GOVERNMENT OF INDIA
Ministry of Agriculture
(Department of Agriculture & Co-operation)

Report on Forest Resources of WESTERN NEPAL SURVEY AREA

(NEPAL)

VOLUME 1

(RESULTS AND RECOMMENDATIONS)

सत्यमेव जयते

FOREST SURVEY OF INDIA
NORTHERN ZONE
SIMLA
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Contents

GOVERNMENT OF INDIA

Ministry of Agriculture

(Department of Agriculture & Co-operation)

P R E F A C E

With a view to set up a paper mill in Nepal in the joint sector with His Majesty's Government of Nepal, the Hindustan Paper Corporation requested the Forest Survey of India to undertake a survey of Forest Resources in Western Nepal. It was requested that a light intensity survey of a large forest area to the extent of about 35,000 sq.km. may be completed quickly within a period of about six months. Based on the findings of this survey, further intensive survey could be carried out of specific forests.

Accordingly, field work of survey operation was carried out from October 1979 to February 1980. The total gross geographical area covered was 50,000 sq.km.

The field data was duly processed and the draft report was discussed first with the officials of the Hindustan Paper Corporation, Ministry of External Affairs and thereafter with the officials of His Majesty's Government of Nepal.

The survey has revealed a clear picture of various land-use pattern, forest composition, availebility of forest resources of different species in different localities and their local use. Terrain evaluation has been made. Information of existing infrastructure and extraction cost have also been furnished. It should now be possible to undertake further intensive study of specific areas for utilisation of forest produce for specific purpose. It is hoped that the information furnished in this report would be useful for improvement of the quality of life of the people and to strengthen the bond of friendship between the two countries.

I thank the people and the officials of the Royal Government of Nepal for the facilities extended to our field staff during the period of survey operation. I thank the Hindustan Paper Corporation for entrusting the work to the Forest Survey of India.

(N. D. BACHKHETI)
INSPECTOR GENERAL OF FORESTS

Contents

TABLE OF CONTENTS (VOLUME-I)

		Page
	Preface	
	Botanical, Local and Nepali names of important species.	(i)
	Abbreviations used	(ii)
	Summary	1-16
CHAPTER-I	BACKGROUND	17-34
	1.1 Introduction	17
	1.2 Name of the Area	18
	1.3 Location	19 & 21
	Location Map of Survey Area	20
	1.4 Locality Factors	22
	1.5 Physical Features	22
	Physical Map of Survey Area	23
	1.6 Geology, Rock & Soil	24
	Geological Map of Survey Area	25
	1.7 Natural Resources	26
	1.8 People and their Socio-economic conditions.	26-27 & 31
	Some Photographs showing way of life and socio-economic conditions of people in survey area	28-30
	1.9 Infrastructures	31
	1.10 Present system of management of, forests.	31-32
	Some photographs showing extravagant use of wood for different purposes in survey area.	33-34
CHAPTER-II	RESOURCE BASE	35-62
	2.1 Forest Types	35-37
	2.2 Area	37-41 & 47-48
	Some photographs showing damage to forests by biotic interference and one forest patch unaffected by these interferences in the survey area	42 to 46
	2.3 Stand Tables	48-49

Contents

	2.4	Volume Tables	49
	2.5	Stock Tables	49 - 51
	2.6	Stand and Stock Tables for dead & dying trees.	51
	2.7	Stand and Stock Tables for different Catchments.	51
	2.8	Standard Error	51-52
		Tables of Chapter-II (II.8 to II.17	53-62
CHAPTER-III	MARKET STUDIES AND CONSUMPTION PATTERN		63-71
	3.1	Demand Zone	63
	3.2	Methodology of Consumption Survey	64-66
	3.3	Wood Consumption by Local People for domestic purposes.	64-66
	3.4	Population and number of house holds.	66
	3.5	Present consumption of wood (i.e. during 1980)	67-70
	3.6	Future Demand Trends	70-71
CHAPTER-IV	GROWTH RATE AND POTENTIAL ANNUAL CUT		72-79
	4.1	Growth Rate	72-73
	4.2	Rotation	73-74
	4.3	Potential Annual Cut	74-76
	4.4	Cull	76-79
CHAPTER-V	ECONOMIC AVAILABILITY AND COST OF RAW MATERIAL DELIVERY		80-90
	5.1	Why Cost Studies ?	80
	5.2	Objectives	80
	5.3	Premises Adopted	81
	5.4	Logging Operations	81-82
	5.5	Logging Costs	82-83
	5.6	Transport Costs	83-84
	5.7	Transport Distance	84-86
	5.8	Cost Classes	86
	5.9	Distribution of Growing Stock into Cost Classes	86-87

	5.10	Floatability of Rivers	87-88
	5.11	Terrain Study	88-89
	5.12	Scope of Mechanisation	89-90
CHAPTER-VI		WOOD BALANCES AND RECOMMENDATIONS	91-93
	6.1	Wood Balances	91
	6.2	Recommendations	92-93

Contents

BOTANICAL, LOCAL AND NEPALI NAMES OF IMPORTANT SPECIES

Botanical Name	Local Name	Nepali Name
Pinus roxburghii	Chir	Kohote Salla
Pinus wallichiana	Kail	Gobre Salla
Cedrus deodara	Deodar	Devdar
Abies pindrow	Fir/Raga	Thingure
Picea smithiana	Spruce	Jhule Salla
Tsuga dumosa	Tsuga (Hemlock)	Thingre Salla
Taxus baccata	Thuner	-
Cupressus torulosa	Surai/Cyprus	-
Shorea robusta	Sal	-
Terminalia tomentosa	Asin	-
Anogeissus latifolia	Dhawra/Bakli	-
Acer Spp.	Kainjal	Phiraphere
Betula Spp.	Chamarpayyan/ Bhojpatar	Saur
Quercus incana)	Ban Oak	Banjh
Quercus dilatata) Oaks	Moru Oak	-
Quercus semecarpifolia)	Kharsu Oak	Kharsu

For botanical and local names of other species please see appendix-VII of this Report.

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A B B R E V I A T I O N S U S E D

Km	Kilometre
Sq.km/km^2	Square kilometre
ha./hect	hectare
Cm	Centimetre
Cu.m./M^3	Cubic metre
Kg.	Kilogram
D.B.H.O.B.	Diameter at breast height overbark (Breast height is 4'6" or 1.37 metres from ground on uphill side in case of sloping ground).
WRE	Wood round equivalent
A.A.I.	Average Annual Increment
F.R.I.	Forest Research Institute
MAI	Mean Annual Increment
B.L.	Broad Leaved
Misc.	Miscellaneous
Spp.	Species
H.W.	Hardwood
O.B.	Overbark
U.B.	Underbark
%	Percent

Contents

SUMMARY

The Hindustan Paper Corporation proposed to prepare a feasibility report for establishment of a Pulp/Paper/Craft mill based on conifer raw material from the western hill region of Nepal. A part of this feasibility report regarding assessment of availability of raw material was entrusted to this organisation with the approval of Ministry of Agriculture, Govt. of India. The gross geographical area covered by this survey is about 50,000 km^2. The effective geographical area (excluding snow covered area) surveyed is 36,607.267 km^2. The survey area lies between $27^{\circ}45'$ to $30^{\circ}30'$ North latitudes and $80^{\circ}30'$ to $83^{\circ}45'$ East longitudes. Mahakali, Seti, Bheri, Karnali, Rapti, Dholagiri and Lumbini Anchals are either partly or wholly covered by the survey area.

2. Almost entire area has hilly terrain with wide altitudinal variation. The altitude varies from 250 metres to 7500 metres. Forest bearing slopes are generally steep to precipitous. Moderate and gentle slopes are mostly under cultivation.

3. Altitudinal variation is the main factor which effects the climate of the area which is typically of temperate zone at lower elevations. The average annual rain fall varies from 900 mms to 1600 mms and it is mostly received between July to September. Snow fall occurs at elevations above 2000 metres but remains for appreciable periods only above 2500 metres altitudes. The survey area lies in catchments of river Karnali, Bheri, Babai and Rapti.

4. The geology of the area consists mostly of upper Siwaliks, middle Siwaliks, middle Himalay s and inner Himalayas. The rocks mostly found in Siwalik region are sand stones, shales and conglomerates whereas the rocks found in Himalayan region are phylites, quartzites, mica schists, gneiss and granites etc. The soil of the tract varies from sandy to clay-loam. The soil is very poor in fertility in exposed and non-forest areas. Usually deep and friable clay-loam soil rich in fertility with thick layer of humus is found on Northern slopes in forest areas.

5. The survey area is fairly rich in natural resources particularly forests which have not yet been exploited for commercial purposes due to lack of infrastructure. The rivers flowing in the survey area especially Karnali has sufficient flow even during lean periods and has tremendous hydro-electric and irrigation potential.

6. The population density in the survey area is low and people are mostly poor. There is no good market in the survey area and common modern amenities like road transport is not well developed. Main lively-hood is from agriculture and cattle rearing. Primitive methods of cultivation are employed and the crops mostly grown are maize, paddy and wheat. Transport of commodities is mostly by manual carriage. Only near Jumla some apple orchards are coming up. Industrial activity is in a limited scale. The population of the survey area according to 1971 census was 16,05,350. There are no roads worth the name. Only two katcha roads partly lying in the survey area are under construction. The transport means are by Air or on foot. Only five places namely Simikot, Surkhet, Jumla, Dolpa and Doti in the survey area are connected by occasional air services.

7. The objectives of this survey were as under:

A. (1) To prepare a complete photointerpretation map and estimate area of the following land use and forest types:-

(i) Forest;
(ii) Scrub land;
(iii) Crop land including habitation;
(iv) Pasture land;
(v) Water spreads;
(vi) Badly eroded and barren.

(2) The forest area is to be divided into the following strata:-

(i) Upland hardwoods;
(ii) Fir-Spruce-Hemlock;
(iii) Chir-pine; and
(iv) Low land hardwoods.

(3) The forests in strata (ii) & (iii) above should then be divided into three stand size classes and three density classes as under:-

(a) Stand size class :

(i) Mature and overmature;
(ii) Middle aged;
(iii) Young including pole crop.

(b) Density class :

(i) Below 30%
(ii) 30% to 60%
(iii) Above 60%

B. To assess pulpable volume in the two forest types of (i) Chir-pine and (ii) Fir-Spruce-Hemlock within an estimated standard error of less than 10%.

C. To carry out logging and transport study and ascertain the net availability of wood at mill site (Chisapani) from the surveyed areas into cost classes depending upon its accessibility for undertaking the economic logging and extraction operations.

The study would include:-

(1) Terrain evaluation;

(2) Optimum methods to be adopted in mechanized and conventional logging and extraction operations from the forest areas upto the water course. This study will include identification of the equipment including mechanised equipment which should be required for the purpose.

(3) Floatability of various rivers through which material will have to be floated in the form of logs or splits.

(4) To undertake demand studies to arrive at a safe surplus wood balances.

