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GOVERNMENT OF INDIA
Pre Investment Survey of Forest Resources
25, Subhash Road
DEHRA DUN

Report on Plywood Resources of Singalila And Tonglu Ranges of Darjeeling Division, West Bengal

1975

Contents

R/EZ-9

REPORT ON PLYWOOD RESOURCES OF SINGALILA AND TONGLU RANGES OF DARJEELING DIVISION, WEST BENGAL.

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PREFACE

The West Bengal Forest Directorate carried out the resources survey of the forest areas of Singalila and Tonglu Ranges of Darjeeling Division of West Bengal during 1970-71. The report has since been published in the Bulletin No.47 Pt.I & II of the West Bengal Forest Directorate. Since the design for the survey was adopted on an ad-hoc basis, the West Bengal Forest Directorate requested the Preinvestment Survey of Forest Resources organization to undertake a survey on proper design. The main function of the survey was to determine the availability of plywood raw material at a precision of ± 10% at 95% probability level.

While carrying out the survey, besides preparation of forest inventory information, efforts were made to study (1) economics of logging and transport of plywood raw materials to the two alternative sites, viz. Siliguri and Ramam, (2) diameter distribution of plywood species and others, and (3) cull studies.

As a result of this survey it has now been said that a commercial plywood factory requiring more than 16,000 m^3 per year of ply logs can be sustained easily. This quantity of plywood raw material is available annually after meeting the existing commitments. As a result of the logging studies, it has been found that Ramam will be a better site for the factory. It is, however, suggested that for siting the mill etc. a detailed feasibility study may be carried out before going in for financing such a programme.

This is almost the first report prepared by the new Eastern Zone of the Preinvestment Survey of Forest Resources organization under the charge of Dr. A.K. Banerjee. The work of Dr. Banerjee and his staff deserves appreciation particularly when it had to be done without the availability of aerial photographs. Had the photographs been available the work would have been a little quicker and probably the area figures would have been more accurate. But inspite of everything it can safely be assumed that the errors, if any, are insignificant.

(ROMESH CHANDRA)
CHIEF COORDINATOR.

C H A P T E R - I.

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CHAPTER-I.

INTRODUCTION

The forest areas of Singalila and Tonglu ranges in Darjeeling Division of West Bengal are situated in the north western corner of the State, bordering Nepal and Sikkim. Even though some plantations were raised as early as in 1920 and clearfelling followed by planting is being continued, the operation is on a very limited scale because of the difficulties of accessibility and exploitation. In the lastdecade a number of roads have been built and the West Bengal Forest Corporation which has taken over these areas recently have plans to widen the existing road and to layout new ones. As a result of this development, the locked-up forest resources fo these ranges will be soon available for exploitation and therefore information on reliable resources inventory has assumed importance.

The West Bengal Forest Directorate completed the resources survey of these regions in the year 1970-71 and compiled a report which was published by the W.B. Forest Directorate as Bulletin No. 47 Pt. I & II (1). The design for this survey was adopted on an ad-hoc basis and the published report does not claim any specific accuracy. West Bengal Forest Directorate, therefore, requested the Preinvestment Survey of Forest Resources Organisation to undertake this job and indicated preference for getting certain specific information on the resources of the area, which has been indicated later inthe report.

The present work was taken up in the field and completed between November 1974 to December 1974.

The forests of the area generally belong to the middle hill forests corresponding to Champion and Seth's (2) 8 B/C1 (East Himalayan subtropical wet hill forests), Upper hill forests corresponding to upper hill forests II B/C1 (East Himalayan wet temperate Forests). They are composed of a large number of broadleaved species and three species namely Taxus baccata, Tsuga dumosa and Abies densa of the coniferous group.

1.2 OBJECTIVES

The objectives of the survey are enumerated below :-

1) Determination of standing plywood volume at a precision of ± 10% at 95% probability level. The species considered suitable for plywood (local names in bracket) are :-

1. Acer campbellii (Kapasi)
2. Alnus nepaulensis (Utis)
3. Beilschmiedia sp. (Tarsing)
4. Symingtonia populnea (Pipli)
5. Castanopsis tribuloides & C. hystrix (Katus)

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6. Cinnamomum sp.(Sissi)

7. Elaeocarpus lanceaefolius (Bhadrase)

8. Machilus edulis (Lapchekawla)

9. Machilus gammiena (Chiplo kawla)

10. Machilus odoratissima (Lalikawla)

11. Alcimandra cathcartii (Tite champ)

12. Michelia excelsa (Mithe champ)

13. Nyssa sessiliflora (Lekh chilauni)

14. Prunus nepaulensis (Arupate)

15. Quercus lamellosa (Buk)

16. Quercus lineata (Phalant)

17. Phoebe species (Angare)

18. Cedrela species (Toon)

19. Betula species (Bhujpat)

20. Michelia lanuginosa (Phausre champ)

21. Engelhardtia spicata (Mauwa)

22. Echinocarpus dasycarpus (Gobre)

23. Quercus pachyphylla (Sungre, Sungre katus)

24. Taxus baccata

25. Mangnolia campbellii (Chcge champ)

26. Tsuga dumosa (Tengresalla)

27. Abies densa (Gobresalla)

28. Rhododendrons (Guras, chimul etc.).

Others : Non-plywood.

The study of the economics of logging and transport of plywood raw materials from the forests to two alternative sites namely Silliguri and Raman (See Fig.1)

.....3.

3) Preparation of diameter distribution of Tables of plywood and 'other' species.

4) Cull study

1.3 AREA STATEMENT

The ranges in the project area are divided into a number of forest blocks. The net areas for each block have been calculated from the data available in Tenth Working Plan for the Darjeeling forest division(3) reduced by the areas which have gone out of natural forest stocking because of road building, plantations etc. The net area, therefore, excludes the planted up area, roads, rest houses, forest villages, rivers, very steep rocky areas and land slide areas. It may, however, be mentioned that net area statement cannot be treated as absolutely correct which could have been the case had the aerial photographs been available. But the error, if any, will be small and is not likely to effect the data to any significant extent.

TABLE 1. - AREA STATEMENT

Division	Range	Block	Total area (ha.)	Net area(ha.)
Darjeeling	Singalila	Phalut	1475.94	1391.89
	Singalila	Sabarkum	2151.79	2044.72
	Singalila	Ramam	1572.26	1236.41
	Singalila	Siri	1134.74	1118.34
	Singalila	Sandakphu	2111.33	1993.25
	Singalila	South Rimbick	1651.19	1329.72
	Singalila	North Rimbick	1085.82	1065.37
Darjeeling	Tonglu	Tonglu	304.74	246.77
	Tonglu	Rilling	565.34	500.60
	Tonglu	Salimbong	772.58	717.10
	Tonglu	Salimbong Extn.	Not considered	
	Tonglu	Kankibong	1692.86	1580.70
	Tonglu	Little Rangit	787.55	478.34
	Tonglu	Batasi	339.15	113.31
	Tonglu	Rithu	1494.96	1418.42
			17140.25	15252.83

.....4.

1.4. LOCAL FEATURES.

The area is situated between latitudes 27°-30'-7" and 26°-59'-4" North and longitudes 88° - 11'- 52" to 88°- 11' - 0" East. Manebhanjang a small village on the south-east corner of the area can be reached by an all weather road from Darjeeling (Figure- 1)

Climate:- The climate is sub-tropical to temperate. The mean maximum and mean minimum temperatures of Darjeeling which is a little east of the area under consideration, are 47°F and 25°F in January, and the mean maximum and mean minimum temperatures during the hottest period are 66°F and 58°F respectively. In the area under study the temperature is generally lower than that of Darjeeling. Forest is very common during December, January and February. It snows almost every year but is not of consequence as the total fall is small and it does not stay for long.

Rainfall is very heavy in the monsoon months namely June to October. The rainfall at Salimbong Tea Estate varied between 207 to 228 cm. between 1951 to 1965 with an average of 254 cms. At Sandakphu the average between 1960 to 1965 has been calculated to be 339 cms.

Topography and drainage:- The terrain is mountainous with elevation ranging from 1525 m. to 3655 m. The maximum elevation is in the north-east corner. The northern slopes of the survey area are drained by Ramam river, Great Rangit river and Little Rangit river. Part of the Southern slopes are the catchments of Mahanada and the Balason river. The slopes of the Project area are generally steep to very steep. Out of 130 plots chosen at random as per design described later, the distribution was found to be as follows:-

Table- 2- Percentage distribution of slopes.

Slope %	Percentage distribution of plots.
Less than 2	0.00
" " 2-9	0.80
" " 10-19	18.12
" " 20-29	38.90
" " 30-39	36.10
" " 40-49	6.08

It will be seen that the largest concentration is within 20-39% slope.

Rocks:- The rocks belong to the Archean age. They are comprised of the Archean granite-gneiss and highly metamorphased schists. In addition there were some Amphibolites and ultra basics. In 26.9% of the plots, rocks were found on top surface while in 56.9% they were found at depth of 0-1 m.,

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7.7% at depth more than 1 m. and in 8.4% of the plots the rocks were not met with even at the depth of 3-5 meters.

Soils :- The soils are generally yellow and grey brown Podzolics. The soils are generally mixed up with certain amount of stones derived in situ or transported. Table NO.3 shows the percentage of soil profiles (121 examined) of various stoniness in the top surface.

TABLE -3. Percentage Distribution of different categories of stoniness in Soils.

Percentage by volume of stones in the solum	Percentage of soils examined
Less than 1	40.5
1-5	36.4
5-25	18.2
25-50	4.1
50-75	0.8

The depth of soil is variable and out of 130 random plots chosen the depth of soil was found to be distributed as indicated in table-4.

TABLE -4 Table showing the distribution of depth of the profiles examined.

Depth of soil in cm.	Percentage distribution
Less than 15	9.2
15-30	26.1
31-90	53.8
90-180	9.2
180 +	1.5

A look at the table will indicate that the maximum number of profiles have soil depth varying between 31 cm. - 90 cm.

