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**GOVERNMENT OF INDIA
MINISTRY OF AGRICULTURE AND
IRRIGATION**

(Department of Agriculture)

**REPORT ON
FOREST RESOURCES OF
RAJGARH & NAHAN**

(CATCHMENTS)

HIMACHAL PRADESH



PRE-INVESTMENT SURVEY OF FOREST RESOURCES

DEHRA DUN

1978

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PREFACE

Survey of Forest Resources of Rajgarh and Nahar Forest Divisions was taken up during 1974-75 and 1975-76 working seasons to provide data base for the development of the forests and forest industries. The objectives of the survey were (i) to collect inventory of forest resources, (ii) to indicate areas available for raising plantations, (iii) to estimate the present requirement of wood for local population and industries, (iv) to carry out accessibility and cost studies and (v) to indicate the industrial possibilities for the area. The wood resources were to be assessed division-wise within $\pm 10\%$ at 95% probability level.

The report presents the basic fact about area surveyed and the procedure adopted for inventory, both for field work and Photo-interpretation, Market & Demand Investigations, Cost Studies and the Data Processing. On the basis of the information so collected, annual available cut of raw material has been worked out and wood balances arrived at. Finally, conclusions have been drawn about the utilization of the available raw material.

In carrying out the survey work strict supervision has been exercised, most modern equipments have been used and specially trained personnel have been employed. It may be stated with the confidence that the result presented herein possess a high degree of reliability.

It is hoped that this report will be of considerable interest, not only to the Himachal Pradesh Forest Department at whose request the survey work has been carried out but also to planners, administrators, and the entrepreneurs who may be interested in setting up of wood based industries in the region and the development of the area as a whole.

The Preinvestment Survey of Forest Resources acknowledges the hard work put in by members of the Northern Zone including S/Shri J.N. Mullick, A.P. Dwivedi & V.P. Singh.

(C.L. Bhatia)
Chief Coordinator

SUMMARY

Survey of Forest Resources of Rajgarh and Nahar Forest Divisions was taken up during 1974-75 and 1975-76 working seasons to provide data base for the development of the forests and forest industries. The objectives of the survey were (i) to collect inventory of forest resources, (ii) to indicate areas available for raising plantations, (iii) to estimate the present requirement of wood for local population and industries, (iv) to carry out accessibility and cost studies and (v) to indicate the industrial possibilities for the area. The wood resources were to be assessed division-wise within $\pm 10\%$ at 95% probability level.

2. The total geographical area of Rajgarh and Nahar Forest Divisions is 2,80,012 ha. The land use pattern of the area was studied with the help of 100% photo-interpretation. The area under different land use classes as worked out by photo-interpretation is indicated below :-

Table No. 1

Area under different land use classes

Land Use class	Rajgarh Divn.		Nahar Divn.	
	Area in ha.	% of total area.	Area in ha.	% of total area
1. Forested	69426	41.90	74824	65.46
2. Non-forested				
(i) Scrub	16220	9.79	2837	2.48
(ii) Cultivation including orchards	48624	26.33	25277	22.11
(iii) Barren land	532	0.32	1076	0.94
(iv) Habitation	34	0.02	215	0.19
(v) Water/river beds etc.	1219	0.73	5530	4.84
(vi) Grassy land	33771	18.81	2195	1.92
(vii) Photo-gap	3477	2.10	2355	2.06
Total Non-forested	96277	58.10	39485	34.54
Grand Total (1 + 2)	165703	100%	114309	100%

3. Systematic sampling was carried out to estimate the growing stock for the area. The growing stock was studied for following forest types recognised for the purpose :-

1. Chir
2. Kail
3. Deodar
4. Mixed conifers
5. Conifers mixed with temperate hardwoods
6. Sal
7. Oaks
8. Others

(ii)

The area of these forest types was worked out by 100% photo-interpretation separately for Rajgarh and Nahar Forest Divisions and is given below:-

Table No.2

Area of different forest types in Rajgarh & Nahar Forest Divn.

S.No. Forest type	Area of Rajgarh Forest Division (ha.)	Area of Nahar Forest Division (ha.)
1. Chir	14824	5589
2. Kail	278	-
3. Deodar	2057	-
4. Mixed conifers	619	-
5. Conifers mixed with temperate hardwoods	11973	4840
6. Sal	13	21198
7. Oaks	19154	866
8. Sal mixed with hardwood	-	7805
9. Others	20508	34526
Total	69426	74824

4. Local volume table of Chir was prepared by felling more than 200 trees in the area. The volume tables of other species were adopted from similar areas. The total and per hectare growing stock in each forest type for each division has been worked out and is given in table nos. 3 & 4.

Table No.3

Distribution of Growing stock per hectare in Nahar Forest Divn.

Forest Type	Area (ha.)	Volume/ha. (m ³)	Total volume (000 m ³)	S.E.%
Chir	5539	51.283	236.677	25.3
Conifers mixed with temperate hardwoods.	4840	37.706	182.497	14.2
Sal	21198	164.358	3484.061	4.7
Sal with hard wood.	7805	86.319	673.720	8.8
Oaks	866	97.162	84.142	28.6
Others	34526	42.143	1455.029	7.5
Total	74824	- 82.408	6166.126	3.6

Table No.4Distribution of Growing stock per hectare in Rajgarh Forest Divn.

Forest Type	Area (ha.)	Volume/ha. (m ³)	Total volume (000 m ³)	S.E.%
Chir	14824	42.014	622.816	10.4
Kail	278	26.412	7.343	34.1
Deodar	2057	141.058	290.156	30.0
Mixed conifers	619	122.836	76.035	23.8
Conifers mixed with temperate hardwoods.	1973	93.726	1122.181	14.5
Sal	13	102.266	1.329	29.8
Oaks	19154	92.734	1776.227	9.8
Others	20508	43.240	886.766	12.3
Total	69426	68.891	4782.853	5.9

5. The following annual yield of important species has also been approximated on the basis of growing stock and increment.

Table No.5Annual Yield of important Species

S.No.	Species -	Yield in cubic meters
1.	Chir	27400
2.	Deodar	3200
3.	Mixed conifers (mainly fir & spruce)	1900
4.	Oaks	45300
5.	Sal	65700

6. The total area available for raising plantation has also been worked out. Such area include poorly stocked forests, scrub land, pasture and grass lands and barren land. The area under these classes of lands works out as under:-

Table No.6Area available for raising plantations

Land use class	Area in hectares
Poorly stocked forests	18,825
Scrub lands	19,057
Pasture and grass lands	33,366
Barren land	1,608

7. The present and future requirement of wood has been approximated. The future projection has been made for the years 1981 and 1991. The present wood consumption and the projected future demand work out as under:-

Table No.7

Summary of present wood consumption and projected future demand

S.No.	Species	1974-75	1981	1991
1.	Chir	8303.30	21663.00	31034.22
2.	Deodar	1515.90	4982.97	6380.44
3.	Sal	2630.60	6879.47	11229.93
4.	Others	6276.80	17440.41	26689.00
Total		18726.60	50965.85	75333.59

8. The wood balance have also been calculated for these years. The wood balance for the years 1974-75, 1981 and 1991 are as under:-

Table No.8

Wood balances for the years 1974-75, 1981 and 1991
(In thousand m³)

S.No.	Species	Years		
		1974-75	1981	1991
1.	Chir	19	6	(-) 4
2.	Deodar	2	(-) 2	(-) 3
3.	Sal	63	59	54
4.	Others	39	28	19

9. The wood balances in respect of chir, deodar and other coniferous species are just enough to meet the present and future requirement of local population and existing industries. If the growing stock of these species is not enriched by large scale plantation, it may not be possible even to meet the future requirements. It is, therefore, not feasible to plan any large or small scale industries based on the raw material of coniferous species.

10. The only species which may have substantial amount of wood balance is sal. The wood balance of this species for the years 1974-75, 1981 and 1991 works out to 63,000, 59,000 and 54,000 cubic metres respectively. The forests of this species are situated on comparatively easier slopes and therefore extraction is no problem. This species, however, has its own silvicultural problems. Regeneration of sal is not satisfactory in all the areas. Therefore, artificial method of regenerating the area may sometime become un-avoidable. This species is a very good

(v)

structural timber and is widely used in the survey area as well as in the adjoining areas of Haryana, Punjab, Uttar Pradesh and Delhi etc. Some wood working units for manufacture of door, window, ~~beams~~ , rafters etc. may be planned but since the sizes of such products are not standardised it may not be feasible to establish such units in the area.

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PREINVESTMENT SURVEY
OF
FOREST RESOURCES
NORTH ZONE

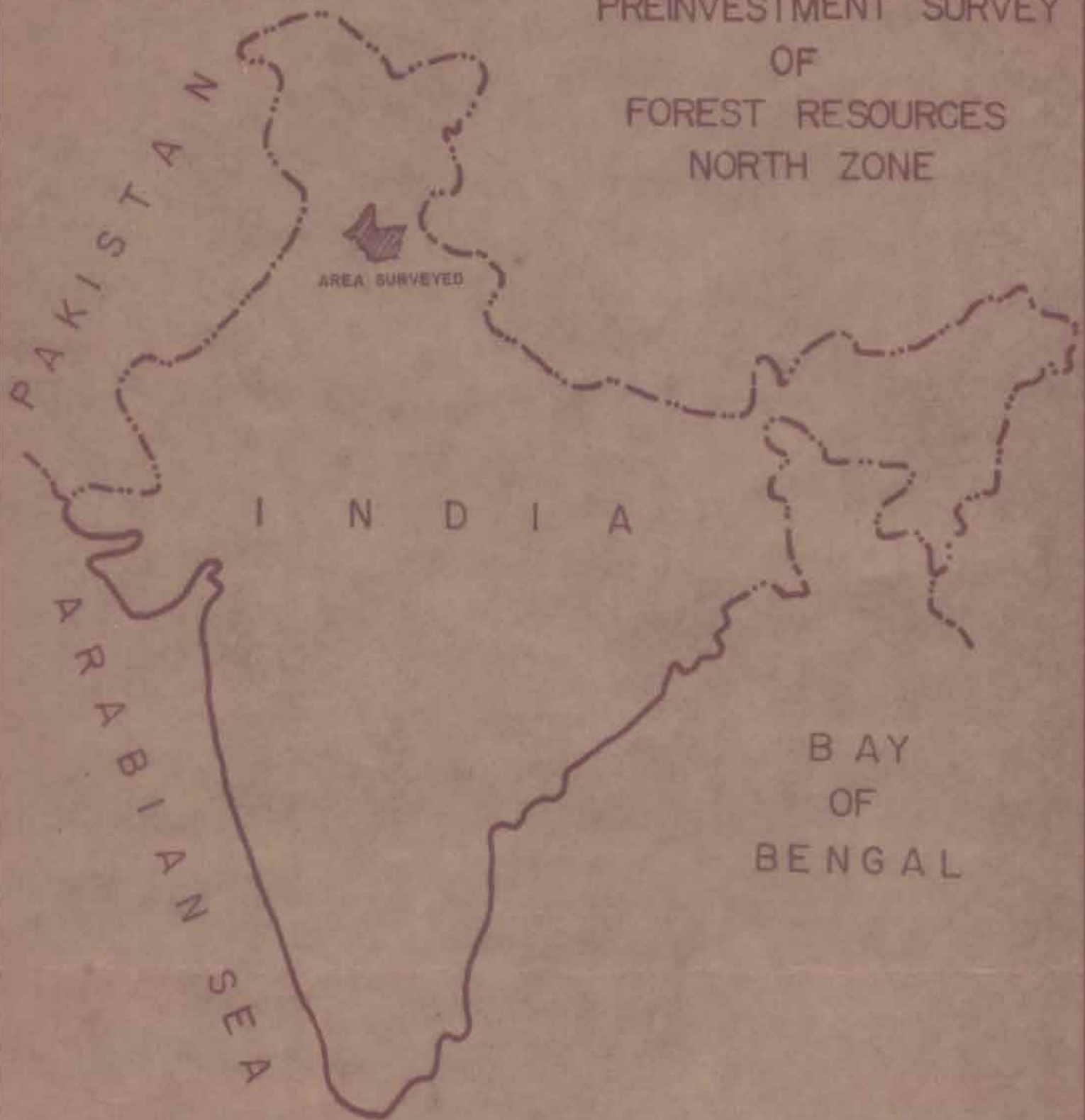
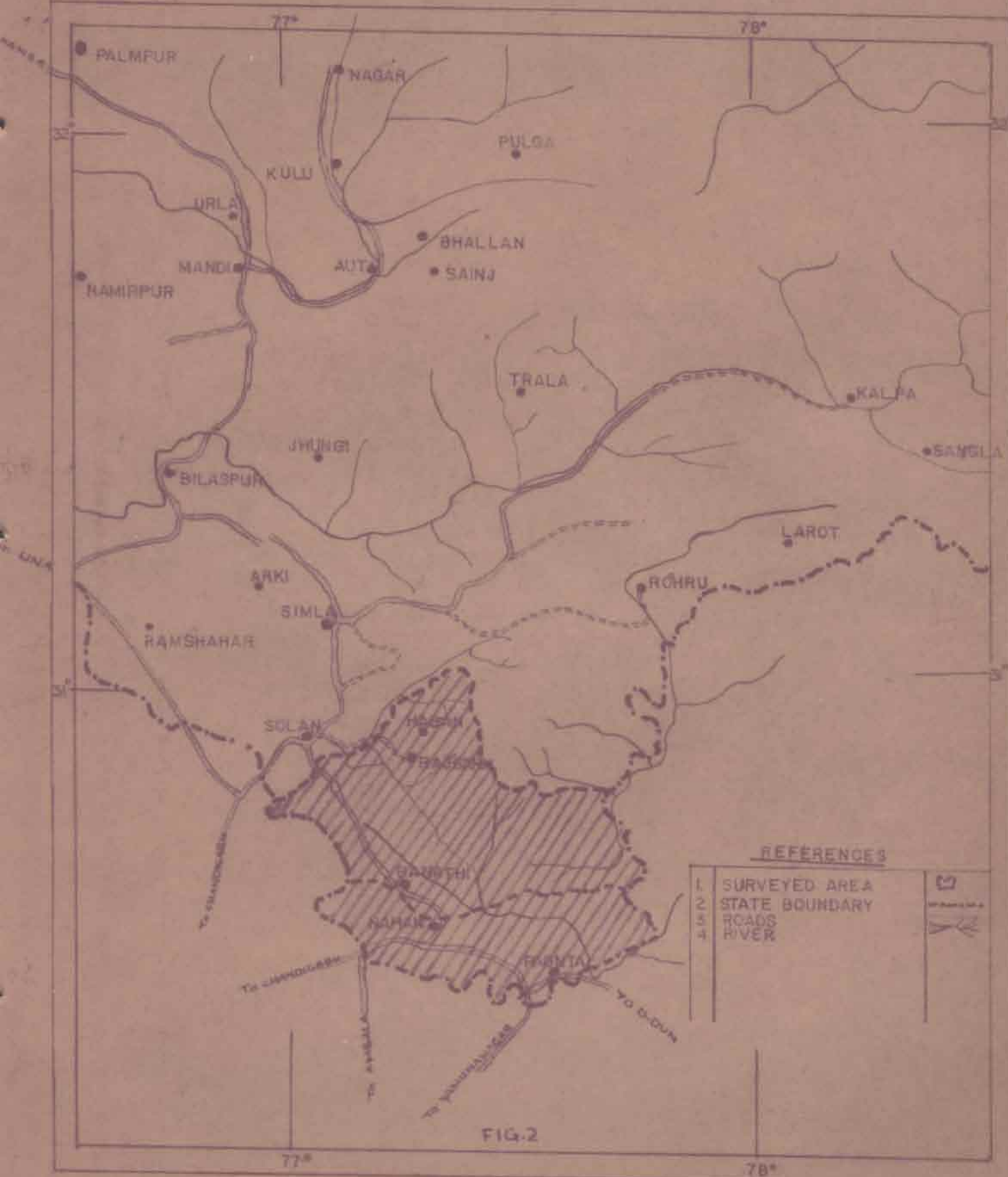


FIG. 1

PREINVESTMENT SURVEY OF FOREST RESOURCES NORTH ZONE RAJGARH AND NAHAN FOREST DVNS.



CHAPTER - 1

GENERAL INFORMATION OF THE SURVEY AREA

1. NAME:

The survey area consists of Rajgarh and Nahen Forest Divisions of Sirmur District, Himachal Pradesh. This survey area hereafter would be referred to as 'area' in this report.

2. AREA:

The total geographical area and area under different land use classes have been estimated on the basis of 100 percent photo-interpretation. The interpreted photographs for the area were sent to 70 Field Party, Survey of India for transference, preparation of maps and calculation of area. The total geographical area as worked out by 70 Field Party, Survey of India is given below :-

(a) Rajgarh	-	1,65,703 ha.
(b) Nahen	-	1,14,309 ha.
Total	-	<u>2,80,012 ha.</u>

Land use pattern of the area has been studied and the following table indicates the area under different land use classes in Rajgarh and Nahen Forest Divisions separately.

Table No. 1

Land use class	Rajgarh Divn.		Nahen Divn.	
	Area in ha.	% of total areas.	Area in ha.	% of total area.
1. Forested	69426	41.90	74824	65.46
2. Non-forested				
(i) Scrub	16220	9.79	2837	2.48
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(vi) Grassy land	31171	18.81	2195	1.92
(vii) Photo gap	3477	2.10	2355	2.06
Total Non-forested	96277	58.10	39485	34.54
Grand Total	165703	100%	114309	100%

3. LOCATION:

The area lies in the outer Himalayan ranges and Shiwaliks between $77^{\circ} 1' 12''$ and $77^{\circ} 49' 40''$ east longitude and between $30^{\circ} 22' 30''$ and $31^{\circ} 1' 20''$ north latitude. The area is covered by the following quarter inch and 1:50,000 map sheets of Survey of India.

i) Quarter inch sheets 53/E & F

ii) 1:50,000 map sheets
53 F/1,2,3,5,6,7,9,10,11,14,15

4. BOUNDARIES:

The area is bounded on the north by Mahasu district, on the east by the Tons river, dividing it from the territory of Uttar Pradesh, on the south by Haryana and on the west by Solan and Simla Districts of Himachal Pradesh.

The area comprises mainly of the catchment of the river Yamuna and part of Markanda and Ghaghar.

5. GEOLOGY:

Most of the geological formation of the area belongs to Siwaliks, sub Himalayan and Himalayan groups. The sub Himalayan group comprises of unmetamorphosed Tertiary rocks and the Himalayan group contains metamorphosed formations of Pre-tertiary age ranging down to Arapians. The order of the super position of the formations exposed in the area is as follows:-

Sub Himalayan group	Recent & Sub recent	Alluvium, flood, plain deposits Terrace formations, gravels and 'dun' deposits.
Pliocene to Pleistocene	Upper Siwaliks	Boulder conglomerate Pinjore Sandstones, Sandrock and pebble bed.
Lower to Middle Miocene	Lower Siwaliks (Nahan)	Coarse to medium, micaceous sandstones, red-clays, calcareous penecontemporaneous conglomerate and pebble beds.
	Kasauli stage	Fresh water grey sandstone often micaceous, minor clay intercalation usually of grey or violet colour with fragmentary plant remains.
Lower Miocene	or (Bansa limestone?) Dagshai stage.	Purple and green sandstones, bright pink clay, pisolitic clay conglomerates, lower part occasionally fossiliferous. Sandstones and clays of brackish water origin with clay conglomerates and gypseous nodules.

	Eocene	Subathu stage	Red clays and sandstones, olive gray and green splintery shales, impersistent shelly limestones, carbonaceous beds, thin bands of, impure nummulitic shelly limestones, ferruginous sandstones.
Himalayan group	Permocar-boniferous	Krol series	Basic dykes and sills. Calcareous slates often sheared. Dolomitic beds and limestones. Gritty slate and quartzites. Carbonaceous shales with quartz veins.
	Carbonife-rous.	Infra-krol Blaini series	Limestone and slates. Boulder beds, limestone and bleached slates.
		Deoban and Shali limestone and shales.	
		Jaunsar series	
	Devonian	(Chandpur slates, schistose phyllite and quartzite).	
	Pre-cambrian	Simla slates Chail series Jutogh series	Boileaugunge Quartzites.
	Archaean Group		Carbonaceous schists and limestones.
		Granites (Chor granites) (Late Palaeozoic age?)	Granites and Gneissose granite.

The area around Rajgarh is broken by normal faulting. Blaini and Jutogh series are found exposed in this area. These faults tend to be parallel running in SW-NE direction. Blaini beds on the North east of Chala gradually become schistose. The dense limestone ends beyond Ghar Dhar. On the north-eastern side of Chor granite the Jutogh series and Chail series are typically developed. Deoban series, consisting mainly of massive limestone with some inter-bedded shales, have a great thickness. At Chaur mountain, horn blende schists and amphibolites occur. The peak of the mountain is 3647 metre a.m.s.l., the highest on the border of the area. It is composed of a gneissose-granite, which is supposed to be of late Palaeozoic age.

Subathu and Dagshai rocks are common in area near Sarahan, Banethi etc. These mainly consists of sand stones, shales, conglomerates etc. Lower areas consist of Siwalik formation. These consist of alternate bands of soft, coarse grained, micaceous sand-stones and pink or grey shales. The Siwalik formation is exposed on south-west of the main boundary fault.

The Nahan rocks terminate near the nala to the east of Nobwala and expose again at the Hajhyar-ki Nadi section, north-east of Kaulowala khud. The upper-Siwalik formations are divisible into two conformable stages namely Pinjor sand stone pebble bed and the upper Boulder conglomerate stage.

6. SOIL:

There is a great variation in the soils of the area. The lower areas, particularly Paonta valley have deep alluvial soils. The soils in this valley are sandy to sandy-loam with high water table. In upper areas brown and podzol type of soils usually occur. There is wide variation in the soil characteristics in the hills. The texture is generally sandy loam to loam and clayey in pockets. The soils are shallow on steeper slopes but comparatively deeper on easy slopes. The soils are rich in organic matter and nutrients, except those on the exposed and eroded sites. The soils are generally acidic in nature except those derived from lime-stone.

7. TOPOGRAPHY:

But for a small portion of the area of Nahan Forest Division constituting Paonta valley, the most part of the survey area is hilly. The elevation ranges from about 500 metre to 3,650 metre. The highest peak near the border of the area is Chur peak which is 3,647 metre in height. The most of the hilly ranges run between east to west. The highest hill range is in Chur dhar which forms the nerve centre of the hill ranges. Most of the hill ranges originate from this main hill. There is net work of interlinked mountain ranges radiating from Chur dhar peak. From Chur dhar a spur called Mini Dhar runs towards the south, later on, it turns to the east forming Haripur dhar. Haripur dhar at Haripur branches off into two ranges called Langra dhar and Dungi Bhungi dhar. The Langra dhar runs towards east and ends into Sainj river near Minus. The Dungi Bhungi dhar with its branches separates Tons and Giri catchment.

Towards north and west wards there are other dhars such as Bathau ki dhar, Thandi dhar etc. Sain dhar and Sarahan Dharti dhar are two important and independent ranges to the south of the Giri river. The Dharti dhar enters the area at Sadna ghat and runs eastwards from Saroga to Banethi; Nawani, Janta, Jaitak, Dhashog, Rama Kausar, Malgai and ends near Rajban. Its altitude varies from 500 m to 1500 m. The northern slopes drain into Giri and the southern slope into Bata Markanda rivers.

The other region consists of small hills and plain areas. The valley which forms a major part of Nahan Forest Division is called Kairda Dun which is an extension of main Dehradun valley. This valley narrows down from and is about 20 Km along Yamuna to about 600 metre near Kolar. It is about 30 Km long from Kolar to river Yamuna beyond Paonta Sahib.

8. CLIMATE:

The climate is mostly montaine type. It varies from place to place depending upon the altitude. In higher hill ranges the climate is mostly temperate type, in middle areas, it is sub-tropical and in the lower region it is tropical. The Chur dhar is under the snow for greater part of the year. The lower areas, particularly Paonta valley, which has the elevation of about 600 m., has tropical to sub-tropical climate.

The temperature of the area varies mostly with elevation. This may be comparatively lower in the higher hill ranges. In Siwalik zone the days are hot but the nights are comparatively cooler. Dust storms are quite common in this area particularly during summers. January is usually the coldest month of the year, while temperature upto 45°C. are recorded in lower areas in June. Areas having elevation of 2000 metre and above receive snow fall during this period. The mean maximum temperature during January may be around 10°C. The minimum temperature, however, may go below the freezing point. Frost is common throughout the area. The average rainfall in this area is 1700 mm, varying from 1400 mm to 2500 mm. Most of the rainfall occurs during July and August. In higher hills, the rainfall and snowfall occur during January and February. The number of rainy days vary from 60 to 80 averaging about 68 when rainfall is 2.5 mm or below. About 85% of the rain is received between June to October.

9. INFRASTRUCTURE:

The area is very hilly. There have been considerable developments of road communications in the past decade. However, there are no national highways passing through the area. The important roads of the area are:-

- i) Solan-Nahan-Paonta Road
- ii) Solan-Rajgarh-Minus Road
- iii) Nahan-Kalamb Road and beyond
- iv) Jagadhri-Paonta-Rajban-Rohru Road
- v) Nahan-Dadahu-Rajban Road
- vi) Dadahu-Chopal Road
- vii) Rajgarh-Nei-Sainj Road
- viii) Nahan-Bagthan-Rajgarh Road
- ix) Sarahan-Narag-Ochhaghat Road
- x) Solan-Dhamla Road

Besides these roads, there are large number of jeepable fair weather roads. There are approximately 0.25 Km roads per Sq.Km. of the area.

The area is not connected with any railway line. The nearest railway head (N.G.) on Kalka-Simla line is Solan which is about 20 Km. away. The broad-gauge railway is quite far and the nearest railway station is Jagadhri.

10. MINERAL RESOURCES:

The area has good deposits of gypsum, limo-stone, oron (pyrites), marble, slates etc. The deposits of gypsum, have been found at Korga, Bharli, Shilorna and Ridana. It is reported that high qualities gypsums available will be of the order of 60 million tonnes. The deposits of marble are found at Naura, Bhaunari and Jarag. Lime stone is found at a number of places. The important deposits are those situated at Sataum, Bhatrog, Mandhali, Katya, Naura, Bhaunrari and at a number of other places. These deposits

occur mainly in the Beoban, Krol, Blaini series of rocks formation. The other minerals whose occurrence has been detected are iron, iron (pyrites), lead, mica, mineral pigments, ochre, slates etc.

11. FOREST:

Forests of the area consist of the following types, according to revised classification (Champion & Seth, 1968):-

- (i) Moist Bhabar Sal (3C/C 2b):- Sal is the most important species forming about 75% of the crop. Both sub types i.e. Bhabar dun sal forests and Bhabar damar sal are found in the area. This type is mainly found in the Nahan Forest Division. The important species are sal, sain, gurjam, haldu, bahera, foldu, jamun etc.
- (ii) Dry Siwalik Sal forests (5 B/C1a):- These forests occur on Siwalik hills in Nahan Forest Division. The associates of sal are Anogeissus latifolia, Terminalia tomentosa, Lannea coromandelica, Buchanania lanzen, Acacia catechu, Bauhinia sp. etc.
- (iii) Northern Dry Mixed Deciduous Forests (5B/C2):- These forests occur on outer hills and plain areas. The important species are Terminalia tomentosa, Anogeissus latifolia, Acacia catechu, Terminalia hallerica, Buchanania lanzen, Diospyros tomentosa, Lannea coromandelica, Holoptelia integrifolia, Hymenodictyon excelsum, Butea monosperma etc.
- (iv) Pine forests (Champion & Seth, Forest type 9C₁ & (9C₂) :-

Both lower or Siwalik chir pine forests and upper or Himalayan chir pine forests occur in the area. The Siwalik chir forests occur between 600-900 m. on Dharti dhar and 650-1900 m on Kamrao-Bharli dhar. The floristic composition of Siwalik chir pine forests consists of Pinus roxburghii with number of broad leaved species. The important broad leaved species are Shorea robusta, Terminalia tomentosa, Terminalia chebula, Anogeissus latifolia, Lannea coromandelica, Cassia fistula, Eublica officinalis, Quercus incana may be found in suitable sites.

The Himalayan pine forests occur from 900 metres to 2,000 metre over-lapping tropical dry deciduous forests at the lower elevation ending in the temperate forests. This type forms the important forests of the area. The main species is Pinus roxburghii. The chir forests are usually found in pure patches. Lower region species such as Syzgium cumini, Lannea coromandelica, Terminalia chebula etc. occur. In the higher elevations species such as Quercus leucotrichophora (Syn. Q. incana), Rhododendron arboreum, Pieris ovalifolia, Myrica nazi etc. are found.
- (v) Himalayan moist temperate forests:- The temperate forests are small in extent mostly occurring in higher hills. The area is mostly under deodar, fir and spruce. The forests of Kharsu are also common along higher ridges.

- (vi) Ben Oak forests (12 C1a, 12 C1c, 12 C1d, 12 C2a) These forests occur on extensive areas usually on cooler aspect of the hills - in the chir zone. The trees are usually branchy, malformed due to heavy lopping. The important species are Quercus laucotrichophora (Q. incana), Rhododendron arboreum, Pieris ovalifolia, Acer oblongum, Pyrus pashua, Myrica nagi etc.

The sal forests are managed under conversion to uniform and selection system. Forests containing almost pure sal situated on comparatively gentle slopes are managed under uniform system. The forests on steeper slopes with varying quantity of mixture of miscellaneous species are generally managed under selection working circle. The mixed miscellaneous forests are usually managed under selection working circle and protection working circle. Chir forests are managed under "Punjab shelterwood system" with a rotation of 120 years. Deodar occurs mostly in Rajgarh Forest Division and is managed under irregular shelterwood group system with floating periodic blocks. The forests of fir and spruce and oaks are managed under the selection system.

12. RIVERS:

The major part of the area forms the Yamuna catchment. The other important rivers besides Yamuna are Giri, Tons, Jalal, Markanda, Bata, Ghaggar etc. A large proportion of the area is drained by the Giri or its tributaries. The Giri river rises in the hills of Jubbal and enters in the survey area from south-west side. It continues its course for about 40 km. forming the boundary of Solan and Simla districts. It flows about 88 km. in the area and meets Yamuna at Rampur Ghat. This river is used for timber floating from Rajgarh Forest Division. The major river Yamuna do not flow in the area but it forms the boundary of the survey area with that of Uttar Pradesh. The north-eastern corner of the area drains into Tons river. This river is also used for timber floating. Sainj is the tributary of Tons. The Jalal river is shallow and narrow and meets Giri river at Dadaha. Bata river starts from Dharti Dhar and runs towards east and joins Yamuna at Bata Mandi. The Ghaggar river also starts from Dharti Dhar and run towards south and flows towards Haryana.