8. Of the total effective geographical area (36,607.267 km^2) covered 14,639.536 km^2 is under forest and it constitutes about 40% of the effective geographical area and 29.3% of total geographical area. The forests found in the survey area are mostly of Himalayan moist temperate and sub-tropical types. For the purpose of estimating growing stock these forests have been divided into six forest types namely Chir; Kail-Deodar; Fir-spruce-Tsuga; Conifers mixed with broad leaved; High level hardwoods and low level hardwoods. The total forest area and exploitable forest area under each of these types is respectively 1922, 802, 811, 2636, 5092, 3376 and 1816, 657, 695, 2399, 4791, 3270 km^2. All forest areas situated on slopes below 60° have been taken as exploitable forests. The distribution of exploitable forest area in each forest type into different regeneration classes, density classes, lopping classes, fire incidence classes and grazing incidence classes (by percentage) is given in Chapter-II of this Volume.

9. The number of stems/ha. in different forest types of exploitable forests varies from 150 (Chir type) to 413 (low level broad leaved type). The total number of stems in the exploitable forests is 444.633 millions. The volume/ha. varies from 70 m^3 (low level hardwoods) to 320 m^3 (Fir-Spruce-Tsuga type) in different forest types of exploitable forests. The total volume in the exploitable forests is 166.953 million m^3.

10. The stems/ha. of important species in different forest types, total stems (000) of important species by diameter classes, volume/ha. U.B. (m^3) of important species in different forest types and total volume U.B. (000 m^3) of important species by diameter classes (for exploitable forests) is given in Table Nos. S.I, S.II, S.III and S.IV respectively.

Table No.S.I

Stems/ha. of Important Species in different Forest Types

Species	Forest Types					
	Chir	Kail-Deodar	Fir-spruce-Tsuga	Conifers mixed with H.W.	High level Broad leaved	Low level Broad leaved
Chir	109.136	-	-	22.553	1.485	8.862
Kail	0.021	214.228	15.015	31.672	1.975	-
Deodar	-	2.532	-	-	-	-
Fir	-	4.630	132.862	33.183	3.094	-
Spruce	-	6.622	18.223	13.246	0.399	-
Tsuga	-	4.630	6.506	8.450	0.211	-
Thuner	-	-	19.165	5.325	1.824	-
Cypress (Surai)	-	5.658	34.001	-	-	-
All Oaks	5.040	35.254	24.807	43.335	125.997	0.693
Bhojpatar	-	9.461	30.381	22.808	8.970	-
Kainjal	-	-	3.638	6.584	3.252	-
Sal	5.298	-	-	23.644	0.080	178.580
Sain	-	-	-	2.060	-	21.631
Dhawra	-	-	-	0.501	-	25.638
Up land hardwoods	17.882	16.992	56.248	45.651	237.572	10.718
Low land hardwoods	11.623	-	-	4.786	3.130	166.784
Total conifers	109.157	238.300	225.772	114.429	8.988	8.862
Total Broad leaved	40.843	61.707	115.074	149.369	379.001	404.044
Grand Total	150.000	300.007	340.846	263.798	387.989	412.906

Contents

Table No.S.II

Total Stems (000) of Important Species by Diameter Classes

Species	Diameter Classes in Cms.									Total
	10-20	20-30	30.40	40-50	50-60	60-70	70-80	80-90	90+	
Chir	9589.403	7881.120	5565.659	3253.075	1521.760	685.538	253.715	72.745	17.497	28840.512
Kail	13201.268	5206.472	2724.939	1302.229	669.477	299.494	152.677	61.543	51.712	23669.811
Deodar	-	-	93.671	27.592	31.374	7.917	-	-	5.911	166.465
Fir	6192.284	4946.425	2708.305	1913.962	1181.440	723.533	642.283	316.857	357.663	18982.752
Spruce	3047.468	491.760	331.964	337.539	197.648	185.128	115.789	92.379	271.363	5071.038
Tsuga	1000.324	399.303	218.169	326.102	176.053	205.202	241.846	130.700	187.057	2884.756
Thuner	1949.910	1212.166	182.220	84.240	23.504	9.315	14.388	5.031	3.144	3483.918
Cyprus	1123.519	855.770	472.679	175.581	55.733	15.347	29.252	7.721	-	2735.602
All Oaks	40912.613	14802.690	7450.823	5586.715	3064.175	2056.157	1089.588	582.998	580.593	76126.382
Bhojpatar	5684.366	3102.498	1921.748	841.003	498.207	282.898	109.899	39.016	23.816	12503.451
Kainjal	1427.976	1036.786	290.407	271.222	128.994	138.723	71.257	4.482	19.582	3389.429
Sal	47800.596	10742.931	3486.862	1814.294	706.698	328.270	115.283	52.175	14.703	65061.812
Sain	3552.510	1584.161	1066.131	689.460	283.108	202.379	108.218	42.225	38.568	7566.760
Dhawra	6216.402	1536.185	554.320	124.914	59.011	11.956	-	-	-	8502.788
Upland hardwoods	98454.182	25683.603	8038.183	2783.861	784.269	464.509	183.646	79.169	81.685	136553.107
Low land hardwoods	37049.872	9009.542	1829.086	819.205	215.297	87.065	57.680	13.336	13.528	49094.611
Grand Total:	277202.693	88491.412	36935.166	20351.024	9596.748	5703.431	3185.521	1500.377	1666.822	444633.194

Table No.S.III

Volume/ha. U.B. (m^3) of Important Species in Different Forest Types

Species	Forest Types					
	Chir	Kail-Deodar	Fir-spruce-Tsuga	Conifers mixed with hardwoods	High level hardwoods	Low level hardwoods
Chir	70.079	-	-	16.357	1.545	6.258
Kail	0.136	95.798	14.265	20.311	0.976	-
Deodar	-	3.065	-	-	-	-
Fir	-	-	156.776	30.986	5.686	-
Spruce	-	12.318	55.512	7.484	2.031	-
Tsuga	-	-	34.598	14.468	1.545	-
Thunder	-	-	3.557	0.594	0.808	-
Cyprus	-	0.458	14.379	-	-	-
All Oaks	1.251	8.092	18.911	35.253	70.832	0.485
Bohjpatar	-	1.905	15.899	11.493	6.908	-
Kainjal	-	-	1.619	4.055	1.479	-
Sal	1.949	-	-	3.291	0.028	26.685
Sain	-	-	-	0.191	-	11.587
Dhawra	-	-	-	0.063	-	4.899
Uplandhardwoods	1.546	3.796	4.044	6.019	38.049	0.953
Low land hardwoods	1.295	-	-	0.293	0.524	19.333
Total Conifers	70.215	111.639	279.087	90.200	12.591	6.258
Total Broad Leaved	6.041	13.793	40.473	60.658	117.820	63.942
Grand Total	76.256	125.432	319.560	150.858	130.411	70.200

Table No.S.IV

Total Volume U.B. (000 m^3) of Important Species by Diameter Classes

Species	Diameter Classes in Cms.									Total
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90+	
Chir	538.924	2280.385	3688.647	4684.207	3627.291	2417.932	1246.816	498.216	155.405	19437.823
Kail	940.710	2106.077	2523.571	2160.468	1776.897	1196.425	868.465	460.244	621.042	12653.899
Deodar	-	-	57.251	32.223	51.222	18.032	-	-	424.733	201.461
Fir	936.715	2074.463	2568.715	2838.578	2720.349	2347.158	2816.747	1827.536	2926.175	21056.436
Spruce	264.279	214.899	295.739	536.187	494.421	677.061	631.367	667.235	3656.293	7437.481
Tsuga	89.427	172.762	193.134	540.073	454.859	772.559	1267.356	865.550	2260.393	6616.113
Thunder	124.813	326.331	94.843	90.638	39.050	54.450	-	22.799	24.563	777.487
Cyprus	46.630	230.368	297.428	176.751	97.254	33.624	109.651	38.007	-	1029.713
All Oaks	2515.265	4246.432	5158.716	7019.881	7140.808	6147.830	4545.650	3271.410	5619.116	45665.108
Bhojpatar	755.156	1124.097	1527.485	1111.852	1067.617	874.046	466.689	212.500	159.044	7298.486
Kainjal	120.064	248.917	160.028	289.377	214.930	347.704	257.196	23.276	118.868	1780.360
Sal	1420.082	2304.402	1802.346	1769.044	1108.860	767.233	385.710	230.132	94.504	9882.313
Sain	235.121	466.454	598.858	694.970	473.139	518.142	394.232	205.800	247.466	3834.182
Dhawra	530.531	457.455	366.629	136.198	97.921	28.523	-	-	-	1617.257
Upland hardwoods)	5203.180	5389.181	3924.930	2405.805	1200.294	975.435	627.295	350.773	718.853	20795.746
Low land hardwoods)	2004.559	2075.316	995.174	847.374	357.586	217.125	205.727	63.814	102.640	6869.315
Grand Total	15725.456	23717.539	24553.494	25333.626	20922.498	17393.279	13822.901	8737.292	16747.095	166953.180

Contents

11. Annual potential cut (Yield) both gross and net worked out for different species in the exploitable forests is given in Table No.S.V. This potential annual cut has been worked out basing on growing stock/ha., its age and growth rate in case of conifer species and per hectare growing stock, total growing stock and rotation in case of broad leaved species. The gross potential annual cut works out to 2548789 m^3 and the net 22,39,698 m^3 respectively. The potential net annual cut has been worked out after deducting the cull which has been adopted for different species from surveys conducted in similar areas in India.

Contents

Table No.S.V

Expected Potential Gross and Net Annual Cut of different species

Unit - m^3

Species	Total growing stock	Increment Percent	Rotation	Yield formula	Gross Yield	Cull %	Net Yield
Chir	19437823	1.91	120 years	$\frac{1}{2}$ (AAI)	185631	-	185631
Kail	12653899	2.37	150 years	$\frac{1}{2}$ (AAI)	149949	-	149949
Deodar	201461	1.74	150 years	$\frac{1}{2}$ (AAI)	1753	-	1753
Fir	21056436	1.11	120 years	AAI + $\frac{VM}{\text{rotation}}$	316373	20	253098
Spruce	7437481	1.11	120 years	AAI + $\frac{VM}{\text{rotation}}$	129489	20	103591
Tsuga	6616113	1.11	120 years	AAI + $\frac{VM}{\text{rotation}}$	116488	20	93190
Thuner	777487	1.11	120 years	AAI	8630	5	8198
Cyprus	1029713	1.11	120 years	AAI	11430	5	10858
Oaks	45665108		120 years	2 x growing stock/ rotation	761085	20	608868
Bhojpatra	7298486		120 years	2 x growing stock/ rotation	121641	5	115559
Acer Spp.	1780360		120 years	2 x growing stock/ rotation	29673	5	28189
Sal	9882313		120 years	2 x growing stock/ rotation	164705	5	156470
Sain	3834182		120 years	2 x growing stock/ rotation	63903	5	60708
Dhawra	1617257		120 years	2 x growing stock/ rotation	26954	5	25606
Upland hardwoods	20795746		120 years	2 x growing stock/ rotation	346596	5	329266
Lowland hardwoods	6869315		120 years	2 x growing stock/ rotation	114489	5	108764
Total	166953130				2548789		2239698

12. The consumption of wood which is entirely by local people for different purposes has been estimated by conducting a low intensity survey. There is no consumption by wood based industries, and export of wood outside the survey area. The main consumption by local people is for house construction, repairs and replacements of the same; agricultural implements, furniture and fixtures and fuel wood. The total estimated present and future demand of wood for this purpose is given in Table No. S.VI.