The hydrogenion concentration of 121 soils examined with the help of field Ph. meters indicated that the Ph. varies between 4.0 to 7.0. The maximum number of them had Ph. of 6.5.

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Roads :- (Fig.1) As mentioned earlier Manebhanjang which is in the south east corner of the project area is well connected with Darjeeling and also with Siliguri. A number of roads have been constructed within the project area and a few more are either under construction or will be taken up soon.

Table - 5 - Roads.

Name of road	Km.
1. Manebhanjang - Phalut Road (via Meghma, Tonglu, Gairibas, Kalipokri & Sandakphu)	43
2. Manebhanjang - Rimbick road (via Dhotrephatak, Dilpa, Gairibas)	40
3. Dhatrephatak to Salimbong (Forest road)	5
4. Dhatrephatak - Lodhamakhola (S.E.B. Road) near Barahatta Village (Via. Palmjua)	33

Besides, another road from Gairibas to Rimbick is proposed for construction by Forest Department.

Out of the above roads Manebhanjang - Phalut road and Manebhanjang - Rimbick bazar via Palmajha and Manebhanjang - Dilpa road are only jeepable. Only 20 Km. from Manebhanjang of the Manebhanjang - Rimbick road is suitable for heavy transport. Manebhanjang - Dilpa road, Manebhanjang - Salimbong road and Manebhanjang - Palmajha road are suitable for half tonne truck (1.5 cubic meter capacity). They can however, be convert ed for use by heavier transports by a small investment.

Power :- Hydel power station at Bijanbari and supply from Jaldhaka project are the present sources of power in the areas. The proposed hydel power station at Rimam is located close to the project area and is expected to be ready in a reasonably small period of time.

Maps :- The following survey sheets (4" = 1 Mile) were used for the present work.

1) Part of sheet No. 269 SW/1
2) Part of sheet No. 269 SW/2
3) Part of sheet No. 269 SW/4
4) Sheet No. 269 NW/3

C H A P T E R - II.

Contents

DESIGN

No pilot survey was considered necessary as the data c· collected by the Silvicul-tural division of West Bengal formed the basis of our sampling design. Considering infinite population andblock as stratum, the variations in the basal area per plot in each block were calculated. The size of the sample with10% precision is obtained according to the formula. (1)

$$n = \frac{t^2 (\Sigma Pj \ Sj)^2}{E^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where n = Size of the sample i.e. the total number of points to be surveyed.

Pj = The area proportion of the j^{th} block

Sj = The Standard deviation of the j th block

E = Precision fixed at 10%

t = 2

'n' worked out to be 130 . They were allocated to different blocks by the method of optimum allocation. Formula adopted was as follows :-

$$nj = \frac{Pj \ Sj}{\Sigma Pj \ Sj} \times n \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where the variables have same meaning as for formula (1)

The following table shows the number of points obtained by the aforesaid method, which need to be surveyed in each block for the required precision.

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Table :- 6 Allocation of plots to different blocks.

Sl.No.	Block	No. of plots to be surveyed.	No. of clusters of plots.
1.	Kankibong	12	6
2.	Tonglu	4	2
3.	Batasi	4	2
4.	Rithu	12	6
5.	Salimbong	6	3
6.	Rolling	4	2
7.	Little Rangit	6	3
8.	Sandakphu	14	7
9.	Phalut	12	6
10.	Siri	8	4
11.	North Rimbick	8	4
12.	South Rimbick	12	6
13.	Sabercum	16	8
14.	Ramam	12	6
	Total	130	65

As the terrain was very hilly continuous camp shifting to visit large number of points would have been prohibitively expensive. It was therefore, decided that cluster sampling will be adopted, where each cluster will have 2 plots at a distance of 100 meters.

In order to decide on the exact points to be visited, 4" = 1 mile base map was sub-divided by longitudinal and horizontal grids at thirty second intervals. This grid pattern resulted in 236 number of grid squares. Each of these squares were numbered and with the random number table of Fisher and Yates (4), squares were selected separately for each block (Fig.2) as per allocation shown earlier and the plot centres were marked on the grid centre.

.....9.

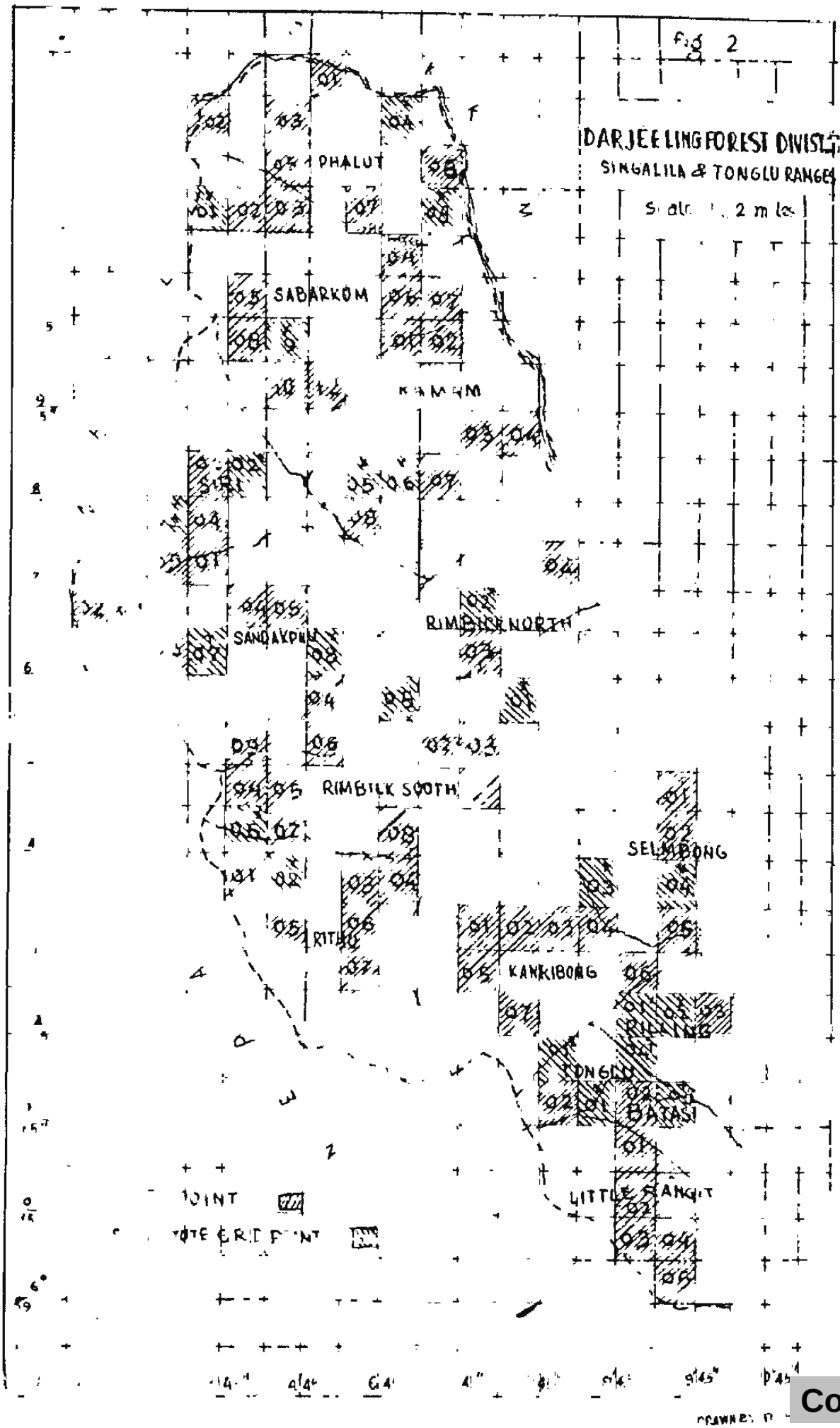
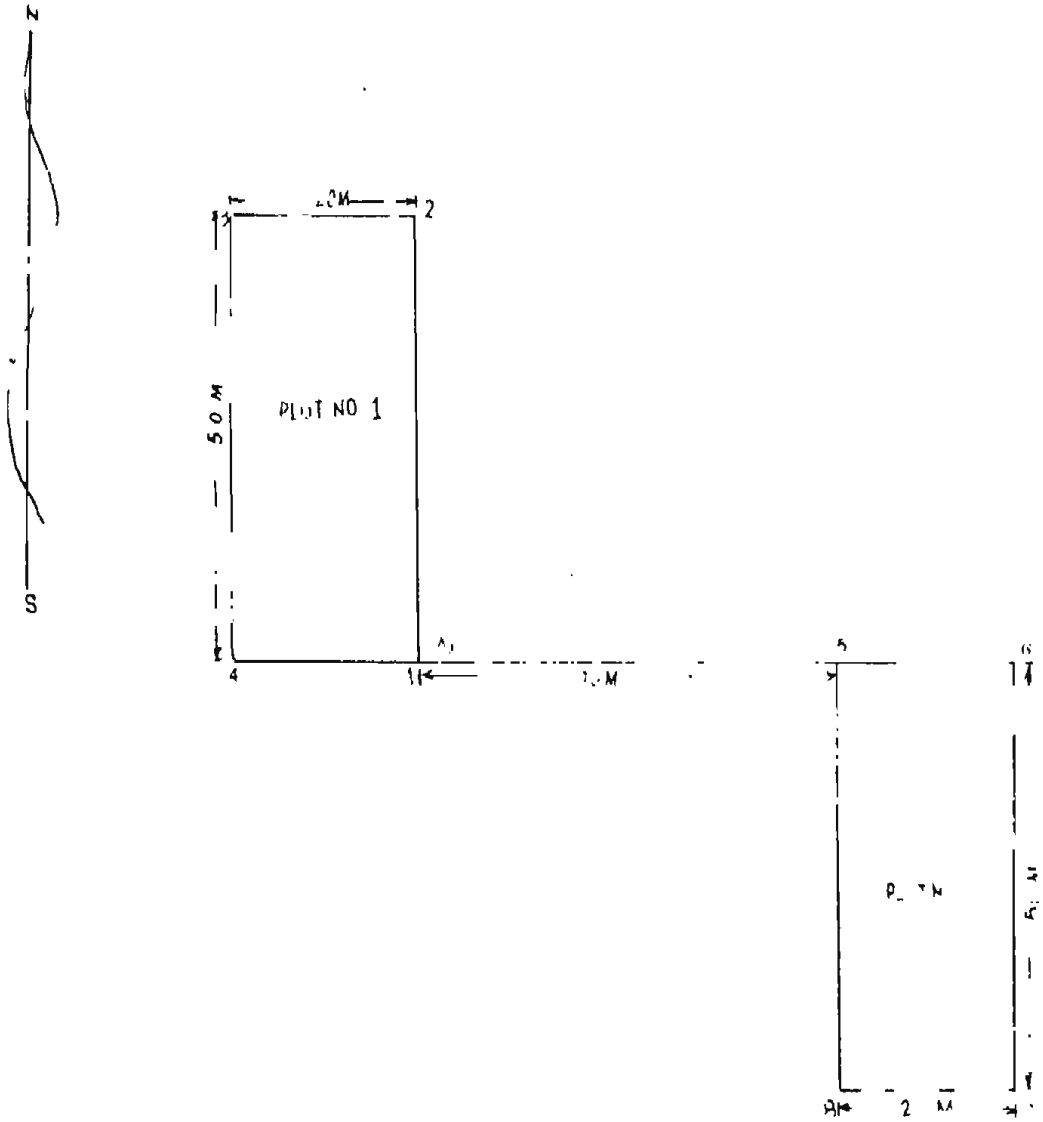