13. EXISTING INDUSTRIES:

There is one cement factory recently established in the area. Nahan Foundary at Nahan is also a famous industry. There is a rosin and turpentine industry at Nahan. There are no major wood based industries in the area. Mention may be made of small scale wood based industries such as furniture making, fruit packing cases, saw mills etc. The area feeds chir and sal wood waste to Shri Gopal Paper Mills, Jagadhri.

14. PEOPLE:

The total population of the area as per 1971 census is 2,45,033. About 90% of the people live in villages. The major communities are Brahamin, Bhattis, Rajputs, Kanets and some other communities. Many Scheduled caste and Scheduled tribe people are found in the district, who form about 30.18 % of the total population. The important communities are Kolis, Dumrahs, Chanels and Chamars. Certain other communities such as Jats, Sainis, Labanas, Banjaras, Gujjars, Telis, Lohar, Sheikhhs, Musalmanas are also found in small numbers.

The most of the rural population is engaged in agriculture and horticulture. The size of the holdings are small. People grow crops like Maize, Potatoes and Wheat etc. The per capita income of the population in the area at 1961 price lvel during the year 1970 is Rs.550/- as against Rs.339/- for whole of the country.

CHAPTER-II

INVESTIGATION AND METHODOLOGY

On the request of Forest Department, Government of Himachal Pradesh, Preinvestment Survey of Forest Resources undertook a survey in Rajgarh and Nahan Forest Divisions with the following objectives:-

1. Inventory of Forest Resources
2. To indicate areas available for raising plantations.
3. To estimate the wood demand of local population and industries.
4. Accessibility and Cost studies.

1. INVENTORY OF FOREST RESOURCES:

The main objectives for the inventory were:-

- i) to estimate the areas under different land use and forest types.
- ii) to estimate the total growing stock within $\pm 10\%$ at 95% probability level for each forest division and its distribution in different forest types.
- iii) to prepare land use and forest type map.
- iv) to prepare Local Volume Table of chir.

2. TO INDICATE THE AREA AVAILABLE FOR RAISING PLANTATION:

To work out the total area under poor density forest, degraded forest, scrub land, pasture and grass lands and indicate in general the geological and soil characteristics of the area for considering plantation.

3. DEMAND STUDIES:

The main objectives of these studies were:-

- i) to find out the present level of wood consumption.
- ii) to estimate the future level of wood consumption.

4. ACCESSIBILITY AND COST STUDIES:

The main objectives of cost and accessibility studies were:-

- i) to estimate the cost at which raw materials from different forest areas may be made available on the industrial sites.
- ii) to work out the volume under different cost classes which would be made available at the industrial site.

METHODOLOGY OF INVENTORY

1. INVENTORY:

Sampling Design:

On the basis of data collected for variation, it was considered that about 500 sample points in area would be sufficient to give the desired precision. Systematic sampling was undertaken because certain informations of soil and geology was to be collected from the non-forested sample plots. This design was selected because photographs of the project area could not be obtained prior to the survey which could have helped in stratifying the area into various forest types.

Layout of Sample Plots:-

Grids were marked on 1:63,360 topo map sheets at the interval of thousand yards. Sample grids were spaced at 2000 yards by 3000 yards (1829 m by 2743 m). The distance along the X-axis will be 2000 yards (1829 m) and for Y-axis it will be 3000 yards (2743 m) (fig. 3). The grid centres are taken as the cross section of the grids marked on the maps. There are four sample points along four grid lines, emerging from the grid centre (grid north, east, south and west). The distance of each sample point is 300 yards (274.8 m) from grid centre. All the sample points except those falling on cultivation, habitation etc. were visited.

Variable plot method was used at each of these sample points for collection of information. But where bamboo was found to occur, fixed plots of the size 0.1 hectare with sample point as the centre of the plot were also to be laid out. Fixed plots were square in shape, with its four apices facing north, east, south and west. Sample points and/or the fixed plots were numbered as 1 to 4 starting from north in a clock-wise direction. (North-1, East-2, South-3 and West-4). Each sample point was located on the ground with the help of photographs and the map by selecting some reference points both on the map or photograph and the ground. Bitterlich relaskop was used for enumeration of the crop. Tally was taken with basal area factor 2 sq.m. per hectare.

RECORDING OF DATA :

For collection of information in codified form from each sample point, the following forms were used:-

1. Point/Plot Description Form (PDF):- The description of several parameters such as geology, soil, land class, vegetation, forest types, forest quality, density, stocking regeneration, biotic interference etc. were collected and recorded in this form for an area of 2 hectares around the sample point (Appendix-I).
2. Tally Sheet:- Tally of all the trees above 10 cm. diameter was taken with the help of Relaskop. The diameter of all the 'in' trees with their species was recorded in this form. (Appendix-I).

3. Sample Tree Form:- In this form detailed information about the trees such as height, clear bole, bark thickness, increment, crown width etc. were recorded in respect of all 'E' trees occurring between north and west directions. (Appendix-I).

4. Bamboo Enumeration Form:- When bamboo was found to occur and it was so recorded in the point/plot description form, the information on bamboo clumps and culms were recorded in this form. Separate form was used for each plot. (Appendix-I).

2. PHOTO INTERPRETATION:

The photographs of the Task Nos.523-A on scale of 1:15,000 of the year 1967 were procured for the survey. The photographs scales were found to vary from 1:15,000 to 1:20,000. The total number of photographs involved in the area was 2229. There was a gap of about 45.00 Km² for which photographs were not available.

Two types of interpretation have been carried out:-

- (a) plot/point interpretation.
- (b) 100 percent interpretation.

(a) Plot/Point Interpretation:- Sample points and the grid centres have been transferred from the 1:63,360 topo maps sheets to the photographs by photo-interpretation section of Head Office. The land use class of each sample plot was studied on the photographs. They were classified into various classes.

(b) 100 percent photo-interpretation:- 100 percent photo-interpretation was done by the field crews of this organisation. A minimum area of delineation was 5 hectare. The area has been divided into following classes:-

- 1. Forest land
- 2. Scrub land
- 3. Cultivation
- 4. Grass land
- 5. Barron land
- 6. Habitation
- 7. Orchards
- 8. Water features.

Forest lands were further classified into the following forest types:-

- 1. Chir
- 2. Deodar
- 3. Kail
- 4. Fir
- 5. Spruce
- 6. Fir-Spruce
- 7. Mixed conifers
- 8. Conifers mixed with broad leaved species.
- 9. Doodar-Kail
- 10. Moru Oak
- 11. Kharsu Oak
- 12. Mixed hardwoods.

13. Ban Oak
14. Chir with Oak
15. Chir with Khair
16. Khair
17. Eucalyptus species
18. Sal
19. Sal with other hardwoods
20. Broad leaved with bamboo.

Forest types were further classified into the following volume density classes:-

(a) Volume class

- i) Low volume - 50 m^3 or less per hectare
- ii) Medium volume - $50 \text{ m}^3 - 150 \text{ m}^3$ per hectare
- iii) High volume - More than 150 m^3 per hectare.

(b) Density class

- (i) Density less than 0.4
- (ii) Density 0.4 to 0.7
- (iii) Density more than 0.7

Identification of large number of forest types on the photographs has become possible because the photographs were of good quality and intensive checking has been done by inventory crews. Species constituting more than 30%, has been regarded as pure crop in the interpretation.

3. DEMAND STUDY:

- (i) The present production of timber and fuelwood has been collected from the annual administrative reports of the forest divisions.
- (ii) A sample survey was conducted for estimating the wood requirements for construction and repair of houses and fuelwood. For this 20 villages were selected randomly and 5 houses in each village were visited and the quantity of wood used in the house construction and repairs of houses and fuelwood was determined after careful measurements and enquiry from the head of the house.
- (iii) All the wood consuming industries have been visited and their consumption of wood has been determined. A large number of such industries are small and usually these do not keep the records for the consumption of wood.
- (iv) The consumption of wood by Government departments and organizations have been estimated on the basis of the records of the Forest Department.
- (v) The present need by all categories of wood users viz., local population, industries, organisations etc. has been worked out from the data so collected.
- (vi) Future need of wood has been projected. The demand has been projected for the year 1981 and 1991.

4. COST AND ACCESSIBILITY STUDIES:

- (i) The survey area was divided into various cost or logging units, mainly from the point of view of terrain and extraction facilities. Detailed study of 1:50,000 topographic map sheets was done to judge the most economic and feasible method of extraction.
- (ii) All calculations of cost have been done from the costs units. Areas inside a cost unit has been regarded as uniform.
- (iii) The possibilities of extraction of timber from different cost units by different methods of extraction have been studied and the prevalent one was used for working out the cost etc. The minor transport means were also studied. When it was not possible to lay down any of the minor transport means with the conventional methods, the unit was classified as inaccessible.
- (iv) The cost figures of different operations viz., felling, conversion, transport etc. have been collected from the contractors working in the forest. Only such cost units have been visited where the coupes were under working.
- (v) Whenever a number of alternatives for minor and major transport modes from a particular unit was available, the cheapest one was selected for the study.
- (vi) All calculations of cost of transport are from the coupe to Yamunanagar because most of the timber of the area goes to Yamunanagar.
- (vii) Depending upon the cost of various operations, each unit has been classified into cost classes. Correlating the volume of each cost unit with the cost classes, the weighted cost volume of raw material has been assessed.

CHAPTER III
DATA ANALYSIS

1. TREE VOLUME STUDY:

As overbark and under bark measurements at the two ends of a section were available the over bark and under bark volume of each section was calculated by the 'Smalian' Formula ;

$$V = \frac{\pi L}{8} (D_1^2 + D_2^2)$$

where: V is the volume, D_1 and D_2 the average diameters at the two ends of a section; and L is the length of the section.

D_1 and D_2 represent overbark measurements for overbark volume and underbark measurements for underbark volume. In case of stump volume and volume of the first section of each of the other tree portions, the average diameter at the top of the stump or at the top of the first section was considered to represent average diameter of the section, and volume was calculated as

$$V = \frac{\pi}{4} D^2 \times L$$

where: 'D' is the average diameter at the top of the stump or the top of the first section.

Volumes of all the sections of the tree were added to obtain overbark and underbark volume of the tree.

2. BARK PERCENTAGE:

Total over bark and total under bark volume were calculated for each diameter class. The overbark volumes was expressed as a percentage of the underbark volume in order to estimate bark percentage.

3. INCREMENT STUDY:

(a) Age-height and age-diameter (Chir)

Number of rings were recorded at the breast height point of each felled tree. Age correction was done on the basis of the seedling data. The diameter and height were plotted against age on smooth curves drawn. From these curves diameter and height were read against age for Chir.

(b) Diameter increment

Radial increment during last 10 years, 20 years and 30 years was recorded for some standing trees of coniferous species from increment cores. Average diameter increment during last 10 years, 20 years and 30 years were derived for each diameter class.

4. VOLUME STUDY

(a) General volume equation:

Felled tree data was collected for Pinus roxburghii (Chir) only. Since sample tree data for this species was inadequate, local volume equations were derived directly from the felled tree data and no general volume equation was developed for this species.

For sal, the general volume equation developed by F.A.O. in North Zone was taken.

For other species, it was decided that local volume equations developed for Uttarkashi Catchment, U.P. be used. Therefore, no general volume equations were developed.

(b) Local Volume equations

In order to obtain local volume equation for chir, the following types of regression equations were tried:-

$$V = a + bD^2$$

$$V = a + bD + D^2$$

$$V = a + bD + cD^2 + cD^3$$

$$\sqrt{V} = a + bD$$

$$V/D^2 = a + b/D^2$$

$$V/D^2 = a + b/D + c/D^2$$

$$V = a + bD + c/D$$

$$V = a + bD^2 + c/D$$

$$\log V = a + b \log D$$

Where : V = Total underbark volume (m³) including branches.
D = Overbark diameter at breast height (m).

The following equation was selected keeping in view the standard error of estimate, the multiple determination coefficient and the applicability of the equation in the entire range of data.

$$\frac{V}{D^2} = 11.7563 - 2.7070/D + 0.1919/D^2$$

or

$$V = 0.1919 - 2.7070D + 11.7563 D^2$$

The equation is applicable to 12 cm. d.b.h. and above. To arrive at a local volume equation for sal, general volume equation derived for sal by F.A.O. in Northern Zone was used. Volume of each sample tree was estimated by substituting the diameter and height of each sample tree in the following general volume equation.

$$V = 0.1180 + 0.2570 D^2 H \quad \text{where H is the height (m).}$$

The same type of local volume equations were tried as for Chir and the following equation was selected;

$$V/D^2 = 9.0500 - 1.7288/D + 0.2283/D^2$$

Or

$$V = 0.2283 - 1.7288 D + 9.0500 D^2$$

The local volume equations developed for Uttarkashi Catchment by Preinvestment Survey of Forest Resources were used for the following species:

Kail

$$V = 0.2232 - 2.3509 D + 11.9067 D^2$$

Deodar

$$V = -0.0017 + 8.2098 D^2$$

Spruce

$$V = 0.2935 - 4.5414 D + 16.3252 D^2$$

Fir

$$V = 0.4198 - 2.7255 D + 10.8934 D^2$$

Ban oak

$$V/D^2 = 7.7030 - 1.2582/D + 0.0854/D^2$$

or

$$V = 0.0854 - 1.2582 D + 7.7030 D^2$$

Moru oak

$$V/D^2 = 10.1631 - 1.5547/D + 0.0988/D^2$$

or

$$V/D^2 = 0.0988 - 1.5547 D + 10.1631 D^2$$

Rest of species

$$V = 0.3846 - 3.4559 D + 10.9876 D^2$$

These volume equations are applicable for overbark diameters of 20 cm. and above.

For trees in the diameter class 10-20 cm., the following average volumes obtained from the felled trees in that class were used for estimating the volume of the enumerated trees.

Kail	0.1276 m ³
Spruce	0.1050 m ³
Fir	0.2064 m ³
Deodar	0.1360 m ³
Ban oak	0.0924 m ³
Moru oak	0.1153 m ³
Rest of species	0.0780 m ³

(c) Enumerated Tree Volume:

The volume of each enumerated tree was obtained from the overbark diameter at breast height of a tree and the local volume equation of a species.

5. TREE VOLUME STUDIES

(a) Volume per hectare at a sample point.

An estimate of volume per hectare was obtained at each sample point from the trees tallied at the sample point with the following formula.

$$\text{Volume/ha.} = \text{BAF} \frac{\sum_{i=1}^m V_i}{B_i}$$

Where: V_i - Volume of the i th tallied tree for a species estimated from the local volume equation (m^3)

B_i - Basal Area of i th tallied tree (m^2)

m - the number of trees tallied at a sample point.

BAF - Basal area factor of Relaskop 2 Sq.metre per hectare.

(b) Sampling error:

The project area was not stratified before undertaking the survey. However, after survey, the estimate of forest area of each forest type was provided by the Photo-interpretation and Mapping Section of our organisation. A systematic cluster sampling design was used in the survey.

Post stratification was done on the basis of the forest types recorded by ground party. For estimating the sample error of the growing stock for each forest type, the clusters falling in a forest type were considered to constitute a simple random sample. Since in some cases a complete cluster was not falling in a forest type, ratio method of estimation was considered appropriate for estimating the sampling error.

(c) Stand and Stock tables:

An estimate of the number of stems per hectare by species and diameter class was obtained at each sample point from the trees tallied at that point as follows:-

$$\text{No. of stems/ha.} = \text{BAF} \frac{\sum_{i=1}^m 1}{B_i}$$

Where: B_i - Basal area of the i th tallied tree in a diameter class of a species.

m - Number of trees tallied at a sample point belonging to that class.

From these, estimates of the stems/ha. by species and diameter class were calculated for each forest type of a Division.

Similarly, the estimate of volume/ha. by species and diameter was obtained at each sample point from the tallied tree at that point from the formula.

$$\text{Volume/ha.} = \text{BAF} \frac{\sum_{i=1}^m V_i}{\sum_{i=1}^m B_i}$$

Where: V_i - Volume of i th tallied tree in a diameter class of a species derived from local volume equations (m^3).

B_i - Basal area of i th tallied tree in a diameter class of a species (m^2)

m - The number of trees, tallied at a sample point belongs to that class of the species.

From these, estimate of the volume/ha. by species and diameter class was obtained for each forest types of each Division.

6. BAMBOO

There were only 57 bamboo bearing points in the whole survey area. The occurrence class and quality class was noted for these points. It was noticed that 48 of these belonged to quality class-2 and 43 to occurrence class-1. Therefore, separate estimates of bamboo clumps and culms were not obtained.

The bamboo clumps in each plot were classified into three size classes (less than 1 m. diameter, 1 to 2 m. diameter and more than 2 m. diameter.) The average number of clumps per hectare by size classes are given below:-

	Size class		
	Less than 1 M.	1 to 2M.	Above 2 M.
No. of clumps per hectare.	33.86	14.74	5.61

CHAPTER IV

GROWING STOCK AND ANNUAL YIELD

1. FOREST TYPES:

The forests were classified into the following forest types on the basis of 100% photo-interpretation:-

1. Chir
2. Deodar
3. Kail
4. Fir
5. Spruce
6. Fir/Spruce
7. Kail, Fir/Spruce
8. Mixed conifers
9. Conifers mixed with broad leaved
10. Sal
11. Sal with other hardwoods
12. Hardwoods
13. Ban Oak
14. Chir with Oak
15. Chir with khair
16. Khair
17. Eucalyptus spp.
18. Deodar kail
19. Kharsu oak
20. Moru oak
21. Kharsu and Moru
22. Broad leaved with bamboo.

Some of the forest types recognised above were too small in extent. Therefore, the above forest types were grouped into the following classes:-

1. Chir
2. Kail
3. Deodar
4. Mixed conifers
5. Conifers mixed with temperate hardwoods
6. Sal
7. Oaks
8. Others

The areas of these forest types as worked out by 100% photointerpretation for Rajgarh and Nahan Forest Divisions is indicated in Table IV-1.

Table IV-1

Area of different forest types in Rajgarh and Mahan Forest Division.

S.No.	Forest Type	Area of Rajgarh Forest Division. (ha.)	Area of Mahan Forest Division. (ha.)
1.	Chir	14824	5589
2.	Kail	2218	-
3.	Deodar	2057	-
4.	Mixed conifers	619	-
5.	Conifers mixed with temperate hardwoods	11973	4840
6.	Sal	13	21198
7.	Oaks	19154	866
8.	Sal mixed with hardwood	-	7805
9.	Others	20508	34526
Total		69426	74824

2. DENSITY:

Each forest type was further differentiated into the following density classes:-

1. Less than 0.4
2. 0.4 to 0.7
3. More than 0.7

The area of different forest types under these density classes is given in table Nos. IV-2 and IV-3 for Rajgarh and Mahan Forest Divisions respectively.

Table IV-2

Area under different forest types in Rajgarh Forest Division

S.No.	Forest Type	Area under different density classes in ha.		
		Less than 0.4	0.4 to 0.7	More than 0.7
1.	Chir	4161	8180	2483
2.	Kail	-	25	253
3.	Deodar	159	731	1167
4.	Mixed Conifers	20	259	340
5.	Conifers mixed with temperate hardwoods	3021	2772	6680
6.	Sal	-	13	-
7.	Oaks	9463	7840	1851
8.	Others	not worked out		
Total		69426		

Table IV-3

Area under different forest types in Mahan Forest Division

S.No. Forest Type	Area under different density classes in hectare.			
	Less than 0.4	0.4 to 0.7	More than 0.7	Total
1. Chir	725	1519	3345	5589
2. Conifers mixed with temperate hardwoods.	1276	2846	718	4840
3. Sal	1775	6594	12829	21198
4. Sal mixed with hardwoods	1792	5835	177	7805
5. Oaks	310	177	379	866
6. Others	Not worked out			34526
Total				74824

3. PREPARATION OF VOLUME TABLES:

Local Volume Table for Chir was prepared on the basis of felled tree data collected in Rajgarh and Mahan Forest Divisions. The felling of trees was carried out on points selected randomly. The selection of tree was also done at random. Only normal healthy growing trees were felled for preparation of volume tables. The number of trees felled in each diameter class is given in table IV-4.

Table IV-4

Number of Chir trees felled in each diameter class

Diameter class	No. of trees felled
10-20	80
20-30	12
30-40	8
40-50	9
50-60	18
60-70	26
70-80	17
80-90	17
90-100	10
100-110	15
110-120	5
More than 120	2
Total	219

Since sample tree data for this species was inadequate, local volume equations were derived directly from the felled tree data. No general volume equations were developed because the data so collected was quite sufficient to meet the requirements of local volume equations.

Table IV-5

LOCAL VOLUME TABLE FOR CHIR (NAHAN & RAJGARH DIVISIONS)

Diameter (m)	Volume (m ³)
.10	.0364
.15	.0504
.20	.1208
.25	.2499
.30	.4379
.35	.6846
.40	.9901
.45	1.3544
.50	1.7775
.55	2.2593
.60	2.8000
.65	3.3994
.70	4.0576
.75	4.7746
.80	5.5504
.85	6.3849
.90	7.2782
.95	8.2303
1.00	9.2412

4. GROWING STOCK

Using these volume tables on plot enumeration data, plot volume has been worked out. These plot volumes were grouped together for each forest type and figures for volume per hectare for each forest type have been computed. Table No. IV-6 and 7 indicates the total volume and volume per hectare for Rajgarh and Nahan Forest Divisions separately.

Table IV-6

DISTRIBUTION OF GROWING STOCK PER HECTARE IN NAHAN FOREST DIVISION.

Forest Type	Area (ha.)	Volume/ha. (m ³)	Total volume (000 m ³)	S. I. %
Chir	5589	51.293	286.677	25.3
Conifers mixed with temperate hardwoods	4840	37.706	182.497	14.2
Sal	21198	164.358	3484.061	4.7
Sal with hard wood	7805	86.319	673.720	8.8
Oaks	866	97.162	84.142	28.6
Others	34526	42.143	1455.029	7.5
Total	74824	82.408	6166.126	3.6

Table IV-7.

DISTRIBUTION OF GROWING STOCK PER HECTARE IN RAJGARH FOREST DIVISION.

Forest Type	Area (ha.)	Volume/ha. (m ³)	Total volume (000 m ³)	S.E. %
Chir	14824	42.014	622.816	10.4
Kail	278	26.412	7.343	31.1
Deodar	2057	141.058	290.156	30.0
Mixed conifers	619	122.836	76.035	23.8
Conifers mixed with temperate hardwoods	11973	93.726	1122.181	14.5
Sal	13	102.266	1.329	29.8
Oaks	19154	92.734	1776.227	9.8
Others	20508	43.240	886.766	12.3
Total	69426	68.891	4782.853	5.9

DISTRIBUTION OF GROWING STOCK PER HECTARE:

The distribution of volume per hectare by different forest types and important species is given in Table No. IV-8 for Rajgarh Forest Division and in Table IV-9 for Nahan Forest Division.

The distribution of total growing stock by important species has been worked out for Rajgarh and Nahan Forest Divisions separately and the results are indicated in Table Nos. IV-10 & IV-11 respectively.

Table IV-8

DISTRIBUTION OF VOLUME PER HECTARE BY IMPORTANT SPECIES IN RAIGARH FOREST DIVISION

S.No. Forest Type	Volume in m ³							Rest of species	Total
	Chir	Kail	Deodar	Mixed conifers	Banoak	Horu	Kharsu	Sal	
1. Chir	39.219 (93.3)	-	0.142 (0.3)	-	0.826 (2.0)	-	-	0.112 (0.3)	1.715 (4.1) 42.014 (100)
2. Kail	-	28.412 (100.0)	-	-	-	-	-	-	28.412 (100)
3. Deodar	-	1.933 (1.4)	130.418 (92.5)	-	7.787 (5.5)	-	-	-	0.920 (0.6) 141.058 (100)
4. Mixed conifers	3.918 (3.2)	17.178 (14.0)	21.937 (17.8)	61.006 (49.6)	2.649 (2.2)	-	14.689 (12.0)	-	1.499 (1.2) 122.836 (100)
5. Conifers mixed with temperate hardwoods.	5.961 (3.4)	6.439 (6.9)	1.520 (1.6)	9.923 (10.6)	19.347 (20.6)	9.550 (10.2)	18.563 (19.8)	-	22.423 (23.9) 93.726 (100)
6. Sal	-	-	-	-	-	-	-	66.456 (65.0)	35.810 (35.0) 102.266 (100)
7. Oaks	0.232 (0.3)	0.141 (0.2)	-	1.572 (1.7)	59.997 (64.7)	1.702 (5.1)	11.531 (12.4)	-	14.559 (15.6) 92.734 (100)
8. Others	0.652 (1.5)	-	-	-	4.436 (10.3)	3.656 (8.5)	0.669 (1.5)	-	33.967 (73.3) 42.240 (100)

Note:- The figures in bracket shows the percentage of the volume of the species with respect to total volume per hectare in the forest types.

Table IV-9

DISTRIBUTION OF VOLUME PER HECTARE BY IMPORTANT SPECIES IN NAHAN FOREST DIVISION

S.No. Forest Type	Volume in m ³				Total
	Chir	Banoak	Deodar	Sal	
1. Chir	38.490 (75.0)	-	-	12.803 (25.0)	51.293 (100)
2. Conifers mixed with temperate hardwoods	12.158 (32.2)	3.762 (10.0)	0.520 (1.4)	6.272 (16.6)	22.706 (100)
3. Sal	-	-	-	140.091 (85.2)	140.091 (100)
4. Oaks	1.943 (2.0)	82.986 (85.4)	-	12.233 (12.6)	97.162 (100)
5. Sal mixed with other hardwoods	0.982 (1.2)	-	-	49.751 (57.6)	50.733 (100)
6. Others	0.127 (0.3)	-	-	2.562 (6.1)	2.689 (100)

Note:- (i) The figures in bracket shows the percentage of the volume of the species with respect to total volume per hectare in the forest type.

(ii) Forest Type 'Others' also include a small proportion of deodar and mixed conifers.

Table IV-10

DISTRIBUTION OF TOTAL GROWING STOCK BY FOREST TYPES AND IMPORTANT SPECIES IN RAIGARH
FOREST DIVISION.

Forest type	Area in ha.	V o l u m e i n 000 m ³								Total	
		Chir	Kail	Deodar	Mixed conifers	Banoak	Moru	Kharsu	Sal		Rest of species
Chir	14824	581.382	-	2.105	-	12.245	-	-	1.660	25.423	622.815
Kail	278	-	7.313	-	-	-	-	-	-	-	7.313
Deodar	2057	-	3.976	268.270	-	16.018	-	-	-	1.892	290.156
Mixed conifers	619	2.125	10.633	13.554	37.763	1.640	-	9.092	-	0.928	76.035
Conifers mixed with temperate hardwoods	11973	71.371	77.094	18.199	118.808	231.642	111.312	222.255	-	268.470	1122.181
Sal	13	-	-	-	-	-	-	-	0.864	0.865	1.329
Oaks	19154	4.443	2.701	-	30.110	1149.183	90.062	220.865	-	278.835	1775.227
Others	20508	13.371	-	-	-	90.974	74.977	13.720	-	693.723	833.765
Total	69426	672.992	101.747	302.128	186.681	1501.702	279.381	465.932	2.524	1260.765	2252.252

Table IV-11

DISTRIBUTION OF TOTAL GROWING STOCK BY FOREST TYPES AND IMPORTANT SPECIES IN MAHAN FOREST DIVISION

Forest type	Area in ha.	V o l u m e i n 000 m ³				Total
		Chir	Banoak	Deodar	Sal	Rest of species
Chir	5389	215.121	-	-	-	71.536
Conifers mixed with temperate hardwoods	6840	58.845	18.208	2.517	30.356	72.571
Sal	21198	-	-	-	2969.649	514.412
Oaks	866	1.682	71.868	-	-	10.594
Sal mixed with other hardwoods	7805	7.864	-	-	388.307	277.749
Others	34526	4.835	-	-	88.455	1362.188
Total	74824	287.597	90.074	2.517	3476.768	2309.070
						6165.126

Note:- The Forest type 'other' also includes a small area under deodar, hail and mixed conifers.

5. CULL

Cull refer to the natural defects in the timber which make it unsuitable for commercial utilization. The volume of defective timber is described as cull volume. The cull volume in case of chir, has been studied and it has been found that it makes less than 1% of the total volume. In case of other species, the data of cull volume has not been collected in the survey. Similar studies conducted in Uttar Pradesh and Jammu and Kashmir indicate the presence of appreciable amount of cull in Fir and Spruce and oaks. Therefore, for finding out the net volume, the following percentage of cull has been assumed. No cull percentage for sal has been adopted as no fellings were carried out.

Chir	- Nil
Deodar	- Nil
Mixed conifers	- 10%
Oaks	- 15%

6. NET VOLUME

The gross volume of each species in Rajgarh and Nahan Forest Division is indicated in Table IV-12. After deducting the cull volume from the total volume of each species, the net volume has been worked out. Table No. IV-13 indicates the total volume and net volume of important species both in Rajgarh and Nahan Forest Divisions.

Table IV-12

GROSS VOLUME OF IMPORTANT SPECIES IN 000 m³

S.No.	Name of species	Rajgarh Forest Division	Nahan Forest Division
1.	Chir	672.992	287.697
2.	Kail	101.747	-
3.	Deodar	302.128	2.517
4.	Mixed conifers	186.681	-
5.	Ban Oak	1501.702	90.074
6.	Moru	279.381	-
7.	Kharsu	465.932	-
8.	Sal	2.524	3476.768
9.	Rest of species	1269.765	2309.070
Grand Total		4782.852	6166.126

Table IV-13

NET VOLUME OF IMPORTANT SPECIES

(in 000 m³)

S.No.	Name of species	Cull percentage	Net Volume		Total
			Rajgarh	Nahan	
1.	Chir	nil	672.992	286.697	959.689
2.	Kail	nil	101.747	-	101.747
3.	Deodar	nil	302.128	2.517	304.645
4.	Mixed conifers	10	168.012	-	168.012
5.	Ban Oak	15	1276.446	76.562	1353.008
6.	Moru	15	237.473	-	237.473
7.	Kharsya	15	396.042	-	396.042
8.	Sal	nil	2.542	3476.768	3479.310
9.	Rest of species	nil	1269.765	2309.070	3578.835
Total			4427.147	6151.614	10578.761

7. GROWING STOCK OF BAMBOO:

Bamboo is found mostly in Nahan Forest Division. The common species is the Dendrocalamus strictus and bamboo occurs in an area of 6031 hectares, most of which lies in Nahan Forest Division.

