over and under bark.

(i) Form quotient is obtained by dividing the average diameter at the half height above 1.37 m by average dia. at 1.37 m this is calculated both for O.B. and U.B. diameters.

(j) The height of clear bole is the mean height of first green branch and the height of green branches all sides of the stem. It is deducted from the total height to get the length of crown.

(k) Sapwood percentage in standard timber is obtained from the U.B. dia. (i.e. diameter with sap wood and Sap wood thickness, measured at the middle of he first and last timber section and at the cross cut nearest mid timber. Diameters without sap wood are first computed by deducting twice the sap wood thickness from the U.B. diameters at each point. The following formula is then applied :

$$\text{Sap wood \%} = \frac{S1''+2S2''+S3''}{S'1 + 2S'2 + S'3} \times 100$$

where S'1 S'2 S'3 are the sectional areas of the diameter with sapwood at middle of first section, section nearest mid timber and the middle of the last stem timber section & S1", S2", S3" are the sectional areas corresponding to the diameters without sap wood at those places.

A summary is then made on S.P. Form 4 by copying the entries required directly from the S.P. Form 7 of the several sample trees.

Boswellia serrata

Height class 9.1 - 12.0 Cu.M
Diameter class 35.1.40.0 cm

APPENDIX - III

SUMMARY OF SAMPLE TREE MEASUREMENTS

Step III (Sorting the data by height class & Diameter class)

Region	Comptt. No.	Sample Tree No.	Grown class	Age Years	Diameter at 1.37 Metre	Total ht.in M.	Length of shoot of last year in m & Dec.	FORM FACTORS Timber Stem	Timber Branch	Small wood Stem	Small wood Branch	SOLID VOLUME in Cu.M. Timber Stem	Timber Branch	Small wood Stem	Small wood Branch
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
Rewa	269	1	Dia	42	35.3	11.2	-	0.228	-	0.034	0.039	.02489	-	.0377	.0226
-	269	2	Dia	40	35.3	11.0	.99	0.226	-	0.332	0.118	.2443	-	.0358	.1281
-	477	1	Dia	-	35.4	11.20	-	0.218	-	0.030	0.022	.2413	-	.0339	.0241
-	487	9	D2a		39.3	12.0	-	.236	-	0.039	0.033	.3438	-	.0573	.0487
-	45	6	D2a	-	37.2	11.4	1.13	.213	.113	0.027	0.073	.2644	.1403	.0340	.0904
-	176	5	D2a	-	40.0	10.5	-	.236	.061	0.048	0.019	.3122	.0806	.0641	.0249
-	60	14	D1a	-	36.3	11.0	.92	.199	.063	0.063	.070	.2264	.0721	.0721	.0801
-	60	17	D1a	-	36.2	11.2	.98	.165	-	.025	.030	.1900	-	.0285	.0347
-	-	14	D1a	-	38.8	10.0	.90	.258	-	.019	.022	.3054	-	.0235	.0266
-	-	22	D1a	-	38.2	12.1	-	.285	-	.067	.113	.3933	-	.0933	.1560
-	- 10 trees				372.0	111.5	-	2.264	0.237	0.684	0.539	2.7700	0.2930	0.4802	0.6567
	-				37.2	11.2	-	0.226	0.024	0.068	0.054	0.2770	0.0293	0.0480	0.0657

Col.No.17 to 25 continued in next page

APPENDIX III (CONTINUED)

Barkness	Bark percentage of total volume	Length of stem timber in M.	Crown length in M.	Crown width in M.	Crown length in M. Total height	Form quotient		Percentage of sapwood in stem timber
						Over bark	Under bark	
17.	18.	19.	20.	21.	22.	23.	24.	25.
-	17.3	3.0	6.87	8.00	.616	.566	.562	-
-	22.8	3.0	7.00	10.30	.636	.549	.532	-
-	18.0	3.0	6.20	9.00	.553	0.564	.562	-
-	26.7	3.0	5.75	7.00	.479	.463	.410	-
-	42.6	3.0	6.40	10.0	.560	.546	.492	-
-	17.6	3.0	5.00	8.00	.470	.640	.626	-
-	26.5	3.0	7.3	8.0	.660	.578	.538	-
-	36.6	5.0	5.2	8.0	.460	.441	.391	-
-	20.0	3.0	6.8	6.0	.680	.461	.466	-
-	40.7	5.0	7.0	10.0	.580	.460	.417	-
-	268.8	34.0	63.5	84.3	-	-	-	-
	26.9	3.4	6.4	8.4				

Locality Nimar Tract, M.P.

APPENDIX - IV SPECIES - *BOSWELIA SERRATA*

Step IV (Summary of complete data by height and diameter class, use separate form for standard timber, small wood, total timber etc.)