Fig 2
DARJEELING FOREST DIVISION
SINGALILA & TONGLU RANGES
PHALUT
SABARKOM
RIMBIK NORTH
SANDAKPUR
RIMBIK SOUTH
SELIMBONG
KANKIBONG
TONGLU
BATASI
LITTLE SANGIT
JOINT
TRIJUNCTION

Contents

ORIENTATION OF THE PLOTS IN THE CIVIC CENTRE

NOT TO SCALE



The plot area was 0.1 hectare of a rectangular shape 50 m (l) x 20 m. (b) taking into account the fertility gradient which is generally from north to south. The orientation and dimensions of the cluster of two is indicated in figure 3.

Laying out of the plots and collection of information

The field partics job was to reach the grid centres with the help of the available map and local features like compartment boundary lines, roads, foot paths and Survey of India benchmark pillars, villages etc.

After laying out the cluster of plots as per design, the party collected the informations as per Form 1 to Form IV. A manual appearing as Appendix - 1 explains the specific meaning of each of the columns for different forms.

C H A P T E R – III

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INVENTORY

3.1. Blockwise distribution of stems by diameter and utility classes

The enumeration form (Form II) contained the diameters of the trees having diameter above 10 cm. overbark separately for each plot. This information was then tabulated separately for plywood and species other than plywood for four diameter classes namely 10-39 cms., 40-69 cms., 70-99 cms and 100 cms and above. The total number of trees for the utility classes in each diameter class for all the plots falling in a block were then added up and multiplied by net area divided by area sampled. Table-7 gives the estimates of all stems (including standing culls) separately for each block, diameter classwise for the utility classes.

Table -7 - Blockwise distribution of stems by diameter and utility classes (Estimates)

	Diameter Classes (Cms.)				
	10-39	40-69	70-99	100+	Total
I. South Rimbick (1329.72/12)					
Plywood	48756	29919	31027	16621	126323
Others	87540	17730	4432	-	109702
Total	136296	47649	35459	16621	236025
II. North Rimbick (1065.37/8)					
Plywood	110532	38619	25302	3995	178448
Others	49273	10654	6658	1332	67917
Total	159805	49273	31960	5327	246365
III. Sandakphu (1993.25/14)					
Plywood	269079	58372	8542	5695	341688
Others	39863	5695	-	-	45558
Total	308942	64067	8542	5695	387246
IV. Siri (1118.34/8)					
Plywood	61508	50324	22366	11183	145381
Others	20969	11183	1398	-	33550
Total	82477	61507	23764	11183	178931

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	10-39	40-69	70-99	100+	Total
V. Sabarcum	(2044.72/16)				424263
Plywood	287528	102232	17891	16612	
Others	35781	7667	3834	1278	48560
Total	323309	109899	21725	17890	472823
VI. Raman	(1236.41/12)				
Plywood	211212	51515	10303	5151	278181
Others	78303	15455	1030	-	94788
Total	289515	66970	11333	5151	372969
VII. Phalut	(1391.89/10)				
Plywood	203217	43149	8352	15311	270029
Others	59852	4176	-	-	64028
Total	263069	47325	8352	15311	334057
VIII. Little Rangit	(478.34/8)				
Plywood	20927	11360	7175	3587	43049
Others	24514	3587	-	-	28101
Total	45441	14947	7175	3587	71150
IX. Tonglu	(246.66/4)				
Plywood	59810	2467	-	-	62277
Others	27747	-	-	-	27747
Total	87557	2467	-	-	90024
X. Batasi	(113.31/2)				
Plywood	5664	1700	1700	-	9064
Others	5099	566	-	566	6231
Total	10763	2266	1700	566	15295

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	10-39	40-69	70-99	100+	Total
XI. Rilling	(500.60/4)				
Plywood	75090	5006	-	2503	82599
Others	72587	1252	-	-	73839
Total	147677	6258	-	2503	156438
XII. Kawkibong	(1580.70/14)				
Plywood	346634	75650	25969	19195	467448
Others	189689	21453	3387	2258	216787
Total	536323	97103	29356	21453	684235
XIII. Salimbong	(717.10/6)				
Plywood	37051	39442	14342	2390	93225
Others	22708	3586	3586	1195	31075
Total	59759	43028	17928	3585	124300
XIV. Rithu	(1418.42/12)				
Plywood	178482	41370	5910	-	225762
Others	174936	10638	5910	-	191484
Total	353418	52008	11820	-	411336
Project Area	(15252.83/130)				
Plywood	1915490	551125	178879	102243	2747737
Others	888861	115642	30235	6629	1039367
Total	2804351	664767	209114	108872	3787104

Note :- (1) Figures against the blocks are the net area in hectare/Sample Plots.

(2) Standard error of the stem estimate works out to be 5.57% (for entire project area).

.....13.

The data presented in table -7 have been pictorially represented in bar-diagram figure- 4. The features of the stem distribution that need pointed mention are:-

1) Approximately 75% of the total number of trees belong to plywood utility class.

2) In the plywood class, the number of trees are maximum in 10 cm.- 30 cm. diameter class, progressively reducing with the increase of class size.

3) The large number of plywood trees in the lower diameter class is indicative of the fact that in the not- too- distant past, the regeneration and establishment of regeneration were ample.

4) Approximately 25% of the trees are in ' others' category.

5) Among ' others' category trees in 70 cm. - 99 cm. and 100 + cm. are few in number.

6) The standard error of the stem estimate in total project area is 5.57%.

This is, however, not valid for the figures in each block.

It may be specially pointed out here that Form -2 of Appendix -1 based on which the tables of distribution have been compiled, does not have any columns to include remarks about the health or condition of the enumerated trees. The estimates above, therefore, are gross and include standing hollow and rotten trees but exclude the dead ones. In the chapter dealing with cull studies (Chapter IV), these have been worked out separately and used for computation of net volume of different categories of wood.

3.2. COMPUTATION OF VOLUME.

Some definitions:- Gross volume for the following categories of wood have been calculated. Different categories of wood have been defined as below:-

a) Plywood:- Wood having a minimum length of 2.5 meters and having dimensions upto 30 cm. d.o.b. at the thin end of species considered as ' plywood.'

b) Total Timber:- Wood having dimensions upto 20 cm. d.o.b. for all categories of species with a minimum of 2.5 m.

c) Residual timber:- Total timber excluding plywood. This should have a minimum length of 2.5 meters.

d) Small wood:- Wood having dimensions of 20 cm. d.o.b. at the thick end to 5 cm. d.o.b. at thin and of all categories of species.

e) Total wood = Total timber + Small wood.....14

BAR DIAGRAMS SHOWING AGE & SEX DISTRIBUTION
BLACK
M CLASS
GAM

Methodology of computation.

In order to compute the gross volume, the net area, number of trees and volume of individual trees are required. The first two information have been already presented in Table-1 and Table - 7, The individual volumes are, therefore, necessary now to be worked out by constructing local volume tables. As the number of species in the Project area run to a few dozens, it was decided that individual local volume equations for plywood, total timber and smallwood for more important and more numerous plywood species will be made out from general volume equation- based on data obtained by felling of at least 25-30 trees of each species, distributed in various diameter classes over the entire area. For volume equations other than those more important ones, an omnibus equations will have to be similarly constructed from data obtained by felling a large number of different categories of trees.

Volume equations.

For general volume equations the following were tried and the one best fitting, the collected data was chosen.

1) $V = a+bD^2H$

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

3) $V = a+bD^2H + cD^2 + dH$

4) $V = a+bD^2H + cD$

Where V= volume(m^3), D = D.B.H.(cm.) H = height (meters) and a,b,c,d are constants.

Tables 8 and 9 incorporate the general volume equations selected for plywood and total timber.