The total number of clumps and culms (healthy) is given in table IV-14.

Table IV-14

TOTAL NUMBER OF CLUMPS AND CULMS (HEALTHY)

Clump size	Average No. of clumps/ha.	Average No. of culms per clump.	Total No. of culms/ha. (Healthy)
Less than 1 metre	33.860	10.162	344.085
1 metre to 2 metre	14.740	16.315	240.483
More than 2 metre	5.610	24.142	135.436
Total	54.21		720.004

The green bamboo weight has been obtained by the equation derived by Central Zone of Preinvestment Survey for Chanda area. The formula is given below:-

$$W = 1.54865 + 0.03878 D^2 L$$

where D is the diameter (m) of the culm at base and L the length upto 2 cm top diameter limit.

The green weight in each class was obtained by substituting the values of diameter and height in each size class. The results are summarised below:-

Table IV-15

GREEN WEIGHT OF BAMBOO CULMS

Size class	Av. Dia. (cm)	Av. height (m) (upto 2 cm top dia)	Average weight per culm (Kg.)
Less than 1 metre	2.081	1.784	1.848
1 metre to 2 metre	2.210	2.315	1.987
More than 2 metre	3.142	3.500	2.889

The total tonnage in each class was obtained by multiplying the total number of bamboo culms by the estimated weight of a bamboo culm for that class. The total growing stock in terms of green weight works out 907 9076 tonnes.

8. DISTRIBUTION OF VOLUME PER HECTARE

1. Chir forest type:

Tables IV-16 and IV-17 give the figures of volume per hectare of chir forest type in Rajgarh and Nahan Forest Divisions respectively. In Rajgarh Forest Division, volume per hectare of chir is maximum in diameter class of 40-50 cm. The distribution is fairly good in each diameter class. The distribution in Nahan Forest Division however is not satisfactory because the trees of lower diameter classes i.e. below 30 cm. are absent. The volume per hectare figures indicate the presence of low volume both in Rajgarh and Nahan Forest Divisions. In Rajgarh Forest Division, the number of trees per hectare is 115.781 and in case of Nahan Forest Division, it is only 42.108. But the volume per hectare figures are higher in case of Nahan Forest Division (51.293 m³) than Rajgarh Forest Division (42.108 m³). This is mainly because in Rajgarh Forest Division larger number of trees of lower diameter classes are present. In Nahan Forest Division about 25% of the growing stock consists of other species while in case of Rajgarh Forest Division, this percentage is hardly 7%. The figures of number of stems per hectare for chir forest type is given in tables IV-18 and IV-19 for Rajgarh and Nahan Forest Divisions respectively.

Table No. IV-16

FOREST DIVISION - RAIGARH

VOLUME/HA. BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - CHIR
AREA - 1824 Ha.

Species	Diameter Classes in Cm.								Total	%
	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89		
Shorea robusta	0.112	-	-	-	-	-	-	-	0.112	.3
Pinus roxburghii	2.325	6.420	10.729	11.438	5.087	2.331	0.586	0.303	39.219	93.3
Cedrus deodara	-	0.142	-	-	-	-	-	-	0.142	.3
Quercus incana	0.342	0.136	0.258	0.090	-	-	-	-	0.826	2.0
Rest of species	0.467	0.523	0.140	0.362	0.107	0.116	-	-	1.715	4.1
Total	3.246	7.221	11.127	11.890	5.194	2.447	0.586	0.303	42.014	
Percentage	7.7	17.2	26.5	28.3	12.4	5.8	1.4	.7		100

TABLE No. IV-17

FOREST DIVISION - NAHAN

VOLUME/HA. BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - CHIR
AREA - 5589 Ha.

Species	Diameter Classes in Cm.								Total	%
	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89		
Pinus roxburghii	-	-	3.599	17.191	7.008	2.476	5.403	2.813	38.490	75.0
Rest of species	-	1.077	3.800	1.601	1.880	2.095	-	2.350	12.803	25.0
Total	-	1.077	7.399	18.792	8.888	4.571	5.403	5.163	51.293	
Percentage	0	2.0	14.4	36.7	17.3	9.0	10.5	10.1	100	

Table IV-18
FOREST DIVISION - RAIGARH

STEMS/HA. BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - GHR

Species	Diameter Classes in Cm.							Total	%
	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	
Shorea robusta	0.535	-	-	-	-	-	-	-	0.535 .5
Pinus roxburghii	42.706	28.437	16.971	8.969	2.461	0.756	0.126	0.052	100.514 86.8
Cedrus deodara	-	0.358	-	-	-	-	-	-	0.358 0.3
Quercus incana	3.705	0.826	0.409	0.108	-	-	-	-	5.048 4.4
Rest of species	5.988	2.583	0.322	0.343	0.051	0.039	-	-	9.326 8.0
Total	52.934	32.240	17.702	9.420	2.512	0.795	0.126	0.052	115.781
Percentage	45.7	27.8	15.3	8.1	2.2	0.7	.2		100

Table IV-19

FOREST DIVISION - M HAN

FOREST TYPE - CHIR

SPECIES/HA. BY SPECIES AND DIAMETER CLASSES

Species	D i a m e t e r C l a s s e s i n C m.							
	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89 Total %
Pinus roxburghii	-	-	5.055	12.230	3.411	0.884	1.138	0.438 23.156 53.3
Rest of species	-	11.709	9.213	1.722	1.092	0.753	-	0.463 17.952 43.7
Total:	-	4.709	14.268	13.952	4.503	1.637	1.138	0.901 41.108
Percentage	-	11.4	33.7	33.9	11.0	4.0	2.8	2.2 100

2. DEODAR

Deodar is found only in Rajgarh Forest Division. The distribution of volume per hectare in different diameter classes is given in table No. IV-20. The total volume per hectare in deodar forest type is 141.058 m³ per hectare in which deodar is 130.418 m³ per hectare which forms about 92.5% of the total volume. Maximum volume occurs in diameter classes 40-50 cm and 50-60 cm. The distribution of total number of stems per hectare is given in Table No. IV-21. The trees of lower diameter classes i.e. /above 80 cm. are absent. The other important species which find their place in this forest type are kail, banoak, moru oak etc. Deodar usually forms pure crop in many localities.

3. KAIL /below 30 cm are not sufficient. The trees of higher diameter classes i.e.

Kail forest type is confined mostly in Rajgarh Forest Division. It occurs in small area (less than 10 hectare) in Nahan Forest Division. The volume per hectare in this forest type is 26.412 m³. This growing stock is mostly confined to the trees of lower diameter classes. Trees above 40 cm. are usually absent. The distribution of volume per hectare and stems per hectare is given in table numbers IV-22 and IV-23 respectively.

4. MIXED CONIFERS

Table No. IV-24 gives the distribution of volume per hectare in different diameter classes for this forest type. In this forest type the coniferous species e.g. chir, kail, deodar, fir & spruce occur in mixture with two or more than two species. This forest type occurs mostly in Rajgarh Forest Division. In Nahan Forest Division a small area of about 30 hectares has been found to possess this forest type. The total growing stock per hectare is 122.836 cubic metres. The contribution of various coniferous species viz., chir, kail, deodar, fir and spruce to the total volume is 3.2, 14, 17.8, 25.5 and 24.1 respectively. Maximum volume occurs in 40-50 cm. diameter class. The total number of stems per hectare is 140.145. The maximum number of trees belong to deodar (33.4%) followed by kail (21.4%), spruce (14.2%), fir (12.1%) and chir (5.0%). The trees of lower diameter classes i.e. below 30 cm. are present only in case of deodar, kail, spruce and khair. Trees above 70 cm. occur mainly belonging to the species e.g. fir and spruce. The distribution of stems per hectare of each species in different diameter class is given in table IV-25.

Table IV-20

FOREST DIVISION - RAIGARH

VOLUME/HA (M³) BY SPECIES AND DIAMETER CLASSES. FOREST TYPE : DEODAR

Species	Diameter Classes (Cm.)										Total	%
	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100+		
Cedrus deodara	7.456	16.210	15.911	37.128	37.139	16.252	2.322	-	-	-	130.418	92.5
Quercus incana	1.969	1.203	1.450	1.549	1.616	-	-	-	-	-	7.787	5.5
Pinus excelsa	-	-	1.933	-	-	-	-	-	-	-	1.933	1.4
Rest of species	-	0.920	-	-	-	-	-	-	-	-	0.920	0.6
Total	9.425	18.333	17.294	38.677	38.755	16.252	2.322	-	-	-	141.058	
Percentage	6.7	13.0	12.3	27.4	27.5	11.5	1.6	-	-	-	100	

Table No. IV-21

FOREST DIVISION - RAJGARH

FOREST TYPE - DOEDAR

STEMS/HA. BY SPECIES AND DIAMETER CLASSES

Species	Diameter classes (cm)										
	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100-109	110+ Total %
Pinus excelsa	0.000	0.000	2.598	0.000	0.000	0.000	0.000	0.0000	0.000	0.000	2.598 1.4
Cedrus deodara	54.827	30.747	16.073	23.368	16.321	4.916	0.500	0.000	0.000	0.000	146.752 79.0
Quercus incana	21.308	4.527	1.860	1.281	0.970	0.000	0.000	0.000	0.000	0.000	29.946 13.1
Rest of spp.	0.000	6.416	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.416 3.5
Total	76.135	41.390	20.531	24.649	17.291	4.916	0.500	0.000	0.000	0.000	185.712
Percentage	41.0	22.2	11.1	13.3	9.3	2.6	0.3	-	-	-	100

Table No. IV-22

FOREST DIVISION - RAJGARH

FOREST TYPE - KAIL

VOLUME / H.A. (m³) BY SECTORS AND DIAMETER CLASSES

Species	Diameter Classes in cm.										Total	%
	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100+		
Pinus excelsa	5.592	10.982	9.938	-	-	-	-	-	-	-	26.412	100.0
Total	5.592	10.982	9.938	-	-	-	-	-	-	-	26.412	
Percentage	21.2	41.2	37.6	-	-	-	-	-	-	-		100.0

Table No. IV-23.

FOREST DIVISION -
STEMS/HA. BY SECTORS AND DIAMETER CLASSES
 FOREST TYPE - KAIL

Species	Diameter Classes in cm.										Total	%
	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100+		
Pinus excelsa	43.823	35.336	13.455	0.000	0.000	0.000	0.000	0.000	0.000	0.000	92.614	100
Total	43.823	35.336	13.455	0.000	0.000	0.000	0.000	0.000	0.000	0.000	92.614	
Percentage	47.3	38.2	14.5	-	-	-	-	-	-	-	-	100

Table No. IV-24

FOREST DIVISION - RAJGARH

FOREST TYPE : MIXED CONIFERS

VOLUME/HA. (M³) BY SPECIES AND DIAMETER CLASSES

Species	Diameter Classes in cm.										Total	%
	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100+		
<i>Pinus roxburghii</i>	-	0.441	1.938	0.716	0.823	-	-	-	-	-	3.918	3.2
<i>Pinus excelsa</i>	.511	3.416	4.883	4.453	3.915	-	-	-	-	-	17.178	14.0
<i>Cedrus deodara</i>	2.923	3.788	6.640	3.797	2.849	.950	-	0.950	-	-	21.897	17.8
<i>Picea morinda</i>	2.585	0.125	3.438	4.484	6.132	1.142	4.974	2.650	4.097	-	29.627	24.1
<i>Abies pindrow</i>	-	-	6.045	10.331	5.893	5.290	0.927	0.942	1.951	-	31.379	25.5
<i>Quercus incana</i>	-	0.991	1.658	-	-	-	-	-	-	-	2.649	2.2
<i>Quercus semicarpifolia</i>	-	0.640	3.076	6.534	3.509	0.930	-	-	-	-	14.689	12.0
Rest of species	-	-	1.499	-	-	-	-	-	-	-	1.499	1.2
Total	6.019	9.401	29.177	30.315	23.121	8.312	5.901	4.542	6.048	-	122.836	
Percentage	4.9	7.7	23.7	24.7	18.8	6.8	4.8	3.7	4.9	-		100

Table No. IV-25

FOREST DIVISION -
STEMS/HA. BY SPECIES AND DIAMETER CLASSES

FOREST TYPE : MIXED CONIFERS

Species	Diameter Classes in cm.										Total	%
	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100+		
<i>Pinus roxburghii</i>	-	2.327	3.304	0.838	0.536	-	-	-	-	-	7.005	5.0
<i>Pinus excelsa</i>	4.636	13.499	6.612	3.537	1.666	-	-	-	-	-	29.952	21.4
<i>Cedrus deodara</i>	24.882	8.841	9.545	2.883	1.182	0.327	-	0.210	-	-	46.870	33.4
<i>Picea morinda</i>	10.594	-	5.502	2.733	2.007	-	0.737	0.189	0.153	-	19.915	14.2
<i>Abies pindrow</i>	-	-	5.791	7.163	2.334	1.336	0.237	0.210	0.316	-	17.387	12.4
<i>Quercus incana</i>	-	1.594	3.798	-	-	-	-	-	-	-	5.392	3.9
<i>Quercus semicarpifolia</i>	-	2.144	-	1.387	-	-	-	-	-	-	3.531	2.5
<i>Acacia catechu</i>	6.838	-	-	-	-	-	-	-	-	-	6.838	4.9
Rest of spp.	-	-	3.255	-	-	-	-	-	-	-	3.255	2.3
Total	46.952	28.405	34.807	18.541	7.725	1.663	0.974	0.609	0.469	-	140.145	
Percentage	33.5	20.3	24.9	13.2	5.5	1.2	0.7	.4	.3	-		100

5. -Conifers mixed with temperate hardwoods

This forest type occurs both in Rajgarh and Nahan Forest Divisions. The volume per hectare of this forest type is 93.726 m^3 and 37.706 m^3 for Rajgarh and Nahan Forest Divisions respectively. The detailed distribution of volume per hectare in different diameter classes is given in Table IV-26 and IV-27 respectively for Rajgarh and Nahan Forest Divisions. These tables indicate that figures of volume per hectare in Rajgarh Forest Division are almost two and a half times of the figures of Nahan Forest Division. This may be because of poor stocking of this type in Nahan Forest Division. In Nahan Forest Division the common species in the mixture are chir, sal, deodar, banoak, moru oak and some other broad leaved species.

In Rajgarh Forest Division high level conifers such as fir, spruce also form the main crop. The most important species in the mixture is banoak which forms about $1/5$ th of the total volume in Rajgarh Forest Division. About 75% of the volume in this forest type is constituted by broad leaved species. All the three of oaks species viz., banoak, moru oak and kharsu oak are found. The detailed distribution of the number of stems per hectare of different species in different diameter classes is given in table IV-28 and IV-29 for Rajgarh and Nahan Forest Divisions respectively.

Table No. IV-26

Volume/ha. by species and diameter classes

Forest Type: Con. mixed with
Temp. Hardwood
Forest Division - Rajgarh.
Area - 11973 ha.

Species	Diameter Classes in cm.										
	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100+	Total %
<i>Pinus roxburghii</i>	0.693	0.971	1.881	1.194	1.322	-	-	-	-	-	5.961 6.4
<i>Pinus excelsa</i>	0.677	0.778	3.091	0.781	0.850	-	-	-	-	0.292	6.439 6.9
<i>Cedrus deodara</i>	0.465	-	0.633	0.211	0.211	-	-	-	-	-	1.520 1.6
<i>Picea morinda</i>	1.501	0.788	1.226	2.053	1.129	0.514	0.832	-	-	0.315	8.538 9.1
<i>Abies pindrow</i>	-	0.347	0.506	0.532	-	-	-	-	-	-	1.385 1.5
<i>Quercus incana</i>	4.253	4.738	3.583	2.208	2.180	1.073	0.315	0.492	0.334	0.171	19.347 20.6
<i>Quercus dilatata</i>	2.273	1.792	1.366	1.278	1.172	1.230	0.215	0.219	-	-	9.550 10.2
<i>Quercus semicarpifolia</i>	2.413	3.442	3.083	3.279	2.166	1.643	0.845	0.870	0.222	-	18.563 19.8
Rest of species	6.106	7.523	5.200	1.851	0.747	0.996	-	-	-	-	22.423 23.9
Total	18.356	20.259	21.169	13.587	9.777	5.156	2.207	1.581	0.556	0.778	93.726
Percentage	19.6	21.6	22.6	14.5	10.4	5.8	2.4	1.7	.6	.8	100

Volume/ha. by species and diameter classes

Forest Type: Con. Mixed
with Temp. Hardwood.

Forest Division: Mahan

Area 4840 Ha.

Species	Diameter classes in Cm.							Total	%
	10-19	20-29	30-39	40-49	50-59	60-69	70-79		
Shorea robusta	2.120	3.386	0.766	-	-	-	-	6.272	16.6
Pinus roxburghii	0.311	2.275	5.489	1.621	0.432	-	-	12.158	32.2
Cedrus deodara	-	0.520	-	-	-	-	-	0.520	1.4
Quercus incana	-	1.338	0.591	0.341	0.358	1.134	-	3.762	10.0
Rest of species	6.802	3.398	4.070	0.309	-	0.415	-	14.994	39.8
Total	9.233	12.917	10.916	2.271	0.820	1.549	-	37.706	
Percentage	24.5	34.5	29.0	6.0	2.2	4.0	-		100

Table No. IV-28

Stems/he. by species and diameter classes

Forest Type: Con. Mixed
with Temp. Hardwood
Raizgarh.

Forest Division - Raizgarh

Species	Diameter Classes in Cm.										Total	%
	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100+		
<i>Pinus roxburghii</i>	15.080	4.118	3.461	0.920	0.639	-	-	-	-	-	24.218	7.0
<i>Pinus excelsa</i>	5.063	2.185	3.506	0.581	0.368	-	-	-	-	0.001	11.709	3.4
<i>Cedrus deodara</i>	8.417	-	0.535	0.161	0.103	-	-	-	-	-	4.216	1.2
<i>Picea morinda</i>	14.294	4.962	2.247	1.598	0.466	0.125	0.138	-	-	0.024	23.844	6.9
<i>Abies pindrow</i>	-	0.814	0.609	0.394	-	-	-	-	-	-	1.814	.5
<i>Quercus incana</i>	46.031	20.099	6.881	2.112	1.429	0.452	0.103	0.104	0.058	0.021	77.290	22.2
<i>Quercus dilatata</i>	19.754	6.166	1.564	0.968	0.544	0.378	0.041	0.033	-	-	29.448	8.5
<i>Quercus semicarpifolia</i>	20.931	11.863	4.724	2.585	0.948	0.499	0.195	0.145	0.028	-	41.918	12.0
<i>Acacia catechu</i>	1.786	-	-	-	-	-	-	-	-	-	1.786	.5
Rest of species	78.279	30.113	11.248	1.849	0.467	0.394	-	-	-	-	131.350	37.8
Total	204.640	89.350	34.775	11.155	4.964	1.848	0.477	0.282	0.086	0.016	37.623	
Percentage	58.9	25.7	10.0	3.2	1.4	.5	.2		.1		100	

Table No. IV-29

Stems/ha. by species and diameter classes

Forest Type: Con. Mixed
with Temp. Hardwood.

Forest Division - Nahan

Species	Diameter classes in Cm.						Total	%
	10-19	20-29	30-39	40-49	50-59	60-69		
<i>Shorea robusta</i>	12.701	11.121	1.003	-	-	-	24.825	12.8
<i>Pinus roxburghii</i>	4.794	18.150	9.181	1.471	0.235	-	33.841	17.4
<i>Cedrus deodara</i>	-	1.592	-	-	-	-	1.592	.8
<i>Quercus incana</i>	-	5.563	1.370	0.329	0.245	0.493	8.000	4.1
<i>Acacia catechu</i>	9.218	0.842	0.707	-	-	-	10.787	5.5
Rest of species	87.204	17.657	9.758	0.379	-	0.155	115.153	59.4
Total	113.917	54.905	22.019	2.179	0.480	0.648	194.148	100
Percentage	58.7	28.3	11.4	1.1	.2	.3		

6. Sal

This forest type occurs mostly in Nahan Forest Division. It occupies only a small area (13 ha.) in Rajgarh Forest Division. The table IV-30 and IV-31 give detail distribution of the volume per hectare of different species in different diameter classes for Rajgarh and Nahan Forest Divisions respectively. The volume per hectare figures of this forest type is 164,358 m³ in Nahan Forest Division. Sal alone constitutes 140,091 m³ per hectare (85.2%) indicating comparatively purer crop of sal. Maximum volume is found in 30-40 cm. diameter class followed by 20-30 cm. diameter class. The table of distribution of stems per hectare, which is given at no. IV-32 the presence of maximum number of trees in diameter classes of 20-30 cm. The trees in the diameter classes 10-20 cm. are lesser than that of 20-30 cm. which indicates that the distribution of stems per hectare is not satisfactory.

Table No. IV-30

FOREST DIVISION - RAJG-RH

VOLUME/HA. BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - SAL

AREA - 13 Ha.

Species	DIAMETER CLASSES IN cm.							Total	%
	10-19	20-29	30-39	40-49	50-59	60-69	70-79		
Shorea robusta	-	20.613	30.523	15.920	-	-	-	66.456	65.0
Rest of species*	11.782	5.509	7.302	-	5.185	-	6.032	35.810	35.0
Total	11.782	25.522	37.825	15.920	5.185	-	6.032	102.266	
Percentage	11.5	25.0	37.0	15.6	5.1	-	5.8	100	

Table No. IV-31

FOREST DIVISION - NARAYVOLUME/Ha. BY SPECIES AND DIAMETER CLASSESFOREST TYPE - SALAREA - 21198 ha.

		<u>DIAMETER CLASSES IN CM.</u>											
		10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100+	Total	%
Shorea robusta	15.800	36.707	41.642	26.577	10.663	4.306	1.054	0.719	0.247	0.376	140.091	85.2	
Rest of species	5.578	5.030	5.819	3.546	2.912	1.505	1.375	0.368	0.254	1.880	24.267	14.8	
Total :	19.378	41.737	45.461	32.123	13.575	5.811	2.429	1.087	0.501	2.256	164.358		
Percentage :	11.8	25.4	27.7	19.5	8.3	3.5	1.5	.7	.3	1.3	100		

Table No. IV -32

FOREST DIVISION - MAHARASHTRA
STATES/H. BY SPECIES AND DIAMETER CLASSES
FOREST TYPE - SAL

Species	DIAMETER CLASSES IN CM.										Total	%
	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100+		
Shorea robusta	90.347	105.546	61.306	24.393	5.608	1.547	0.272	0.143	0.035	0.043	289.238	76.3
Rest of species	45.878	26.842	8.134	3.554	1.695	0.558	0.370	0.067	0.037	0.108	87.243	23.2
Total :	136.225	132.388	69.440	27.947	7.301	2.105	0.642	0.210	0.072	0.151	376.481	
Percentage :	36.2	35.2	18.4	7.4	1.9	.6	.2	.1			100	

Table No. IV-33

STEMS/AI. BY SPECIES AND DIAMETER CLASSES FOREST TYPE - SAL

Species	DIAMETER CLASSES IN Cm.						Total	%
	10-19	20-29	30-39	40-49	50-59	60-69	70-79	
Shorea robusta	-	62.096	40.695	14.088	-	-	-	36.8
Rest of species	151.050	32.274	13.673	-	2.613	-	1.467	63.2
Total	151.050	94.370	54.368	14.088	2.613	-	1.467	317.956
Percentage	4.5	29.7	17.1	4.4	.8	-	.5	100

Oaks

This forest type occurs in Rajgarh and Nahan Forest Divisions. In Rajgarh Forest Division it occurs in a larger area. The important species of oak which are found are Quercus leucotricophora (Syn Q. incana), Q. himalayana (Syn Q. dilatata) and Q. senecioidifolia. There is not much difference in the volume per hectare figures of this forest type in Rajgarh and Nahan Forest Divisions. In Rajgarh Forest Division the volume per hectare figures in this forest type is 92 734 and in Nahan Forest Division it is 97 162. The distribution of volume per hectare of important species in different diameter classes is given in tables IV-34 and IV-35 for Rajgarh and Nahan Forest Divisions respectively. In Nahan Forest Division the important species is banoak. It constitutes about 85% of the total volume while in case of Rajgarh Forest Division, this species forms only 64% of the total volume. Here kharsu and moru oaks are also present. The contribution of kharsu and moru oaks to the total volume is 12.4 and 5.1% respectively. The tables of distribution of stems per hectare (table IV-36 and IV-37) indicate that distribution of stems per hectare in different diameter classes is almost satisfactory. The trees of higher diameter classes are more abundant in Rajgarh Forest Division than in Nahan Forest Division.

Table No. IV-34

Forest Division - Raizach

Forest Type - Oaks

Volume/ha. by species and diameter classes.

Area - 19154 Ha.

Species	Diameter Classes in Cm.										Total	%
	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100+		
<i>Pinus roxburghii</i>	-	-	0.102	0.130	-	-	-	-	-	-	0.232	.3
<i>Pinus excelsa</i>	-	-	0.141	-	-	-	-	-	-	-	0.141	.2
<i>Picea morinda</i>	-	-	0.127	0.159	-	-	-	-	-	-	0.286	.3
<i>Abies pindrow</i>	-	-	0.506	-	-	0.149	0.306	-	0.161	0.164	1.286	1.4
<i>Quercus incana</i>	16.468	13.403	10.025	7.159	5.569	2.640	2.132	0.975	1.119	0.507	59.997	64.7
<i>Quercus dilatata</i>	1.086	0.432	1.235	0.538	-	0.607	0.474	-	0.330	-	4.702	5.1
<i>Quercus semi-carpifolia</i>	0.275	1.497	2.368	3.273	1.697	0.915	0.319	0.323	0.495	0.169	11.531	12.4
Rest of species	4.251	3.902	3.035	1.600	1.126	0.377	0.268	-	-	-	14.559	15.6
Total	22.080	19.234	17.539	12.859	8.592	4.688	3.499	1.288	2.105	0.840	92.734	-
Percentage	23.8	20.7	18.9	13.9	9.3	5.1	3.8	1.4	2.3	.8	100	-

Table No. IV-35

FOREST DIVISION - MALAY

FOREST TYPE - OMB

AREA - 866 ha.

Species	DIAMETER CLASSES IN Cm.										Total	%
	10-19	20-29	29-39	40-49	50-59	60-69	70-79	80-89	90-99	100+		
<i>Pinus roxburghii</i>	-	-	-	1.943	-	-	-	-	-	-	1.943	2.0
<i>Quercus incana</i>	25.403	17.704	15.245	12.344	4.820	-	1.739	-	1.825	-	82.986	85.4
Rest of species	2.144	4.696	2.407	1.398	1.588	-	-	-	-	-	12.233	12.6
Total :	27.553	22.400	21.652	15.585	6.408	-	1.1739	-	1.825	-	97.162	
Percentage :	28.4	23.1	22.3	15.9	6.602	-	1.353	-	1.925	-	100	100

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Table No. IV - 36

Forest Type : Oaks.

Forest Division - Raigach

Stems/ha. by species and diameter classes.

Species	Diameter Classes in Cm.										Total	%
	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100+		
<i>Mnus roxburghii</i>	-	-	0.176	0.090	-	-	-	-	-	-	0.266	.1
<i>Mnus excelsa</i>	-	-	0.126	-	-	-	-	-	-	-	0.126	0.0
<i>Nicea morinda</i>	-	-	0.126	0.080	-	-	-	-	-	-	0.206	.1
<i>Alnus pindrow</i>	-	-	0.553	-	-	0.041	0.070	-	0.023	0.019	0.706	.2
<i>Quercus incana</i>	178.230	53.822	13.292	7.062	3.397	1.053	0.627	0.210	0.188	0.066	265.947	70.3
<i>Quercus dilatata</i>	9.420	1.195	1.662	0.431	-	0.197	0.103	-	0.044	-	13.055	3.4
<i>Quercus semicarpifolia</i>	2.387	4.253	5.040	2.422	0.860	0.283	0.063	0.055	0.065	0.016	13.444	3.5
Rest of species	54.494	21.547	6.309	1.517	0.669	0.138	0.071	-	-	-	84.745	22.4
Total	244.531	83.617	30.284	11.605	4.926	1.712	0.934	0.265	0.320	0.101	378.495	
Percentage	64.6	22.1	8.0	3.1	1.3	.5	.2	.1	.1	.1		100

Table No. IV-37

FOREST DIVISION - MAHA

BT'S/HA. BY SPECIES AND DIAMETER CLASSES FOREST TYPE - OAKS

Species	DIAMETER CLASSES IN CM.										FOREST TYPE - OAKS		
	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100+	Total	%	%
Pinus roxburghii	-	-	-	1.281	-	-	-	-	-	-	1.281	.3	
Quercus incana	274.985	76.489	34.620	11.082	3.037	-	0.544	-	0.333	-	401.090	87.0	
Rest of species	27.487	23.745	4.619	1.604	1.132	-	-	-	-	-	58.587	12.7	
Total :	302.472	100.234	39.239	13.967	4.169	-	0.544	-	0.333	-	460.958		55
Percentage :	65.6	21.8	8.5	3.0	.9	-	.1	-	.1	-		100	54

This forest type is constituted by amalgamating various types already discussed in Chapter -II. The volume per hectare figures in this forest type is almost the same, both for Rajgarh and Nahan Forest Divisions. It is 43.240 cubic metre per hectare for Rajgarh Forest Divisions and 42.143 cubic metre per hectare for Nahan Forest Division. Table No IV-38 and IV-39 give the distribution of volume per hectare figures of important species in different diameter classes for Rajgarh and Nahan Forest Divisions respectively. The distribution of stems per hectare of important species under different diameter classes is given in table no IV-40 and IV-41 respectively for Rajgarh and Nahan Forest Divisions.

Table No. IV-38

FOREST DIVISION - RAJGARH

VOLUME/HA. BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - OTHERS (REST OF SPECIES)

AREA - 20508 ha.

Species	DIAMETER CLASSES IN Cm.										FOREST TYPE - OTHERS (REST OF SPECIES)	
	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100+	Total	%
<i>Pinus roxburghii</i>	-	0.122	0.144	0.180	0.100	0.106	-	-	-	-	0.652	1.5
<i>Quercus incana</i>	0.325	0.563	0.524	0.507	0.380	0.401	0.248	0.340	0.608	0.540	4.436	10.3
<i>Quercus dilatata</i>	1.129	0.526	0.433	0.386	0.517	0.216	0.221	0.112	0.116	-	3.656	8.5
<i>Quercus semicarpifolia</i>	0.315	0.354	-	-	-	-	-	-	-	-	0.669	1.5
Rest of species	16.002	9.530	4.365	1.304	0.863	1.145	0.188	0.097	-	0.330	33.627	78.2
Total :	17.771	11.095	5.466	2.377	1.863	1.868	0.657	0.549	0.724	0.870	43.240	
Percentage:	41.1	25.7	12.6	5.5	4.3	4.3	1.5	1.3	1.7	2.0		100

Table No. IV-39.