TABLE No. S.VI

Estimated present and future demand of wood in the Survey Area:Unit-M^3(WRE)

Purpose	Wood consumption in the year								
	1980			1990			2000		
	Conifers	Broad leaved	Total	Conifers	Broad leaved	Total	Conifers	Broad leaved	Total
1. House construction repairs and replacement	131701	80742	212443	161829	99151	260980	198726	121757	320483
2. Agricultural implements	-	10231	10231	-	12564	12564	-	15429	15429
3. Furniture & fixtures	5929	3718	9642	7275	4566	11841	8934	5607	14541
4. Fuel wood	551412	992363	1543775	677134	1218622	1395796	831521	1496460	2327989
Total	389037	1087054	1776091	846238	1334903	2181181	1039181	1639261	2678442

Contents

13. The average logging and transport cost for different operations has been worked out by calculating the quantum of each operation especially off-road transport and on-road transport involved in bringing conifers raw-material from the forest to the proposed mill site. For working out this quantum the same cluster centres as used for inventory survey have been adopted as units. After working out the quantum of each operation involved the cost has been worked out by adopting cost figures of same operations in similar areas in India. This has been done as no felling operations are being carried out in the survey area. The only means of transport possible/anticipated are by manual carriage, animal carriage, dryslides, wet slides and floating in the river. The average cost of logging and transport operations has also been worked out for Karnali and Bheri catchments and the same comes to Rs.249 and Rs.313/m^3 respectively. The distribution of growing stock into different cost classes for Karnali and Bheri catchments is given below:

Distribution of growing stock of Karnali and Bheri Catchments into different cost classes (by percentage).

Cost Classes	Range of Cost/M^3	Karnali catchment	Bheri catchment
1. Low (A)	Less than Rs.200	29.49%	23.60%
2. Medium (B)	Rs.200 to less than Rs.300	47.80%	32.92%
3. High (C)	Rs.300 to less than Rs.400	17.29%	18.63%
4. Very High (D)	Rs.400 and above	5.42%	24.85%

The average cost of different logging and transport operations adopted is as follows :

1.	Felling including lopping and roping	= 0.18 man days/m^3 = Rs.2.70/m^3
2.	Cross cutting including delimbing & debarking	= 1.00 man days/m^3 = Rs.15.00/m^3.
3.	Sawing/splitting into hakaries and ass-orted sizes.	= 2 man days/m^3 = Rs.30.00/m^3
4.	Engraving property hammer marks and numbering the pieces.	= 0.06 man days/m^3 = Rs.0.90/m^3
5.	Dry slides/rolling/man carriage from stump site to wet slide/launching site.	= 2 man days/m^3/km = Rs.20.00/m^3/km.
6.	Wet slides	= 1.0 man days/m^3/km = Rs.10.00/m^3/km.
7.	Khad vahan (Khad floating)including cost of launching and collection	= 0.25 man days/m^3/km = Rs.2.50/m^3/km
8.	River floating including launching rafting etc.	= 0.02 man days/m^3/km = Rs.0.25/m^3/km.
9.	Collection at boom & stocking or loading into trucks.	= 0.8 man days/m^3 = Rs.8.00/m^3
10.	Boom making charges	= Rs.2.00/m^3
11.	Overhead/supervision charges.	= Rs.20.00/m^3

Under this study floatability of river Karnali and Bheri was also studied and it has been found that both these rivers and some of their tributaries are suitable for timber transport by floating. Considering the present conditions i.e. non existence of road net work and non-availability of skilled labour it is opined that there is little possibility of mechanised logging at present.

...../16

With mechanised logging there will be economy in cost, increased utilisation of wood and even the broad leaved species which are not floatable can be extracted for marketing. With the present methods of logging and transport only coniferous timber can be harvested as it can be transported by floating.

14. Taking into account the potential net annual cut and present/future annual demand the wood balances have been worked out and the same are given in Table No. S. VII.

Table No. S. VII

Present and Future position of Wood Balances

Unit - M^3

Year	Total yield (Net)		Demand of wood		Surplus (+) Deficit (-)		Total Surplus (+) Deficit (-)
	Conifers	B.L.	Conifers	B.L.	Conifers	B.L.	
1980	806268	1433430	689037	1087054	(-)117231	(+)346376	(+)463607
1990	806268	1433430	846238	1334903	(-) 39970	(+) 98527	(+)58557
2000	806268	1433430	1039181	1639261	(-)232913	(-)205831	(-)438744

From Table No.S.VII it will be found that the survey area is not going to remain surplus in wood for 8 long and within 20 years the area will be deficit to almost the same tune as it is surplus now.

15. However, some districts like Jumla, Mugu, Tibrikot, Humla and parts of Doti and Accham have comparatively High percentage of forest area and low density of population. It will be better if some such areas are selected and the availability of raw-material to feed the paper mill from such smaller areas is found out either by re-surveying this area by improved sampling design or in the alternative by re-processing the data of the present survey relating to these areas.

CHAPTER - I.

1.1 Introduction

The Hindustan Paper Corporation proposes to prepare a Feasibility Report for establishment of a Pulp/Paper/Craft Mill to be located some where near Chisa Pani and based on conifers raw material from the western hill region of Nepal. A part of this Feasibility Report so far as availability of conifers raw material is concerned was assigned to Preinvestment Survey of Forest Resources Organisation. Therefore, on request from Hindustan Paper Corporation the survey in Western Hill Region of Nepal was undertaken by this Organisation and the objectives of survey were as under:-

A. (1) To prepare a complete photointerpretation map and estimate area of the following landuse and forest types:-

(i) Forest;
(ii) Scrub land;
(iii) Cropland including habitation;
(iv) Pasture land
(v) Water spreads
(vi) Badly eroded and barren.

(2) The forest area is to be divided into the following strata:-

(i) Upland hardwoods;
(ii) Fir-spruce-Hemlock;
(iii) Chir-pine; and
(iv) Lowland hardwoods.

(3) The forests in strata (ii) & (iii) above should then be divided into three stand size classes and three density classes as under:-

(a) Stand size classes :

(i) Mature and overmature;
(ii) Middle aged;
(iii) young including pole crop.

(b) Density classes:

(i) Below 30%
(ii) 30% to 60%
(iii) Above 60%

B. To assess pulpable volume in the two forest types of (i) Chir-pine and (ii, Fir-Spruce-Hemlock within an estimated standard error of less than 10%.

C. To carry out logging and transport study and ascertain the net availability of wood at mill site (Chisapani) from the surveyed areas into cost classes depending upon its accessibility for undertaking the economic logging and extraction operations. The study would include:-

(1) Terrain evaluation;

(2) Optimum methods to be adopted in mechanized and conventional logging and extraction operations from the forest areas upto the water course. This study will include identification of the equipment including mechanised equipment which should be required for the purpose.

(3) Floatability of various rivers through which material will have to be floated in the form of logs or splits.

D. To undertake demand studies to arrive at safe surplus wood balances.

1.2 Name of the Area

The survey area is named as "Western Nepal Survey" and comprises partly or wholly of Baitadi and Dandeldhura districts of Mahakali anchal, Bajura, Bajhang, Achham, Doti and Kailali districts of Seti Anchal; Jajarkot, Dailekh, Surkhet and Bankey districts of Bheri anchal; Humla, Mugu, Tibrikot and Jumla districts of Karnali anchal, Rukum, Rolpa, Sallyan and Pyuthan districts of Rapti anchal; Dolpa, Banglung and Myagdi districts of Dholagiri anchal and Gulmi and Argha districts of Lumbini anchal. This entire area right upto international boundary in the West, North & South is also called "Far Western Region" which is one of the four development regions into which the country has been divided.

1.3 Location

The survey area is situated between $27^{\circ}45'$ and $30^{\circ}30'$ North latitudes and $80^{\circ}30'$, $83^{\circ}45'$ East Longitudes. The area is covered by the following map sheets:

(i) Quarter inch sheets - (1" = 4 miles scale) - 62/C, D,F,G,H,J,K,L,O,P =10sheets

63/I,M = 2 sheets.

(ii) One inch sheets (1" = 1 mile scale) - 62C/10,11,12,14,15,16 = 6 sheets.

62 D/9,13 = 2 sheets.
62 F/4,8,12,15,16 = 5 sheets.
62 G/1 to 16 = 16 sheets.
62 H/1,2,5,6,9,10,11,13,14,15 = 10 sheets.
62 J/3,4,8 = 3 sheets.
62 K/1 to 16 = 16 sheets
62 L/1 to 16 = 16 sheets
62 O/2,3,4,6,7,8,12 = 7 sheets
62 P/1,2,3,4,5,6,7 = 7 sheets
63 I/9,13 = 2 sheets.
63 M/1 = 1 sheet.

Thus, the entire geographical area under survey is covered by above indicated 91 map sheets of 1"=1 mile scale. However, the map sheet Nos. 62 F/4,8,15,16; 62 J/3,4,8; 62 K/5,9,10,11,13, 14,15; 62 O/2,3,4,6,7,8,12; 62 P/1,5,9 of snow covered areas near China Boundary were not made available and hence the geographical area actually surveyed is covered by following 67 map sheets:

62 C/10,11,12,14,15,16	= 6
62 D/9,13	= 2
62 F/12	= 1
62 G/1 to 16	=16
62 H/1,2,5,6,9,10,11,13,14,15	=10
62 K/1,2,3,4,6,7,8,12,16	= 9
62 L/1 to 16	=16
62 P/2,3,4,6	= 4
63 I/9.13	= 2
63 M/1	= 1
G. Total	=67

In the north the international boundary between Nepal & China forms the boundary of the survey area. Towards West the survey boundary runs along the North-South ridge separating the catchments of Karnali and Mahakali rivers. In the East the boundary runs along the North-South ridge separating the catchments of Karnali and Narayani rivers. The southern boundary starting from Western side runs along the ridge called Churia hills running parallel to Tarai tract and then this boundary meets Karnali river near Chisa Pani and again moves along Churia hills until it again meets Babai river at the confluence of Sardakhola and Babai river. Thereafter it runs along Sardakhola upto Dhareni and then follows a ridge named Mahabharat lekh dividing Sardakhola and Babai catchments. Following this ridge, this southern boundary meets Rapti river at the confluence of Sitkhola & Rapti rivers. From this confluence it takes a turn towards South and joins the eastern boundary. The location map of the survey is given at page-20.