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TABLE :- 8 ESTIMATED GENERAL VOLUME EQUATIONS FOR PLYWOOD

Species	Equations
Sp-1 (Acer campbelli)	$V = -0.2835 + .0000260\ D^2H$
Sp-2 (Alnus nepaulensis)	$V = -0.1554 + .0000292\ D^2H$
Sp-6 (Cinnamomum species)	$V = -0.1554 + .0000359\ D^2H$
Sp-9 (Machilus gamblena)	$V = -0.0762 + .0000272\ D^2H$
Sp-10(Machilus odoratissima	$V = -0.2856 + .0000303\ D^2H$
Sp-12(Michelia cathcartii)	$V = -0.1458 + .0000248\ D^2H$
Sp-15 (Quercus lamellosa)	$V = -0.3660 + .0000359\ D^2H$
Sp-16 (Quercus lineata)	$V = -0.1902 + .0000227\ D^2H$
Sp-17 (Phoebe species)	$V = -0.3340 + .0000324\ D^2H$
Rest of species	$V = +0.6334 + 0.00004\ D^2H - 0.0323\ D$

.....16.

TABLE - 9 - ESTIMATED GENERAL VOLUME EQUATIONS FOR TOTAL TIMBER

Species	Volume Equations
Sp-1 (Acer cambelli)	$V = 0.0094 + .0000263\ D^2H$
Sp-2 (Alnus nepaulensis)	$V = 0.2021 + .0000281\ D^2H$
Sp-6 (Cinamomum species)	$V = -0.1505 + .0000352\ D^2H$
Sp-9 (Machilus gamblana)	$V = +0.0659 + .0000275\ D^2H$
Sp-10 (Machilus Odoratissima)	$V = +0.0303 + .0000308\ D^2H$
Sp-12 (Michelia cathcartii)	$V = -0.0205 + .0000263\ D^2H$
Sp-15 (Quorcus lamellosa)	$V = -0.1922 + .0000373\ D^2H$
Sp-16 (Quercus lincata)	$V = +0.0270 + .0000225\ D^2H$
Sp-17 (Phoebe Species)	$V = -0.2763 + .0000355\ D^2H$
Rest of species	$V = -0.1748 + .0.00003\ D^2H$

From the general volume equations, the local volume equations were constructed by using the diameter and height data in the sample tree forms (Form No.4).

For local volume equations, the following equations were tried and the ones best fitting were accepted.

1) $V = a+bD$

2) $V = a+bD+cD^2$

3) $V = a+bD^2$

4) $V = a+bD+c\sqrt{D}+\frac{d}{D}$

5) $V = a+bD^2+ c\sqrt{D}$

6) $V = a+bD + \frac{C}{D}$

Where V = volume (m^3), D = Diameter (cm.) In case of smallwood $a+b\sqrt{D}$ was tried. Local volume equations selected for plywood and total timber are given in Tables 10 and 11.

.....17.

TABLE - 10. LOCAL VOLUME EQUATIONS (PLYWOOD)

Species	Equations
Sp-1 (Acer cambelli)	$V = -.0962 - .0145\ D + .0008\ D^2$
Sp-2 (Alnus nepaulensis)	$V = +.2248 - .0353\ D + .0013\ D^2$
Sp-6 (Cinnamomum species)	$V = .3353 - .0437\ D + .0012\ D^2$
Sp-9 (Machilus gamelana)	$V = -.3417 + .0055\ D + .0006\ D^2$
Sp-10(Machilus odoratissima)	$V = -1.3359 + .0565\ D$
Sp-12(Michelia excelsa)	$V = -2.1537 + .0745\ D$
Sp-15 (Quercus lamellosa)	$V = -3.7287 + .1431\ D - .0005\ D^2$
Sp-16 (Quercus lineata)	$V = .3129 - .036\ D + .0009\ D^2$
Sp-17 (Phoebe species)	$V = -.5193 + .0252\ D$
Sp- Rest of Species	$V = -3.1373 + .0926\ D + .00008\ D^2$

.....18.

TABLE - 11 LOCAL VOLUME EQUATIONS FOR TOTAL TIMBER.

Species	Equations
Sp-1 (Acer Cambelli)	$V = -.3077 + .00078\ D^2$
Sp-2 (Alnus nepaulensis)	$V = .7287 - .042628\ D + .00137\ D^2$
Sp-6 (Cinnamomum speices)	$V = -.3219 + .00073\ D^2$
Sp-9 (Machilus gamelana)	$V = -.0672 + .00063\ D^2$
Sp-10 (Machilus odoratissima)	$V = -3.511 + .0915\ D + 35.411\ \frac{1}{D}$
Sp-12 (Michelia excelsa)	$V = -6.4152 + .0902\ D + 32.479\ \frac{1}{D}$
Sp-15(Quercus lamellosa)	$V = -9.246 + .1650\ D + 134.00\ \frac{1}{D}$
Sp-16(Quercus lineata)	$V = 1.4402 + .00082\ D^2 - .3431\sqrt{\frac{1}{D}}$
Sp-17(Phoebe species)	$V = -0.7931 + 0.0362\ D$
Rest of species	$V = -4.0496 + .1003\ D + 39.727\ \frac{1}{D}$

The following volume equation was accepted for smallwood.

Local volume equation for smallwood.

Name of species	Volume equation
All species taken together	$-.0037 + .0312\sqrt{D}$

3.3 GROSS VOLUME

A suitable computer programme involving the enumerated data as basic input and the volume equations as the operating element was made out and the gross volumes were computed.

.....19.

TABLE :- 12 GROSS VOLUME(TOTAL)- DARJEELING PROJECT AREA 1974

(Vol. in Cu.m.)

S.No.	Block	Area in hectare	Average Volume per Plot	Volume per hectare	Estimated Vol.
1.	South Rimbick	1329.72	29.398	293.98	390915.10
2.	North Rimbick	1065.37	28.809	288.09	306921.43
3.	Sandakphu	1993.25	13.875	138.75	276567.42
4.	Siri	1118.34	29.881	298.81	334174.49
5.	Saborcum	2044.72	24.865	248.65	508415.53
6.	Ramam	1236.41	22.870	228.70	282773.14
7.	Phalut	1391.89	21.803	218.03	303475.76
8.	Little Rangit	478.34	23.455	234.55	112193.16
9.	Tonglu	246.66	6.093	60.93	15027.96
10.	Batasi	113.31	21.185	211.85	24005.10
11.	Relling	500.60	13.814	138.14	69150.89
12.	Kemkibong	1580.70	38.128	381.28	602684.52
13.	Salimbong	717.10	29.422	294.22	210988.06
14.	Rithu	1418.42	11.821	116.21	164837.40

.....20.

TABLE :-13 (GROSS) PLYWOOD VOLUME IN DARJEELING PROJECT AREA 1974

(VOL. IN cu.m.)

S.No.	Block	Area in hectare.	Average volume per Plot	Hectare	Estimated Vol.
1.	South Rimbick	1329.72	22.5179	225.179	299425.0
2.	North Rimbick	1065.37	20.9717	209.717	223426.2
3.	Sandakphu	1993.25	10.5481	105.481	210250.0
4.	Giri	1118.34	26.3478	263.478	294658.0
5.	Sabercum	2044.72	20.7242	207.240	423747.8
6.	Ramam	1236.41	15.6282	156.282	193228.6
7.	Phalut	1391.89	18.5262	185.262	257864.3
8.	Little Rangit	478.34	18.7281	187.281	89584.0
9.	Tonglu	246.66	1.2054	12.054	2973.2
10.	Ba tasi	113.31	13.7466	137.466	15576.3
11.	Relling	500.60	6.0153	60.153	30113.6
12.	Kankibong	1580.70	26.6496	266.496	421250.2
13.	Salimbong	717.10	22.1336	221.336	158720.0
14.	Rithu	1418.42	7.5966	75.966	107751.7
	Total	15252.83	17.8889	178.889	2728568.9

Note :-

1. Individual block estimates are arrived at on the basis of the observations within the block.

2. Different regression equations were estimated for different main plywood species and one more equation for other remaining plywood species, with the help of these equations the plywood volume was estimated.

.....21.

TABLE - 14 - TOTAL TIMBER VOLUME IN DARJEELING PROJECT AREA - 1974

(Vol. in cu. m.)

S.No.	Block	Area in hectare.	Average volume per Plot	Hectare	Estimated Volume
1.	South Rimbick	1329.72	28.4407	284.407	378181.7
2.	North Rimbick	1065.37	27.4125	274.125	292044.6
3.	Sandakphu	1993.25	11.9096	119.096	237388.1
4.	Siri	1118.34	29.6420	296.420	331498.3
5.	Sabercum	2044.72	23.9515	239.515	489741.1
6.	Raman	1236.41	21.4444	214.444	265140.7
7.	Phalut	1391.89	19.9813	199.813	278117.7
8.	Little Rangit	478.34	22.6669	226.669	108424.8
9.	Tonglu	246.66	2.6752	26.752	6598.6
10.	Batasi	113.31	20.3844	203.844	23097.6
11.	Relling	500.60	12.0313	120.313	60228.7
12.	Kankibong	1580.70	34.5216	345.216	545682.9
13.	Salimbong	717.10	29.0016	290.016	207970.5
14.	Rithu	1418.42	9.8215	98.215	139310.1
	Total	~~15252.62~~ 15252.83	22.0075	220.075	3363425.4

Note :-

Estimates are based on separate equations for major plywood species and another equation for all the other species.

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TABLE - 15 - Small Wood volume in Darjeeling Project Area 1974

(Volume in cu. m.)

S.NO.	Block	Area in hectare.	Average volume per Plot	Hectare	Estimated Volume.
1.	South Rimbick	1329.72	.9576	9.576	12733.40
2.	North Rimbick	1065.37	1.3964	13.964	14876.83
3.	Sandakphu	1993.25	1.9656	19.656	39179.32
4.	Siri	1118.34	.2393	2.393	2676.19
5.	Sabercum	2044.72	.9133	9.133	18674.43
6.	Ramam	1236.41	1.4261	14.261	17632.44
7.	Phalut	1391.89	1.8217	18.217	25356.06
8.	Little Rangit	478.34	.7878	7.878	3768.36
9.	Tonglu	246.66	3.4174	34.174	8429.36
10.	Batasi	113.31	.8009	8.009	907.50
11.	Relling	500.60	1.7823	17.823	8922.19
12.	Kankibong	1580.70	3.6061	36.061	57001.62
13.	Salimbong	717.10	.4208	4.208	3017.56
14.	Rithu	1418.42	1.7997	17.997	25527.30
	Total	15252.82	1.5646	15.646	238702.56

The gross volume of different categories of wood in the Project area as a whole are repeated. The figures of residual timber and total wood have been calculated by the following formula.