FOREST DIVISION - NAIAN

VOLUME/HA. BY SPECIES AND DIAMETER CLASSES FOREST TYPE - OTHERS (REST OF SPECIES)
 AREA - 34495 ha.

Species	DIAMETER CLASSES IN Cm.										Total	%
	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100+		
Shorea robusta	1.217	0.698	0.498	0.149	-	-	-	-	-	-	2.562	6.1
Pinus roxburghii	-	0.054	0.073	-	-	-	-	-	-	-	0.127	.3
Rest of species	12.167	10.076	6.661	5.199	2.670	1.023	0.580	0.265	0.093	0.720	39.454	93.6
Total :	13.384	10.828	7.232	5.348	2.670	1.023	0.580	0.265	0.093	0.720	42.143	
Percentage:	31.8	25.7	17.2	12.7	6.3	2.4	1.4	.6	.2	1.7		100

TABLE NO. IV-40.

FOREST DIVISION - RAJG-RH

STEMS/HA, BY SPECIES AND DIAMETER CLASSES FOREST TYPE- OTHERS

Species	DIAMETER CLASSES IN CM.										Total	%
	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100+		
Pinus roxburghii	-	0.343	0.247	0.132	0.044	0.035	-	-	-	-	00.801	.3
Quercus incana	3.513	2.392	0.911	0.458	0.243	0.163	0.077	0.076	0.105	0.058	7.996	2.6
Quercus dilatata	9.795	1.473	0.576	0.263	0.212	0.061	0.050	0.021	0.015	-	12.466	4.1
Quercus semicarpifolia	2.733	1.230	-	-	-	-	-	-	-	-	4.023	1.3
Acacia catechu	3.616	-	0.131	-	-	-	-	-	-	-	3.747	1.2
Rest of species	212.530	52.036	9.661	1.228	0.516	0.416	0.049	0.021	-	0.033	276.910	90.5
Total :	232.257	57.584	11.746	2.181	1.015	0.675	0.176	0.118	0.120	0.091	305.943	
Percentage :	75.9	18.8	3.9	.7	.3	.2	.1				100	

Table No. IV-41.

FOREST DIVISION -- MIHAN

STEMS/HA. BY SPECIES AND DIAMETER CLASSES

FOREST TYPE -- OTHERS

Species	Diameter classes in cms.										Total
	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100+	
Shorea robusta	6.855	2.020	0.787	0.136	-	-	-	-	-	-	9.728 3.7
Pinus roxburghii	-	0.152	0.079	-	-	-	-	-	-	-	0.231 .1
Acacia catechu	14.641	2.141	0.230	0.075	0.089	-	-	-	-	-	17.176 6.5
Rest of species	161.036	54.931	14.105	5.300	1.589	0.369	0.162	0.052	0.013	0.051	237.668 89.7
Total :	182.512	59.304	15.151	5.511	1.678	0.369	0.162	0.052	0.013	0.051	264.603 68
Percentage :	68.9	22.4	5.7	2.1	.6	.2		.1			100

RATE OF GROWTH

Chir

On the basis of data collected during the survey the diameter-height relationship of Chir has been worked out and is given in table no.IV-42.

Table No.IV-42

AGE/HEIGHT AND DIAMETER RELATIONSHIP FOR CHIR

S.No.	Age	Corresponding height in m.	Corresponding diameter in cm.
1.	10	5.8	6.0
2.	20	8.3	11.5
3.	30	10.8	17.2
4.	40	13.3	22.8
5.	50	16.8	28.3
6.	60	18.3	33.6
7.	70	20.6	39.0
8.	80	22.7	44.3
9.	90	24.5	49.6
10.	1000	25.4	54.4
11.	110	26.2	58.7
12.	120	26.8	62.3
13.	130	27.1	65.0
14.	140	27.4	66.3
15.	150	27.6	67.2

The rate of growth of chir was studied by increment borings as well as by collection of felled tree data. The increment percent as worked out from increment borings in terms of annual increment percent in basal area is given in table no.IV-43.

Table No. IV-43

Item	Formulae used	Diameter in cm.					
		15	25	35	45	55	65
Last 10 years	$\frac{D_0^2 - D_2^2}{D_0^2} \times 10$	4.56	3.75	2.69	2.26	1.99	1.56
Previous 10 years	$\frac{D_2^2 - D_3^2}{D_2^2} \times 10$	6.66	4.60	3.24	2.35	2.13	1.48
Previous to previous 10 years	$\frac{D_3^2 - D_4^2}{D_3^2} \times 10$	5.21	5.03	3.25	2.88	2.38	2.04

Whereas :

- D_1 = Diameter over bark at breast height.
- D_0 = Diameter under bark at breast height.
- D_2 = $D_0 - 2$ (last 10 years increment).
- D_3 = $D_0 - 2$ (last 20 years increment).
- D_4 = $D_0 - 2$ (last 30 years increment).

In this table the percentage diameter increment has been worked out for the last 10 years, previous 10 years and previous to previous 10 years. The formulae used have also been indicated in the above table.

The figures of growth percentage in basal area as indicated above can be safely assumed as the growth percent in volume. On this basis the volume increment of chir has been worked out taking into consideration the number of stems per hectare in each diameter class and is given in table no. IV-44.

Table No. IV-44

PERIODICAL INCREMENT OF CHIR

Diameter class.	For the last 10 years.	For the previous 10 years.	f. For the previous to previous 10 years
10-20	0.342	0.516	0.384
20-30	0.512	0.655	0.683
30-40	0.441	0.526	0.526
40-50	0.323	0.332	0.412
50-60	0.115	0.125	0.138
60-70	0.038	0.037	0.051
Total:	1.777	2.191	2.194

Other conifers species :

From the table of volume per hectare and stems per hectare of different species, the mean age of the crop has been worked out, taking into consideration the mean age of the diameter which has got the maximum number of stems per hectare. The mean age of other species has been worked out on the basis of Preinvestment Survey of Reports of Uttarkashi area (Uttar Pradesh).

Table No. IV-45

MEAN AGE OF THE CROP

Species	Diameter class which has got the maximum No. of stems/ha. (cm.)	Diameter class which has got the maximum volume/ha. (cm.)	Mean age of the crop.
Chir	10-20	40-50	28
Deodar	10-20	50-60	42
Oaks	10-20	10-20	30
Sal	20-30	30-40	18

Mean annual increment calculated on the basis of mean age and volume per hectare for chir, deodar, oaks and sal in their respective forest types is approximated as under :-

Table No. IV-46

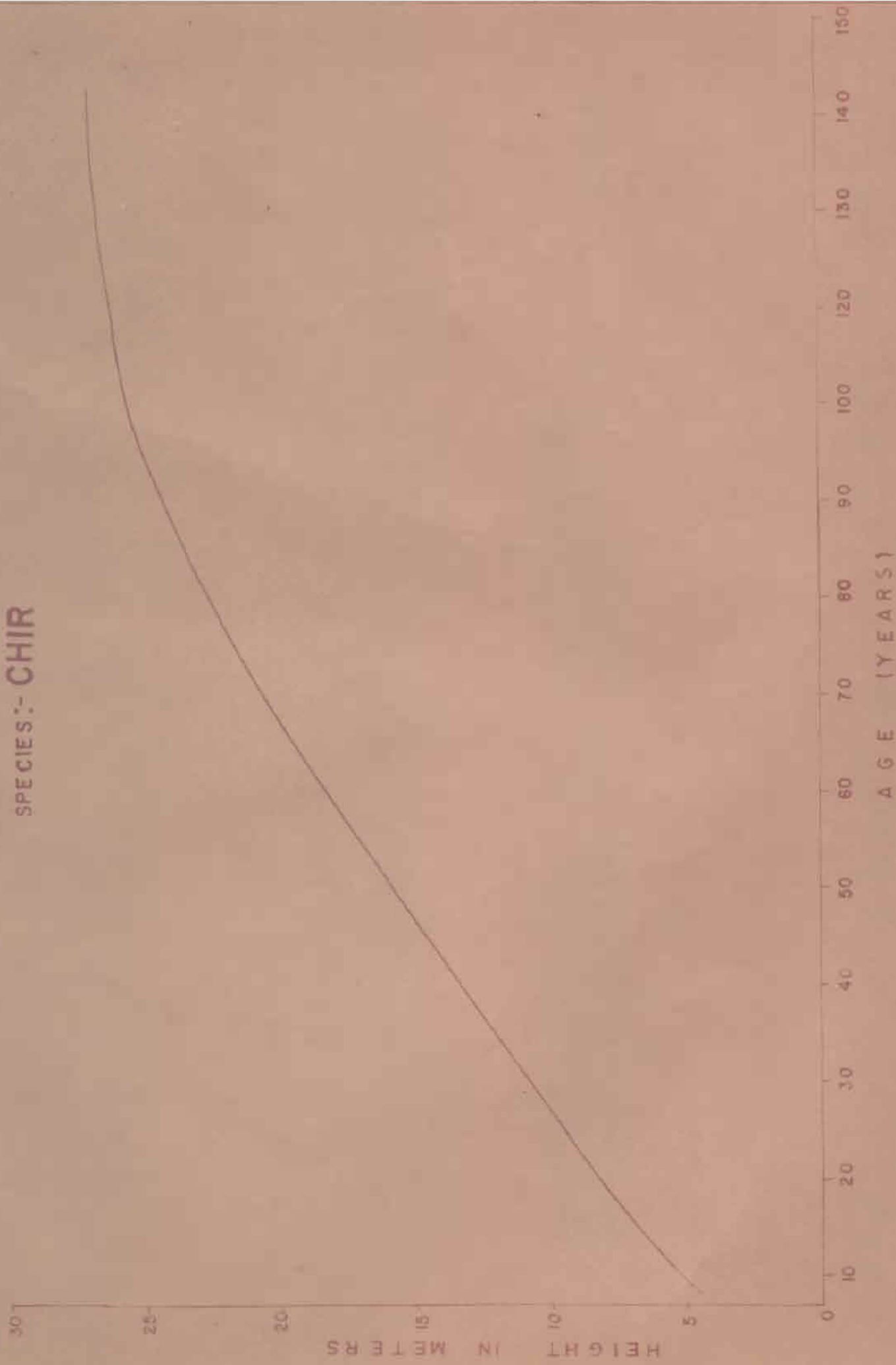
MEAN AGE AND MEAN ANNUAL INCREMENT OF IMPORTANT SPECIES

Species	Mean age	Mean Annual Increment in m ³ /ha.
Chir	26	1.508
Deodar	42	3.105
Oaks	30	2.541
Sal	48	2.918

The average annual increment of chir as calculated on the basis of increment borings works out to 2.054 cubic meters per hectare. To be on safer side the increment value as obtained in table no. IV-46 may be adopted for further calculations.

Rajgarh — Nahar,
AGE/DIAMETER RELATION

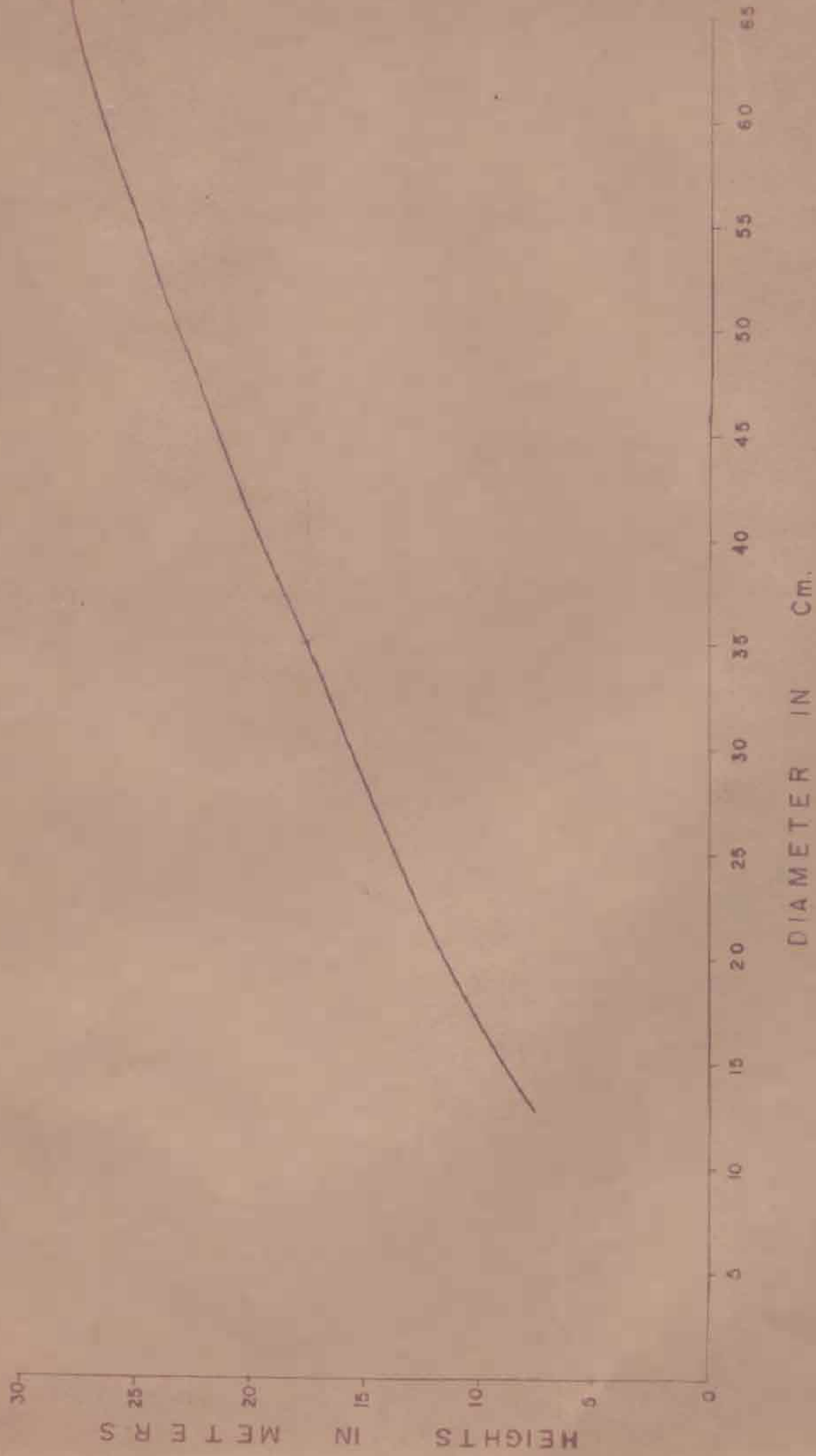
SPECIES:- CHIR



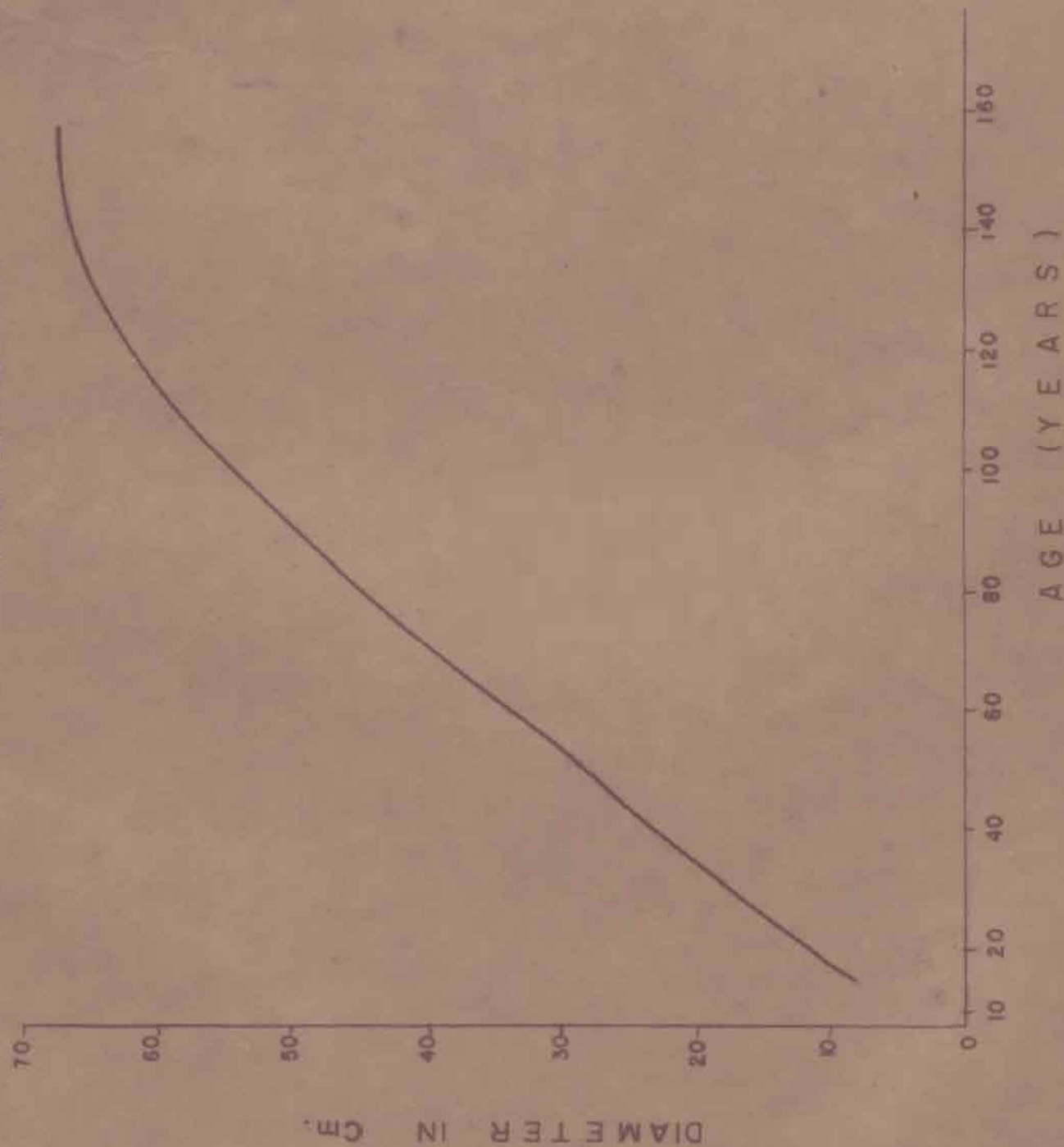
Rajgarh - Nahar.

DIA/HEIGHT RELATION

SPECIES:- CHIR



Rajgarh — Nahar
AGE/DIAMETER RELATION
SPECIES:- CHIR



CHAPTER - V.

PRESENT MANAGEMENT AND FUTURE PROPOSALS

The objects of the present management of the forests in the area are :-

- 1) to preserve and improve the vegetational cover all over the area so as to prevent denudation and erosion in hill slopes and conserve soil and moisture,
- 2) to cover blank hill sides with tree covers and replace the inferior misc. patches with suitable and important species,
- 3) to provide for bona fide domestic and agricultural requirement of wood by local population for timber, fuel-wood, grass, grazing and minor forest products,
- 4) to bring about the normal distribution of age-classes and establish normal regeneration,
- 5) to arrest soil erosion by afforestation and other soil conservation measures,
- 6) consistent with the above to obtain maximum annual yield in perpetuity of various forest products such as timber, fuel-wood, grass, bamboo etc.

Thus present management emphasises on production of forest produce which are required for meeting the demand of local population and increase annual yield in terms of large size timber (Sloepors) alongwith some forest conservation objectives. In order to achieve the objectives mentioned above, the management practices for different forest areas as adopted in current working plans are summarised in table no. IV-1.

Table No. V-1

Name of working Circle.	Important species	Silvicultural system adopted.
1	2	3
<u>RAIGARH FOREST DIVISION</u>		
Deodar Working Circle.	Deodar and kail with some percentage of fir and spruce in certain areas.	This circle includes all pure mixed forests of deodar and kail with the exception of few isolated patches. These forests have been managed under irregular shelterwood system with floating periodic blocks. Certain areas which have been found suitable for raising deodar and kail plantations have also been included to manage under this working circle. Regeneration is usually achieved naturally but artificial regeneration in certain areas may also be carried out. Regeneration period is about 30 years with a rotation of 150 years.
Chir Working Circle.	Chir with some amount of ban oak and broad leaved species.	The silvicultural system adopted for Chir forests is Punjab Shelterwood system with fixed periodic blocks. The period of regeneration adopted is 30 years with a rotation of 120 years. There is emphasis on achieving natural regeneration. If natural regeneration fails, artificial regeneration is adopted.
Selection Working Circle.	This working circle includes all the fir and spruce forests, oak forests and some broad leaved forests.	The silvicultural system adopted for the management of these forests is selection system. The exploitable size is fixed at 60 cm. with felling cycle of 15 years. There is emphasis on obtaining natural regeneration but artificial regeneration of important species can be undertaken where it is required.
Protection Working Circle.	The forests occurring along precipitous slopes in temperate zone usually covered with oaks and conifers. Along Giri river on lower elevations the forests of khair and sissoo are also managed under this working circle.	The objects of management in this working circle is to protect the hill sides against further erosion and conserve the area which is badly eroded to improve soil and water regime of the area. In these forests no felling is prescribed.

Name of working Circle.	Important species	Silvicultural system adopted.
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NAHAN FOREST DIVISION

Soil conservation Working Circle.	This working circle comprises of almost pure sal crop.	The silvicultural system adopted for the management of these forests is modified uniform system with fixed periodic blocks. Natural regeneration has to be obtained and conditions favourable to its establishment is to be created. Advance growth etc. is retained to form future crop. The conversion period adopted for the conversion of this area is 125 years. Regeneration is aimed to be obtained by natural methods, but artificial method may be adopted in areas where it is difficult to obtain regeneration naturally.
Selection Working Circle.	Sal mixed with forests of sain, khair, chir, tandu, amalash, Zhingar etc.	The silvicultural system adopted is selection-cum-improvement fellings. The aim is to grow species which are the best suited to a particular locality. Important and valuable species are given preference over less important species. The selection diameter is fixed for different species. The selection diameter is 10 cm. for sal, shisham and sain, 60 cm. for chir, 30 cm. for khair and 40 cm. for other chhal species. The felling cycle is fixed at 10 years.
Protection Working Circle	The forests situated on broken and eroded siwaliks, bamboo bearing forest of steep and precipitous areas. Species such as chir, sal, ban oak are also found in better areas.	Most of the areas in this working circle are badly eroded. Therefore the object is to improve the vegetative cover by protecting the existing vegetation and improving it by resorting of sowings and plantings of various species. Felling is usually not prescribed. Grazing etc. is also prohibited.

Name of working circle.	Important species	Silvicultural system adopted
Plantation Working Circle		The working circle overlaps with sal conversion, selection and protection working circles. The objects of the management of this circle are to obtain the existing plantation of various species and to raise plantation of important species. The silvicultural system adopted has clear felling with artificial plantations. The species selected for plantation are deodar, walnut, Bauhiana Sisham, chhal and Eucalyptus.
Bamboo Working Circle	Main species is Dendrocalamus strictus	These forests are managed under selection-cum-improvement follings. Three years felling cycle is usually adopted.

From the present objectives of the management, it is clear that present system of management of the forests are designed with a view to producing large size trees for production of logs and sleepers and various structural timbers. The forests situated in areas where terrain is difficult are generally worked for obtaining efficient soil conservation. The forests situated in higher and interior hills are also managed under this system. These forests can be exploited if our logging techniques are improved.

FUTURE PROPOSALS

The large size timber required for the production of railway sleepers and other structural timbers may continue to be in demand for long time. Therefore, some of these forests may be required to be managed with a view to producing large size timbers. Recently there has been a consistent demand for industrial woods. The main object of taking of this work was to work out the existing growing stock of coniferous species particularly of chir which is important species of the area from the industrial point of view. Therefore existing growing stock of chir along with the information of the area which may be brought under chir plantation is desired. The data collected for this purpose may not be enough to give a complete idea of various areas which are suitable or otherwise for raising chir plantation. The whole area which is understocked or is under degraded forests, scrub lands, grass lands etc. may be selected for undertaking plantation of chir, if such areas occur in the suitable altitudinal zone of this species. For areas below 1000 metres selection of other species might be necessary. The selection of species in lower areas (below 1000 metres) will depend upon various edaphic factors.

ANNUAL YIELD

Annual yield is a function of growing stock, rate of growth, rotation, management of systems and several other factors. These factors are being examined in the subsequent paragraphs.

Growing Stock:

The growing stock of important species has already been worked out in Chapter-IV and is being reproduced below in table V-2.

Table No. V-2

GROSS AND NET GROWING STOCK OF IMPORTANT SPECIES

Species	Gross Growing stock in 000 m ³ .	Net growing stock in 000 m ³ .
Chir	959.669	959.669
Kail	101.747	101.747
Deodar	304.645	304.645
Mixed conifers	186.681	168.012
Ban oak	1591.776	1353.008
Moru Oak	279.381	237.473
Kharsu	465.932	396.042
Sal	3479.212	3479.230
Others	3577.613	3577.613
Total:	10946.656	10577.439

Rate of growth:

The Mean Annual Increment of important species in their respective forest types has been worked out on the basis of mean age of the crop. The figures of Mean Annual Increment of important species is given in table V-3.

Table No. V-3

MEAN ANNUAL INCREMENT OF IMPORTANT SPECIES

Species	M.A. I. in m ³ /ha.
Chir	1.508
Deodar	3.105
Oaks	2.541
Sal	2.918

Rotation:

Taking into consideration the present system of management, the growing stock, rate of growth and utilization pattern, the rotation of important species has been decided. Deodar is an important structural timber species and is proposed to be managed to produce logs, which may meet the requirement of structural grade further. Chir an important species of the area is proposed to be managed for the production of logs suitable to yield fruit packing cases. Trees with 40 cm. diameter at breast height over bark are supposed to be sufficient to yield material required for packing cases. In the survey area, chir attains a diameter of 40 cm. approximately at the age of 72 years. Chir trees of the diameter class 40-50 cm. yield maximum amount of resin which is an important produce and yields substantial revenue, sometimes greater than the timber value of the crop. It is proposed to adopt a rotation of 80 years for the chir crop in the area. Fir and spruce occur in comparatively smaller area. These species may be managed under a rotation of 150 years in order to produce sleepers etc. Sal is primarily used for the production of structural timbers, railway sleepers etc. A rotation of 120 years is supposed to be good enough for the production of structural material.

Thus the rotations of important species as adopted in the proposed management is indicated in table No. V-4.

Table No. V-4
ROTATION OF IMPORTANT SPECIES

<u>Species</u>	<u>Proposed rotation in years</u>
Chir	80
Deodar	120
Fir-Spruce	150
Oaks	100
Sal	100

Annual Yield:

Annual yield of important species may be regulated by the following formula:

$$\text{Annual Yield} = \frac{\text{Total growing stock}}{\text{Rotation}} + \frac{\frac{1}{2} \text{ MAI of the crop}}{\text{Rotation}}$$

The annual yield of different species under proposed management works out as under:-

Table No. V-5
ANNUAL YIELD OF IMPORTANT SPECIES

S.No.	Species	Yield in cubic metres
1.	Chir	27400
2.	Deodar	3200
3.	Mixed conifers (mainly fir & spruce)	1900
4.	Oaks	45300
5.	Sal	65700

The annual cut from other forests has not been calculated as these may be required to meet the requirement of the local population and for meeting their domestic requirements.

Chir is an important industrial species. It yields timber required for packing cases, paper and pulp and various other industrial purposes. Attempts are required to be made for raising large scale plantation of chir in the areas which lie in its altitudinal zones. This species may be planted up in the following types of areas:

1. Poorly stocked forests.
2. Scrub lands
3. Pasture and grass lands.

The area under this land use class has been worked out by total interpretation and is given in table No. V-6.

Table No. V-6
TOTAL AREA UNDER DIFFERENT LAND USE CLASSES AVAILABLE FOR RAISING CHIR PLANTATION.

Land use class	Area in hectares
Poorly stocked forests	18,825
Scrub lands	19,057
Pasture and grass lands	33,366
Barron land	1,608

All the areas under different land use classes as mentioned above may not be found suitable for raising chir plantation because of the presence of various adverse edaphic and topographical factors such as shallow soil depth/zone of root penetration, precipitious slopes etc. The soil depth was studied on each sample plot of inventory and results indicate that about 65 to 75% of the sample plots fell on the soils having more than 30 cm. soil depth.

CHAPTER - VI

DEMAND STUDY

1. OBJECTIVES

The main objectives of the demand study were :

- (1) to estimate the present wood consumption by local population and industries;
- (2) to forecast the level of wood consumption for the year 1981 and 1991.

2. WOOD CONSUMPTION

The consumption of wood by local population and industries has been estimated by collecting actual information. The estimate of consumption has been made by recognising the following categories of wood utilization :-

(1) Wood utilization by local population

- (a) House construction and repairs;
- (b) Agricultural implements;
- (c) Fuel.

(2) Wood utilization by industries

- (a) Packing cases industries;
- (b) Furniture industries;
- (c) Other industries.

(3) Wood utilization by Government Departments and Organisations.

Wood consumption by local people :

Local population consume wood for construction and repairs of houses, agricultural implements and for fuel. Faster scientific development and mechanization in the various fields have changed the requirement of many commodities but it has not been able to relegate the importance of wood in the use of man-kind. The area being rich in forests, local population enjoy sufficient rights and concessions for felling extraction for the timber from the forests in order to meet their domestic requirements. In the construction and repair of houses, wood is very important material. Other building materials such as bricks, cement etc, are not popular because of the easy availability of wood. For fuel, timber is the cheapest material. Thus wood remains the main item in the construction and repairs of houses, agricultural implements and fuel wood in the area. Wood is also used in fencing of the fields and houses. Large number domestic and agricultural implements are wooden.

3. WOOD CONSUMPTION FOR HOUSE CONSTRUCTIONS AND REPAIRS:

House types are generally influenced by climate, economic conditions and local customs of the people. The general technical characteristic of house constructions in India is indicated in table No. VI-1.