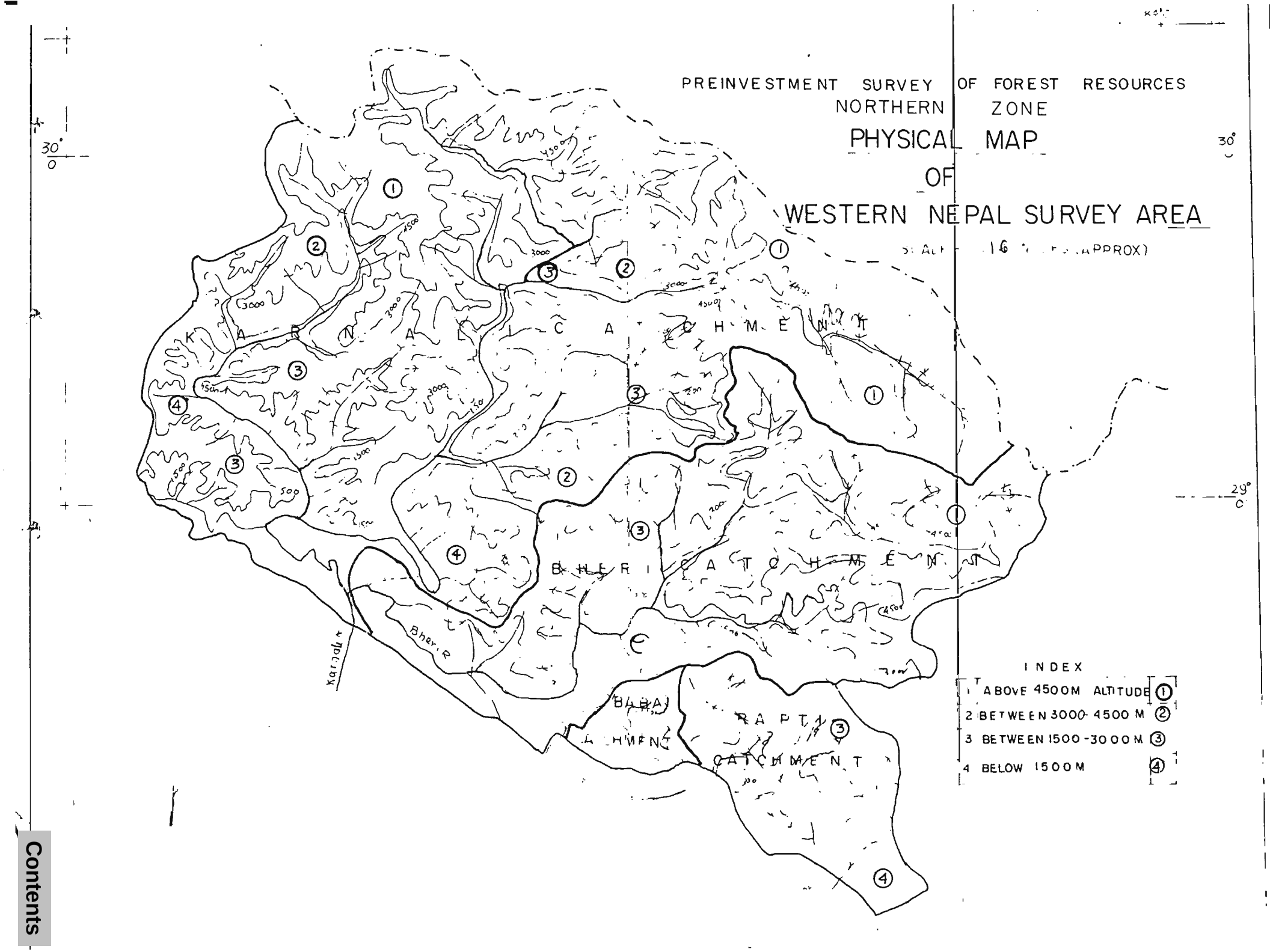
1.4 Locality Factors

The climate of the area is typical of temperate zone at altitudes above 1500 metres and of sub-temperate zone at lower elevations. Autumns are generally very cold at higher elevations and summers are quite hot at lower elevations. In summer maximum temperature rises upto 31°C. in the month of May at lower altitudes. At higher altitudes minimum temperature falls below freezing point in winters.

The average annual rain fall varies from place to place. The low elevation areas such as Surkhet, Chisapani, Salyan, Pyuthan receive higher rainfall as compared to higher elevation areas such as Jumla, Humla, Mugu, Dolpa. The average annual rainfall varies from about 900 mm to 1600 mm. Most of the rain fall takes place between July to September and winters are generally dry. Snow fall occurs generally at higher altitudes above 2000 metres. But it seldom remains for appreciable period below 2500 metres altitude.

1.5 Physical features

The terrain is mountainous with elevations varying from 250 metres to 7500 metres. Slopes are generally steep to precipitous. The forests are confined to steep slopes. Moderate and gentle slopes are mostly under cultivation. There are a few very wide valleys particularly in Rapti, Babai and Bheri catchments. The valleys in Karnali catchment are comparatively narrow. Almost entire area of these valleys is under plough. The inner Himalayas beyond Jumla are very precipitous and covered by permanent snow. Physical map of the survey area is given at page-23.


PREINVESTMENT SURVEY OF FOREST RESOURCES
NORTHERN ZONE
PHYSICAL MAP
OF
WESTERN NEPAL SURVEY AREA
INDEX
1 ABOVE 4500M ALTITUDE (1)
2 BETWEEN 3000-4500 M (2)
3 BETWEEN 1500-3000 M (3)
4 BELOW 1500M (4)
KARNALI CATCHMENT
BHERI CATCHMENT
RAPTI CATCHMENT
Karnali
Bheri
30°
29°

Contents

1.6 Geology, Rock & Soil

The survey area extends from Siwaliks to inner Himalayas. The geological formations of the tract are comparatively of recent origion. The underlying rock consists mostly of coarse boulders, conglomerates with irregular bands and lenses of sand rocks and with intercolation of yellow, brown grey sandy clays in upper Siwaliks; Medium to coarse grained, friable, arkosic sand stone, fine to medium grained massive grey and stones, interbedded with greenish grey clays, grey shales and thinbands of pseudo - conglomerates occasionally silty sand stones in middle Siwaliks; and fine grained hard grey sand stones interbedded with purple red even chocolate coloured shales, noduler maroon pseudo conglomerates and clayey shales in lower Siwaliks. The underlying rock in outer and middle Himalayas is mostly grey, dark grey and green phylites, quartizite and sills of basic rocks interbedded with fine to medium grained garnet mica schists, calc-schist and thin bands of marble and skarns. In the innder Himalayas the rock consists mostly of medium to coarse textured augen gneiss, garnet mica-gneiss, kganite - sillimaniti gneiss, migmatites and thin bands of marble and granites.

The soil of the tract varies from sandy to clay-loam. Over the large area of the track, the soil, however, is clay-loam. The soil depth and the organic matter is quite variable. In exposed areas, particularly near villages the soil, is very poor with low organic content. Usually deep and friable clay-loam soil with thick layer of humus is found on northern slopes. The soil is shallow, poor and sandy loam in lower portions as well as southern exposed slopes. Varying quantities of gravels are also present on the surface which have a marked influence on soil fertility. Geological map of the survey area is given at page-25.

Contents

1.7 Natural Resources

The area is fairly rich in natural resources particularly the forests which have not yet been exploited for commercial purposes to any appreciable extent. There are hardly any means of communication and, therefore, forests have not been put to any commercial use except to meet the local demand for timber and fuel wood. The area is very rich in water resources. There are four perennial rivers carrying sufficient discharge even during lean periods. Karnali river, particularly, holds tremendous potential for hydroelectric power generation and irrigation but its potential has not yet been exploited.

1.8 People and their Socio-economic conditions

The entire survey area is mountainous and far away from the developed towns. The population is sparse and scattered. The people are living far away from motor roads. The nearest road points are at Surkhet and Dandedhura. The people from far off places take at least 15-20 days to reach the road points. The main markets for consumable goods are Nepalganj and Dhangarhi. The entire population of the area is living in isolation from modern developments and hence people are continuing age old methods of living. Main lively hood is from agriculture and cattle rearing. The farming methods are, however, primitive. The use of improved seeds, fertilisers, insecticides, improved farming tools etc. is completely unknown. The yield of agricultural crops, therefore, is very poor. Maize, paddy & wheat are the main food crops grown in the area. People grow other subsidiary crops also such as potatoes, pulses, Tobacco, Sugarcane etc. in small quantities. They grow almost every thing

for their requirement in their fields and do not depend on outside markets for their food requirements. Cultivation is mostly done on un-terraced/faulty terraced fields which results into lo[illegible] of soil erosion and loss of fertility. Except in valleys, irrigation is not common. Wherever a little bit irrigation facilities exist, they are the joint efforts of the people. There is hardly any surplus agricultural produce, which can be sold. In fact, there is no market centre in the survey area for sale of surplus produce, if any. If the people have to buy or sell anything, they have to travel long distances sometimes involving more than 15-20 days walking. The only marketable surplus is ghee which is sold mostly at small places in Tarai belt. Long queues of people carrying ghee at their back while moving down and salt and other essential items such as cloth, shoes etc. on their way back can be seen almost everywhere. There is hardly any fruit production in the area except near Jumla where apple orchards are coming up, rather slowly and in small extent only. Industrial activity in the area is practically absent. People use wooden utencils for storage & carriage of ghee, milk and other food items. At many places people use donas (i.e. containers prepared from tree leaves) for eating the food. They use metal utensils for cooking the meals.