Residual timber volume = Total timber volume – plywood Volume

Total wood = Total timber volume + smallwood

TABLE : 16 – Gross volume for various categories of wood

SL.NO.	Utility class	Gross vol./ha. (cu.m. rounded)	Standard error %	Gross total vol. in reference project area (1000 cu.m. rounded)
1.	Total timber	220.0	6.12	3363
2.	Plywood	178.9	7.37	2728
3.	Residual timber	41.1	–	635
4.	Smallwood	15.7	10.00	239
5.	Total Wood	235.7	–	3602

3.4. Cull Studies

The computed gross volume includes culls which need to be substracted to arrive at the net volumes.

The culls in the forests have been sampled by two separate modes of observations.

Firstly, in each plot, 25% of the area were further observed and Form – 3 (Appendix – 1) was filled up. Those observations allowed computation of percentage of trees which were obviously hollow and rotten and cannot be used for utilisation as plywood or timber. These will be referred to as 'standing culls'. Secondly, apparently healthy trees, when felled and sectioned showed different types of defects making parts of tree . logs unutilisable, to be referred to as 'hidden cull'.

Form – 4 (Appendix) was used for the purpose.

The standing cull in the area are as follows :-

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TABLE : 17- STANDING CULLS IN THE FORESTS.

Block No.	Total No. of trees.	No. of sound trees	No. of hollow trees	No. of rotten trees	No. of hollow & rotten trees	Total No. of unsound trees.
(11) South Rimbick	27	19	3	0	5	8
(12) North Rimbick	29	21	5	1	2	8
(16) Ranam	42	39	0	0	3	3
(21) Little Rangit	22	11	10	0	1	11
(22) Tonglu	27	27	0	0	0	0
(23) Batasi	7	3	1	2	1	4
(24) Rolling	48	44	3	0	1	4
(25) Kakibong	71	53	6	2	10	18
(26) Salimbong	53	43	1	0	4	5
(28) Rithu	31	27	1	3	0	4
Total	357	292	30	8	27	65
Percentage		81.79	8.41	2.24	7.56	18.21

It will be seen from this table that 8.41 + 2.24 + 7.56 =18.21 are the standing culls. The volume of such trees are included in the gross volumes and need to be deducted.

The 'hidden culls' which worked out to be 2.39% have been already taken care of in the volume equations and therefore are not necessary to be deducted again from the gross volume.

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3.5 NET VOLUME

The net volume in the project area can now be computed.

TABLE - 18 NET VOLUME OF DIFFERENT CATEGORIES IN PROJECT AREA.

Utility class	Cu.m(rounded)			1000 Cu.m.(rounded)		
	Gross vol/ ha.	Cull %	Net Vol. /ha	Gross Vol.in project area.	Cull %	Net Vol.in project area.
Total timber	220.0	18.21	179.9	3363	18.21	2751
Plywood	178.9	18.21	146.3	2728	18.21	2231
Residual timber	41.1	18.21	33.6	635	18.21	519
Smallwood	15.7	-	-	239	-	239
Standing cull timber	40.0	-	40.0	606	-	606

.....26.

CHAPTER - IV

LOGGING AND TRANSPORT STUDIES:

Object of this cost study in the project area of Darjeeling Division is to determine the logging and transport costs of the standing wood at two alternative mill sites at Siliguri and Ramam.

In this connection it is worthwhile to highlight certain facts about the present infrastructure and industrial complex situated in these two places. Siliguri is situated by the side of river Mahananda and it is one of the busiest industrial centres of North Bengal. Existing facilities regarding power, communication and other economic advangages, render this area as one of the most potential industrial sites in the North Eastern Region of the country. However, the proposed site of industries at Siliguri is beset with only one difficulty i.e. the location lies a little away from the belt of raw material sources.

Ramam, on the other hand is situated very much within the belt of various raw materials and distance from various parts of the forest tracts is quite low compared to the other proposed site i.e. Siliguri. Furthermore when the Ramam hydel project (50 M.W.) is commissioned, industrial power will be plentiful near the site.

This study aimed at determining whether or not the plywood raw material can be transported to these two different places and supplied at a competitive rate to the manufacturers.

The cost study of the economic supply of the standing volume from the project area is based on the similar studies developed in the scandinavian countries by Samsetvon Sagabadon etal (6). The following premises have been adopted.

1. The classification of terrain with respect to the logging condition(2) Delineation of forest area which are inaccessible with the existing logging condition and (3) classification of the forest with respect to the cost factor.

The cost study has got a direct bearing on the present extraction pattern and existing infrastructure in terms of roads etc. Therefore, it is essential to have certain ideas on the present status of timber exploitation and various factors controlling logging and transport of timber in this zone. Departmental operations in these forest areas are not very common and extraction is mainly done through private agencies and the timber extraction as influenced by following factors is detailed below:-

a) Terrain:- The terrain in this forest area varies from hilly to very hilly and slope generally lies between 20% to 39% and altitude varies from 1525 mtr. to 3655 mtr. and such type of inaccessible terrain condition renders timber extraction very difficult.

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b) River : Though there are quite a good number of perennial streams in this forest area but they are characterised by turbulance, rapids and huge bouldary beds and therefore, none are economically feasible for timber floating. Besides hardwood floating is not possible.

c) Roads : The details of existing roads have been already indicated earlier in Chapter I.

Transport and felling equipments.

Scientific logging operations and mechanised timber transport operation from the forest to the roadhead are not carried out by the private agencies. Felling is carried out mainly by axes. Conversion to logs are done by cross cutting by two man peg tooth saws. Generally no debarking is done.

Conversion.

Conversion of logs into squares are generally done in the following sizes :

20 cm x 20 cm
25 cm x 25 cm.
30 cm x 30 cm
15 cm x 15 cm

Scants and planks are also converted depending on the local demands, out of which 2.4M. x 0.2M., x.025M., or .0375 M. or .0187 M. of planks are the popular sizes.

Off road transport

In sloping areas situated just by the side of roads, off road transportation is done by rolling logs from the stump to road side and manual carriage from stump to road side when the distance from the road side is appreciable and when the assortments are not too heavy. Thus for off road transportation of timber no mechanical equipment is used. Hence in most of the cases sawing is done at site only. Finished produce is thus generally carried by manpower.

Transportation of timber.

Road transportation of timber is done by half ton (1.5 m^3) trucks upto Siliguri. Loading and unloading in this truck is done manually.

Labour

Forest villagers and outsiders are generally engaged for logging and allied timber operations. They do not possess any specialised training and have only limited experience.

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Cost and accessibility study

This study has been done separately for timber, small wood and charcoal. The following phases have been dealt.

1) Since the investigation is being carried out for two alternative sites, evaluation of cost structure has been made on a comparative basis.

2) With due consideration to the exploitation and transportation rates prevalent in different parts of this inaccessible hill region one reasonable set of rates for different operations has been considered in this study.

3) Since there is a good net work of existing roads all calculation regarding off road and on road transport to the proposed mill site have been carried only with reference to these roads. Construction work of certain roads are progressing fast. As these will be commissioned shortly, these have been taken into consideration while calculating transport economics.

4) As the present roads will be converted to truckable roads shortly, the investigation is made on the basis of truckable roads. For this study present hiring rate of diesel truck per cubic metre per kilometer has been taken as the norm.

5) For calculating the transporting cost the block centre has been taken as the reference point.

Logging and transport charges for various forest products

The rates for logging for soft wood and hard wood are different. The data on the basis of market study for the two categories of timber are furnished in Table-19. In Table-20, the transportation cost for Raman location have been calculated.

In case of Siliguri the minimum on road distance is 96 Km.-120 Km. and is therefore obviously much more expensive when compared with Raman.

In order to get the cost of wood at mill site, the total figure can be arrived at by adding the total transporting cost from each block to Raman in Table-20 with the cost of logging, arrived at in Table-19.

It may be seen that the total cost arrived at varies between Rs.65/- and Rs.242/- (approximately).

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TABLE - 19 - LOGGING COSTS

Soft wood (Timber which can be sawn without much difficulties)			Hard wood (Timber which is difficult to saw)		
Operations	Rate per cubic metre	Mandays	Operations	Rate per cubic metre	Mandays.
Felling and cross cutting into logs.	Rs.15.00	3	Felling & cross cutting	Rs.18.00	3
Sawing in scants, planks	Rs.52.55	5	Sawing in scants, planks	Rs.65.75	7
Carriage to roadside ½ km.	Rs.15.50	3	Carriage to road-side ½ Km.	Rs.18.50	3
Loading in truck	Rs. 2.00	½	Loading in truck	Rs. 2.00	½
Unloading from truck	Rs. 1.00	¼	Unloading from truck	Rs.1.00	¼
Loading and stacking in the depot.	Rs.10.00	2	Loading and stacking the depot.	Rs.10.00	2
Supervision charges	Rs. 5.00	2	Supervision charges	Rs. 5.00	2
(All measurements are based on quarter girth formula)					
Total for logs - Rs.45.50			Total for logs	Rs. 54.50	