Table No. VI-1

TECHNICAL CHARACTERISTICS OF HOUSE CONSTRUCTION IN INDIA

Plinth area	Mud	Timber bamboo reed,	Brick cement stone	Others	
All rural areas	84.5%	2.7%	12.3%	0.5%	
All urban areas	44.3%	1.7%	53.3%	0.7%	
Cities	20.2%	0.9%	78.0%	0.9%	
Wall area	Mud bamboo	Timber wood OF sheets	Brick cement concrete	Others	
All rural areas	83.2%	0.9%	15.5%	0.4%	
All urban areas	42.1%	2.0%	55.2%	0.7%	
Cities	21.7%	6.0%	78.1%	0.2%	
Roof	Straw, grass thatches, bamboo reed	Corrugated sheets asbestos sheets tile	Cement concrete	Brick in Mortar etc.	Others
All rural areas	69.6%	23.5%	1.7%	2.4%	2.8%
All urban areas	32.9%	33.6%	19.2%	10.3%	4.0%
Cities	14.5%	27.2%	43.5%	12.5%	2.3%

In the area under study, technical characteristics of the houses are different than those discussed above. In the hills generally two storey houses are constructed. The upper storey is used for the purpose of their own living and ground storey is used for housing their cattle etc. In plains however no such distinction has been observed. The common material used in the walls is stones and boulders reinforced by timber. The reinforcement is done horizontally and vertically. Timber is commonly used in flooring of the top storey. All other members such as doors, windows, ridges, crossers, rafters, wall plates etc. are wooden. The roofing material commonly used are slates, tin sheets etc.

A sample survey was conducted in the area in order to find out exact quantity of wood used in the construction of new houses and repairs of old houses.

Analysis of data obtained from sample survey has revealed that the quantity of wood consumption for construction of houses in area is about 15.5 m³ per house. As per 1971 census, there are 59933 houses in the area. The number of houses in the year 1961 were 37082. This shows that about 210 houses were constructed annually. The average life of a house is estimated to about 50 years and major repairs are undertaken at an interval of 10 years. This shows that about 5% of the houses will need repairs every year. The quantity of wood required for the purpose of repairs of old houses is estimated to about 10% of the quantity required for the construction of new houses. The number of houses during 1974-75 is

estimated to about 40825 and the number of houses requiring major repairs during this year is 2041. Therefore the quantity of timber required for construction and repairs of houses of the area is given in table no. VI-2.

Table No. VI-2

WOOD CONSUMPTION FOR HOUSE CONSTRUCTION & REPAIRS

S.No.	Item No.	No. of houses	Quantity of timber - required in m ³	Total consumption of timber in m ³
1.	Construction of new houses.	210	15.5	3255.00
2.	Repair of houses	2041.	1.55	3163.55
	Total	2251	17.05	6418.55

The survey has revealed that the important species which are used for house construction and repairs are chir, deodar, sal and other broad leaved species. The consumption of deodar is limited in higher areas while chir is utilized for most of the area. Sal is used mostly in Paonta-Valley of Nahar area. The percentage of these species is approximated 40% chir, 15% deodar, 25% sal and 20% other broad leaved species. Thus species-wise consumption for the purpose of house construction and repairs works out as under :-

1. Chir	-	2567.40
2. Deodar	-	962.80
3. Sal	-	1604.60
4. Other broad leaved species.	-	1283.75
Total :	-	6418.55

4. WOOD CONSUMPTION FOR AGRICULTURAL IMPLEMENTS:

The main occupation of the people is agriculture. The agricultural implements such as plough, carts, sugar cane crushers and other irrigation implements are quite common. In spite of the extension of agricultural facilities, the improvement in the agricultural implements has not been very common in smaller villages. The wooden plough still remains the important agricultural implements in the entire survey area except for the Paonta Valley where tractors are also used. The number of agricultural implements during different years of the survey has been found in the table VI-3.

Table No. VI-3

NUMBER OF AGRICULTURAL IMPLEMENTS IN THE AREA

S.No.	Item	Y e a r s				
		1951	1956	1961	1966	1971
1.	Plough	26118	28932	31005	37273	40112
2.	Bullock carts	1134	1297	1405	1249	1358
3.	Sugar cane crushers	231	244	534	506	566
4.	Levellers	-	-	1134	1435	1500
Total :		27483	30473	34078	40463	43536

Most of the requirement of the wood for construction and repair of these agricultural implements are met by the forests. The quantity of timber required for making these implements is worked out as under :-

Table No. VI-4

QUANTITY OF WOOD REQUIRED FOR AGRICULTURAL IMPLEMENTS

S.No.	Item	Total no. of imple-ments.	Life of an impl-ement (In years)	Annual require-ment of A.I.	Quantity of timber required for one unit in m ³	Total require-ment in m ³
1.	Plough	40112	2	20056	0.14	2807.80
2.	Bullock carts	1358	5	272	0.50	136.00
3.	Sugar cane crushers	566	2	283	0.50	141.50
4.	Levellers	1500	2	750	0.15	112.50
Total :		43536		21361		3197.80

The species which are usually used for this purpose are chir, deodar, sal and other broad leaved species. The percentage of these species is approximately 15, 10, 25 and 50 percent respectively. Therefore, the quantity of chir, deodar, sal and other broad leaved species works out as under :-

Chir	-	479.70 m ³
Deodar	-	319.80 m ³
Sal	-	799.40 m ³
Other broad leaved spp.	-	1599.90 m ³
Total :	-	3198.80 m ³

FUEL CONSUMPTION

Wood is combustible material and a well known source of heat. It serves the purpose of domestic fuel as well as of industrial fuel. The share of commercial fuel in rural India is very little. According to the survey conducted by National Council of Applied Economic Research, the total consumption of commercial fuel in rural India is hardly 5.5%. The non-commercial wood such as fire-wood, bagasse, saw mill waste, vegetable waste, cow-dung etc. are largely used. The percentage consumption of different non-commercial fuel for Himachal area as worked out by National Council of Applied Economic Research is given in table VI-5.

Table No. VI-5

PERCENTAGE OF VARIOUS NON-COMMERCIAL FUELS

S.No.	Fuel	Percentage
1.	Firewood	73.0
2.-	Dung cake	20.0
3.	Charcoal	0.2
4.	Vegetable waste	6.8
Total		100

The area consists of mostly hills with altitudes ranging from 700 metres to 4,000 metres. The winter is severe and large amount of timber is used for keeping the houses warm. The use of charcoal is very little and limited only in towns like Nahan, Paonta, Dadahu, Rajgarh and Sarahan etc. The rural population is mostly dependent upon the wood.

Sample survey conducted in the area in order to find out the per capita consumption of wood has revealed that the per capita annual consumption of fuelwood in the area is 550 kg. Therefore, present annual consumption of firewood works out as under :-

1. Total population in the area	=	245033
2. Per capita consumption	=	550 kg.
3. Total consumption	=	134768 tonnes

The removal of firewood from the forests consists of almost all available forest species. It includes lops and tops, branchwood and unextracted material from the working coupes of the Forest Department. The broad leaved species in the coniferous forests such as oaks and other misc. species which have no market value as a structural timber are usually used for this purpose. The coniferous species such as chir, deodar etc. are not generally utilised for fuelwood because the material is used for the production of pulp and almost all available timber is transported to Yamna nagar for pulping Gopal Paper Mills. Large proportion of quantity calculated above is obtained from the trees growing on the private lands. Thus total fuelwood consumption as calculated above may not necessarily affect the wood balances. The charcoal which is converted out of fuelwood in the area is mostly exported outside the area to the plains of Punjab and Haryana.

WOOD CONSUMPTION BY INDUSTRIES:

There are no major wood based industries in the area. The important wood consuming industries in the area are :-

- 1) Packing case Industry,
- 2) Furniture Industry,
- 3) Other Departments.

There are about 40 saw mills which are mostly engaged in sawing, structural timber as well as material for packing cases. The number of saw mills in Nahar Forest Division is larger than Rajgarh Forest Division. The sawn material from the saw mills is largely utilised for construction and repair of houses, for making of fruit packing cases and in furniture industry. It is observed that about 50% of the out-turn from various saw mills is utilised for construction and repair of houses. But in certain cases packing cases are of greater importance and more than 75% of the end product is meant for packing cases. The saw mills are usually small mostly having one hand saw. The vertical band saws are the most common machine used in the area. Saw mills are generally small mostly with 42" pulley size and all sorts of sawing is done with the same machine. The common size of the blade being used in the machine is 7-10 cm. wide and about 20-21 gauge thick. The out-turn of these machines usually varies from about 2 m³ to 4 m³ per day. Except during certain months, the saw mills do not run to their fullest capacity.

These saw mills usually convert the timber brought from the Government forests as well as from private holdings. About one fourth of the timber is brought from the private holdings for sawing.

A saw mill is not a wood consuming industry in itself. The sawn material is used mainly for the following purposes:

- 1) House construction and repairs
- 2) Furniture industry
- 3) Packing case industry
- 4) Other small scale industries.

The consumption of sawn wood for the purpose of house construction and repairs has already been taken into account while working out the wood requirement for this purpose.

Furniture making industry: There are 28 furniture making industries in the area. There may be number of individual carpenters who are engaged in making of various types of furniture, but these have been excluded. Almost all these units have been visited and the consumption of wood has been ascertained. The species-wise break up of the total quantity of wood consumed by these units is given in the Table VI-6.

Table No. VI-6

CONSUMPTION OF WOOD BY FURNITURE MAKING UNITS

Species	Consumption in cubic metres
Deodar	150.00
Kail	52.00
Chir	60.00
Sal	120.00
Sissoo	45.00
Teak (Import)	30.00
Other species	55.00
Total	512.00

Packing Case making industry :- The situation and climate of the area make it suitable for the development of horticulture. A fruit growing belt has already developed around Rajgarh area. Most of the area is under apple cultivation. Total area under orchards is reported to be 5216 hectares. Taking an average annual yield of about 2.0 tonne per hectare, total production of fruits during 1974-75 works out to 10432 tonnes or about 521600 boxes of 20 kg. each. The requirement of timber for packing cases for a box is about 0.015 cubic metres. Thus total requirement of timber for packing cases is 7824.0. The demand of fruit packing cases is seasonal and many times local saw mills are not able to meet the demands of the boxes of local orchardists and these are brought from adjoining area. Most common timber used in the packing case is chir. The other species used are kail, fir, spruce and other species. The species-wise distribution of these species is approximated as 60%, 5%, 10%, 10% and 15% respectively of chir, kail, fir, spruce and other species. The annual consumption of these species for this purpose works out to 4695.00 m³ for chir, 391.0 m³ for kail, 782.0 m³ for fir, 782.0 m³ for spruce and 1174.0 m³ for other species.

WOOD CONSUMPTION BY GOVT. DEPARTMENTS:

Certain quantity of timber is used by existing Government Departments including Forest Department. The supply of timber for the year 1973-74 to various departments as reported by the office of the Divisional Forest Officers is indicated in table no. VI-7.

Table No. VI-7

SUPPLY OF TIMBER TO OTHER DEPARTMENT

Govt. Departments	Quantity of timber used in m ³				
	Sal	Chir	Deodar	Others	Total
Public Works Deptt.	23.0	18.20	28.00	43.60	112.8
Electricity Board Himachal Pradesh.	41.8	-	15.0	-	56.8
Forest Department	23.50	19.50	21.60	12.80	77.7
Other Departments	18.00	38.00	18.70	8.50	83.2
Railways	-	189.20	-	17.25	206.45
D.G.S. & D.	-	236.30	-	-	236.30
Total :	106.60	501.20	83.30	82.15	773.25

Supply to timber markets :- Most of the timber and fuelwood extracted in the area are exported to timber markets of Yamuna Nagar, Dehradun etc. The annual export of the timber and fire-wood is 42 thousand and 30 thousand cubic metres for Rajgarh and Nahar Forest Divisions respectively.

Summary of wood consumption in the area

The present wood consumption for different purposes by local population and industries is summarised as under :-

Table No. VI-8

SUMMARY OF PRESENT WOOD CONSUMPTION(In cubic metres)

S.No.	Item	Chir	Deodar	Sal	Others	Total
1.	House construction and repairs.	2567.40	962.80	1604.60	1283.75	6418.55
2.	Agricultural implements	479.70	319.80	799.40	1599.90	3198.80
3.	Furniture making industry	60.00	159.00	120.00	182.00	512.00
4.	Packing cases making units.	4695.00	-	-	3129.00	7824.00
5.	By Govt. Departments	501.20	83.30	103.60	82.15	773.25
Total		8303.30	1515.90	2630.60	6276.00	18726.60

PROJECTION OF FUTURE DEMAND OF WOOD:

The future demand of wood is governed by large number of factors. The important factors are growth in population, changes in income structure, price trend of various commodities, change in utilization pattern of wood, changes in technology, literacy, availability of substitutes, consumer preferences etc.

Various formulae for projecting future demand of wood have been used. These formulae suffer from one defect or the other. Since the present study intended to indicate approximately the quantity of timber required to be used during coming years and the study has not been done in detail, therefore to discuss the different types of formulae to be used in forecasting of the future demand of timber, will not be in the purview of this study. The future demand of wood can be projected taking into consideration the important factors such as growth in population, change in income structure, price trend etc. which can easily be estimated. The effect of population upon consumption of wood is generally assumed to be uniform and quantitative relationship of income and consumption of wood products has indicated a positive correlation through out the world. Besides the population and income the supply of timber is also important factor which may govern the future consumption of wood. Timber supply is relatively in-elastic and very little can be done to alter the production of wood in the forests. Income has profound impact on the consumption level of wood in general throughout the world, and developing countries like India in particular. The elasticity co-efficient for income can be derived as the ratio of change in quantity consumed to the percentage change in the per capita income.

The projection of future demand of wood for the area is proposed to be made for the years 1981 and 1991.

Population Estimates

The total population of the area according to the 1971 census is 245,033 while it was only 129,551 in 1961. The population for the years 1981 and 1991 can be projected by compound interest formula. The rate of growth in population between 1961 and 1971 works out 2.4. Therefore, assuming the same rate of growth in population between 1971 and 1981, the population for the year 1981 works out to 302,840. Various developmental activities and family planning programme will have impact on the growth rate of the population. The rate of growth in population during 1981 and 1991 is assumed to be 2.0%. Thus population during 1991 works out to be 354,608.

Income Estimates:

As per Himachal Pradesh Statistics per capita income for whole of the Himachal Pradesh for the year 1974-75 is 355.00 at 1961 price level and at current price level it is Rs. 1037.00 as against Rs. 331.00 (Rs. 576.00 at current price level) during 1968-69. The growth in per capita income from the year 1968-69 to 1974-75 works out to 1.5% per year. In view of the various developmental activities, it is expected that the rate of growth in income will increase and therefore, it is estimated that the per capita income during 1981 and 1991 would be as follows :-

Per capita income during the year 1981	=	Rs. 405.00
Per capita income during the year 1991	=	Rs. 506.00

The projection of consumption of wood during these years is worked out on the basis of the following formula :-

$$\log \frac{Y^1}{Y} = 0.4343 \times I.E. \left(1 + \frac{X}{X^1} \right)$$

- Where Y^1 = Per capita consumption at target date,
 Y = Per capita consumption at starting point.
 $I.E.$ = Income Elasticity
 X = Per capita income at starting point.
 X^1 = Per capita income at target date.

The constant 0.4343 is derived by F.A.O. from cross-sectional data. As no historical series of consumption figures are available it is not possible to work out a separate income elasticity applicable to the area. It is, therefore, proposed to adopt an income elasticity of 0.8 which is the factor arrived by F.A.O. for India.

Forecast for Wood consumption:

Using the above formula, the quantity of different species used for construction and repairs of house, for agricultural implements and for fuel has been worked out and is summarised in table no. VI-9.

Table No. VI-9

WOOD CONSUMPTION BY LOCAL POPULATION

Item	Chdr		Deodar		Sal		Others		Total	
	1981	1991	1981	1991	1981	1991	1981	1991	1981	1991
For House construction and repairs	8076.00	10974.70	3190.32	4083.61	3446.08	6818.17	3342.24	5432.66	16054.64	27309.14
Agricultural implements.	1640.74	2114.73	1063.44	1349.05	2704.18	3463.78	5317.20	6818.17	10725.56	13745.73
Total	7716.74	13089.43	4253.76	5432.66	6150.26	10281.95	8659.44	12250.83	26780.20	41054.87

Forecast for industrial wood requirement

The area is likely to be affected by various industrial developments. There is sufficient scope for the development of the small scale industries in the area. Panta and Nahon are developing as future industrial sites in the area. The future demand of wood has been worked out as per the formula discussed earlier. The species proportion in the utilization has also been assumed to be similar as at present.

Summary of present wood consumption and projected future demand.

The present wood consumption species-wise and projected future demand for the year 1981 and 1991 is given below :-

Table No. VI-10SUMMARY OF PRESENT WOOD CONSUMPTION AND PROJECTED FUTURE DEMAND

S.No.	Species	1974-75	1981	1991
1.	Chir	8303.00	21663.00	31034.00
2.	Deodar	1516.00	4983.00	6380.00
3.	Sal	2630.00	6879.00	11230.00
4.	Others	6277.00	17440.00	26689.00
Total		18726.00	50965.00	75333.00

Table No. VI-11

PROJECTED DEMAND OF WOOD BY INDUSTRIES AND DEPARTMENTS.

Item	Chair		Doodur		Sal		Others		Total	
	1981	1991	1981	1991	1981	1991	1981	1991	1981	1991
Furniture making units	151.92	182.30	486.14	619.63	394.99	510.45	546.91	692.45	1579.96	2004.83
Packing cases	12153.60	15647.76	-	-	-	-	7990.99	13417.57	20144.59	23065.33
Other Department	1640.74	2114.73	243.07	328.15	334.22	437.53	243.07	328.15	2461.10	3208.56
Total:	13946.26	17944.79	729.21	947.78	729.21	947.90	8780.97	14430.17	24185.65	34278.72

CHAPTER - VII

ACCESSIBILITY & COST STUDIES

The main objects of these studies were :

- i) to work out the forest areas which are accessible with regard to the present logging techniques.
- ii) to work out the total cost of extraction for making delivery of the wood at Yamunenagar from different units of the forests;
- iii) and to examine the possibility of any modification in the current logging practices

7 Accessibility and Cost studies were undertaken in the area. The study was not done in detail but efforts were made to indicate the areas which are accessible for different types of logging methods. Cost components of different items of felling and extraction were also collected from the different working units. Total cost of extraction of wood from different areas to Yamnagar, which has been selected as the devalivery side has been worked out.

2 METHODOLOGY

The whole area was divided into catchments and sub-catchments depending upon the drainage pattern of the area. Each catchment and sub-catchment was further divided into suitable logging units or cost units. These units were so framed that the same logging and extraction methods would be applicable in one unit and the cost of felling and extraction are uniform. The distances of the cost units from the delivery site have been worked out, taking into consideration both off-road transport and on-road transport. Ten units which had contractor coupes under working, were visited and forest contractors/sub-contractors were interviewed for finding out the cost components of various logging operations. If various alternative for transport modes are available from the particular cost unit, the prevalent one was selected for working out the costs. The cost of various operations was collected and converted into cost per cubic metre for felling and cost per cubic metre per kilometre for extraction. The main objective was to work out the total cost which may include felling, conversion, loading, un-loading, transport etc. for each cost unit which is involved in bringing the wood from the cost unit of the delivery site. The volume of wood available in such cost units is worked out on the basis of sample plot volumes falling in particular cost units. The whole range of cost is classified into different cost classes. The volume in each cost class is determined by attaching the volume of the cost unit to the cost of making delivery of the wood to Yamuna Nagar.

3 FACTORS INFLUENCING LOGGING COSTS

Logging costs are generally influenced by the following factors:-

- 1 Altitude
- 2 Topography
- 3 Slope
- 4 Climate
- 5 Infrastructure
- 6 Forest Density
- 7 Availability of labour

4. ALTITUDE

Logging costs are generally higher on higher altitudes because conditions of working are difficult and period available for working is also short. The information on altitude has been collected from the topo map sheets of the area and inventory sample plots. The highest range in the survey area is Churdhar in which highest peak is Chur (3650 m). Most of the higher ranges are in Rajgarh Forest Division. In Nahar Forest Division, the altitude does not go beyond 2,000 metre. The area under different altitudes and forest types is given in table no. VII-1 for the entire survey area.

Table No. VII-1

AREA OF DIFFERENT FOREST TYPE UNDER DIFFERENT ALTITUDE

Forest Type	Area Sq. Km.						Total
	Altitude						
	Below 500 M	500-1000 M	1000- 1500 M	1500- 2000 M	2000- 2500 M	>2500 M	
Chir	-	17.07	133.97	51.23	1.86	-	204.13
Blue pine	-	-	-	2.78	-	-	2.78
Deodar	-	-	1.31	14.28	4.98	-	20.57
Mixed, Conifers	-	-	-	1.31	4.88	-	6.19
Conifers with temperate hardwoods	-	41.99	42.03	36.80	34.17	13.14	168.13
Sal	128.00	81.49	2.62	-	-	-	212.11
Sal with B.L. spp.	44.69	33.36	-	-	-	-	78.05
Oaks	-	-	30.97	117.98	43.37	7.88	200.20
Others	132.75	270.08	123.55	1.62	22.34	-	550.34
Total	305.44	443.99	334.45	226.00	111.60	21.02	1442.50

5. TOPOGRAPHY

The topography is also an important factor for determining the method of extraction and pattern of conversion. These factors directly effect the logging costs. Logging costs are generally higher in hilly areas than in plains. Most of the area in Rajgarh Forest Division is hilly to very hilly. However, in Nahar Forest Division, there is sufficient area which is plain.

6. S L O P E

The slope plays an important part in determining the logging costs. Generally logging costs are higher in higher slopes but this may not be always true. Logging beyond the slopes of 65° and above may not be possible. The general slope of the area was studied on the basis of the slope at different sample plots of inventory. The area of different forest types under different slopes as worked out by inventory results is given in table No. VII-2.

Table No. VII-2

AREA UNDER DIFFERENT SLOPE UNDER DIFFERENT FOREST TYPES

Area in Sq. Km.						
Forest Type	S L O P E					Total
	70°& above.	60°-70°	45°-60°	20°-45°	0°- 20°	
Chir	4.10	16.73	28.49	146.82	7.99	204.13
Blue pine	-	-	1.08	1.70	-	2.78
Deodar	-	1.08	16.48	20.85	2.16	20.57
Mixed Conifers	-	2.16	2.16	1.87	-	6.19
Conifers with temperate hardwoods	2.16	3.24	32.42	130.31	-	168.13
Sal	-	-	3.02	67.06	142.03	212.11
Sal with other Broad leaved.	-	-	4.53	54.84	18.68	78.05
Oaks	6.82	32.72	51.25	96.43	12.98	200.20
Others	-	9.28	87.15	370.38	83.53	550.34
Total	13.08	65.21	216.58	880.26	267.37	1442.50

7. CLIMATE

The climate of the area is also an important factor in determining the road and water transport systems. The climate governs period during which extraction of wood is possible during the year. Road Transport system is limited to fair weather only because there are large number of roads which are not pucca roads. The rivers which serve an important mode in water

transport do not have sufficient water during dry season and therefore water transport is limited to only few months when the water is plenty in rivers to float timbers. Higher ranges may receive large amount of snow fall during winter which may inhibit the logging operations.

8. INFRASTRUCTURE

The development of sufficient infrastructure of communication means results easy extraction of forest produce resulting in lesser costs. Therefore, the situation of the cost unit with respect to the launching depots or rail heads or road heads is very important factor. Longer off-road distance may involve such a large amount of expenditure which may prohibit the extraction of the wood from the area. The off-road transport systems are generally 30-50 times more costlier. Rail transport is generally cheaper than road transport but the system is out of question because no railway line passes through the survey area.

9. FOREST DENSITY

In dense forests, cost of extraction per cubic metre is generally less than in the open because larger amount of timber is available for working in a smaller area. Table no. VII-3 indicates the areas of different forest types under different crown density :

Table No. VII-3

AREA UNDER DIFFERENT CROWN DENSITIES

(Area in sq.km.)

Forest Type	CROWN DENSITY			Total
	Less than 0.4	0.4-0.7	More than 0.7	
Chir	48.86	96.99	58.28	204.13
Kail	-	0.25	2.53	2.78
Deodar	1.59	7.31	11.67	20.57
Mixed conifers	0.20	2.59	3.40	6.19
Conifers mixed with temperate hardwoods	42.97	51.18	73.98	168.13
Sal	17.75	66.07	128.29	212.11
Sal with BL	17.92	52.36	1.77	78.05
Oaks	97.73	80.17	22.30	200.20
Othersnot worked out			550.34
Total				1442.50

10. AVAILABILITY OF LABOURERS

It has been revealed by the Contractors working in the area that they do not find any difficulty with labour. Skilled and un-skilled both types of labourers are generally available in sufficient numbers. Some of the contractors prefer to keep permanent labour force and employ such labourers which are not local.

11. PRESENT LOGGING MANAGEMENT

At present logging is mainly done by forest contractors in the area. Only in a small area of Nahar Forest Division, felling has been done departmentally. Felling is usually done in the coupes which are marked according to the prescription of the Working Plans. The coupe consists of whole or part of a compartment or sub-compartment. The area of the coupes may range from 50 ha. to 500 ha. or more. The trees to be felled are marked with hammer and an estimation of their standing volume is also made. The marked coupes are generally sold to the forest lessees by the department through public auction. The lessees pays the royalty to the Forest Department and is responsible for the entire felling and extraction operation of the coupe. He is also responsible for marketing the forest produce. The lease period of the coupe is well defined and it varies from few months to a year or more.

Felling and delimbing is generally done with axe and saw. Broad leaved species are usually felled by axe only. Power chain saws are not used at all. The felled trees are cut into logs of different size usually 3 metre long. Cross-cutting is generally done by two men cut saw. The species such as fir, spruce, deodar occurring in higher elevations are usually converted in form of sleepers before transporting. Some time the logs are squared. Squaring is usually done by axe. Conversion of logs into sleepers or scantlings is not done in case of broad leaved species. Broad leaved species are extracted in form of logs. Sometimes these species are converted into charcoal and extraction of charcoal poses no problem.

Major transport method adopted for the transport of the timber of the area is road transport. Only a small fraction of the produce is transported through water for some distance. The land transport systems consists of two parts (i) off-road transport and (ii) road transport. Various off-road transport systems are prevalent in the area. These are dry slide, wet slide, rolling, manual carriage, carriage on mule back etc. Sky line cranes and gravity ropeways have not been erected in the area. The dry and wet slides are used for smaller distances generally inside the coupe. Construction of such slides is done only in higher elevations particularly in areas of deodar, fir and spruce in Rajgarh Forest Division. Rolling is also done for a small distances. Manual carriage or carriage on mule back is done when the felling is scattered over wider areas. When carriages is to be done manually or by mules, the logs are made smaller, usually 1 metre long. Telescopic floating is also done with the help of various rivers and nallahs occurring in the area. The important rivers and nallahs which may be used for such floating are Giri, Jalal, Sainj etc. Some smaller nallahs/khuds may also be used for this purpose for small distances. Road transport is the major transport system for the transportation of forest produce from the forests to the market. The extraction of forest produce is usually done by trucks of 5 tonnes capacity.

COST COMPONENTS OF VARIOUS ITEMS:

12. FELLING

Felling of coniferous species is generally done by saw and axe. The forest contractors generally get the work done on piece meal basis. A sub-contractor is usually responsible for felling works, lopping (if needed) and roping is included in the felling work. The rates of felling are usually higher in higher altitudes. The rates also differ with the species. The rates for broad leaved species are usually higher than for the coniferous species. The rates of felling as prevalent in the area are given below :-

1. Chir	Rs. 2-50 to Rs. 4-00 per m ³
2. Doodar & Kail	Rs. 3-00 to Rs. 5-00 per m ³
3. Fir & Spruce	Rs. 4-00 to Rs. 5-00 per m ³
4. Sal	Rs. 3-00 to Rs. 4-00 per m ³
5. Fuelwood	Rs. 6-00 per tonne

13. CONVERSION

The felled trees are made into logs of suitable sizes. The logs of fir, spruce, deodar and kail and sometime chir are squared and converted into sleepers or scantlings at the coupe site. The rate of conversion of different species is given below :-

1. Chir	Rs. 25-00 to Rs. 30-00 per m ³
2. Doodar & Kail	Rs. 30-00 to Rs. 35-00 per m ³
3. Fir & Spruce	Rs. 35-00 to Rs. 40-00 per m ³

The squaring and conversion of logs into sleepers and scantlings is not done in case of broad leaved species. In case of broad leaved species, the felled trees are converted into logs of suitable length and transported as such.

14. ENGRAVING PROPERTY MARK

The property mark of the contractors is engraved on the two faces of the sleeper or log before they are transported from forests. The operation consists of cleaning the ends of the logs and engraving the property mark. The job is usually done at the rate of Rs. 2-00 to Rs. 2-50 per 100 marks.

15. CONSTRUCTION OF EXTRACTION PATHS:

In plain areas of Nahar Forest Division contractor has to incur certain amount of expenditure on construction of extraction paths inside his coupe and outside for transporting his timbers by trucks. The amount of expenditure on construction of such extraction paths will depend upon the distance of the coupe from the road but generally Rs. 500/- to Rs. 1,000/- is incurred towards such construction of extraction paths.

16. MINOR TRANSPORT SYSTEMS

The rate of minor transport differ with the situation of the coupe. These transport systems are generally resorted to for small distances. The approximate rates for different operations are given below :-

1. Rolling	Rs. 8-00 to Rs. 12-00 per m ³ /km
2. Dry slide	Rs. 5-00 to Rs. 6-00 per m ³ /km
3. Wet slide	Rs. 4-00 to Rs. 6-00 per m ³ /km
4. Telescopic floating	Rs. 2-00 to Rs. 3-00 per m ³ /km

The manual carriage and carriage on mule backs is quite common in the area. The operation is commonly known as 'Kandha Dhulan' and 'Kachhar Dhulan' respectively. The rates of Kandha Dhulan is Rs. 25-00 to Rs. 35-00 per cubic metre for a lead upto 1 km. Higher rates are generally charged for the leads above 1 km.

17. ROAD TRANSPORT

The timber is generally transported to nearby timber markets such as Yamuna Nagar, Dehradun etc. The rates of kachha road are higher than that of pucca road. The rates for hills are comparatively higher than plain roads. The rates which are prevalent in the area are given below :-

<u>Type of Road</u>	<u>Rate in Rs. per m³/km</u>
Hill kachha	Rs. 1.00 to Rs. 1.25
Hill pucca	Rs. 0.75 to Rs. 1.00
Plain kachha	Rs. 0.75 to Rs. 1.00
Plain pucca	Rs. 0.50 to Rs. 0.75

Most of the contractors have their own fleet of trucks for transportation of timber.