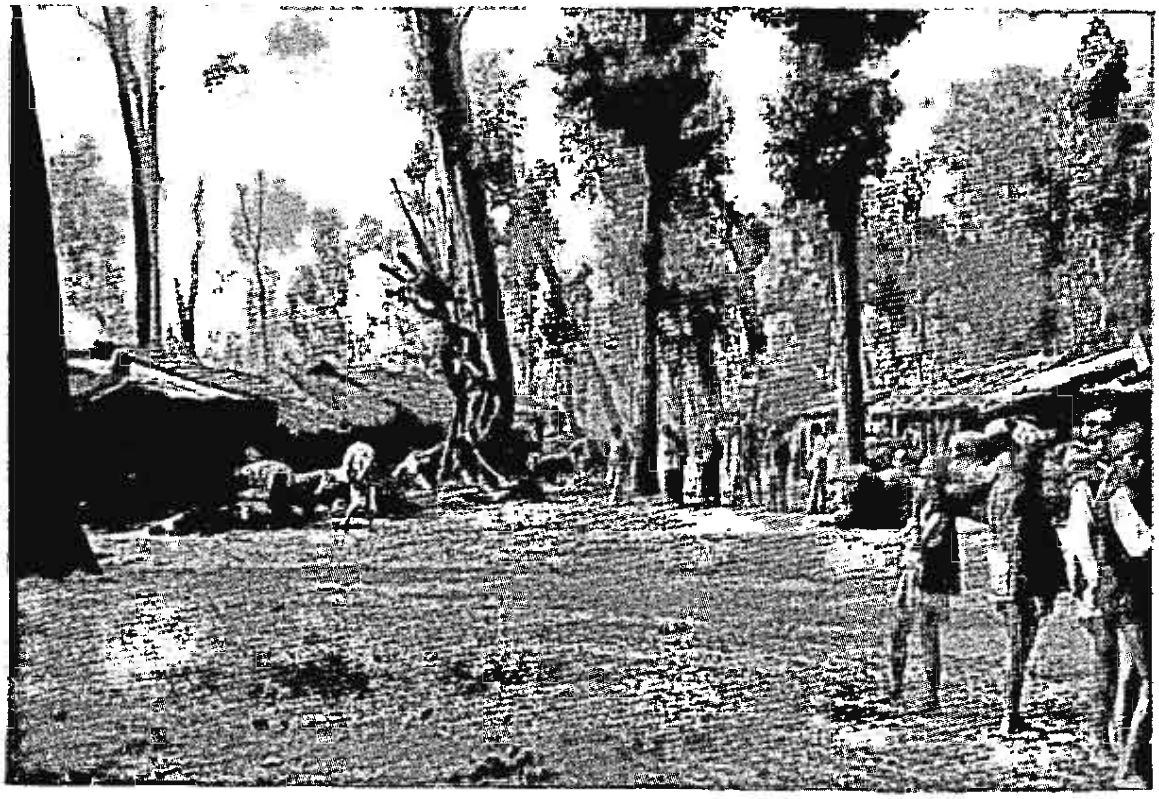
SOME PHOTOGRAPHS SHOWING WAY OF LIFE AND SOCIO-ECONOMIC CONDITIONS OF PEOPLE IN THE SURVEY AREA.

Village Industry for making wooden utensils.

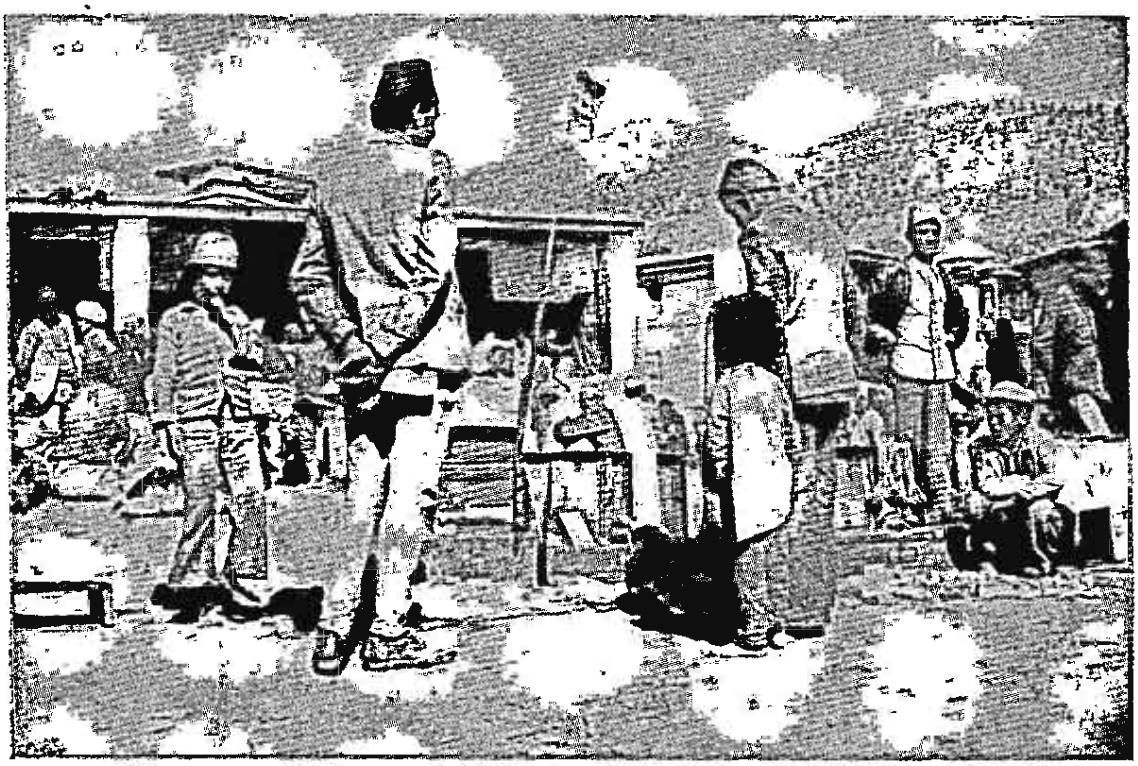
People carrying the commodities at their back —
(A most common transport system)

Photograph by : V. P. Singh, IFS.

Contents



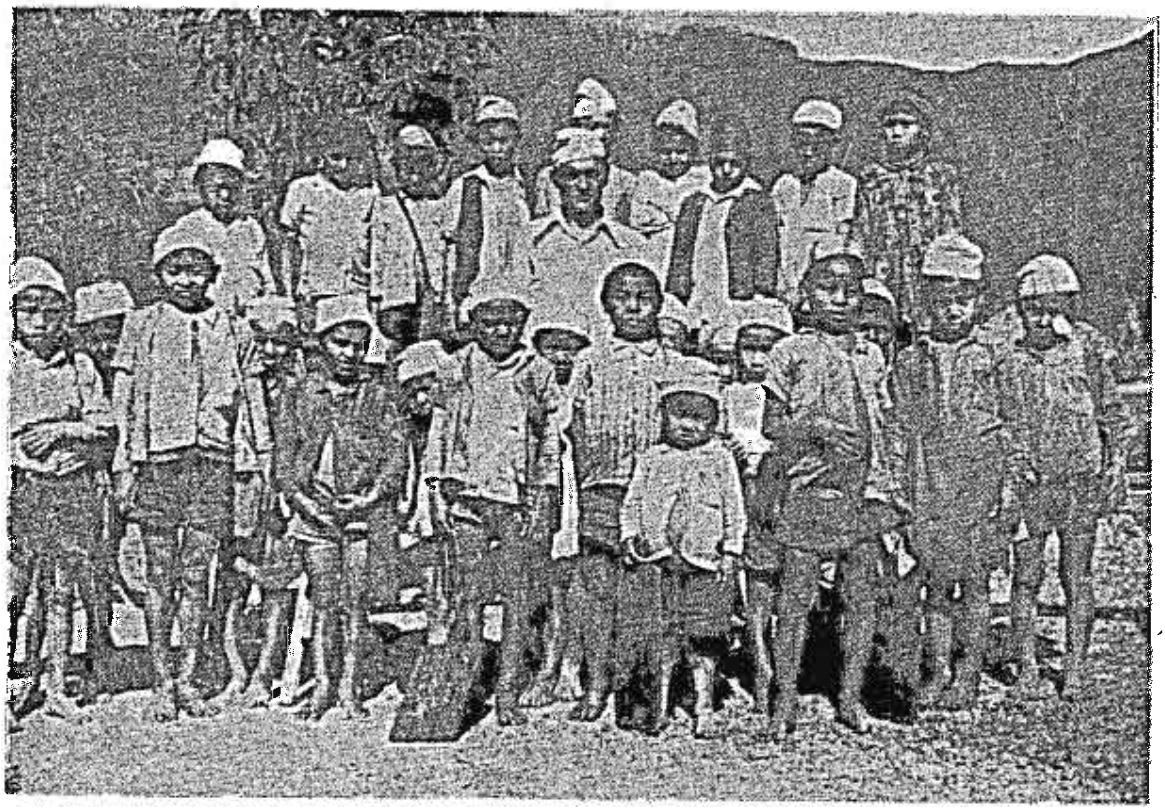
A Market mainly for Salt & Ghee in forest near Chisapani.



Bazar in Boxes at Jumla (Zonal Commissioner's Headquarters)

Photographs by : V. P. Singh, IFS

Contents



School children of a Primary School at Sallikot (3500') near Pyuthan.

Photograph by : V. P. Singh, IFS.

Contents

Quite a large number of people cross the border to India in search of job. Migration of labour for agriculture, industries, hotels etc. from this area to India is quite common. Almost in every village one can come across some retired people who have served in Indian Army or elsewhere. Standard of living of these people is comparatively better than the average. A few phographs depecting socio-economic conditions are given at page 28-30.

1.9 Infrastructure

From communication point of view the area is very backward. Even if it is compared to similar terrain in Nepal, the area lags far behind in infrastructure. There are only two Kacha roads in the survey area. Even these roads are not of much significance from extraction of forest produce point of view. One road i.e. Nepalgunj-Kohalpur-Surkhet Road (110 kms) Penetrates into survey area only about 40 kms (balance being outside the area) and the other road Dhanghrhi-Dandeldhura (140 kms) runs almost along the western boundary of the survey area. Rivers can be made use of for transport of timber but at present floating of timber into rivers is almost unknown. The only communication to the area is by Air. Five places namely Simikot, Surkhet, Jumla, Dolpa and Doti are connected with Nepalgunj by Air, but only skeleton Air services exist for these places. There are only one to two flights per week for each of these places and capacity of the plane is between 12 to 18 persons.