TABLE - 20

TABLE SHOWING COMPARATIVE TRANSPORTING COST OF TIMBER FROM VARIOUS LOADING DEPOTS TO PROPOSED INDUSTRIAL SITES

From	To	Off road transport x 2.5 = km.1*	On road transport distance 2* From	To	Total in Km.	Total in km. Off road + on road	Transporting cost per km. 2.60	Total cost
Phalut	Raman	6.5 x 2.5= 16.25	-	-	-	16.25	16.25 x 2.60	42.25
Jabarkum	Raman	5.5 x 2.5 =12.75	-	-	-	12.75	12.75 x 2.60	33.15
Raman	Raman	2.43x 2.5= 6.075	-	-	-	6.075	6.075 x 2.60	15.80
Giri	Gairibus	6.48x 2.5= 16.20	Giribus	Raman	58	74.20	74.2 x 2.60	192.20
Sandakphu	Gairibus	4 x 2.5 = 10.00	Gairibus	Raman	58	68.00	68.00 x 2.60	176.80
Rithu	Dilpa	2.45 x 2.5= 6.125	Dilpa	Raman	52	58.125	58.125 x 2.60	151.12
Rimbick(S)	Rimbick	2.45 x 2.5= 6.125	Rimbick	Raman	12	18.125	18.125 x 2.60	47.12
Rimbick(N)	Raman	4.2 x 2.5 = 10.50	-	-	-	10.50	10.5 x 2.60	27.30
Rankibong	Dhotri	1.62 x 2.5=4.05	Dhotri	Raman	33	37.05	37.05 x 2.60	96.33
Salimbong	Salimbong	.7 x 2.5 = 1.75	Salinabong	Raman	36	37.75	37.75 x 2.60	103.35
Billing	Dhotri	2.6 x 2.5= 6.20	Dhotri	Raman	33	39.20	39.20x 2.60	101.92
Batasi	Batasi	.98 x 2.5 = 2.45	Batasi	Raman	44	46.45	46.45 x 2.60	120.77
Zonglu	Manobhanjang	4.9 x 2.5 = 12.25	Manobhanjang	Raman	53	65.25	65.25 x 2.60	169.65
Little Rangit	Manebhanjang	3.24 x 2.5=8.10	Manebhanjang	Raman	53	61.10	61.10x 2.60	158.86

1* Off road distance = Actual distance from centre of block to nearest road side depot x 2.5(factor adopted on road and off road distance in such area).

2* On road = Actual distance from loading depot at road side to mill site.

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C H A P T E R - V

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UTILISATION OF RAW MATERIALS

One of the objects of the present study was to find out if there is sufficient raw materials for a commercial plywood factory, in case it is installed in a convenient place near the project area.

5.1. REQUIREMENTS OF A COMMERCIAL PLYWOOD FACTORY

The commercial plywood factory in order to be economic today, should have a minimum installed capacity of producing 1.5 million sq. m. of plywood of 4 mm thickness requiring an annual sustained supply of 12000 cu.m. of plywood logs or more. For reasons of economy of scale a supply of 16000 cu.metres is considered better.

At present market value, the industries can pay up to Rs.400 per cu.m. for class I plywood logs of chosen species delivered at Siliguri. Otherwise, for mixed sorts they can pay rough ly about Rs.300/-. (The data has been collected by discussions with some of existing mill owners at Siliguri).

5.2. RAW MATERIALS ALREADY COMMITTED

The possible commitments already made for plywood supply from the project area to plywood manufacturers by the West Bengal Forest Corporation are :

1) 25000 cu.m. approximately in the period of 1975-79 or about 6000 cu.m. annually to Madora woodcrafts Engineering industries, private Ltd. Calcutta.

2) 1000 cu.m. per year to Assam West Bengal Veneer Private Ltd.

Therefore the commitments may be taken as 7000 cu.m. annually or taking of a period of 20 years commintments is 1,40,000 cu.m.

RECOMMENDATIONS

The net volume of plywood in the project area is ~~2,233,000~~ 2,231,000 cu.m. Reducing it by the commitment already made, the volume comes to approximately 2,100,000 cu.m. Felling for plywood log extraction will have to be done in a concentrated fashion and as per accepted practice in West Bengal, they have to be clearfelled. The area, therefore, has to be restricted to the hectareage which can be planted up successfully with suitable fast growing species by the West Bengal Forest Corporation. Discussion on this point with the Managing Director, West Bengal Forest Corporation revealed that at present or in the near future, their organisation is geared to a maximum of successful artificial regeneration of 500 hectares annually. Taking the net volume of 146.40 cu.m. per hectare (See Table-18), 500 hectare will produce a quantity of 500 x 146.40 = 73200 cu.m. of plywood logs, which is enough for a large size plywood mill requiring 60000 cu.m. annually (which is much more than 12000 to 16000 cu.m. required for a commercial unit). The annual cut of this quantity will be available for about 30 years, when the factory

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has to switch over to artificially raised plantation for wood supply.

Transport study in Chapter-IV (See Table-18) showed that the cost of conversion, logging and transport to Ramam location is cheaper than if the logs are transported to Siliguri. There will, however, be the question of more costs for transport of other raw materials necessary for plywood manufacture like glue, machinery etc. to the factory site at Ramam and also more expenses for transport of finished products to the larger markets and the consumer centres. On the whole however it is felt that much lower transport cost of raw materials at Ramam off-sets the other infrastructure advantages of Siliguri.

The final recommendation, therefore, is that a commercial plywood factory requiring more than 16,000 m^3/year of ply-logs at Ramam is possible in the matter of sustained supply of raw materials at an economic price.

It is, however, necessary to do a detailed feasibility study before such a factory is decided to be installed which the Forest Corporation of West Bengal will certainly like to get done by some competent technical consultants.

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4) Fisher, Ronald A. & Yates, Frank. – Statistical tables (sixth edition) for biological agriculture and medical research.

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A P P E N D I X - 1

CODING INSTRUCTION FOR INVENTORY WORK IN SINGALILA & TONGLU RANGES OF DARJEELING FOREST DIVISION

1. The plot Description Form

Column 1 to 8 to be filled up in the office.

Column 9 to 10 :- Grow loader.

STATE (COL. 11)

The coding for different stages under the jurisdiction of Eastern Zone will be as below :-

STATE	CODE
Andaman & Nicobar	1
Arunachal Pradesh	2
Assam	3
Mizoram	4
Nagaland	5
Tripura	6
West Bengal	7

Revenue District (col.12-13)

Revenue District	Code
Darjeeling	70
Jalpaiguri	71
Coochbehar	72

Division (Col. 14-16)

Some of the forest divisions of North Bengal are coded below :-

Division	Code
Darjeeling	700
Kalimpong	701
Kurseong	702
Jalpaiguri	710

.....1.

Division	Code
Buxa	711
Coochbehar	712

Range (Col. 17-19)

Only two ranges of Darjeeling division are coded below :-

Range	Code
Singalila	071
Tonglu	072

Blocks (Col.20-21)

The coding for blocks of Singalila and Tonglu ranges are given below :-

Block	Code
South Rimbick	11
North Rimbick	12
Sandakphu	13
Siri	14
Sabarkum	15
Ramam	16
Phalut	17
Little Rangit	21
Tonglu	22
Batasi	23
Rilling	24
Kankibong	25
Salimbong	26
Salimbong Extension	27
Rithu	28

Altitude (col. 22-23)

.....3.

Altitude in the centre of the plot will be read by contour lines in metres. The last two digits will be truncated and remaining digits left will be coded in the form as two digit code number.

Example :- Supposing the centre of a plot is located at an elevation of 1045m. Then truncate 45 and record as 10.

Slope (Col. 24-25)

The slope of the plot is to be measured by Abney's level standing at the base line and sighting the other end of the plot. If slope is 50% or more write code 1 against column 24 and reject the plot. If the slope is less than 50% than code the slope classes as follows in col.25.

Slope (Less than 50%)	Code
Less than 2%	1
Between 2-9%	2
Between 10-19%	3
Between 20-29%	4
Between 30-39%	5
Between 40-49%	6

Position of slope (Col.26)

The position of the slope with reference to the hill slope on which it is located will be classified as.

Positions of slope	Code
Ridge top	1
Upper one third	2
Middle one third	3
Lower one third	4
Valley bottom	5

Aspect (Col.27)

A compass bearing will be taken from the centre of the plot to the direction of the maximum slope and record the aspect into one of the following classes.

.....4,

Aspect	Code
North	1
North-east	2
East	3
South-east	4
South	5
South-west	6
West	7
North-west	8

Accessibility classes(col. 28)

If there is a road or a bridal path near the centre of the plot the coding will be as follow :-

Road	Code
If within 100 mtrs	1
If within 101-1000 mtrs.	2
If within 1 Km. - 3 km.	3
Others	4

Rocks (col 29)

The codes in the rocks are given below :-

Rocks	Code
Granite gniess	1
Metamorphic gniess or schist	2
Quartzite	3
Basic rocks	4
Other rocks	5
No rock	6

.....5.

Degree of weathering (col.30)

Degree of weathering of the rocks will be coded as below :-

Degree of weathering	code
Partly weathered	1
Completely weathered	2
Fresh rock	3
No rock	4

Depth of rock (col.31)

Depth of rock	Code
Rock found on the top surface	1
At 0-1 m. depth	2
More than 1 m. depth	3
No rock	4

Litter (col.32-33)

The undecomposed litter will have the following codes depending on their thickness.

Thickness	Code
0-2 cm.	11
2-4 cm.	12
4-6 cm.	13
6-8 cm.	14
8 + cm	15

If there is partly decomposed but recognisable litter then the code will be as follows, depending on the thickness.

Thickness in Cm.	Code.
0-2	21
2-4	22
4-6	23

.....6.

Thickness in cm.	Code
6-8	24
8 +	25

In case there is undecomposed material lying on partly decomposed material, always take coding for that item which is of greater thickness.

Humus (Col.34)

Depending on the thickness, the code will be as follows. The depth of humus will be measured by scraping the litter.

Thickness	Code
0-4 cm.	1
5-8 cm.	2
8-12 cm.	3
13-16 cm.	4
16 +	5

Stoniness (Col.35)

The quantities of stones in the soil will be coded as follows :-

Percentage by volume	code
1%	0
1-5%	1
5-25%	2
25-50%	3
50-75%	4
75-100%	5

Colour (Col.36)

The predominant colour of the upper horizon of soil below humus layer will be determined and classified as :-

Predominant colour	Code.
Black	1
Brown	2

.....7.