18. AMENITIES TO LABOUR

The labourers who work in the coupe are generally of two types, (i) local labour and (ii) imported labour. The local labour work in the coupe and usually return to their villages if situated near about. Otherwise forest contractor has to provide some shelter to temporary as well as permanent labourers. The shelter is generally made in form of 'Jhopri'. Sometimes tents are also supplied. It is reported by the contractors that a sum of Rs. 500/- to Rs. 1,000/- is incurred for this purpose. The contractors also arranges for the supply of ration etc.

Summary of costs of various operations in terms of per m³

1. Felling including roping and lopping

Chir	Rs. 2.50 to Rs. 4.00 per m ³
Deodar & Kail	Rs. 3.00 to Rs. 5.00 per m ³
Fir & Spruce	Rs. 4.00 to Rs. 5.00 per m ³
Sal	Rs. 3.00 to Rs. 4.00 per m ³
Fuelwood	Rs. 6.00 per tonne.
2. Conversion including cross-cutting, squaring, sleeper making etc.

Chir	Rs. 25.00 to Rs. 30.00 per m ³
Deodar & Mail	Rs. 30.00 to Rs. 35.00 per m ³
Fir & Spruce	Rs. 35.00 to Rs. 40.00 per m ³
3. Engraving of property mark Rs. 2.00 to Rs. 2.50 per 100 marks.
4. Minor Transport

(a) Rolling	Rs. 8.00 to Rs. 12.00 per m ³ /km.
(b) Dry slide	Rs. 5.00 to Rs. 6.00 per m ³ /km.
(c) Wet slide	Rs. 4.00 to Rs. 5.00 per m ³ /km.
(d) Telescopic floating	Rs. 2.00 to Rs. 3.00 per m ³ /km.
(e) Manual carriage	Rs. 25.00 to Rs. 35.00 per m ³ lead upto 1 km.
5. Major Transport (Road transport including loading and un-loading).

(a) Hill kachha road	Rs. 1.00 to Rs. 1.25 per m ³ /km
(b) Hill pucca road	Rs. 0.75 to Rs. 1.00 per m ³ /km.
(c) Plain kachha road	Rs. 0.75 to Rs. 1.00 per m ³ /km.
(d) Plain pucca road	Rs. 0.50 to Rs. 0.75 per m ³ /km
6. Construction of extraction path Rs. 500.00 to Rs. 1,000.00 per coupe or Rs. 1.50 to Rs. 3.00 per cubic metre
7. Amenities to labour Rs. 1.50 to Rs. 3.00 per m³
8. Other charges Rs. 1.00 to Rs. 2.00 per m³

COST ANALYSIS

For working out the cost of items of extraction such as felling, extraction etc. method which is prevalent in the area has been taken into consideration. Road transport is the main system of extraction of forest produce except for certain areas where river transport is adopted for small distances. The cost of extraction including felling and transport from the cost unit to the delivery site (Yamma Nagar) has been worked out for each cost unit. The cost of extraction varies from Rs. 65.00 to more than Rs. 200.00 per m³. The cost of extraction for Rajgarh Forest Division is higher than Nahar Forest Division. 25 rupees cost classes have been formed. The total volume in each cost unit has been calculated on the basis of growing stock figures of the sample plots felling in that cost unit. Attaching this volume to the cost of extraction of the unit, volume in different cost classes have been approximated. Reduction in volume due to felling and logging has not been worked out. The total volume which can be extracted in different cost classes is given in table No. VII-4.

Table No. VII-4

Cost classes (Rs.)	Volume of wood which can be extracted in 000 m ³ .	Percentage of total volume.
Less than 75	2885.680	26.4
75-100	2538.834	23.2
100-125	1220.534	11.4
125-150	1409.950	12.9
150-175	1925.135	17.6
More than Rs. 175	617.318	5.6
Inaccessible	351.528	3.2
Total	10948.979	100

Most of the wood in lower cost classes come from Nahar Forest Division. Most of the wood of Sal forest type is in cost class less than Rs. 75-00. Here terrain is easy and most of the units are easily accessible by truck etc. In the cost class Rs. 75-00 to Rs. 100-00 some of the sal forest, sal which broad leaved species and some of the chir forest which are easily accessible are included. Some of the Chir forest which have longer off-road distance, easily accessible forests of ban oak, deodar and kail are included in cost class Rs. 100.00 to Rs. 125.00 and cost class Rs. 125.00 to Rs. 150.00.

Some of the forests of fir, spruce, kharsu, oak etc. and forests of chir, deodar with comparatively longer off-road distances come in the cost class between Rs. 130.00 and Rs. 175.00. The forests of deodar, chir, oaks and other species with very long off-road distances are included in the cost class more than Rs. 175-00. Such forests which are situated in very difficult terrain, steep and precipitous slopes where extraction is practically not possible with present logging methods are classified as inaccessible forests.

AREAS UNDER DIFFERENT COST CLASSES



REFERENCE

1. STATE BOUNDARY	---
2. FOREST DIVISION BOUNDARY	- - - -
3. ROADS	==
4. RIVERS	~~~~
5. PLACES	•
6. COST CLASS < RS 100	Stippled pattern
7. COST CLASS BETWEEN RS 100-150	Diagonal line pattern
8. COST CLASS > RS 150	Cross-hatched pattern

CHAPTER - VIII

INDUSTRIAL POSSIBILITIES

1. The present consumption of wood and projected demand for the year 1981 and 1991 has been worked out in Chapter VI. Species-wise requirement is indicated below in table No. VIII-1.

Table No. VIII-1

Present consumption and future demand in m³

S.No.	Species	1974-75	1981	1991
1.	Chir	8303.00	21663.00	31034.00
2.	Deodar	1516.00	4983.00	6380.00
3.	Sal	2630.00	6879.00	11230 .00
4.	Others	6277.00	17440.00	26689.00
Total		18726.00	50965.00	75333.00

2. The annual yield of important species has also been approximated in Chapter V and is given in Table No. V-5 which is reproduced below:

Table No. VIII-2

ANNUAL YIELD OF IMPORTANT SPECIES(in m³)

Chir	27400
Deodar	3200
Mixed conifers	1900
Oaks	45300
Sal	65700

3. Wood balances, therefore, for the year 1974-75, 1981 and 1991 works out as under :-

Table No. VIII-3

WOOD BALANCES FOR THE YEAR 1974-75, 1981 & 1991

S.No.	Species	Year			in 000 m ³
		1974-75	1981	1991	
1.	Chir	19	6	(-) 4	
2.	Deodar	2	(-) 2	(-) 3	
3.	Sal	63	59	54	
4.	Others	59	28	19	

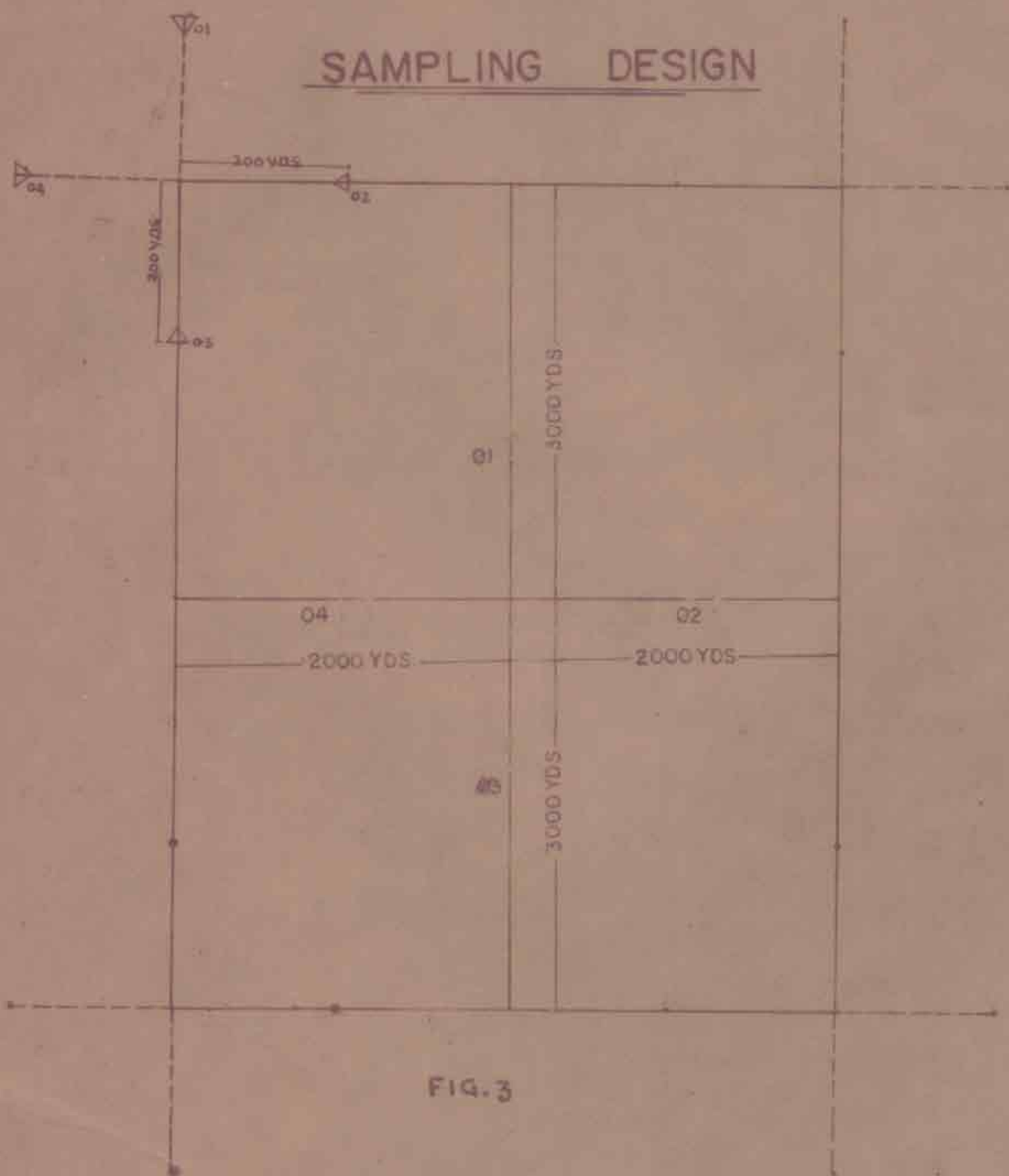
Thus, it would appear that Chir, Deodar and other coniferous species are just enough to meet the present requirements of local population and industries. If the growing stock of these species is not enriched, it may not even be possible to meet local requirements. It is necessary therefore to augment the growing stock of these species by large scale plantations. It is, therefore, not feasible to plan any large or small scale industries based on the raw materials of coniferous species.

4. Oaks form major proportion, in species type others. The wood balances in this category as worked out above are 39,000 m³ for 1974-75, 28,000 m³ for 1981 and 19,000 m³ for 1991. These forests are situated in areas where off-road distances are comparatively longer and the terrain is difficult and slope is steeper. Therefore, such forests are not being extracted at the full extent. It is, therefore, not advisable to plan for any wood based industries on the basis of raw material obtained from these species.
5. The only species which may have substantial amount of wood balances is Sal. The wood balances in respect of this species for 1974-75, 1981 and 1991 work out to 83,000 m³, 59,000 m³ and 54,000 m³ respectively. The forests of this species are situated on comparatively easier slopes and therefore extraction is no problem. This species, however has its own silvicultural problem. Regeneration of sal is not satisfactory in all the areas and therefore, it may not be possible to achieve the annual yield of 65700 m³ as worked out in Chapter V.

It is necessary to point out here that this species is a very good structural timber and is widely used as a structural timber in the survey area and in adjoining areas of Haryana, Punjab, Uttar Pradesh and Delhi. The timber is comparatively costlier and therefore if any industry based on the raw material of this species is planned, this is likely to have an adverse effect on the supply of constructional timber to adjoining areas and their requirements may remain unsatisfied. This may also lead to increase in prices of timber to adjoining timber markets. It is, therefore, felt that this species should continue to be used as per its present practice. It is pointed out here that the species is generally exported to timber markets in form of logs. The main reason behind it, is the development of big timber market in Yamuna Nagar. The sizes for constructional material such as door, window frames, ridges, rafters etc. are very much varying. Therefore actual sawing is preferred by the users themselves. This factor may discourage the establishments of some wood working units in the area.

APPENDIX - I

SAMPLING DESIGN



Ground Sampling Design
for
Chir belt - Himachal Pradesh

Systematic Grid Sampling will be carried out for survey in Chir belt of Himachal Pradesh. Around each grid centre, there will be a cluster of four sample points.

Map sheets on the scale 1" = 1 mile (i.e. 1: 63,360) are available for the area. Grids are marked on these map sheets in thousand yards.

Sample grids will be spaced at 2000 yards by 3000 yards (i.e. 1832 metre x 2748 metre). The distance along the X axes will 2000 yards and for Y axes it will be 3000 yards (see figure 1). Grid centres will be taken as the cross section of the grids marked on the maps.

Four sample points will be clustered around each grid centre. The sample points will be along the four grid lines, emerging from the grid centre (due North, East, South and West). The distance of each sample point will be 300 yards (i.e. 274.8 metre) from the grid centre (see figure II).

Variable plot method will be used at each of these sample points for collection of information. But wherever Bamboo is found to occur, fixed plots of the size 0.1 hectare in extent, with sample point as the centre of the plot, will also be laid. Fixed plots will be square in shape, with its four apices facing North, East, South & West.

Sample points and/or the fixed plots will be numbered as 1 to 4, starting from North in a clock-wise direction (i.e. North-1, East-2, South-3, West-4 also see figure II).

Forms :

For collection of information from each of the sample points, the following forms will be used :-

1. Point Description Form :- The description of several parameters mentioned in the form will be for about 2 hectares of area around the sample point.
2. Tally Sheet (P.A.F-2) :- Tally of all trees above 10 cm. dia. will be taken with Relaskop and with basal area factor - 2, and will be recorded in this form with actual diameters and species codes of the trees.
3. Sample Tree Form :- A larger set of information with regard to height, bark thickness, clear bole and increment bearings etc. will be collected in respect of all 'DN' trees occurring between North and West Directions. This information will be filled in this form.
4. Bamboo Enumeration Form :- Information on bamboo clumps and culms will be recorded in this form.

Detailed instructions for filling up various forms are enclosed herewith.

PLOT DESCRIPTION FORM

CODING INSTRUCTIONS

S.No.	Item	Column Nos.	Instructions
1	Job	1-3	Leave it blank. To be filled in by Data Processing Unit at the time of punching.
2	Card Design	4-5	-do-
3	Report No.	6-7	-do-
4	Sub-Report Number	8	-do-
5	Crew Leader	9-10	Two digits. Write your code number(App.1)
6	State	11-12	Different states in the North Zone should be coded as under :-
		<u>Code</u>	<u>State</u>
		01	Haryana
		02	Himachal Pradesh
		03	Kashmir
		04	Punjab
		05	Rajasthan
		06	Uttar Pradesh
			For survey in Chir belt in H.P. the code will be always 02.
7	Revenue Districts	13-14	Codes for revenue districts for Chir belt of H.P. will be as under :-
		<u>Code</u>	<u>Revenue District.</u>
		01	Sirmur
		02	Solan
		03	Simla
		04	Bilaspur
		05	Una
		06	Mandi
		07	Hamirpur
		08	Kangra
		09	Chamba
		10	Kulu
		11	Minnaur Spiti
		12	Lohaul & Spiti
8	Catchment	15	For survey of Chir belt in H.P. catchment should be coded as certainly to the following main rivers:
		<u>Code</u>	<u>Catchment</u>
		1	Yamuna
		2	Sutlej
		3	Bias
		4	Ravi
		5	Chenab

9. Forest Division

16

In each forest division should be coded as under :

Code Yamuna Catchment Division

1	Nahan
2	Rajgarh
3	Chopal
4	Rohru
5	Solan
6	Simla
7	Kotgarh
8	Kinnaur

Sutlej Catchment

1	Kunihar
2	Solan
3	Simla
4	Bilaspur
5	Una
6	Hamirpur
7	Sunder Nagar

Bias Catchment

1	Una
2	Hamirpur
3	Nurpur
4	Kangra
5	Mandi
6	Nachen
7	Seraf
8	Kulu

Ravi Catchment

1	Nurpur
2	Dalhousie
3	Chamba

Chenab Catchment

1	Pangi
2	Lahaul & Spiti

10. Land class

17

Consider the present land use of the two hectares of area around point/plot under reference. Classify the land use in following categories:-

Code Description

- 1 Forest Land:- Consider as forests all lands with a forest cover (including bamboo and palm) e.g. with trees and/or scrub growth and where land surfaces not use primarily for purposes other than forestry.
- 2 Scrub Land:- It includes all area devoid of trees more than 3 metre height and having bushy growth. It will exclude already growth under forest land,

<u>Code</u>	<u>Description</u>
3	<u>Pasture & Grass lands:-</u> Land primarily managed for cultivation of grasses and grazing cattle e.g. (used for primarily other than forestry).
4	<u>Barren Lands :-</u> All lands with exposed surface and which are lying unutilised e.g. Barren lands, exposed rocks, sand dunes, swamp areas without vegetation.
5	<u>Agricultural Crop Land :-</u> Consider as agricultural crop land, all lands under cultivation with or without any tree cover.
6	<u>Orchard/Non-Forestry Plantations:-</u> Includes of lands on which horticultural orchards and plantation non-forestry species have been raised.
7	<u>Urban, Village & Industrial Lands:-</u> This includes areas of habitation and industrial sites (if not less than 2 hectare).
8	Others :- Includes (a) Water (b) Road other than forest roads. (c) River beds It also includes lands which cannot be classified if any of the above classes.

11 Legal Status

18. One digit. Considering the legal status the following categories have been made. Classify the plot in one of the categories and write the code in this column. Each category is to be identified separately only if it is not less than 2 hectare in area.

<u>Code</u>	<u>Description</u>
1	<u>Reserve Forest :-</u> As per definition IFA.
2	<u>Demarcated protected Forest:-</u> -do-
3	<u>Un-demarcated Forests:-</u> -do-
4	<u>Un-classed Forest:-</u> -do-
5	<u>Bairuni Revenue land :-</u> Land under the control of revenue/other departments.
6	<u>Panchayat/Shamlat land:-</u> Land other under the control of Panchayat.

<u>Code</u>	<u>Description</u>
7	<u>Private land:</u> Not under the control of any Govt. Department.
8	<u>Un-determined Land:-</u> Includes all forest land which cannot be classified in any of the above categories.

12 Geology

19-22

In the visit of the sample point, geology of the area will be studied. Parent rock compactness/hardness will be studied. It may be possible to carry out the study after examining road side cutting, and land slides occurring in the area. After study, classify the parent rock as under :-

<u>Code</u>	<u>Description</u>
01	<u>Sand Stone :-</u> Sand particles cemented by Ferruginous material. It is generally light brown in colour.
02	<u>Lime Stone :-</u> Where the Calcium Carbonate content is high. It is generally grey, brown and blue in colour.
03	<u>Conglomerate :-</u> Where different types of pebbles are aggregated to form a solid structure. It has different colour in the same rock.
04	<u>Shale :-</u> It is hardened clay material which has lost its plasticity. This splits into thin slips parallel to original stratification.
05	<u>Slate :-</u> These are similar to shales but more smooth having high mica content. Varies in colour generally these are black but frequently green or purple.
06	<u>Schists :-</u> These rocks are foliated (coming out in small chips) schists have high mica content (shining).
07	<u>Gneiss :-</u> These are banded rocks which are un-like with respect each other.
08	<u>Quartzite :-</u> Sand stone with greater hardness and are more crystline. These are harder and heavier than sand stones generally white in colour but more frequently formed in colours like purple and brown.

		<u>Code</u>	<u>Description</u>
		09	<u>Phyllite :-</u> These are like slate but very shining. They have glassy in appearance (high mica content).
		10	Un-identified.
Structure	21		Structure of rocks will be studied from the exposed surface of rocks and shall be classified into following categories :-
		<u>Code</u>	<u>Description</u>
		1	Compact and massive
		2	Stratified
		3	Concretious
		4	Jointed
		5	Un-identified.
Hardness	22		Hardness of the rock will be identified with the help of knife and will be classified as under :-
		<u>Code</u>	<u>Description</u>
		1	Very hard
		2	Hard
		3	Soft
		4	Very soft
13	Terrain Data	23-28	The information regarding Terrain has to be filled in from topo sheets. You should study the area around the plot in the topo sheets and record the information regarding :- Item Altitude Topography Slope Position on hill Aspect Stoniness
	Altitude	23-24	From the topo sheets 1" = 1 mile or 1/63,360 find the altitude of the plot centre in metres, write the altitude of four digits drop the last two digit and write the remaining two in the appropriate columns. e.g. an altitude of 519 metres should be written as 0519 drop the last two digits, the remaining two digits only e.g. 05 should be recorded in the form.
	Topography	25	Examine the general topography over an area of about 2 square kilometre in the type of terrain in which the plot lies on topo map and classify the terrain in one of the following classes :-

Code Item

- 1 Precipitous :- Steep areas where logging is not possible.
- 2 Very hilly :- Areas with steep slopes where logging is possible but difficult.
- 3 Hilly :- Area which moderate slopes where logging is no problem as per existing practices.
- 4 Gently Rolling :- Areas with series of rounded hill tops and gentle slopes with wide valleys in between, where logging is easy.
- 5 Flat.

Slope

26

J Measure the slope on topo map (1/63,360) around the plot centres over an area of about 1 sq. km. Take average of 2-3 measurements and classify in one of the following classes. Write the Code number of the class in the appropriate column.

Code Degrees

- 1 70 and above
- 2 60 to less than 70
- 3 45 to less than 60
- 4 20 to less than 45
- 5 0 to less than 20.

Position on Hill.

27

Examine the position of the P.C. on the topo map (1/63,360) with reference to hill slope on which it is located and classify as under. Write the code number of the class so arrived at in the form.

Code

- 1 Ridge top
- 2 Upper 1/3rd
- 3 Middle 1/3rd
- 4 Lower 1/3rd
- 5 Valley

Aspect

28

General aspect of the area where in the plot lies is to be studied on the map and classified as under :-

Aspect , Code

- | | |
|------|---|
| N | 1 |
| NE | 2 |
| E | 3 |
| SE | 4 |
| S | 5 |
| SW | 6 |
| W | 7 |
| NW | 8 |
| None | 9 |

Stoniness - 29

Observe an area of about 2 hectare around the plot and consider the extent of rocks/boulders, greater than 25 cms. in diameter weighs less than about 40 kg. and can easily be moved manually. Hence keeping in view stones/boulders greater than 25 cms, classify the plot in one of the following classes and write the code in the column:

Code

- 1 More than 60% of the land surface is covered with stones/boulders.
- 2 30% to 60% of the land surface is covered with stones/boulders.
- 3 Less than 30% of the land surface is covered with stones/boulders.
- 4 Stones/boulders are absent.

14 Soil Depth 30-34

Information regarding soil is to be filled in for plots classified as forest land. This information may also be collected for areas not falling in any of the above referred category but are visited. For soil data regarding humus, consistency, texture, depth, and moisture, consider the predominant soil type around the plot.

Humus 30

Humus is the decomposed organic matter(leaf, needles, twigs etc.) which has become apart of the upper most soil horizon. This should be clearly distinguished from undecomposed leaf litter. Remove leaf litter from the soil surface before making measurements.

Dig a small pit about 5 cm. in the predominant soil type. Now measure the depth of humus and write the code of the class in which it falls, in the appropriate column.

Code

- 1 5 cm or more
- 2 2 cm to less than 5 cm.
- 3 less than 2 cm.
- 4 Humus absent.

Consistency 31

Classify the soil in and around the plot in one of the following classes and write the class code in this column.

Code

- 1 Friable
- 2 Slightly compact
- 3 Compact
- 4 No soil

Friable:- is one which is loose and which crumbles very easily while pressing with fingers. Such soil can be scraped easily with toe of the shoe. Sand content in this type of soil is more. Digging is very easy.

Slightly compact:- is one which sticks together as a lump when taken in hand. Digging a pit in this type of soil is very easy with a pick axe.

Compact Soil:- is one which makes digging rather different due to soil particles cementing together.

Soil Texture 32

Examine the texture of the soil in the region where the humus and the mineral soil are mixed, by feeling with the hand and classify in one of the following categories and record the code number. Apply this test to the soil type predominant in the area.

Code Item

- | | |
|---|------------|
| 1 | Clayey |
| 2 | Clay loam |
| 3 | Loam |
| 4 | Sandy loam |
| 5 | Sandy |
| 6 | Pebbles |
| 7 | No soil |

Soil Depth 33

Examine the soil depth either by digging pits or by road side cuttings(near the plot) and classify the soil depth in one of the following categories and write the code number in this column.

Code Items

- | | |
|---|------------------|
| 1 | 50 cm. or more |
| 2 | 40 cm. to 49 cm. |
| 3 | 30 cm. to 39 cm. |
| 4 | 20 cm. to 29 cm. |
| 5 | 10 cm. to 19 cm. |
| 6 | less than 10 cm. |
| 7 | No soil |

Soil Moisture 34

The study of soil moisture in the plot. Take some soil in your hand feel the presence of moisture in it.

Code Items

- | | |
|---|---|
| 1 | <u>Water logged</u> :- Where water stands on the soil and drainage is poor. |
| 2 | <u>Humid</u> :- Where soil moisture is high and ball may be formed from the dug soil. |
| 3 | <u>Semi-humid</u> :- Soil moist but ball is not formed. |
| 4 | <u>Dry</u> :- Soil is not moistured at all. |

This column is to be filled up for those sample points which under the land class column have been classified as 'Forest land'.

Observe the growth in the region and classify it in one of the following classes. (A class should be identified independently if it extends to 5 hectares or more.)

<u>Code</u>	<u>Items</u>
1	Forest
2	Degraded forest
3	Scrub
4	Grassy
5	Others

The following definitions of the above classes will help you in determining the category of vegetation class to which the point belongs:-

Forest:- It includes all areas having tree cover of any density. The following types of areas will also be included in this category:-

- (a) Temporarily understocked/or unstocked areas e.g. recently worked areas.
- (b) Young natural stands and Forest Plantations at any stage of growth.
- (c) Areas of degraded forests where it has been cut back.
- (d) Abandoned cultivation having forest cover.
- (e) Forest roads, streams, small open areas in the forests and nurseries which form an integral part of the forests.
- (f) Public and private forests.
- (g) Bamboo bearing areas pure or in admixture with other miscellaneous species.

Degraded Forests:- It includes areas having open forest patches with trees of low height (generally not more than 3 metres in height) near habitation and cultivation showing signs of heavy biotic pressure. In such areas the trees are badly pollared or hacked. It also includes small patches of young coppice growth (rooted waste) looking like regeneration. Such rooted wastes are the result of repeated cutting back of the coppice shoots. The area may or may not have sprinkling of very few scattered undamaged trees. Areas having badly hacked and damaged bamboo clumps are also included in this category.

Scrub:- It includes areas having mostly scrub of bushy growth. The area is generally devoid of trees. Although at times scattered trees (2-3 per hectare) may be found standing. It will also include abandoned cultivation and plantation having scrub growth.

Grassy :- This class covers areas covered predominantly with grasses, provided that these are not less than 2 hectares in extent. Trees or shrubs if present or less than 5% in density.

Others:- All other areas not covered by any of the above classes will not classified in this category.

- 16 Origin 36 Assess the origin of the stand, in the field and classify the information in one of the following classes and write the code in the appropriate column :-

<u>Code</u>	<u>Item</u>
1	Natural
2	Man-made
3	Partially Natural and partially man-made e.g. natural forests, supplimented with artificial regeneration.

- 17 Forest Type 37-38 Classify the forest crop which the plot lies in one of the following forest types, provided that it is not less than 2 hectares in extent.

<u>Code</u>	<u>Item</u>
01	Chir
02	Blue pine
03	Deodar
04	Spruce
05	Fir
06	Spruce Fir
07	Spruce, Fir, Blue pine.
08	Deodar Blue pine.
09	Chir Ban oak
10	Chir khair
11	Chir and other broad leaves species
12	Other conifers broad leaves species
13	Mixed conifers
14	Sal
15	Sal with broad leaved species
16	Ban Oak
17	Moru Oak
18	Kharsu Oak
19	Mixed Hard-woods
20	Eucalyptus & Populars
21	Khair

Species constitutes more than 80% will be considered as pure. Any species less than 20% of the mixture will be ignored. In the case of the mixed forests a species shall be recognised only if it forms a part more than 20% of the mixture.

Later on these forest types were grouped into the following :-

<u>Code</u>	<u>Item</u>
01	Chir
02	Deodar
03	Kail
04	Spruce
05	Fir
06	Mixed conifers
07	Conifers mixed with B.L.
08	Sal
09	Sal with hardwoods
10	Oak
11	Others

18 Storeys

39

Consider the Forest Type to which the plot belongs and describe the vertical distribution of height of the trees in the stand, in one of the following classes. Do not consider shrubs as a storey.

<u>Code</u>	<u>Item</u>
-------------	-------------

- | | |
|---|------------------------|
| 1 | Single storeyed forest |
| 2 | Two storeyed forest |

The variation in height is such that the trees can be grouped into one upper and one lower canopy.

- | | |
|---|-----------------------|
| 3 | Multi-storeyed forest |
|---|-----------------------|

The variation in height is such that it is not possible to group the trees in canopies.

19 Top Height

40-41

Occularly estimate the average height of the top canopy (i.e. the average of the heights of predominant Codominant trees), in about two hectare of the woodland type to which the 'plot' belongs, and round it off to the nearest 5 metres. Record this height in the appropriate column.

The occular estimate must be checked with 2-3 measurements of predominant and Codominant trees in the stand with Blume Leiss Hypsometer.

Example : 1) If the average height is 27 M, round it off to 25 M and record.

11) If the average height is 28 M round off to 30 M and record.

Notes:- In a young crop with scattered mother trees, the top height of the young trees should be recorded. Ignore the mother trees when estimating the height.

20 Size/Age 42

On the basis of the predominant diameter (over bark at breast height) class in the woodland type to which the plot belongs, classify the age in one of the following classes and write the code in the appropriate column.

Code	Age	D.B.H.O.B in cm for conifers.	D.B.H.O.B.Class in cm. for broad leaved species.
1	Regeneration	Less than 10	Less than 10
2	Young	10 to less than 40.	10 to less than 15
3	Middle aged	40 to less than 60.	15 to less than 20
4	Mature	60 to less than 90.	20 to less than 30.
5	Over mature	90 or more	30 or more.