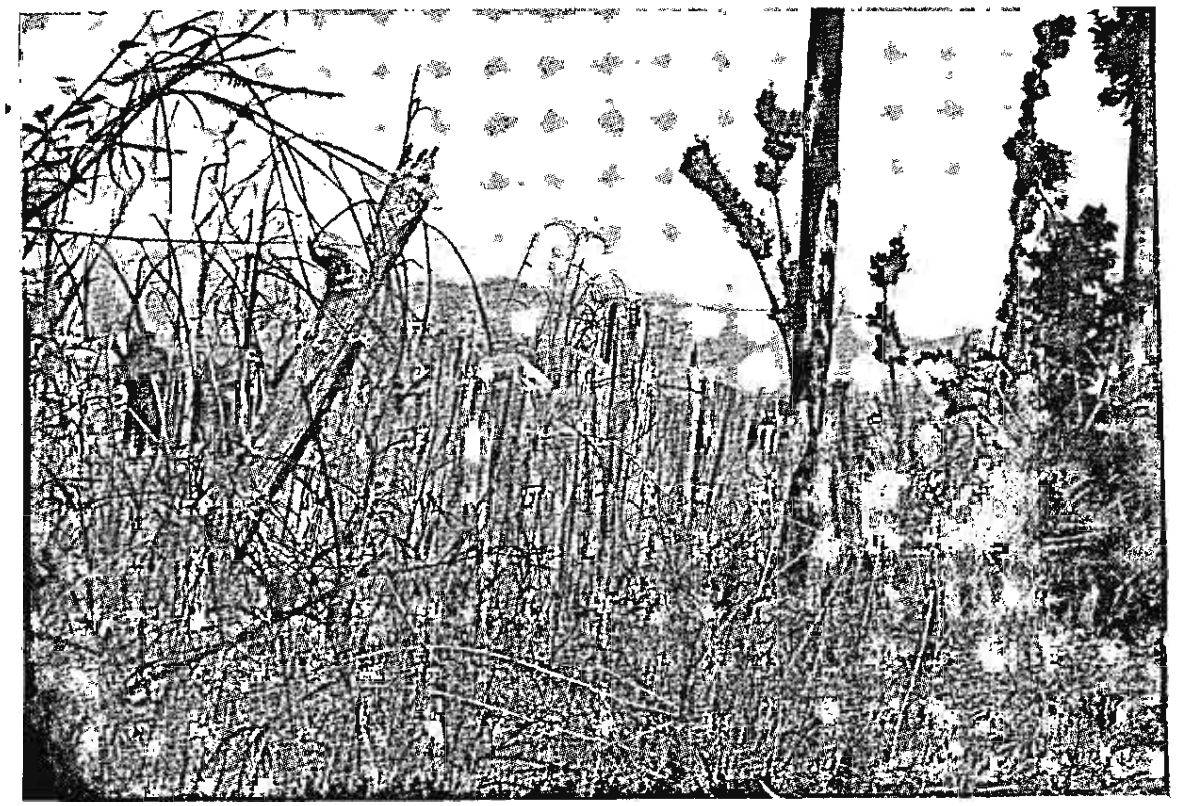
1.10 Present system of management of forests

Except over a small portion of low level hardwoods (Sal and Sain spp.) and Chir forests no commercial fellings are being done at present.

Even felling of small quantities of Chir, Sal & Sain are done only to meet the local demand for timber. In past, about 20-30 years back, some fellings were done in Chir and Kail forests and timber was exported to India. These fellings were, however, done in a haphazard way and no working scheme or silvicultural system was followed for these fellings. Except for very small portion of forests towards southern boundary of the survey area no working plans have even been prepared for the forests of the survey area. Thus the forests are left to their own fate. Demarcation of forests has not been done. It is that there are no well defined boundaries between forest and non-forest lands. It is difficult to say whether there are any encroachments or not, but looking to the extensive honey combing of the forests by cultivated lands, it appears that the encroachments are quite common. There appears to be no control over illicit fellings (done mostly to meet local demand) grazing, lopping, fires, encroachments etc. There is hardly any forest tract free from mass scale lopping. Even the non-conventional spp. like Sal, Chir, Kail are lopped heavily and grazing is rampant in almost all the forests.

The timber is available in plenty just next door. Therefore, people are quite extravagant in use of the timber. Although use of timber in house construction is not high as compared to similar areas in India, but quite a substantial amount of timber is used for non-traditional purposes such as fencing the fields, making cattle sheds etc. A few examples of extravagancy in use of timber are depicted in photographs given at pages 33-34.

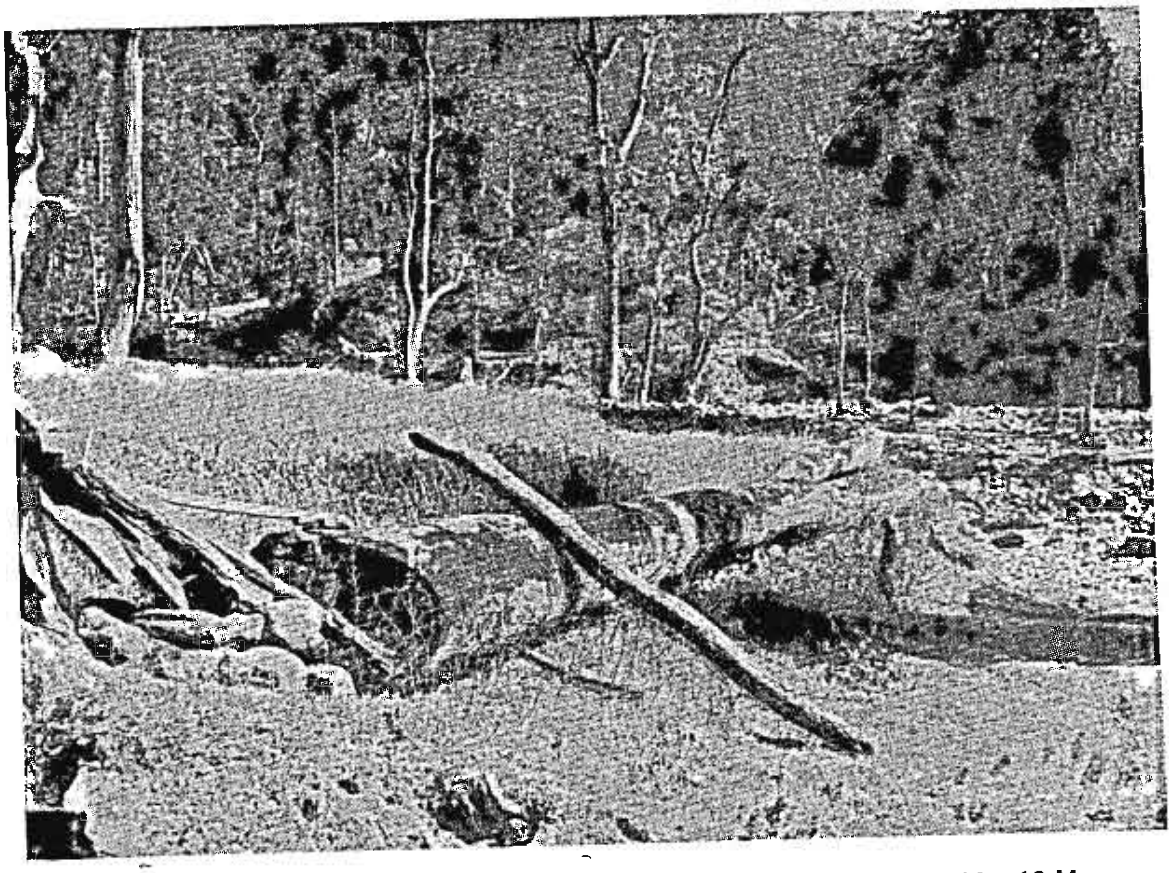
PHOTOGRAPH SHOWING USE OF WOOD FOR DIFFERENT PURPOSES IN THE SURVEY AREA.



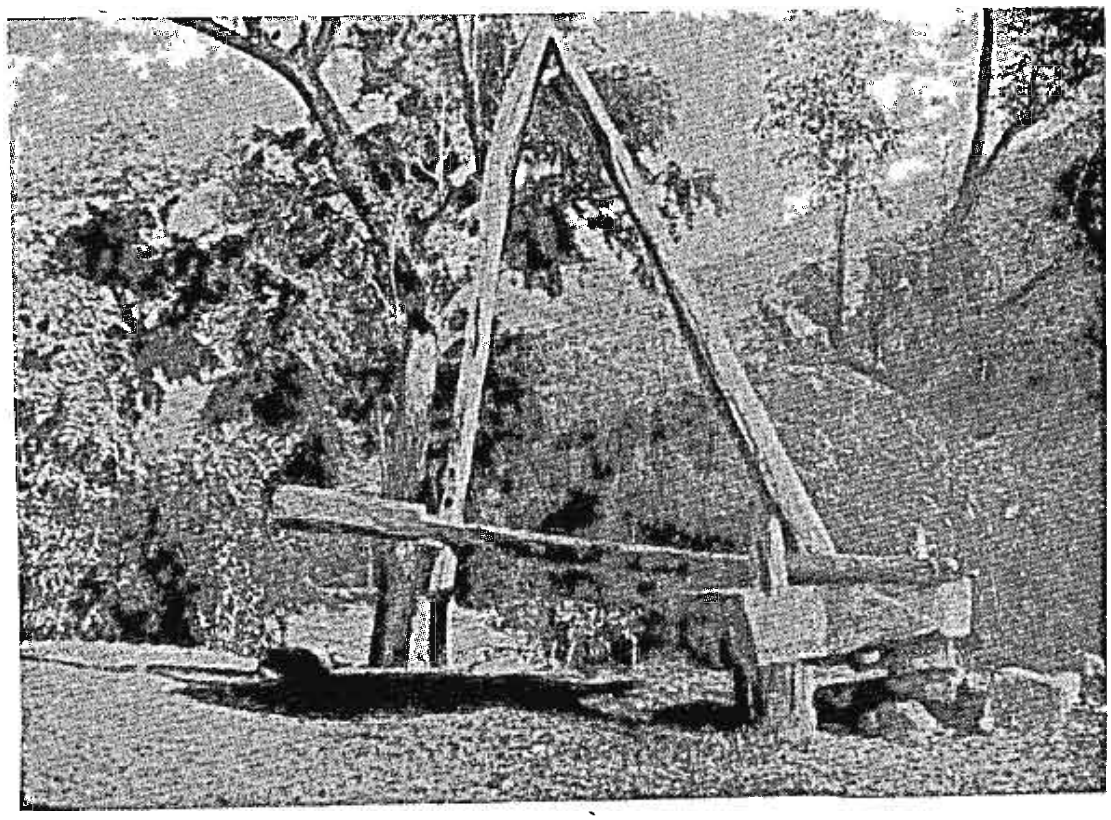
Fencing of agricultural field by Sal posts of 1 to 2 M. girth (posts touching eachother) near Surkhet.

Photograph by : V. P. Singh, IFS.

Contents



A Sal tree of more than 2 M. girth used for protecting a paddy field of 20 x 10 M. against soil erosion.



An Oil Expeller completely made of wood.

Contents

CHAPTER - II

RESOURCES BASE

2.1 Forest Types

The forests of the survey area are mostly of Himalayan moist temperate and sub-tropical types. By composition the forests have both coniferous and broad leaved species almost in equal proportion. Conifers on higher elevations are mostly pure and similarly broad leaved forests towards lower altitudes are also pure. In transiti nal zones, however, the conifers are found mixed with broad leaved species. At lower elevations sal with its associates like Sain and Dhawra occupies more dominant position. At places sal, though in shruby form, is found to occur with Ban Oak. For the purpose of estimating growing stock the forests have been classified into following six forest types :

(i) Chir Type : Where Chir constitutes 80% or more of the crop.

(ii) Kail-Deodar Type : Where Kail and Deodar individually or both taken together constitute 80% or more of the crop.

(iii) Fir-Spruce & Tsuga Type : Where Fir, Spruce and Tsuga individually or all taken together constitute 80% or more of the crop.

(iv) Conifers with B.Ls Type : Where all conifers taken together constitute 50% or more of the crop. but less than 80% and have admixture of broad leaved species.

(v) Low level hardwoods forest Type : Where low level broad leaved species such as Sal, Sain, Dhauri, Dhawra, Khair etc. individually or all taken together constitute 50% or more of the crop. Such forests may or may not have sprinkling of Chir, but its proportion when present should be less than 50%.