Predominant colour

~~Percentage by volume~~	Code
Red	3
Yellow	4
No soil	5

Structure (Col.37)

The degree of development of the structure will be coded as given below:-

Degree of Structure Development	Code
Structureless	0
Weakly developed structure	1
Poorly developed "	2
Well developed "	3

Consistence (Col.38)

To evaluate consistence select and attempt to crush in the hand a small soil mass that appears slightly moist and code as follows:-

Term	Description	Code
Loose	Non-coherent soil material	0
Very friable	crushed, with very gentle pressure and coherent when pressed together.	1
Friable	Soil material crushed, but with gentle to moderate pressure between thumb and fore finger, and coherent when pressed together.	2
Firm	Soil material crushed with moderate pressure between thumb and fore finger but resistence is distinctly noticeable.	3
Very firm	Soil material crushed with strong pressure; partly crushable between thumb and fore finger.	4

Stickiness (Col.39)

Degree of adhesion to objects at field capacity (i.e. Just saturated with moisture).

.....8.

Stickiness	Code
Non sticky	0
Slightly sticky	1
Sticky	2
Very sticky	3

PH (Col.40)

Find out the PH value of the soil at least 15 cm. below the humus layer with the help of the Soil testing kit.

PH	Code
More than 8	1
8-7.1	2
7-6.1	3
6-5.1	4
5-4.1	5
4 and less	6

Texture (Col.41)

The codes for the texture need not be filled up in the field except when there is no soil when the code 6 will be written. If there is soil, collect 500 gm. sample at a depth of 15 cm. from the base of the litter or humus layer and put it in a polythene bag and mark it with plot code number. This sample should be sent to base camp at the earliest.

Texture	Code
Clay	1
Clayey loam	2
Loam	3
Sandy loam	4
Sand	5
No soil	6

.....9-

Depth of soil (Col.42)

The depth of the soil will be estimated by digging a 15 cm. deep pit and guessing the remaining depth. The guess will be based on all available information e.g. exposed soil profile or luxuriance of ground vegetation.

Item	Description	Code
Very shallow	Less than 15 cm	1
Shallow	15 to 30 cms.	2
Medium	31 to 90 cms.	3
Deep	90 cms. and 180 cm.	4
Very deep	180 cm. and above	5
No soil	Nil	6

Roots(Col.43)

The roots will be coded as follows. Quantity should be estimated at a depth of 30 cm.

Quantity of roots	Code
Abundant roots	1
Medium	2
Few	3
Nil	4

Forest (Col.44)

Following 8 types under this scale will be recognised

Item		Description	Code
		All forest areas declared as reserved forest will be considered as forest under this group excluding only the following.	
	(a)	Areas occupied by orchards, parks, private gardens and pastures, and large water areas.	0
	(b)	The forest villages and buildings and hutments of forest department.	

.....10.

	All forested areas as mentioned above with crown density more than 20%	1
	Area with tree cover from 20% to a lower limit of 5%. It may have undergrowth of shrubs of any density	2
	Areas with density of scrub growth more than 20% and scattered trees having density 35% of the total vegetation cover.	3
	Grassy lands and grassy blanks in forest and in any other areas which cannot be classified in the above category.	4
	All forest plantation raised artificially i,e. man made forests.	5

Vegetation (Col. 45-46) The coding for vegetation will be filled up in the base camp. The field party will keep it blank.

No. of Storeys (Col. 47) The codes for different storeys are as follows.

The following items under this group will be recognised.

There is no marked differentiation in the level of the canopy.	1
Two storeys with well defined tiers which can be recognised in the forest.	2
Three storeyed forest. The variation among the tree species is so pronounced that distinct tiers are recognised in the plots.	3

Crown density (Col. 48) This will be measured on the degree of opening in the canopy.

The following classes will be recognised.

No opening	1
50% opening in the canopy	2

.....11.

More than 50% but less than 75% opening in the canopy 3

More than 75 % opening in the canopy 4

Regeneration (Col.49)

This will be estimated occularly. For this the presence of seedlings, sapling and poles in the plot and in the surrounding areas will be taken into consideration.

Regeneration	Code
When one established seedling, sapling or pole of the plywood species is found on an average in every 6 Sq. mt. of area it will be called as profuse.	1
When above in 20 Sq.mt. area on an average it is adequate.	2
When above in more than 20 Sq. mt. but less than 200 sq.mt. it is fair .	3
When less than 200 sq.mt. it is nil	4

Grazing Incidence (Col.50)

Depending on the intensity of grazing the area is subjected to following classes will be an mentioned below :-

Item	Description	Code
Heavily grazed		1
Moderately grazed		2
Grazing absent		3
Fire Incidence(Col.51)	When the area is subjected to occassional and frequent fire	1
	When such a fire hazard is not common in the area.	2
Present Management (Col.52)	Depending on the silvicultural system practised in the forest following groups are being made.	
	Selection :-	
	1. When the trees are felled with regard to certain exploitable diameter.	1

.....12.

Clearfelling :

2. When the trees standing on the forest are clearfelled for the purpose of raising plantation of certain selected species of trees. 2

Thinning

3. When crop is young to middle aged and required removal of some for the healthy growth of the remaining crop. 3

Grid No.(Col.53-54) Fill up the columns as per code No. given in the block maps. The list below indicates total number of the codes in each block.

Block	Grid code
1. Phalut	01 to 08
2. Sabarkum	01 to 10
3. Siri	01 to 06
4. Ramam	01 to 08
5. Sandakphu	01 to 09
6. Rimbick North	01 to 06
7. Rimbick South	01 to 08
8. Rithu	01 to 07
9. Kankibong	01 to 07
10. Selimbong	01 to 05
11. Rilling	01 to 04
12. Tonglu	01 to 02
13. Batasi	01 to 03
14. Little Rangit	01 to 05

Plot No.(Col.55) There will be 2 plots in each grid. The one which will be in north west of the grid centre will be coded as 1

The plot which will be in the south east of the grid centre will be coded as 2

4" sheet map(col.56) To be filled in by the office

Inventory design(Col.57) To be filled in by the office.

.....15.

SPECIAL STUDIES

Volume and Cull Studies

The purpose of the present project is to find out the volume of standing timber and fire wood within a certain precision limit separately for each block. At the same time it has to be separately indicated how much of the standing volume of timber can be utilised for veneering.

Since all timber cannot be used for plywood and even the suitable ones have to have specific sizes for veneering, the methodology of volume determination has to be so adjusted as to bring out this informations without undue duplication of work.

It is accepted by definition that 'timber' is wood upto 20 cms. Diameter over bark. Small wood is defind as wood having dimensions from 20 Cm. diameter over bark to 5 cm. diameter over bark.

Plywood are those species which are mentioned in page No.6 of the manual. These species should have a minimum diameter of 30 Cm. over bark in the thin end of the logs which should not be less than 2.5 Meters in length.

A plywood species in order to be used for veneering should be free from certain defects as follows :-

(a) Extent of deviation from straightness	- 10 cm. in length of 2.5 meters.
(b) Taper	- Below 3 Cm.(for every length of 1 Meter.)
(c) Hollow and spongy heart	- 5 Cm. in diameter.
(d) Rots	- Not permissible
(e) Twist	- Not permissible
(f) Cracks	- 2 Cm. in depth but not extending more than 1/3rd of the length.
(g) Knots	- Both live and dead measuring upto 5 Cm. in diameter and occuring not more than 2 in number in 2.5 meters length.

In the light of remarks made above the methodology of volume measurements has been made out as below :-

.....14.

Methodology:-

The logging crew will fell the selected trees flush to the ground. Before felling they should measure the D.B.H. B.B. and fill-up column No. 51-52 of the Tree Volume and Cull Study form (Form-3). After felling, the portions which have dimensions below 2 Cm. diameter under bark has to be cut away and rejected. All the leaves etc; have also to be removed. By trial and error the exact point where the diameter of the main stem becomes less than 30 cm. d.u.b. and 20 cm. diameter over bark has to be marked. Similarly mark the points in different branches which are more than 30 cm. duu.b. and 20 cm. diameter over bark in dimension. We have, therefore, separated the plywood and residual timber from the small wood of the tree.

For the plywood timber all sections have to be now cross out. From the butt end each section should be of 2.5 meter in length till the last one which may be of any size.

Each plywood section and residual timber section now is to be measured separately for volume determination. The measurements, will consist of determining the diameter over bark and under bark at the mid points of each section. On each mid point two measurements have to be taken at right angles. For each of the sections, for the cull study, a large number of observations and measurements have to be taken, details of which are given at a later stage.

In the matter of small wood convenient sections have to be cut and single diameter measurement in the mid point of the sections along with their lengths have to be noted for determination of small wood volume.

Below are explained the codes that have to be written for various information to fill up the volume and cull study forms.