21 Spacing 43

Observe average spacing of trees in and around the plot in the forest type. Take a few measurements in the beginning. After a few days you should have enough experience to assess the average spacing classify the average in one of the following classes and write the code in this column.

Code	Spacing M.
1	Less than 1.5
2	1.5 to less than 3.0
3	3.0 to less than 4.5
4	4.5 to less than 6.0
5	6.0 to less than 7.5
6	7.5 to less than 9.0
7	9.0 to less than 10.5
8	10.5 to less than 12.0
9	more than or equal to 12.0

22 Regeneration 44

One digit. All seedlings and saplings less than 10 cm. in diameter at breast height (over bark) are to be considered as regeneration. Draw a circle of 2 metres radius around the sample point and count the number of seedlings put the appropriate code.

Code	Description
1	More than 15 - profuse
2	8 to less than 15 - adequate
3	1 to less than 8 - scanty
4	none-nil

23 Chir sub type 45

Wherever Chir occurs whether pure or in mixture with other conifers or broad leaves species. It should be classified into following categories.

<u>Code</u>	<u>Classification</u>	<u>Altitude</u>	<u>Description</u>
1	Lower or unstable sub type.	500 M to 650 M.	Sub species growing around the Chir will be Acacia catechu and Zizyphus spp.
2	Middle or Inter-mediate sub-type	850 M to 1100 M	Under growth of Carisa spinarium & Dodonea Viscosa.
3	The upper or stable sub-type	1100 M to 1550 M	Chir occur under lighted mixture of Quercus incana Rhododendron arboreum, Pin Pyeris ovalifolia Pyrus pashia etc. and other under growth Berberis spp. & Myrsine Africana.
4	Chir Absent	-	Not applicable.

24 Bamboos 60-63

Definition of clump :- A bamboo clump must contain one or more culms or live stumps of currently exploited culms.

Definition of a culm :- A bamboo culm is one which is two metres or more in height and more than 2 cm. in diameter at 1.37 metre height.

Occurrence 60

The presence or absence of bamboo clumps within two hectares area around the plot will be recorded as given below :-

<u>Code</u>	<u>Item</u>
1.	Scattered - 50 clumps or less per ha.
2	Dense - More than 50 clumps but less than 100 clumps per hectare
3	Pure - More than 100 clumps per hectare
4	No bamboo present.

Bamboo
species

61

If more than one species occurs in the plot the most predominant species will be coded in the form.

<u>Code</u>	<u>Item</u>
1	Dendrocalamus strictus
2	Bambusa arundinacea
3	Cephalostachyum pergracile
4	Oxytenanthera spp.
5	No bamboo.

Bamboo
quality

62

Object of assessing site quality for bamboo is to determine the capacity of site to produce bamboo culms of given size. As is the case with trees with tree species, method of assessing the site quality for producing bamboo is indirect one as it relies on the standing clumps in the stand. In case there are no established clumps in nearby area of 2 hectares the quality cannot be defined code number 3 should be filled in such cases. The codes are as under :-

<u>Code</u>	<u>Description</u>
1	Average culms should have height more than 7 metres and average D.B.H. more than 4 cm. (in case of Bambusa species average D.B.H. more than 5 cm. and average height more than 7 metres).
2	Average culms should have height more than 2 metres but average D.B.H. less than 4 cm. (In case of Bambusa average D.B.H. less than 5 cm. but height more than 2 metres).
	<u>Note 1:-</u> Culms more than 4 cm. in diameter in case of dendrocalamus species and Bambusa species respectively but less than 7 metres in height will be recorded under this quality.
3	Bamboo areas not included in quality 1 or 2 should be classified as quality 3.
4	No bamboo

Bamboo
Regeneration

63

Bamboo bearing areas where clump formation is not very clear or area under bamboo regeneration containing bamboo seedlings and culms will be classified in one of the following classes:-

<u>Code</u>	<u>Description</u>
1	Dense regeneration
2	Medium
3	Scattered
4	Absent

25	Weeds & grasses	64	<table><tr><th><u>Code</u></th><th><u>Description</u></th></tr><tr><td>1</td><td>Dense bushes</td></tr><tr><td>2</td><td>Open bushes</td></tr><tr><td>3</td><td>Dense grasses</td></tr><tr><td>4</td><td>Open grasses</td></tr><tr><td>5</td><td>Open bushes & Open grasses.</td></tr><tr><td>6</td><td>Open bushes & dense grasses</td></tr><tr><td>7</td><td>Dense bushes and open grasses</td></tr><tr><td>8</td><td>Dense bushes and dense grasses.</td></tr><tr><td>9</td><td>Absent.</td></tr></table> <p>The incident of weeds and grasses will be coded as under :-</p>	<u>Code</u>	<u>Description</u>	1	Dense bushes	2	Open bushes	3	Dense grasses	4	Open grasses	5	Open bushes & Open grasses.	6	Open bushes & dense grasses	7	Dense bushes and open grasses	8	Dense bushes and dense grasses.	9	Absent.
<u>Code</u>	<u>Description</u>																						
1	Dense bushes																						
2	Open bushes																						
3	Dense grasses																						
4	Open grasses																						
5	Open bushes & Open grasses.																						
6	Open bushes & dense grasses																						
7	Dense bushes and open grasses																						
8	Dense bushes and dense grasses.																						
9	Absent.																						
	Defect & Diseases	65-67	<table><tr><th><u>Code</u></th><th><u>Description</u></th></tr><tr><td>1</td><td>Trees crop is badly lopped</td></tr><tr><td>2</td><td>Tree crop is dying.</td></tr><tr><td>3</td><td>Tree crop defected.</td></tr><tr><td>4</td><td>Trees are mal-formed twisted grain etc.</td></tr><tr><td>5</td><td>No disease, No defect.</td></tr></table>	<u>Code</u>	<u>Description</u>	1	Trees crop is badly lopped	2	Tree crop is dying.	3	Tree crop defected.	4	Trees are mal-formed twisted grain etc.	5	No disease, No defect.								
<u>Code</u>	<u>Description</u>																						
1	Trees crop is badly lopped																						
2	Tree crop is dying.																						
3	Tree crop defected.																						
4	Trees are mal-formed twisted grain etc.																						
5	No disease, No defect.																						
	Grazing Incidence	66	<table><tr><th><u>Code</u></th><th><u>Description</u></th></tr><tr><td>1</td><td>Heavy grazing</td></tr><tr><td>2</td><td>Medium grazing</td></tr><tr><td>3</td><td>Very little grazing</td></tr><tr><td>4</td><td>No grazing.</td></tr></table>	<u>Code</u>	<u>Description</u>	1	Heavy grazing	2	Medium grazing	3	Very little grazing	4	No grazing.										
<u>Code</u>	<u>Description</u>																						
1	Heavy grazing																						
2	Medium grazing																						
3	Very little grazing																						
4	No grazing.																						
	Fire incidence	67	<table><tr><th><u>Code</u></th><th><u>Description</u></th></tr><tr><td>1</td><td>Fire incidence is very high</td></tr><tr><td>2</td><td>Fires are very frequently</td></tr><tr><td>3</td><td>Medium fires occasional</td></tr><tr><td>4</td><td>No fire</td></tr></table>	<u>Code</u>	<u>Description</u>	1	Fire incidence is very high	2	Fires are very frequently	3	Medium fires occasional	4	No fire										
<u>Code</u>	<u>Description</u>																						
1	Fire incidence is very high																						
2	Fires are very frequently																						
3	Medium fires occasional																						
4	No fire																						
26	Plot Status	68	<table><tr><th><u>Code</u></th><th><u>Description</u></th></tr><tr><td>1</td><td>Plot was visited and information collected</td></tr><tr><td>2</td><td>Plot was visited but the information could not be collected.</td></tr><tr><td>3</td><td>Plot could not be visited.</td></tr></table>	<u>Code</u>	<u>Description</u>	1	Plot was visited and information collected	2	Plot was visited but the information could not be collected.	3	Plot could not be visited.												
<u>Code</u>	<u>Description</u>																						
1	Plot was visited and information collected																						
2	Plot was visited but the information could not be collected.																						
3	Plot could not be visited.																						
27	Plot Number	69	One digit. Write the plot no. in one digit.																				
28	Grid Zone Number	70	One digit. The grid zones are mentioned at the bottom of the map sheet. The codes pertaining to various Grid Zones are given in (appendix - II). Write the suitable code in the appropriate column.																				
29	Block Centre Grid Ref.	71-78	Eight digit. Cluster centre grid reference or G.C.G.R. has to be taken from the map sheet, on 1/63,360 sheets. The grids are shown in yards.																				
30	Inventory design	79-80	Two digit. Leave it blank. To be filled in by Data Processing Unit at the time of punching.																				

SAMPLE TREE FORM
CODING INSTRUCTIONS

1. Sample Tree Form is required to be filled in only when the vegetation class in P.D.F. is Forest.
2. Details of the tally trees between North and West Directions should be filled in this form.
3. Bamboo clumps should be ignored.
4. Coding instructions for filling up the Sample Tree Form.

<u>S.No.</u>	<u>Item No.</u>	<u>Col.Nos.</u>	<u>Description</u>
1	Job	1-3	Leave it blank. To be filled up by Data Processing Unit.
2	Card Design	4-5	-do-
3	Report No.	6-7	-do-
4	Sub Report No.	8	-do-
5	Species name	Nil	Write the name of the species in this column (Refer Appendix - III).
6	Serial Number	9-10	Write the serial number of the trees in this column.
7	Species Code	11-13	Refer appendix for the species code for species which are not given in Appendix then in such cases write 098 (Miscellaneous for that species code and write its local name).
8	Dominance	14	Classify the tree in one of the following classes and write the appropriate code for dominance.

<u>Code</u>	<u>Description</u>
1	Dominant
2	Dominated
3	Supressed
4	Tree of under storey
5	Solitary
6	Abnormal and damaged tree.

The following definition will help you in determining the dominance classes.

DOMINANT: Tree is one which forms the uppermost leaf canopy and whose leading shoot is more or less free.

DOMINATED:- Tree one which does not form part of the upper most leaf canopy but the leading shoot of which is not

definitely over topped by the neighbouring trees and its crown is not fully free. Its height is usually about 3/4 of the dominant trees.

SUPPRESSED:- Tree is one whose leading shoot is definitely over topped by their neighbour. Height of such trees is usually about 5/8 of the dominant trees such trees usually suffer from slow growth due to supersession (Note - A small suppressed trees standing with its leader free in a chance gap should not be classed as Dominant or dominated).

TREE OF UNDER STOREY:- is one which is a part of the under storey.

SOLITARY:- Tree is one which is standing alone in a blank.

ABNORMAL AND DAMAGED TREE:- It includes wolf trees, tree of abnormal and damaged trees.

9	Diameter at B.H.in cm.	15-17	Measure with callipers the diameter over bark at breast height of the tree from the point centre.
10	Total height in metres.	18-19	Measure the height of the tree from the base on the uphill side of the tree to the top of the leading shoot with Hypsometer to the nearest metre.
11	Clear Bole	20-21	Measure the height along the stem of the tree from the base on the uphill side to the beginning of the regular crown with B.L. Hypsometer to the nearest metre. Beginning of regular crown in conifers is the point where the first complete live whorl starts. For broad leaved species this point may be recognised as the place from where the 1st major live branch takes off or from where the main stem forks, if forking is above breast height point.
12	Defect Natural	22	Examine the stem of the tree and classify as under on the basis of the extent of "Natural Defects" and write the code in the column headed "Defects Natural".

Code

Description

1	Complete stem length free of natural defects.
2	One third stem length with natural defects.
3	Two third stem length with natural defects.
4	Full stem length with natural defects.

NATURAL DEFECTS:- Under this category all those abnormalities are included which are very natural and normal for the trees e.g. knots, callus formation, twisted or spiral grain (of chir) etc.

13 Defects Others 23

Examine the stem and classify as under on the basis of the extent of defects caused by 'External Agencies' and write the code in the column headed "Defect Others".

<u>Code</u>	<u>Description</u>
-------------	--------------------

- | | |
|---|--|
| 1 | Complete stem free of any defect. |
| 2 | One third of stem length with defects. |
| 3 | Two third of stem length with defects. |
| 4 | Full stem length with defects. |

EXTERNAL AGENCIES DEFECTS:

Include damage caused to the tree stem by pathological, entomological, climatic or biotic factors. Damage by these agencies may result in loss of cellulosic material and weakening of the strength properties of the timber. These include borer attack, fungal attack, fir damage, hollowness, snow and wind damage etc.

14. Crown width 24-26
in decimetres

Measure the crown width in a direction pointing towards the sample point in decimetres.

15 Bark Thickness 27-28
towards P.C.
in mm.

Blaze the tree and remove the bark making a neat cut at the breast height point towards the sample point where the shorter arm of the calliper touches the stem, while taking the diameter measurement "Diameter 1". Measure the bark thickness with a scale to the nearest mm and record in this column.

16 Radial increment 29-30
towards P.C. in
mm.

Collect a core with the increment borer at the breast height point from the side towards point centre. Count the number of annual

17 Last 20 year 31-32

rings from the periphery towards the pith with the help of magnifying glass and measure the increment in millimetre for

18 Last 30 years 33-34

- the last 10 years
- the last 20 years
- the last 30 years

19 Bark thickness 35-36
opposite to
P.C. in mm.

Measure the bark thickness at B.H. opposite to the point centre in same way as done above (col. 27-28) and record.

20 Radial increments
opposite to P.C. 37-38
in mm.
Last 10 years

Measure the increments opposite to the point centre in the same manner as done earlier.

21 Last 20 years 39-40

22	Last 30 years	41-42	
23	Total No. of Trees.	67-68	Total number of trees between North and West direction.
24	Plot Number	69	Plot number should be given as in P.D.F.
25	Grid Zone	70	Grid Zone should be given as in P.D.F.
26	Cluster Centre Grid Ref.	71-78	Should be given as in P.D.F.
27	Inventory Design	79-80	Leave it blank. To be filled up by Data Processing Unit.

TALLY SHEET (B.A. F-2)

CODING INSTRUCTIONS

1. The tally sheet forms should be filled up only when the vegetation class in the P.D.F. is forest. For all other categories of vegetation class tally sheet form is not required, because tally is not required to be taken in all these cases. Tally is to be taken with B.A. F-2.
2. Ignore Bamboo clumps for taking tally with B.A. F-2.
3. Ignore trees having less than 10 cm. D.B.H.O.B.
4. Always take a sweep around the area with the Relaskop to count the tally of 'IN' trees from North and moving in clock-wise direction.
5. Measure with callipers the diameter (OB) at breast height (at a point 1.37 metre above the base of the tree from the uphill side) of all the 'IN' trees.
6. Take only one D.B.H.O.B. measurement towards the point centre.
7. If you can not decide by observation whether the tree is 'IN' or 'OUT' then measure the horizontal distance of the tree from the peg and diameter of the tree and check up from the table given in the end in Appendix.
8. In hilly areas the breast height point (1.37 metre) from the ground level should be reckoned from the uphill side.
9. If there is abnormality at the breast height then in such cases find out another point for measurement of diameter either little above or little below the actual breast height point.
10. In case a tree is forking below or at the breast height point each stem originating from the point of forking will be considered as a separate tree and each will be measured separately for diameter.
11. Code of the species are given in appendix.
12. Instructions for filling the tally sheet form.

<u>S.No.</u>	<u>Item</u>	<u>Col. Nos.</u>	<u>Description</u>
1	Job	1-3	Leave it blank. To be filled in by D.P.U.
2	Card Design	4-5	-do-
3	Report No.	6-7	-do-
4	Sub Report No.	8	-do-
5	Species code	9-11, 15-17 21-23, 27-29 33-35, 39-41 45-47, 51-53 57-59.	Fill up the species code in these columns according to the Appendix - III.

6	Diameter	12-14, 18-20, 24-26, 30-32, 36-38, 42-44, 48-50, 54-56, 60-62.	Diameter should be filled up in nearest cm.
7	Total No. of trees.	67-68	Total number of the trees in tally to be filled in this column.
8	Plot Number	69	Plot number should be given as in P.D.F.
9	Grid Zone	70	Grid Zone should be given as in P.D.F.
10	Cluster - Centre Grid Ref.	71-78	Should be given as in P.D.F.
11	Inventory Design	79-80	Leave it blank.. To be filled up by Data Processing Unit.

APPENDIX

PLOT RADIUS FOR VARIOUS DIAMETERS

*FOR BASAL AREA FACTOR 2. PLOT RADIUS FACTOR = .3536

<u>D.B.H.O.B.</u> CM	<u>PLOT RADIUS</u> M	<u>D.B.H.O.B.</u> CM	<u>PLOT RADIUS</u> M
1.	.3536	51.	18.0336
2.	.7072	52.	18.3872
3.	1.0608	53.	18.7408
4.	1.4144	54.	19.0944
5.	1.7680	55.	19.4480
6.	2.1216	56.	19.8016
7.	2.4752	57.	20.1552
8.	2.8288	58.	20.5088
9.	3.1824	59.	20.8624
10.	3.5360	60.	21.2160
11.	3.8896	61.	21.5696
12.	4.2432	62.	21.9232
13.	4.5968	63.	22.2768
14.	4.9504	64.	22.6304
15.	5.3040	65.	22.9840
16.	5.6576	66.	23.3376
17.	6.0112	67.	23.6912
18.	6.3648	68.	24.0448
19.	6.7184	69.	24.3984
20.	7.0720	70.	24.7520
21.	7.4256	71.	25.1056
22.	7.7792	72.	25.4592
23.	8.1328	73.	25.8128
24.	8.4864	74.	26.1664
25.	8.8400	75.	26.5200
26.	9.1936	76.	26.8736
27.	9.5472	77.	27.2272
28.	9.9008	78.	27.5808
29.	10.2544	79.	27.9344
30.	10.6080	80.	28.2880
31.	10.9616	81.	28.6416
32.	11.3152	82.	28.9952
33.	11.6688	83.	29.3488
34.	12.0224	84.	29.7024
35.	12.3760	85.	30.0560
36.	12.7296	86.	30.4096
37.	13.0832	87.	30.7632
38.	13.4368	88.	31.1168
39.	13.7904	89.	31.4704
40.	14.1440	90.	31.8240
41.	14.4976	91.	32.1776
42.	14.8512	92.	32.5312
43.	15.2048	93.	32.8848
44.	15.5584	94.	33.2384
45.	15.9120	95.	33.5920
46.	16.2656	96.	33.9456
47.	16.6192	97.	34.2992
48.	16.9728	98.	34.6528
49.	17.3264	99.	35.0064
50.	17.6800	100.	35.3600

Instructions for interpretation of Aerial Photographs

Chir belt - Himachal Pradesh

Aerial photographs for most of the areas in Rajgarh and Nahan forest divisions are available. The specifications are :-

Task No. .. 523-A
Scale .. 1:15,000 to 1:25,000
Time of photography .. October, November, 1967.

Each crew leader will carry out interpretation of aerial photographs in the field besides collection of data from the ground samples.

Before a camp is shifted, he will ensure that interpretation of aerial photographs pertaining to the area is also completed and he has not to come back again in that area either for interpretation or its verification.

From the study of aerial photographs and the visits to the area and use of the area should be categorised into the following broad categories.

<u>Sl.No.</u>	<u>Land use</u>	<u>Code</u>
1	Forests	A
2	Scrubs	B
3	Grasslands	C
4	Barren lands	D
5	Rocky outcrops	E
6	Cultivation	F
7	Orchards	G
8	Habitat and Rehabilitation	H
9	Water/River beds	I

Forest lands should be further classified by forest types, crown and volume densities. Important forest types can be one of the following :-

1	Chir
2	Deodar
3	Kail
4	Fir
5	Spruce
6	Fir-spruce
7	Kail-Fir-Spruce
8	Mixed conifers
9	Conifers mixed with Broad leaves.
10	Sal
11	Sal with other hardwoods
12	Mixed hardwoods
13	Ban Oak
14	Chir with oak
15	Chir with khair
16	Khair
17	Eucalyptus species
18	Deodar-kail
19	Kharsu oak
20	Moru oak
21	Kharsu-oak, moru-oak
22	Broad leaves with bamboos.

Crown density classed should be clumped as under :-

<u>Class</u>	<u>Density</u>
I	.4 or less than .4
II	.7 and .4 or .4 to less than .7
III	7 - above .7.

Volume densities (though difficult to predict) should be estimated after due consideration of crown density, height of the trees and age of the forest crop etc. The different classes adopted for volume densities should be :-

<u>Volume Density</u>	<u>Volume per hectare</u>
VI 1 (Low)	50 m ³
V 2 (Medium)	150 m ³ & 50 m ³
V 3 (High)	150 m ³

$$B.A. F-2 \times Av. ht. \times .45 = M^3 \quad 20 \times 20 \times .45 = M^3$$

During the course of interpretation of aerial photographs and their verification in the field if it were felt that some changes are required to be made in broad land use classes, forest types, crown and volume densities, they should be suitably incorporated in the set of instructions after discussions with the officers in charge of the field work.

BAMBOO ENUMERATION AND WEIGHT STUDY FORMCoding Instructions for Field work:

1. Whenever it is indicated in the P.D.F. that there are bamboos occurring in the area, this form should be filled up.
2. For filling up this form, lay out a fixed plot of 0.1 hectare in extent and sample point as the centre of the plot. The plot should be square in size and its all four corners should be towards North, East, South and West.
3. For each plot a separate form will be used.
4. Coding instructions for filling up this form are as follows :-

<u>S.No.</u>	<u>Item No.</u>	<u>Column No.</u>	<u>Description</u>
1.	Job No.	1-3	Leave it blank. To be filled in by DPU.
2	Card Design	4-5	-do-
3	Report No.	6-7	-do-
4	Sub Report Number	8	-do-
5	Crew Leader	9-10	Same as in P.D.F.

Information for columns 11-23 will be filled in for each plot.

Enumeration of Bamboo clumps in the plot by size classes :

Size Class less than 1 metre.	Col. 11-13	All clumps of less than 1 metre, diameter will be recorded in this class.
Size class 1-2 M.	Col. 14-16	All clumps of diameter between 1 M and 2-M. will be recorded in this class.
Size class 2 M. and more.	Col. 17-19	Clumps having diameter more than 2 M. will be recorded here.
Total No. of clumps	Col. 20-22	The number of the clumps will be recorded serially in three digits code number.
Bamboo Flowering	Col. 23	The condition of flowering will be recorded in one of the following classes:-

<u>Item</u>	<u>Code</u>
Gregarious flowering	1
Speradio flowering	2
No. flowering	3

INFORMATION ABOUT CULMS IN A CLUMP

This information should be collected only for one plot in each cluster. Plot No. 1 should be taken preferably. In case there are no bamboos in plot No. 1, Plot No. 2, should be taken. Plot No. 4 will be taken if no bamboo occur in plot No. 1, 2 & 3. Since information is to be collected only from the North-Western quadrant of the plot and in case it happens that although plot No. 1 contains bamboos, yet no bamboo are there in the North-Western quadrant, then North-Western quadrant of plot No. 2 should be taken and so on as the case of selection of plot. Further if it happens that North-Western quadrant of all the plots do not contain any bamboos, the information should be collected from the next quadrant i.e. North-East quadrant of the plot, keeping the selection of the plots and the quadrant as indicated above. Similarly the arguments for collection of information from East, South-West, quadrants can be extended to.

Information in column 24-47 will be filled up as under :-

Clump No.	Col. 24-26	The number of the clumps will be recorded serially in three digit code number.								
Size class	Col. 27	<p>The diameter of the clump will be measured with the help of tape at right angles to each other and average diameter will be recorded to the nearest metre in one of the following three size classes:</p> <table><tr><td><u>Size class</u></td><td><u>Code</u></td></tr><tr><td>Less than 1 metre</td><td>1</td></tr><tr><td>1 metre to 2 metre</td><td>2</td></tr><tr><td>More than 2 metre</td><td>3</td></tr></table>	<u>Size class</u>	<u>Code</u>	Less than 1 metre	1	1 metre to 2 metre	2	More than 2 metre	3
<u>Size class</u>	<u>Code</u>									
Less than 1 metre	1									
1 metre to 2 metre	2									
More than 2 metre	3									
Species code	Col. 28	<p>The species of Bamboo will be recorded according to the code numbers given as below :-</p> <table><tr><td><u>Code</u></td><td><u>Species</u></td></tr><tr><td>1</td><td>Dendrocalamus strictus</td></tr><tr><td>2</td><td>Bambusa arundinacea</td></tr></table>	<u>Code</u>	<u>Species</u>	1	Dendrocalamus strictus	2	Bambusa arundinacea		
<u>Code</u>	<u>Species</u>									
1	Dendrocalamus strictus									
2	Bambusa arundinacea									

No. of culms as per Age :

Number of culms on a clump will be recorded in the following three age classes according to the age of the culms.

Current season's	Col. 29-30	No. of culms of current season will be enumerated and recorded in the two digit code number.
Two season's	Col. 31-32	No. of culms of two seasons will be recorded here in two digit code number.
Three season's & more.	Col. 33-34	No. of all mature culms of three and more season's will be recorded in two digit code number.

Total No. of culms Col. 35-36 Total No. of culms in the clump
(i.e. sum of cols. 29-30, 31-32, 33-34)
will be recorded in two digits code no.

Damaged/Dry/Rotten Culms:

Damaged & Col. 37-38 No. of damaged or top broken culms in the
To broken. clump will be counted and recorded in two
digit code number.

Dry scarred Col. 39-40 No. of culms which are rotten or scarred
or rotten (Dry) and are un-utilizable will be counted
culms. and recorded here in two digit code number.
If the culms is scarred but not dry, it will
not be counted for the purpose of this
column.

Size of Culms :

Average total Col. 41-42 Average total length of two felled culms
length in mts. from each of clumps will be recorded to the
nearest metre in two digit number.

Average length Col. 43-44 Average length upto 2 cm. diameter of two
upto 2 cm. felled culms from each of two clumps will
diameter. be recorded to the nearest metre in two digit
number.

Average culm Col. 45-46 Average of diameters at B.H. of two standing
diameter in cms. culms from each clump will be recorded to
the nearest cm. in two digit number.

Hollowness Col. 47 The cut culms will be observed from both
ends (cut the culms at 2 cms. diameter also)
and the information will be recorded as
below :-

<u>Item</u>	<u>Code</u>
Solid	1
Hollow	2

Bamboo weight

<u>Position on</u>	<u>Col.</u>	<u>Item</u>	<u>Code</u>
weight studies	48	Studies done	1
		Studies no done	2

No. of culms cut Col. 49 No. of culms cut, measured and weighted
measured & should be entered in this column.
weighted.

Green weight Col. 50-52 The green weight of each bundle should be
recorded in this column to the nearest 100 gms.

Dry weight at successive weighings :

After 1 month Col. 53-55 1st weighing to be done after one month of
felling and bundling.

After 2 months Col. 56-58 2nd weighing to be done after two months of
felling and bundling.

After 3 months	Col. 59-61	3rd weighing to be done after three months of felling and bundling.
After 4 months	Col. 62-64	4th weighing to be done after four months of felling and bundling.
	Col. 65-66	It is blank.
Plot No.	Col. 69	Same as in P.D.F.
Grid Zone	Col. 70	-do-
Block Centre Grid Ref.	Col. 71-78	-do-
Inventory Design	Col. 79-80	-do-

APPENDIX - I

<u>Name</u>	<u>Code</u>
Shri M.S. Bist	01
Shri M.S. Mehta	02
Shri R.L. Gandhi	03
Shri O.P. Gaba	04
Shri D.S. Bist	05
Shri S.K. Agarwal	06

APPENDIX - IIGRID ZONES

	<u>Code</u>
O	1
IA	2
IB	3
IIA	4
IIB	5
IIIA	6
IIIB	7
IVA	8
IVB	9

APPENDIX - IIICode Nos. for Northern Zone Species

<u>Botanical name</u>	<u>Code</u>
<i>Shorea robusta</i>	001.
<i>Pinus roxburghii</i>	002
<i>Pinus roxburghii</i> (Twisted grain)	003
<i>Pinus excelsa</i>	004
<i>Cedrus deodara</i>	005
<i>Picea morinda</i>	006
<i>Abies pindrow</i>	007
<i>Taxus baccata</i>	008
<i>Quercus incana</i>	009
<i>Quercus dilatata</i>	010
<i>Quercus semicarpifolia</i>	011
<i>Betula utilis</i>	012
<i>Alnus nitida</i>	013
<i>Populus ciliata</i>	014
<i>Juglans regia</i>	015
<i>Acer</i> spp.	016
<i>Aesculus indica</i>	017
<i>Fraxinus paxus</i>	018
<i>Rhododendron arboreum</i>	019
<i>Pieris ovalifolia</i>	020
<i>Celtis australis</i>	021
<i>Ulmus wallichiana</i>	022
<i>Rhus</i> spp.	023
<i>Morus</i> spp.	024
<i>Corylus colurna</i>	025
<i>Salix</i> spp.	026
<i>Pistacia integerrima</i>	027

<i>Terminalia tomentosa</i>	028
<i>Lannea coromandelica</i>	029
<i>Anogeissus latifolia</i>	030
<i>Mallotus philippinensis</i>	031
<i>Grewia</i> spp.	032
<i>Bauhinia</i> spp.	033
<i>Buchanania latifolia</i>	034
<i>Syzygium cumini</i>	035
<i>Acacia catechu</i>	036
<i>Ficus</i> spp.	037
<i>Boswellia serrata</i>	038
<i>Erythrina suberosa</i>	039
<i>Pyrus pashia</i>	040
<i>Diospyros</i> spp.	041
<i>Eugenia dalbergiodes</i>	042
<i>Salmaia malabarica</i>	043
<i>Terminalia bellerica</i>	044
<i>Cassia fistula</i>	045
<i>Flacourtia ramontchi</i>	046
<i>Kydia calycina</i>	047
<i>Mitragyna parvifolia</i>	048
<i>Ehretia laevis</i>	049
<i>Zizyphus</i> spp.	050
<i>Nyctanthes arborescens</i>	051
<i>Emblica officinalis</i>	052
<i>Aegle marmelos</i>	053
<i>Boehmeria</i> spp.	054
<i>Casuaris tomentosa</i>	055
<i>Limonia</i> spp.	056
<i>Cedrela toona</i>	057

<i>Holoptelea integrifolia</i>	058
<i>Madhuca latifolia</i>	059
<i>Terminalia chebula</i>	060
<i>Lagerstroemia parviflora</i>	061
<i>Adina cordifolia</i>	062
<i>Butea monosperma</i>	063
<i>Cordia myxa</i>	064
<i>Schleochera oleosa</i> (trijuga)	065
<i>Moringa pterygosperma</i>	066
<i>Albizzia lebbek</i>	067
<i>Artocarpus lakoocha</i>	068
<i>Bridelia retusa</i>	069
<i>Dalbergia sissoo</i>	070
<i>Caruga pinnata</i>	071
<i>Phoebe lanceolata</i>	072
<i>Phoenix sylvestris</i>	073
<i>Prosopis</i> spp.	074
<i>Quercus glauca</i>	075
<i>Machilus odoratissima</i>	076
<i>Cypress</i> spp.	077
<i>Thuja compacta</i>	078
<i>Cedrela serrata</i>	079
<i>Melia azadirachta</i>	080
<i>Kigelia pinnata</i>	081
<i>Mangifera indica</i>	082
<i>Cardenia</i> spp.	083
Other miscellaneous	098
<i>Fraxinus</i> spp.	099
<i>Robinia psuedacacia</i>	100

Bearing from S.P.1 to S.P.2	=	150 g	grades
Bearing from S.P.2 to S.P.3	=	250 g	grades
Bearing from S.P.3 to S.P.4	=	350 + g	grades
Bearing from S.P.4 to S.P. 1	=	(50 +g)	grades
Bearing from S.P.1 to S.P. 4	=	250 + g	grades
Bearing from S.P.4 to S.P.3	=	150 + g	grades
Bearing from S.P. 3 to S.P.2	=	50 + g	grades
Bearing from S.P. 2 to S.P.1	=	350 + g	grades

Where 'g' is the angle (in grades) between mean grid north and true north for the map under consideration.