(vi) High Level Hardwood Forest Type : Where high level broad leaved species such as Oaks, Maples, Walnut, Horsechestnut etc. individually or all taken together constitute 50% or more of the crop. Such forests may or may not have sprinkling of Conifers, but the proportion of all the conifers when present should not exceed 50%.

2.1.1 100% photointerpretation was also done from the available 1:50,000 scale (approximately) photography. For this purpose the forests have been divided into following forest types and density classes. Due to small scale and poor quality of photographs the same forest types as recognised in case of ground inventory could not be identified on photographs.

A- Forested

	Symbol & Code
1) Chir pine forests	F 6
2) Blue pine forests	F 5
3) High level mixed conifers	F 3
4) Upland hardwoods	F 7
5) Low Land hardwoods	F 8

B - Non-forested

All land use classes viz. snow covered glaciers, exposed areas & barren lands, agriculture and habitation and water spreads have been grouped into one category "N".

Density Classification

The forested land was further classified into following three density classes -

1. High density (more than 50%)	- I
2. Medium density (25-50%)	- II
3. Low density (5-25%)	- III

The density code has been given to all forest types F6, F5, F3, F7 and F8 in the denominator.

Method of Annotation

	Numerator / Denominator	= Forest Type / Density
Example No.1 =	"N"	= Non-Forested
Example No.2	FC / I	= Chir, High Density.

From photo-interpretation one set of forest type map on 1"=1 mile scale was prepared which has been kept in this office. A small scale map (scale 1"=4mile) has also been prepared from these 1"=1 mile maps and same is given in Vol. III - Maps.

2.2 Area

2.2.1 Total Forest Area

The geographical area surveyed is about 50,000 Km^2. However, quite an extensive area towards China border is covered by snow and map sheets of this area were not available. Therefore, the effective geographic area covered is 36,607.267 Km^2 out of which 14,639.536 Km^2 is under forest. Thus, the forests constitute 39.99% of the effective geographical area or 29.28% of total geographical area. These area figures are based on 100% photointerpretation. Further classification of forest area into various forest types, density classes, regeneration status and biotic interference classes etc., however is based on ground inventory.

2.2.2 Area under different Forest Types

The forest area has been divided into six forest types given in para 2.1. The forest area under each forest type has, further been classified into following physical accessibility classes.

(i) Exploitable Forest - includes all the forests situated on hill slopes below 60° slopes.

(ii) Un-exploitable forests - includes all the forests situated on hill slopes of 60° slope and above.

The break-up of forest area into exploitable and un-exploitable forests and also into different forest types is given in Table No.II.1

Table No.II.1

Distribution of Forest Area by Forest Types and Physical Accessibility Classes

Forest Type	Exploitable area (Km^2)	Un-exploitable area (Km^2)	Total area (Km^2)	Age of total forest area
Chir	1,816.245(94)	105,990 (6)	1,922.235	13.1
Kail & Deodar	657.337(82)	144.583(18)	801.920	5.5
Fir-Spruce-Tsuga	695.173(86)	116.207(14)	811.380	5.5
Conifers mixed with hardwoods	2,398.882(91)	237.466(9)	2,636.348	18.0
Low level hardwoods	3,269.654(97)	106.223(3)	3,375.877	23.1
High level hardwoods	4,791.169(94)	300.607(6)	5,091.776	34.8
Total	13,628.460	1,011.076	14,639.536	100.0

Figures in brackets give the percentage area of each forest type in different accessibility classes.

The break-up of exploitable and un-exploitable forests by forest types and catchments is given in Table Nos. 1,2,3 in the Appendix.

2.2.3 Area under different regeneration classes

The regeneration of main species of the forest type in which the plot falls was observed over an area of about 1 ha. around the plot centre. Depending upon the status of regeneration. The plots were classified into five regeneration classes. The percentage area under different regeneration classes in each forest type is given in Table No.II.2

Table No. II.2

Percentage forest area in different regeneration Classes by forest types(exploitable forests)

Regeneration Status	Forest Types					
	Chir	Kail-Deodar	Fir-Spruce-Tsuga	Conifers Mixed with hardwoods	Low level hardwoods	High level hardwoods
Profuse	2.1	17.0	-	7.2	7.0	8.4
Good	14.2	37.3	14.7	23.2	22.9	22.0
Fair	34.2	23.7	50.0	39.2	49.3	39.8
Poor	38.4	20.3	26.5	20.4	17.3	22.3
Absent	11.1	1.7	8.8	10.0	3.5	7.5
Total	100.0	100.0	100.0	100.0	100.0	100.0

It may be observed from this table that the regeneration position is more or less satisfactory in almost all the forest types.

2.2.4 Area under different Density Classes

The exploitable forests under each forest type have further been classified into different density classes and the percentage area in different density classes is given in Table No.II.3

Table No.II.3

Percentage Forest Area in different Density Classes by Forest Types (Exploitable Forests)

Density Classes	Forest Types					
	Chir	Kail-Deodar	Fir-Spruce-Tsuga	Conifers mixed with hardwoods	Low level hardwoods	High level hardwoods
Less than 30%	32.4	23.4	4.4	16.1	14.7	22.9
30% to less than 60%	63.2	68.8	66.7	69.8	56.6	59.2
Above 60%	4.4	7.8	28.9	14.1	28.7	17.9
	100.0	100.0	100.0	100.0	100.0	100.0

It may be observed from this table that the forests generally are of poor density. The percentage of fully stocked forests (i.e. crown density above 60%) is very small in almost all the forest types.

2.2.5 Area under different Biotic Interference Classes

The forests are subjected to various biotic interferences such as grazing, lopping, fire etc. The exploitable forests have been classified into different grazing, lopping and fire incidence classes and percentage area in each of these classes is given in Table Nos. II.4, II.5 and II.6. For details of the definitions of these classifications Chapter-II of Volume II of this Report may be referred to.

Table No. II.4

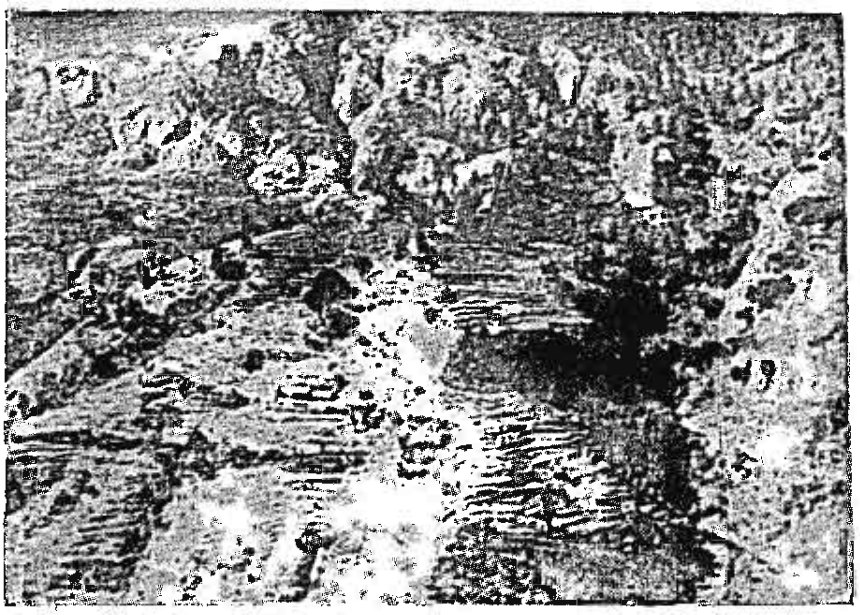
Percentage Forest Area in different Lopping Classes By Forest Types

Lopping Classes	Forest Types					
	Chir	Kail-Deodar	Fir-Spruce-Tsuga	Conifers mixed with hardwoods	Low level hardwoods	High level hardwoods
Very heavy	6.4	9.4	-	6.6	14.8	16.1
Heavy	3.4	12.5	-	9.5	14.0	11.5
Moderate	13.7	18.7	2.2	18.9	29.4	14.5
Light	28.9	9.4	20.0	13.6	19.4	15.6
Absent	47.6	50.0	77.8	51.4	22.4	42.3
Total	100.0	100.0	100.0	100.0	100.0	100.0

Table No.II.5

Percentage Forest Area in different Fire Incidence Classes by Forest Types

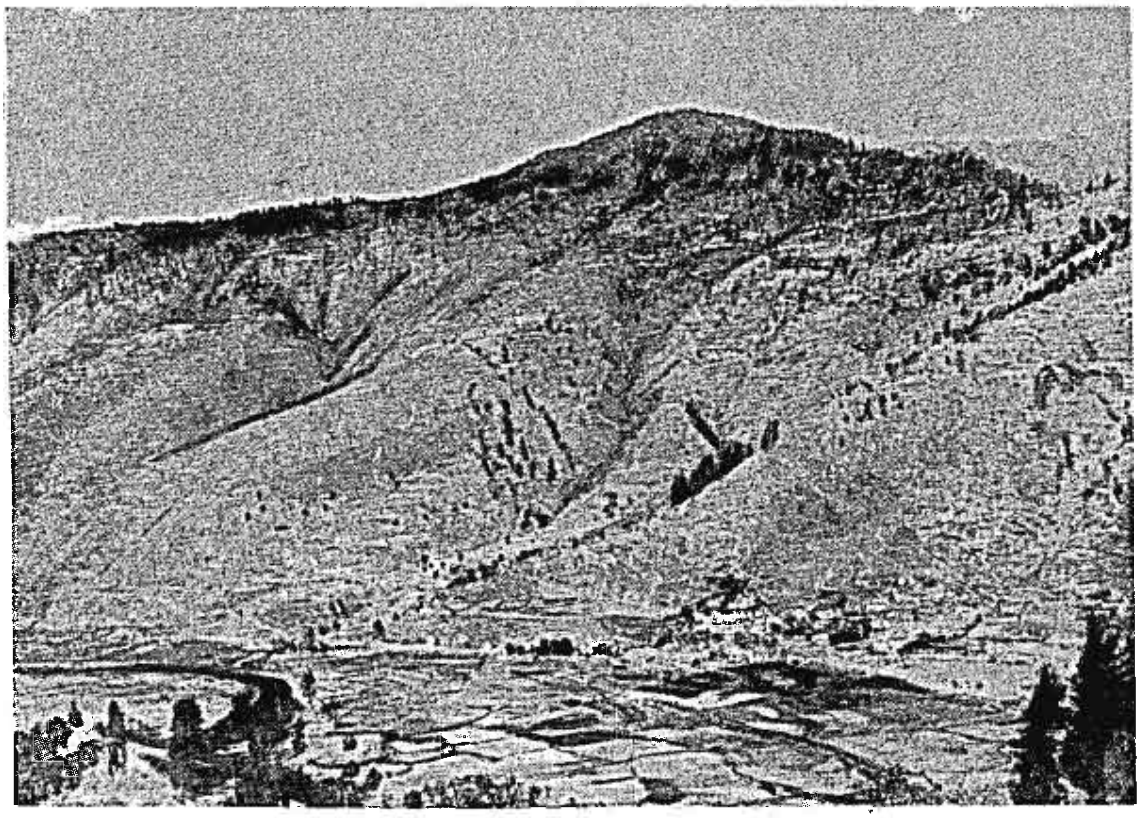
Fire Incidence Classes	Forest Types					
	Chir	Kail-Deodar	Fir-Spruce-Tsuga	Conifers mixed with hardwoods	Low level hardwoods	High level hardwoods
Very High	2.0	9.4	2.2	1.6	-	0.7
Frequent	17.1	23.4	11.1	6.6	-	4.8
Occasional	76.0	46.9	22.2	49.2	43.4	30.1
No fire	4.9	20.3	64.5	42.6	56.6	64.4
Total	100.0	100.0	100.0	100.0	100.0	100.0