Basic average of standard timber πr^2 volumes classified by 5 cm diameter and 3 metre height classes

Diameter class 1.37 metre	HEIGHT CLASS IN METRES															
	6.1 to 9.0				9.1 to 12.0				12.1 to 15.0				15.1 to 18.0			
	D.B.H. (O.B.) CM	Total ht.m	Volume Cu.m	No.of trees	D.B.H. (O.B.) CM	Total ht.m	Volume Cu.m	No.of trees	D.B.H. (O.B.) CM	Total ht.m	Volume Cu.m	No.of trees	D.B.H. (O.B.) CM	Total ht.m	Volume Cu.m	No.of trees
20.0	18.9	9.0	.0170	1	17.4	10.5	.0000	1	20.0	12.6	.0459	1	-	-	-	-
	16.5	8.7	.0302	1	17.4	9.5	.0000	1	20.0	12.5	.0488	1	-	-	-	-
Total	71.4	35.0	0.1257	4	149.1	84.3	0.4331	-	97.0	60.6	.2655	5				
Average	17.8	8.8	0.0314	-	18.6	10.5	0.0541	-	19.4	12.5	.0531	-	-	-	-	
25.0	24.0	9.0	.0000	1	22.0	9.8	.0943	1	23.3	12.2	.1224	1	25.0	16.5	.3769	1
	23.8	8.9	.1257	1	22.6	11.0	.1000	1	21.1	13.0	.0686	1	23.2	18.0	.1268	1
Total	47.8	17.9	.1257	2	563.2	277.0	2.5830	25	701.5	395.4	3.7439	31	48.2	34.5	.5037	2
Average	23.9	8.9	0.0629	-	22.5	11.1	0.1033	-	22.6	12.7	.1208	-	24.1	17.2	.2518	-
30.0	30.0	8.3	.1095	1	26.5	11.4	.1240	1	25.4	12.6	.1272	1	30.0	15.5	.2160	1
					25.3	11.4	.0942	1	28.7	13.7	.2357	1	29.7	15.5	.1764	1
Total	30.0	8.3	0.1095	1	652.9	205.8	3.4248	24	969.2	457.5	0.9067	35	373.5	204.5	2.8510	13
Average	30.0	8.3	0.1095	-	27.2	11.1	.1430	-	27.6	13.2	.1973	-	28.7	15.7	.2190	-
35.0					31.2	11.0	.2850	1	32.3	14.3	.2767	1	32.9	15.8	.2799	1
					33.2	10.0	.1431	1	32.2	13.5	.1887	1	32.9	16.1	.3862	1

Total	873.9	296.3	6.0863	27	1412.3	571.4	11.6391	43	504.7	270.8	5.2748	17
Averag	32.4	11.0	.2254	-	32.8	13.6	.2707	-	33.2	16.5	.3103	-
40.0	36.3	11.0	.2264	1	35.6	13.6	.3380	1	36.9	16.0	.5927	1
	36.2	11.2	.1900	1	36.0	13.4	.3526	1	39.3	16.0	.4058	1
Total	372.0	111.5	33.3063	10	1220.6	454.4	12.1608	33	019.5	338.7	9.3016	22
Average	37.2	11.2	0.3063	-	37.0	13.7	.3685	-	37.3	15.4	.4229	9
45.0	43.8	11.4	.4502	1	41.4	15.0	.4417	1	43.6	17.8	.5565	1
	-			-	42.5	15.0	.2756	1	43.6	17.3	.3845	1
Total	43.8	11.4	.4502	1	458.4	154.0	4.4562	11	600.4	233.9	7.9818	14
Average	43.8	11.4	.4502	-	41.6	14.0	.4951	-	42.9	16.7	.6645	-
50.0	45.8	12.0	.5026	1	46.1	14.5	.6751	1	45.2	15.5	.4376	1
	46.6	11.0	.4316	1	46.6	15.0	.5674	1	45.2	16.5	.7394	1
Total	185.8	44.5	2.5955	4	607.2	181.1	8.4099	13	136.2	47.6	1.8462	3
	46.5	11.1	.6489	-	46.7	13.9	.7704	-	45.4	15.9	.6465	-

TREE VOLUME AND OUTTURN

Region..... Species.....

Comptt.....

Stump (height cm)	Age (years)	Dia-meter	Diameter at 1.37 m		Total height (m)	Len-gth	Utilisable bole											
							Thick-end comit for badly fluted trees Diameters (cm)				Mid Diameter (cms)				Thin end Diameter (cms)			
			At right angles	Ave rage			O.B. U.B.	At right angles	Ave rage	Sap-wood thick-ness (cm)	O.B. U.B.	At right angles	Ave rage	Sap-wood thick-ness (cm)	O.B. U.B.	At right angles	Ave rage	Sap-wood thick-ness (cm)

Step II

SUMMARY OF SAMPLE TREE MEASUREMENTS

Sample plot form 4

Sample Form

Height class.....

Diameter class.....

Species : *Boswellia Serrata*

Compt. No.	Sample Tree No.	Crown class	Age Years	Diameter at 1.37 M Cms. & dec.	Total height (M)	Length of shoot of last years M & dec	FORM FACTORS								Bark thickness at 1.37 m Cms & dec.	Bark % of total volume	Length of stem timber m	Crown length m
							Timber		Small wood		Timber		Small wood					
							Stem	Branch	Stem	Branch	Stem	Branch	Stem	Branch				
							(To three places of decimals)				(To three places of decimals)							
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
269	1	D1a	42	35.3	11.2	-	.0228	-	.0034	.0039	.2489	- -	.0377	.0426	1.65	7.3	3.0	6.87

Crown width m	Crown length Total height	Form quotient		Percentage of Sap wood in stem timber
		Over bark	Under bark	
		To three places of decimals		
22	23	24	26	27
8.00	.613	.616	.566	.562

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