APPENDIX - II

MANUAL FOR VOLUME & CULL FACTOR STUDY
(FOR CHIR)

The study of volume factor and cull factor study in Rajgarh and Nahar Forest Division for Chir (Pinus - Roxburghii) is to be carried out with the cooperation of Working Plan Staff of Rajgarh Forest Division.

1. SAMPLING DESIGN

1.1 It has been decided to carry out this study only with respect to Chir. The selection of point for felling has been done on the basis of two stage sampling with restrictions on the number of trees to be felled on each point. In first stage sample points were selected systematically at the distance of 2,000 yards to 3,000 yards for inventory. On the basis of inventory results the sample plots were classified into different forest types. At the second stage, the selection of sample point for felling the trees for the study of volume and cull factor studies has been done randomly.

1.2 It has been worked out that for required precision felling of 5 to 10 trees in each diameter and height classes would be enough for calculation of volume factor.

1.3 Thus in total 135 to 150 trees covering the whole range of diameter and height classes would be felled. It is assumed that 30 sample plots would be sufficient to provide the above required number of trees to be felled. The selection of these 30 plots is to be done randomly. The plots selected with the help of random table are given in the annexure - 1.

2. SELECTION OF SAMPLE TREES:

2.1 To collect the data for volume and cull factor study the trees will have to be felled to enable the measurement at different places of height. For this purpose, it is necessary that the trees should be selected without bias and should represent the whole class of population.

2.2 For this purpose in each sample plot, a tally will be taken with relascope, as in inventory using basal area factor - 2. All the trees of 10 cm (6 1/2 over bark) and over will be serially numbered in the sequence of tally. The tally will start from North West direction and proceed in a sweep in clockwise till it completes the circle.

2.3 The number of trees for felling at each sample point would be 4 to 6. For this take the tally as described in para 2.2 and given them the serial number. It has been decided to fell first 4 to 6 even numbers of trees found in the tally.

If the required numbers of trees for one diameter/height class are achieved and other dia-height class trees are not available the felling may not be done at that sample point.

2.4 In order to reduce the expenditure on this study and to avoid the felling of more number of trees, it has been decided to carry out the measurements for the study in departmental or contractors coupe, if available adjacent to the sample plot.

3. FIELD PROCEDURAL:

3. FELLED PROCEDURE:

3.1 The Crew leader should copy out the approaches of the sample points selected randomly, where the felling is to be done. This work should be completed at the hrs., where approach description for all the sample plots are available.

3.2 All the tools and implements should be collected for the field work before proceeding to the field. The crew leader should have a list of tools required in the forest and should check it personally.

3.3 Locate the sample point with the help of approach description and maps of the area. In case the centre of the plot (peg) is not available this can be located with the help of reference tree.

3.4 In case the old sample points are not located inspite of thorough search all around, then locate a sample point afresh, as it is done for inventory, and fix the point. Record this fact that the sample point done by inventory crew could not be located.

3.5 From the sample point, take a relascope tally using basal area factor-2 and give serial number to all the 'in' trees which are 10 cm. and above at breast height over bark.

3.6 Mark the breast height point in a range in all trees on the side facing to the plot centre. The diameter should be taken towards the point centre and perpendicular to the point centre.

3.7 Felling of the trees should be undertaken under the direct supervision of crew leader. The trees should be felled as near to the ground level, as possible. The trees should be felled using all precautions for felling. For felling, use power chain saw and hand saws.

4. NUMBERING OF TREE PORTION:

4.1 The following sequence will be used for denoting the main stem and the branches of the tree. The main stem of the tree up to the leading shoot will be tree portion 01 and the branches will be called as tree portion 02, 03, 04 and so on depending upon the number of branches of 5 cm. diameter over bark. See figure 1.

5. MEASUREMENT OF STEM WOOD:

5.1 Measure the length of stem from the breast height point up to the tip of leading shoot placing the tape reading 1.37 metre at B.H. of the tree and record the length of the tree. Let this be 'L'.

5.2 Marking of the sections will be at $L/10$, $2L/10$ and upto $9L/10$ along the main stem of the tree portion 01. If there is any abnormality on the stem with the tree portion 01 such as knots, swelling, burs etc. mark must be shifted above or below from the point so that the abnormal portion is avoided. The marking should be continued up to the tip of the tree upto 5 cm. d.b.b. Also mark the sections where D.O.B. is 5 cm, 10 cm and 20 cm and record in the appropriate column. In case $L/10$ sections fall on these diameters then separate marking is not required. Cut the tree at the various sections marked with the chalk. The trees should be cut in such a manner that the end faces are perpendicular to the axis of the log.

6. NUMBERING OF SECTION:

6.1 Number of the sections should be done serially from the base of the tree to the tip (upto 5 cm d.b.h.). The first section number will be 01 at the stump level and the successively numbers will be above the stump level at various points where the section have already been marked. The section will be numbered as 01, 02, 03 and so on. It is illustrated in the fig. No. II.

7. MEASUREMENT OF THE SECTIONS:

7.1 The following measurements are to be made and recorded of each section on the tree volume study forms:-

Height of the section from the ground level.

In case of first section, theoretically measurement should be taken at ground level. The section of the stump level will be studied when it is not possible to get the tree cut exactly at the ground level. To find out the height of any section from the ground level, measurement is taken from the breast height point which forms the reference point even for the section at breast height point. For the purpose of measurement the height of any section, place 1.37 metres point of the tape at breast and take the reading. The height will be measured correct to a centimetre.

8. MEASUREMENT OF DIAMETER:

8.1 On each section the diameter over bark and under bark towards sample point, another diameter perpendicular to the first will be measured. The diameters will be measured with the help of metre scale correct to a mm. If the face of the section where the measurement is to be done is not perpendicular to the axis of the log the scale will be held perpendicular to the axis and correct diameter will be recorded.

9. COUNTING OF ANNUAL RINGS:

9.1 Count the total number of rings and record in the appropriate column. Care should be taken to avoid false rings which some times appears on the sections. For this count only those rings which forms a complete circle. Whenever the rings are close, make the use of magnifying glasses. To make the rings more distinct you can clean the cut portion of the section with water.

10. MEASUREMENT OF DEFECT:

10.1 Section is to be examined to see if there are any defects on it. There may be rot, knot, hollowness etc. on the face of the section. If there is any defect then enclose the defect in a rectangle by drawing a line with copying pencil and measure the sides of the rectangular and write in the appropriate column. This will give the area of the defective portion. Sometimes defect may be present in more than one patch then it has to be examined whether it is possible to take out a sound piece in between the defective portions.

10.2 If the two defective portions are within 10 cm it is then not possible to take out any sound piece in between. In such cases the defective portions will be combined and one rectangular portion covering the entire defective area will be there and its measurement will be recorded. Where the defective portions are more than 10 cm apart the measurements are to be recorded, separately by enclosing each within rectangle. See Figure II.

11. MEASUREMENT OF BRANCH WOOD:

All the branches of 5 cm and above dbh are to be considered as separate tree portion. Just as in case of tree portion 01, i.e. the main stem when first section is at the base of the tree, similarly in case of branches the first section would be at the base of the branch, i.e. from the junction of the main stem and the branch of the junction of the branch and sub-branch, as the case may be. The sub-branch means a branch which is not originating from the main stem and which is coming out of other branch. The further section of the branch will be done at an interval of one metre till the point where 5 cm. diameter over bark is reached. The portion of the branch less than 5 cm. dbh will be ignored. If the length of the last section where 5 cm dbh has been reached is less than 0.5 metres, it should be included in the previous section. But if the length of the last section is more than 0.5 metre it would be treated as a separate section.

12. STEM ANALYSIS

Stem analysis will be carried out in chir on the same trees in each diameter and height class, felled for volume study. The measurements are to be done on the face of each section and also in the breast height section.

13. DETERMINATION OF AVERAGE RADII:

13.1 For each section two under bark callipered diameter at right angles are totalled and averaged giving average diameter and this figure is divided by two to give average radius. Two average radii angularly as far apart as possible should be located on each section covering from the pith to the circumference with the help of analysis rule or ordinary scale. The selected radii should be ruled on the section with the soft pencil.

13.2 The first measurement is always to be done at breast height section, mark the two average radii as explained above. Count the rings from the pith to the periphery on these average radii and fix pin at every 10 rings. In case the total number of rings are not multiple of 10, then less than 10 rings will be left in between the last pin and periphery of the section. If the annual rings are clear and well spaced it is only necessary to place a strip along the selected radii, if there are defects on the surface of the section it must be cleaned. Moistening with water brings out the rings more clearly.

13.3 The first measurement is always to be done on the breast height section. Counting should be done by decades from the pith outwards along the line marked. A pin should be inserted on each completed decade. Leave the incomplete decade on circumference. It should be checked that there is same number of rings on each radius.

13.4 On each of remaining section, a number of rings corresponding to the outer most incomplete decade on the breast height section should be marked off first, counting from the cambium.

13.5 The remaining rings should be marked off in decade counting inwards and the total number noted.

13.6 Radii should be measured from the pith outward to each pin beginning with the outer most. These measurements should be taken to the nearest millimeter. Repeat the measurement in all other sections in the same way as explained above.

14. SEEDLING DATA:

14.1 Free growing seedling from 1 m. to 2 m. in height should be selected and their ages determined by any method which can be satisfactorily applied. For this purpose, the data should be recorded in seedling data form. It is better to select the seedling if it is occurring near the sample point. If the seedling of the required height is not available near the plot, then the adjacent area should be searched. One seedling at one plot would be enough to give the desired result.

14.2 If the felling is going on in some departmental or contractor's coupe and which fall near the sample point, this data may be recorded from the felling coupe. Count the rings at the ground level and at height of 1 metre, 1.37 metres, 1.5 metres and 1.75 metres and record in appropriate columns.

TREE VOLUME STUDY FORM-ITree Volume Study (For standing trees).

All the columns in Tree Volume Study Form (for standing trees) excepting Vol. I to 5 and 77-78 are to be filled. The information in col. 8-23 pertain to the plot description form and col. 24-63 pertains to sample tree form data as given in the Inventory Manual for Chief belt (HF). Fill up each column as explained below :-

Col. No.

1-3	Job No.	Leave it blank.
4-5	Card Design	Leave it blank.
6-7	Crew Leader	Give your Code Number
8-9	State	For H.P. Code is 02.
10	Forest Division	Give the Code of the division in which you are working. The code number for different divisions is given in the Inventory Manual.
11	Forest Type	Classify the Forest into forest type as per the instruction given in the Inventory Manual.
12-14	Species	Write the species code in col. 12-14.
15	Origin	Refer F.D.F. instructions in Inventory for Chief belt (Rajgarh-Nahan).
16-17	Average Height	
18	Size class	
19	Crown density	
20	Slope	
21-22	Altitude	Fill up from the list available at the office.
23	Aspect	Fill up from the list available at the office.
24	Tree No.	Write the number of the tree.
25-27	Species	Refer Inventory Manual for Rajgarh-Nahan.
28	Dominance	Refer Sample Tree Form Instructions in Inventory Manual.
29-31	D.B.H.O.B. towards S.P.	Measure the diameter at breast height with the calliper pointing the longer arm towards the sample point or peg.
32-34	D.B.H.O.B. perpendicular to P.C.S.P.	Measure the diameter at breast height keeping the longer arm of the calliper in a direction perpendicular to the sample point.

35-36	Height of the Tree	Refer Sample Tree Form instruction in Inventory Manual.
37-38	Clear Bole	-do-
39	Natural defect	-do-
40	Defect others	-do-
41-42	Crown width towards P.C.S.P.	Measure the crown width in the direction of the sample point in decimeter and record.
44-48	Crown width perpendicular to S.P.	Measure the crown width in a direction perpendicular to the sample point in decimeter and record.
47-48	Last 10 years increment towards S.P.	Refer sample tree form instruction in the Inventory Manual.
49-50	Last 20 years increment towards S.P.	-do-
51-52	Last 30 years increment towards P.C.	-do-
53-54	Last 10 years increment perpendicular to S.P.	-do-
55-56	Last 20 years increment perpendicular to S.P.	-do-
57-58	Last 30 years increment perpendicular to S.P.	-do-
59	<u>Tree Felled</u> Tree Not felled	Use the following code to denote whether the tree has been felled or not. Tree Not felled - 1 Tree felled - 2
60-61	No. of tree portions	Write the total number of tree portion in the tree. This column should be filled only when the tree has been felled. In case of coniferous species it will always be 01.
62-63	Total No. of Trees	This will correspond to the total tallied trees in the sample point.
64	Point No.	Give the number of the sample point i.e. 1, 2.
65-67	Cluster No.	Give the number of the cluster in 3 digits
68	Grid Zone	It is always 1 for H.P.
69-76	C.G.G.R.	Give the grid reference of the cluster
77-78	Inventory Design	Leave it blank.

TREE VOLUME STUDY FORM (Felled Trees) - III

Fill up the various columns as explained below :-

Col. No.

1-3	Job No.	Leave it blank.
4-5	Card Design	-do-
6-7	Tree Number	Here give the serial number of the tree that was given to the tree after taking tally.
8-10	Species	Give the species code for the tree.
11-12	Tree Portion	Write the code for the tree portion for which the data is being recorded in the subsequent columns. For main stem it will be 01 and for branches it will be 02, 03 and so on.
13-14	Section No.	How the section will be numbered has already been explained. Here write the section no. for which the data is being collected.
15-18	Height of the section.	The height of the section above the base of the tree in case of 01 portion and above the junction of the branch and stem for junction of two branches in case of tree portion 02 or more to be given in this column. It has been already explained that B.H. will be taken as a reference point for the determination of the height of the section for portion No. 01. The height is to be recorded correct to the nearest centimeter.
19-20	D.O.B. towards point centre.	Measure the diameter over bark towards point centre upto the nearest millimetre.
23-26	D.O.B. perpendicular to P.C.	Measure the diameter over bark in a direction perpendicular to the point centre upto the nearest millimeter.
27-30	D.U.B. towards P.C.	Measure the under bark diameter towards point centre upto the nearest millimeter.
31-34	D.U.B. perpendicular to P.C.	Measure the under bark diameter in a direction perpendicular to point centre to the nearest millimeter.
35-37	No. of rings at the section.	Count the number of rings on the face of the section from the pith to the periphery of the section of record the number.
38	Gull presence	Examine whether there are defects on the section or not and fill the appropriate code as given below :- Defects present - 1 Defects absent - 2

39-40

Type of defect

This column will be filled only when in col. 38 the presence of defect has been shown. When there is no defect put '0' in the column No. 38 & 40. In case there is a defect it will be classified into the following main classes in col.

<u>Type of defect</u>	<u>Code</u>
Knot	1
Rot	2
Crack	3
Insect damage	4
Burrs	5
twist	6
Others	7

In col. 40 each of the above defect is to be further classified according to the description given below :-

Rot

Fibrous Rot	1
Pocket Rot	2
Spongy Rot	3

Knot

Loose knot	1
Tight knot	2

Cracks

Superficial cracks	1
--------------------	---

(Not deeper than 0.5 cm. and not wider than 1 mm.)

Radial shake	2
(Crack from surface inwards deeper than 2.5 cm. and wider than 1 mm).	

Star shake	3
(Crack from pith onwards)	

Cup shake	4
(Crack along the rings)	

Others

Fire damage	1
Hollowness	2

41-43 } Size of
44-46 } rectangle.

Enclose the defect in a rectangle and write the measurement of the sides in mm.

47-48 }
49-51 }
52-54 }

When the number of defects is more than one these columns are to be used similar to columns 39-40. Whenever there is no defect put '00' as the size of the rectangle.

- 55 **Straightness** Each section has to be examined in respect to its straightness. It will be classified into the following classes and the appropriate code will be used :-
- | | <u>Code</u> |
|---|-------------|
| Straight | 1 |
| Slightly bent
(less than 10°) | 2 |
| Pronounced bent
(one bend more than 10°) | 3 |
| Crooked
(more than 1 bend) | 4 |
- 56 **Shape of section** Classify the end face of the section in the following classes and write the appropriate code :-
- | | <u>Code</u> |
|---|-------------|
| Circular | 1 |
| Elliptical
(one diameter longer than the other by more than 20%) | 2 |
| Fluted
(where the periphery of the section is wavy). | 3 |
- 57 **Anticipated out turn (Round wood%)** Assess the anticipated percentage of the wood in round that can be utilised from the tree. While assessing the utilisable wood give due consideration to loss in felling. Defects natural and others etc. The assessment will be done for the entire tree and not section-wise. The following code will be used to denote the various utilisation percentages :-
- | | |
|---------------|---|
| Up to 10% | 1 |
| 10-20% | 2 |
| 20-30% | 3 |
| 30-40% | 4 |
| 40-50% | 5 |
| 50-60% | 6 |
| 60-70% | 7 |
| 70-80% | 8 |
| and above 80% | 9 |
- 58 **Anticipated outturn (Sawn wood %)** Assess the anticipated out turn of the sawn wood after accounting for the losses in sawing, defects etc. and classify into one of the following classes :-
- | | |
|---------------|---|
| Up to 10% | 1 |
| 10-20% | 2 |
| 20-30% | 3 |
| 30-40% | 4 |
| 40-50% | 5 |
| 50-60% | 6 |
| 60-70% | 7 |
| 70-80% | 8 |
| 80% and above | 9 |

59-62	Average D.B.H. O.B.	Calculate the average D.B.H., O.B. by converting the girth over bark at breast height into diameter. Average diameter = Girth \times 7/22 Write the diameter nearest to the millimeter.
63-66	Total length of the tree (in cms.)	Measure the length of the tree from B.H. point to the tip of the tree and add 1.37 M. to get the total length of the tree.
67-68	Total No. of section.	Here write the total number of sections for each tree portion.
69	Point No.	Write the point number of the cluster.
70	Grid Zone	It will always be 1 for H.P.
71-78	Cluster Centre Grid reference	Write the C.C.G.R. from the map sheet.
79-80	Inventory Design	Leave it blank.

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GROWTH STUDY FORM NO. III
GROWTH STUDY FORM

The detailed columnwise instructions for filling in the Growth study Form is given below :-

Col. No.

1-3	Job No.	Leave it blank
4-5	Card Design	-do-
6-7	Crew Leader	Write your code.
10-11	Species	Write the code number of the species, as given in the inventory manual of H.P. (Chir Belt). In this case it will be always Chir.
12-13	Section No.	Write the number of the section on which the measurement is being done.
14-17	Height above the base	Measure the length of the section taking BH point as reference and subtract or add the value to 1.37 M. depending upon whether the section is below B.H. or above B.H. respectively.
18-20	No. of rings on the section.	Count the total number of rings on the section and write the total count.
21-24	D.O.B. mm.	Write the average diameter over bark which is calculated from the girth measurement.
25-28	D.U.B. mm.	Write the average diameter under bark calculated by subtracting double the bark thickness from the average diameter over bark.
29	Radius No.	In each section two average radii will be drawn. Number one of them as 1 and the other as 2. The measurement on each section have to be done on radius 1 and radius 2 separately.
30	Century code	When the total number of rings are within 100 then put century code 1. When the number of rings are 101 to 200 for this put century code 2. Similarly when the rings are 201-300 put century code 3 and so on, that means if there are 325 rings on a section then for the 1st ten decades write 1 under century code, for 11th to 20th decade write 2 under century code, for 21st to 30th decade write 3 under the century code and for the remaining decades write 4 under the century code.
31-33		Under 31-33 write the width of the 1st decade
34-36		in col. 34-36 write the width of the second
37-39		decade and so on till col. 48-60 where the
40-42		width of the 10th decade will come. If the
43-45		total number of rings are more than 100. Then
46-48		for century code 2 write the width under 34-36
49-51		and so on so that the 20th decade will come

52-54		under col. 58-60." Similarly for century
55-57		code 3 the width of the 21st decade will
58-60		come under col. 31-33 and so on.
61-63	Width of incomplete decade.	Write the width of those rings which are in the incomplete decade i.e. width of these rings which are between the last pin and the periphery of the section.
64-65	Total number of sections.	Write the total number of sections on which the measurements have been done.
66	Sample Point No.	Write the sample point no. in this column.
67-68	Cluster No.	Write the cluster number of the sample point.
70	Grid Zone	It will always be 1 for H.P. area.
71-78	C.C.G.R.	Write the cluster centre grid reference as done in the inventory work from the map sheet.
79-80	Inventory Design	Leave it blank.

SEEDLING HEIGHT FORM NO. IVSEEDLING HEIGHT FORM

The columnwise instructions for filling in the seedling Height Form is given below :-

Col. No.

1-3	Job No.	Leave it blank.
4-5	Card Design	-do-
6-7	Crew Leader	Write your Code Number.
8-9	Seedling No.	Give the number of the Seedling. The first seedling taken for felling and measurement will have 01 No., the second seedling taken will be 02 and so on.
10-12	Species	Write the code No. of the species as given in the Inventory Manual.
13-16	Diameter at Collar.	Measure the over bark diameter at collar with the help of metric scale, after cutting at the base in millimetres and record.
17-20	Diameter at BH	Measure the over bark diameter at the B.H. point with the help of metric scale, after cutting the B.H. point in millimetres and record.
21-23	Height in Cms.	Write the total height of the seedling correct to cms. For this measure the length of the seedling from the base to the tip of the seedling.
24-26	No. of rings at collar.	Count the total number of rings at the collar section and record. For this the cut should be clear and made with sharp edged instrument.
27-29	No. of rings at B.H.	Count the total number of rings at the B.H. section and record.
65-66	Total No. of seedlings.	Write the total number of seedlings felled in the vicinity of the sample point.
67	Sample Point No.	Write the sample point no. of the cluster.
68-69	Cluster No.	Write the cluster No. of the sample point.
70	Grid Zone	It will always be 1 for H.P. area.
71-78	C.C.G.R.	Write from the map sheet.
79-80	Inventory Design.	Leave it blank.

Sheet - IList of Roads

<u>S. No.</u>	<u>Name of Road</u>	<u>Distance in Kms.</u> (in the survey area)
1.	Solan-Nahan-Paonta Road	109
2.	Solan-Rajgarh-Minus Road	122
3.	Nahan-Kalamb Road and beyond	27
4.	Jagadhri-Panota-Rajban-Rohru Road	69
5.	Nahan-Dadahu-Rajban Road	65
6.	Dadahu-Chopal Road	67
7.	Rajgarh-Nel-Sainj Road	56
8.	Nahan-Bagthan-Rajgarh Road	86
9.	Sarahan-Narag-Ochhaghat Road	37
10.	Solan-Dhamla Road	42

Sheet -2Glossary of Local Terms

Bajri	Fine gravel
Chhappar	Athatched roof or a hut
Dhar	A ridge or a spur
Dhulan	Carriage of timber by labour
Gujjar	A professional grazier
Koka etc.	Miscellaneous species of inferior trees.
Khala	Water course
Khad	A deep water course
Khöl	A deep ravine
Nadi	A river
Phara	An off cut.
Shamlat	Forest owned by villagers.
Sokta	Dry fuelwood.
Tibba	Peak
Tatoh	A grassy blank.

GLOSSARY OF LOCAL NAMES OF TREES

<u>Local Names</u>	<u>Botanical names</u>
Amla-	Emblia-officinalis
Bahera	Terminalia bellirica
Ban Oak	Quercus leucotricho flora (Sy. Q. incana)
Braś	Rhododendron arboreum
Chil or chir	Pinus roxburghii
Deodar	Cedrus deodara.
Dhauri	Lagerstoemia parviflora
Gutal	Trewia nudiflora
Jhingen	Lannea coromandelica
Haldū	Adina cordifolia
Kachnar	Bauhinia variegata
Kail	Pinus wallichiana
Khair	Acacia catechu
Kharsu oak	Q. Somocarpifolia
Kusun	Schleichera oleosa
Mahua	Madhuca longifolia var latifolia
Moru oak	Quercus himalayana
Phaldu	Mitragyna parvifolia
Pula	Kydia calycina
Rai	Picea sithiana
Sain	Terminalia alata (Syn. T. tomentosa)
Sai	Shorea robusta
Semal	Bombax ceiba
Tendu	Diospyros tomentosa
Tosh	Abies pindrow

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

CHIR FELT SURVEY - HIMACHAL PRADESH
NORTH ZONE

Grids Zone	Block Centre Grid Reference	Design
70	71-78	79-80

Name of Crew Leader:

For Lend class No.1 to No.4			Lard Class 1	For Forest type and degraded forests	Blank	Bamboo	Biotic Influence
Geo.	Terrain Data	Soil Data					
11-12	State						
13-14	Revenue District						
15	Catchment						
16	Forest Division						
17	Land Class						
18	Legal Status						
19-20	Parent Rock						
21	Structure						
22	Hardness						
23-24	Altitude						
25	Terrain						
26	Slope						
27	P.O.H.						
28	Aspect						
29	Stoniness						
30	Humps						
31	Consistency						
32	Texture						
33	Depth						
34	Moisture						
35	Vegetation						
36	Origin						
37-38	Forest Type						
39	Storeys						
40-41	Top Height						
42	Size/Age						
43	Spacing						
44	Regeneration						
45	Chir sub type						
60	Occurrence						
61	Species						
62	Quality						
63	Regeneration						
64	Weeds/Grasses						
65	Defects - Diseases						
66	Grazing - Incidence						
67	Fire Incidence						
68	Plot Status						
69	Plot No.						

SAMPLE TREE FORM

Total No. of trees	Plot No.	Grid Zone	Cluster centre grid reference	Inventory Design
67-68	69	70	71-78	79-80

Name of Crew Leader:

[illegible]

PRE INVESTMENT SURVEY OF FOREST RESOURCES
NORTHERN ZONE.

TALLY SHEET (B.A.F.-2)

Job	Card Design	Report Number	Sub R. Number
1-3	4-5	6-7	8

Total No of trees	Plot No.	Grid Zone	Block Centre Grid Reference.	Inventory Design.
67-68	69	70	71-78	79-80

Name of Crew Leader:

Date:-

[illegible]

PREINVESTMENT SURVEY OF FOREST RESOURCES
(NORTHERN ZONE)

2800 ENUMERATION & WEIGHT STUDY FORM

PLOT NO.	GRID ZONE	BLOCK CENTRE GRID REFERENCE	INVENTORY DESIGN
69	70	71-78	79-80

CARD DESIGN	REPORT NO.	SUB REPORT NO.	CREW LEADER
4-5	6-7	8	9-10

INFORMATION ON CLUMPS

NO. OF CLUMPS BY SIZE CLASSES			
Less than 1 M	1 to 2 M	More than 2 M	Bamboo Flowering
11-13	14-16	17-19	20-22 23

INFORMATION ABOUT CULMS IN CLUMPS

Clumps No.	Size class	Species code.	No. of culms as per age			Total no. of culms	Damage/Dry/Rotten Culms		Size of culms	Avg. length upto 2 cm dia. in M.	Avg. culm dia. in cms.	Hollow ness
			Current season's	Two season's	Three season's		Damage & top broken	Dry scarred or rotten culms				
24-26	27	28	29-30	31-32	33-34	35-36	37-38	39-40	41-42	43-44	45-46	47

WEIGHT STUDIES

Clump No.	No. of culms cut measured & wtd.	Green rot in 100 gms.	Dry weight on successive weighing			
			After 1 month	After 2 months	After 3 months	After 4 months
48	49	50-52	53-55	56-58	59-61	62-64 65-68

Date _____

8-9	State	10	Forest Division	11	Forest type	12-14	Species	15	Origh	16-17	Average ht.	18	Size class	19	Crown density	20	Slape	21-22	Altitude	23	Aspect	24	Tree No.	25-27	Species	28	Domiance	29-31	D.R.H.O.D. Perpendicular to DC	32-36	Ht. of the tree	37-38	Clear bole	39	Natural defect	40	Defect others	41-43	Crown width towards P.C.	44-46	Crown width perp. to P.C.	47-48	Last 10 years incr. towards PC	49-50	Last 20 years incr. towards PC	51-52	Last 30 years incr. towards PC	53-54	Last 10 years incr. perp. to SP	55-56	" 20 " " " "	57-58	" 30 " " " "	59	Tree felled/Tree not felled	60-61	No. of tree portion	62-63	Total No. of trees	64	Point No.	65-67	Cluster No.	68	Grid Zone	69-76	C.O.C.R.	77-78	Inventory design
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P. INVESTMENT, SURVEY OF
 FOREIGN RESOURCES
 NORTHERN ZONE

1-5	Job No.	4-5	Gard Design	6-7	Green Under	8-9	Tree No. of	10-11	Species
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Total no. of sec.	Sample point no.	Cluster no.	Grid Zone	Block centre grid ref.	Inventory Design	79-80
64-65	69	57-59	70	71-78		

Date _____

Name of the Crew Leader

[illegible]

Job no.	Card design	Crew leader
1-3	4-5	6-7

Total No. of Seedling	Point No.	Cluster No.	Grid Zone	Cluster Centre	Grid Reference	Inventory	Design
64-65	66	67-68	70	77	78	79	80

Name of Crew Leader:

[illegible]

Signature of the Recorders with date.