	Volume and Cull Study Form.	
Item	Column Number	Description.
Job No.	1-3	To be filled in by the office.
Card design	4-5	-do- -do-
Report No.	6-7	-do- -do-
Sub-Report No.	8	-do- -do-
Crew Leader	9-10	The code No. of the Crew Leader is to be filled.
Sl. No. of trees	11-12	To be filled in by the office.

cont

ITEM	Column number	Description
Species Code	13-15	As given below

NAME OF SPECIES	CODE
1. Acer campbellii(Kapasi)	001
2. Alnus nepaulensis (Utis)	002
3. Beilschmiedia species(Tarsing)	003
4. Symugtonia populnea (Pipli)	004
5. Castanopsis tribuloids & Chystrix(Kalus)	005
6. Cinnamomum species (Sissi)	006
7. Eleeocarpus lancealfolius (Bhadrasi)	007
8. Machilus edulis (Lapchekawla)	008
9. Machilus gamelana (Chiple kawla)	00 9
10. Machilus odoratissima(Lali kawla)	010
11. Michelia kathcartii(Tite champ)	011
12. Michelia doltasopa(Mithe champ)	012
13. Nyssa javanica (Letch chilauni)	013
14. Prunus nepalensis (Arupate)	014
15. Quercus lamellosa(Buk)	015
16. Quercus lineata (Phalant)	016
17. Phoebe species (Angare)	017
18. Cedrela species(Toon)	018
19. Betula species(Bhujpat)	019
20. Michelia lanuginosa (Phansre)	020
21. Engelhardtia spicata(Mawa)	021
22. Echinocarpus dasycarpus (Gobre)	022
23. Quercus pachyphylla (Sungre,Sungre Katus)	023
24. Taxus baccata	024
25. Magnolia campbellii(Ghoge champ)	025
26. Tsuga dumosa (Tangresela)	026
27. Abies densa (Gabrasala)	027
28. Rhododendron spp.(Guras,chimul)	028
29. Others.	040

Item	Column number	Description
Tree portion	16-17	-
For stem timber part	-	First section of the main stem - code = 01 Second section of the main stem - Code = 02 Third Section of the main stem - Code = 03 and so on.
For branch timber part	-	First section of the first branch - Code = 20

.....15.

		Second section of the first branch - Code = 21 and so on First section of the 2nd branch - Code = 30 Second section of the 2nd branch - Code = 31 First section of the 3rd branch. - Code = 40 Second Section of 3rd branch - Code = 41
For stem and branch small wood part -		First section - Code = 11 Second section -Code = 12 and so on upto 19 and all others as 19. The first section of the main stem will be 2.5 metres and the subsequent sections also will be of the same length. The last section can be of any size (less than 2.5 metres). The same principles will hold good for the branches as well. If the branches do not have even one section of 2.5 metres then any available size less than 2.5 metres will be measured.
Length of the Section	18-20	The length of the section in respect of the main stem will be the length of the bole from one end to the other end of the log. The length will be measured upto 0.5 cm. and rounded off to the nearest whole number. The length of the section of the branches should be from the junction of the branch with the main stem to the other end of the section.
Diameter measurements at the section(in mm.) at right angles	21-32	The measurements of each of diameter O.B. and diameter U.B. will be taken to the nearest mm. at the mid-point of the section. Two measurements at right angles for each item has to be taken.

.....16.

		Measurement for U.B. will be in same directions as the one for O.B.
a. Diameter O.B.	21-26	-
i) First measurement	21-23	
ii) Second measurement at right angles to the first one.	24-26	
b. Diameter U.B.	27-32	
I) First measurement	27-29	
ii) Second measurement at right angles to the first one.		
Gall Study	33	Examine each section and see if there is any defect.

Defect	Code
1. No. defect	0
2. Defect present	1

(Defect includes only Hollow or spongy heart, cracks, twists, rots and knots in the sections)

Rote and its measure ments.	34-40	-
Type of rot	34	1) Examine the section for rot. See if it is present or absent. Determine the category if not is present and code as below.

Rot	Code.
No rot	0
Fibrous rot	1
Pocket rot	2
Spongy rot	3

.....19.

Measurement of rot	35-40	Enclose the rotten portion in a rectangle or square and take the following measurements in cm.
		i) Measure length in Cm. and enter in col.35 to 36.
		ii) Measure width in cm. and enter in col.37 to 38.
		iii) With the help of a steel wire measure the depth of rot in cm. and enter in column 39 to 40.
		If there are more than one isolated rots, add up the volume of all the pockets and find out the cube root and repeat the result in three pairs of columns (Col.35 & 36, 37 & 38, 39 & 40)
Hollowness and its position vis-a-vis rots	41	Examine the section for hollowness whether it is included in the rotten portion or not. Fill in the following codes for hollowness.

Description	Code
Hollowness present inside the rotten portion.	1
Hollowness present but outside the rotten portion,	2

Hollowness absent	42-45	If hollowness is present but is not contained with the rotten portion, then measurement of Hollowness will be taken.
i) Diameter in Cms.	42-43	Enter actual measurements.
ii) Length in Cms.	44-46	Enter actual measurements.
For scattered hollowness follow instructions as given under rot.		

.....18.

Twist	47	Twist is that defect in which the fibre instead of straight line occurs in a spiral. Code If straight 1 If absent 2
Cracks & Shakes	48	Watch the section and enter the following. No defect 1 Cup shake 2 Star shake 3 Cracks 4
Bend	49	Axis of log does not deviate 1 Axis of log deviates from the straight line at an angle less than 10^0. 2 Axis deviates at an angle more than 10^0 3 More than one pronounced bend 4
Knots presence	50	Examine the section and find out if there is a live or dead knot. 1) If absent 1 if present 2
Knots measurements	51	Measure the knot diameter in Cm. and enter in column
D.B.H.(O.B.) in cm.	52-53	Measure the diameter B.H.(O.B.) in Cm. and enter.
Total height in metres	54-55	Measure the total height of the tree before felling and enter.
	56-57	Measure the height of the tree after felling and enter.
Map sheet reference	58	To be filled in by the office.
Block reference	59-60	The codes will be same as given for Blocks in the Plot Description Form.

.....19.

Grid reference	61-62	The grid reference will be the similar to the reference indicated against grid reference earlier.
Inventory design	63-64	To be filled in by the office.

Total number of trees to be felled and their locations.

Felling will be restricted to the 9 main ply-wood species in the area. A minimum of 30 number of trees have to be felled for each species distributed evenly almost all over the blocks depending on their availability. In addition, some trees of various species randomly chosen will have to be felled. The trees of the diameter classes (10 cm. classes) should be covered within the 30 trees to be felled for each species.

The classes will be as follows :-

0 to 10 Cm.

10.1 to 20 cm.

20.1 to 30 cm.

30.1 to 40 cm.

40.1 to 50 cm.

50.1 to 60 cm.

60.1 to 70 cm.

70.1 to 80 cm.

80.1 to 90 cm.

90.1 to 100 cm.

100.1 cm. and over.

@@*@*@*@*@*@*

FORM-1

Job No. 1-3	Card design 4-5	Report No. 6-7	Sub-report No. 8	Crew Leader 9-10

PLOT DESCRIPTION FORM
Pre-Investment Survey of
Forest Resources,
EASTERN ZONE

Grid No.	Plot No.	4 Sheet Map	Inventory Design
53-54	55	56	57

					Terrain Data	Plot Data					ROCK			SOIL DATA																				
State	Revenue District	Forest Division	Range	Block	Altitude	Slope	Slope	Position of Slope	Aspect	Accessibility Class	Rock	Degree of Weathering	Depth at which rock found	Litter	Humus	Stoniness	Colour	Structure	Consistence	Stickiness	P.H.	Texture	Depth	Roots	Vegetation	Forest type	No. of Storey	Growdensity	Regeneration	Grazing incidence	Fire incidence	Present Management		
11	12-13	14-16	17-19	20-21	22-23	24	25	26	27	28	29	30	31	32-33	34	35	36	37	38	39	40	(41)	42	43	44	45-46	47	48	(49)	(50)	(51)	(52)		

Date

Name of Crew Leader.

PLOT ENUMERATION FORM

F O R M-2

PRE INVESTMENT SURVEY OF FOREST RESOURCES EASTERN ZONE.

Job No.	Card Design	R.No.	Sub-Report No.
1-3	4-5	6-7	8

Forest type	Total No. of trees in the plot.	Map sheet reference	Block code	Grid point code	Sample plot refe-rence	Inven-tory Design
63	64-65	66	67-68	69-70	71	72

Species			Species			Species			Species			Species			Species		
Code	Dia.	Cm.	Code	Dia.	Cm.	Code	Dia.	Cm.	Code	Dia.	Cm.	Code	Dia.	Cm.	Code	Dia.	Cm.
9-11	12-14	15-17	18-20	21-23	24-26	27-29	30-32	33-35	36-38	39-41	42-44	45-47	48-50	51-53	54-56	57-59	60-62

Date

NAME OF CREW LEADER

Contents

TREE VOLUME AND CULL STUDY. FORM-3

PREINVESTMENT SURVEY OF FOREST RESOURCES, EASTERN ZONE.

Job Card No	Design	Report No.	Sub-Report No.	Crew Leader	Sl. No. of trees	Species code.
1-3	4-5	6-7	8	9-10	11-12	13-15

D.B.H.(OB) in cms.	Total height in Metre Before felling	Total height in Metre After felling	Map sheet Reference	Block Reference	G.P.D. Reference	Inventory Design
52-53	54-55	56-57	58	59-60	61-62	6364

Date

Tree portion	Length of section in cms.	Diameter measurements at the mid point of sections in cm. at right angles. Over Bark First	Over Bark Second	Under bark First	Under bark Second	Cull study code	Type of Rot	CULL STUDY: ROT Measurements Length	Width	Depth	CULL STUDY: HOLLOWNESS Measurements Position	Diameter	Length	Twist	Cracks and snakes	Bend	Presence	KNOTS Measurements Diameter in Cms.
16-17	18-20	21-23	24-26	27-29	30-32	33	34	35-36	37-38	39-40	41	42-43	44-46	47	48	49	50	51

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Contents

SAMPLE TREE FORM.

FORM - 4.

PREINVESTMENT SURVEY OF FOREST RESOURCES
EASTERN ZONE

Job	CD
1-3	4-5

Block No.	Grid No.	Map sheet	Plot No.
6-7	8-9	10	11

No. of trees
29-30

Name of species	Sl. No.	Species Code.	D.B.H. (O.B.) cm.	D.B.H. (U.B.) cm.	Total height (M)	Defects			
						Top broken	Hollowness	Rotten	Any other defects
	12-13	14-16	17-19	20-22	23.24	25	26	27	28

CREW LEADER: _____

DATE: _____