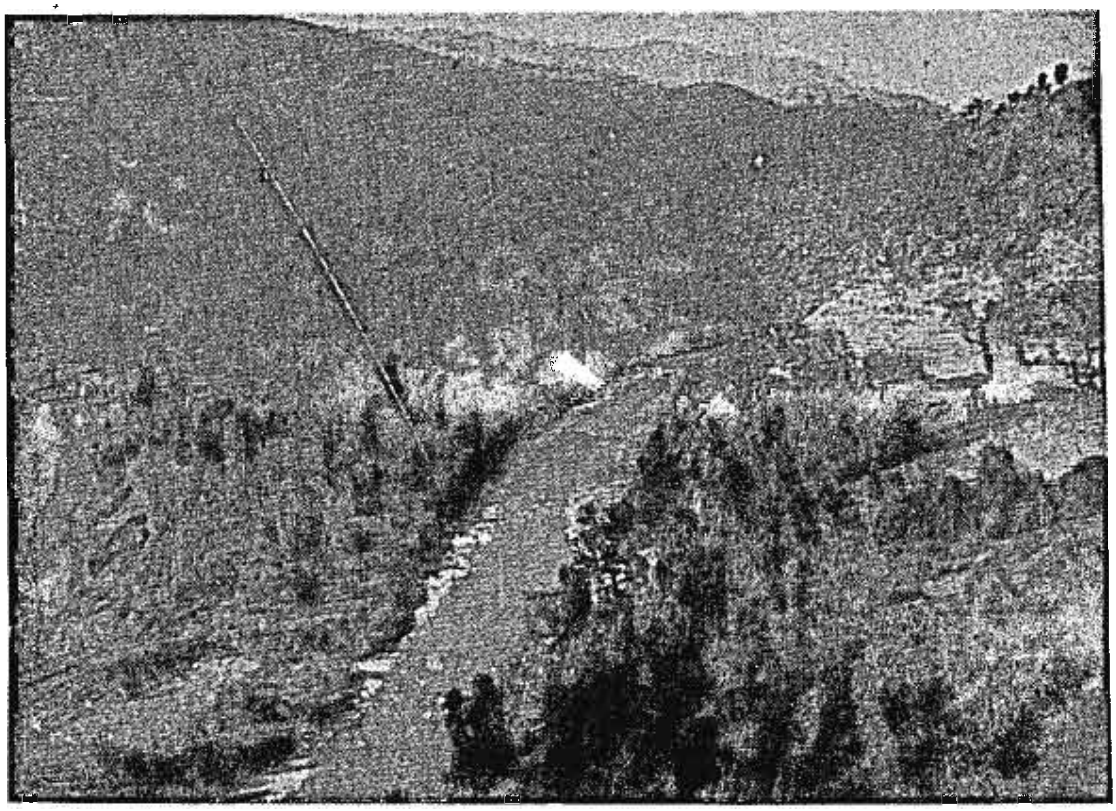
Chir Forests honey combed by encroachments and extensive cultivation in Dailekh District.

Photograph by : V. P. Singh, IFS.

Contents



Hill slopes near habitation rendered barren by excessive biotic interference in Jumla.



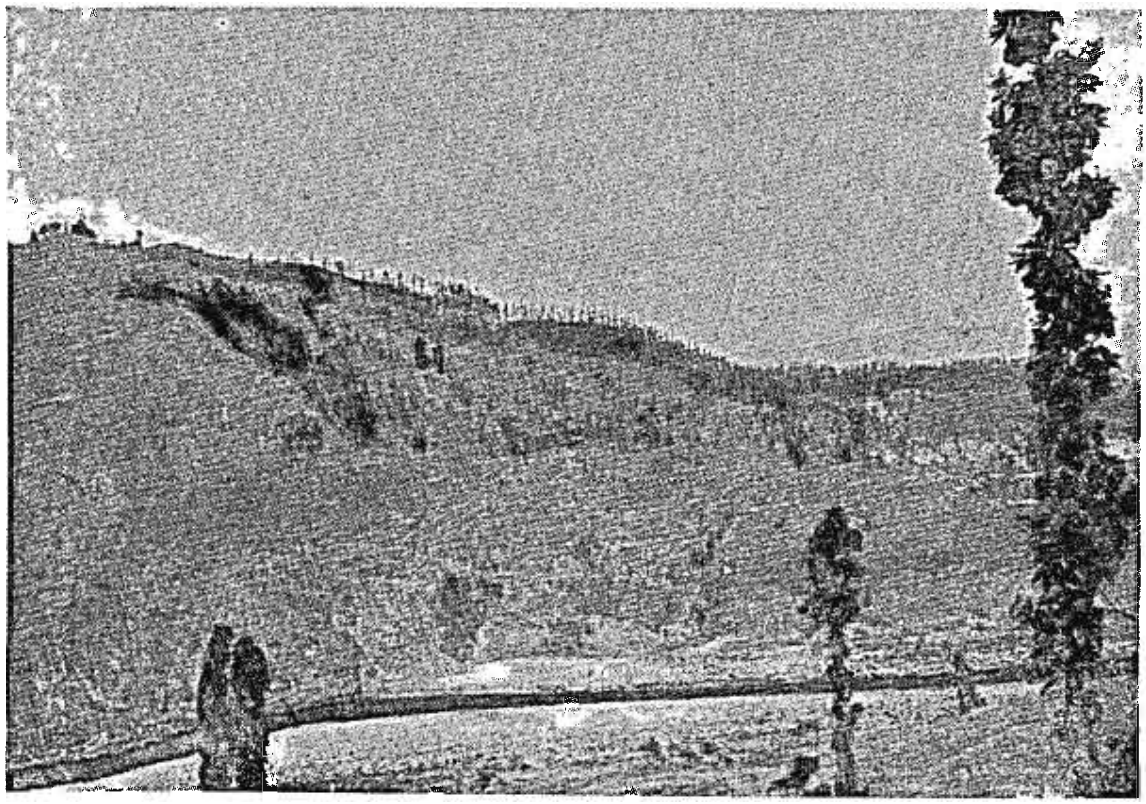
A good patch of Low-level hardwood forests affected by encroachments near Sallikot (Pyuthan).

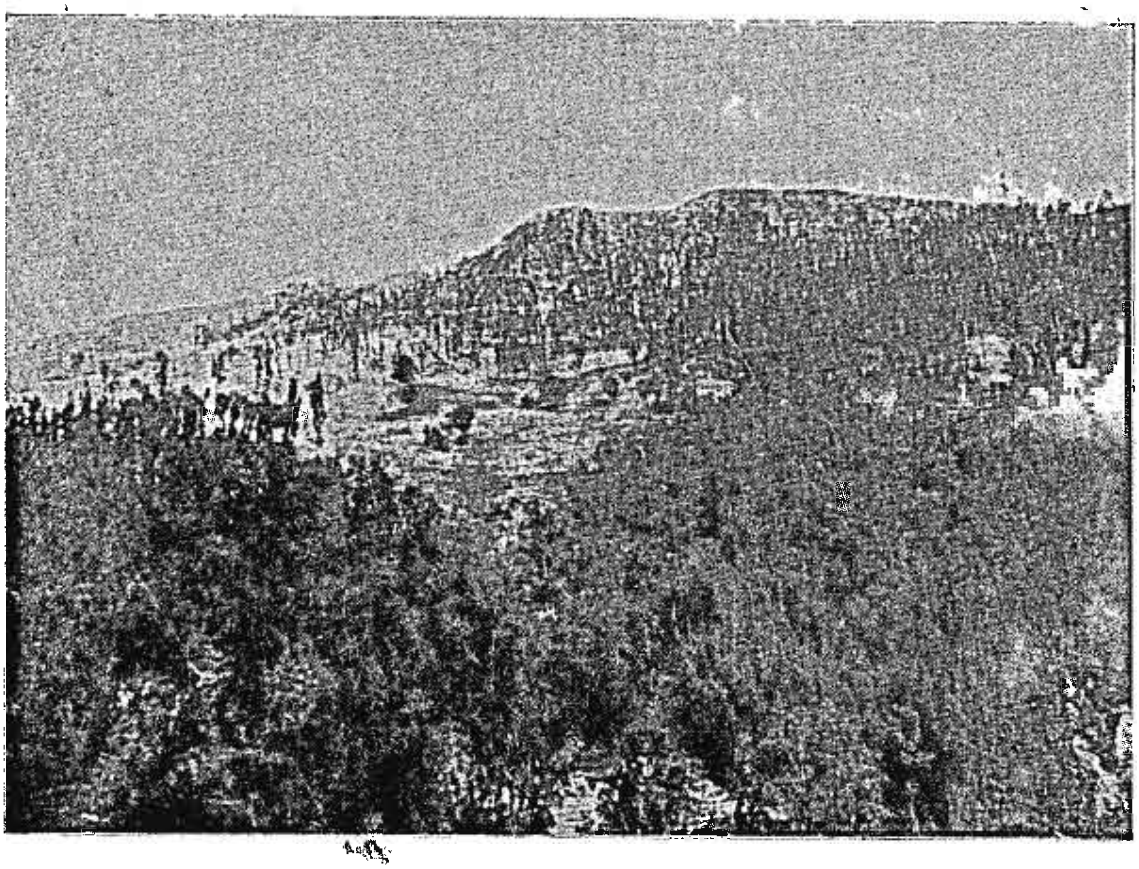
Contents

Heavily lopped and encroached Kail forests near Jumla.

Photograph by : V. P. Singh, IFS.

Contents





Mass scale lopping of Low-level Hardwood forests in District Dailekh.

Photographs by : V. P. Singh, IFS

Contents

Sal Forest near Chhinchu (Surkhet District) encroached and trees girdled.

A patch of forest unaffected by biotic interference in Jajaikot District.

Contents

Table No. II.6

Percentage Forest Area in different Grazing Incidence Classes by Forest Types

Grazing incidence classes	Forest Types					
	Chir	Kail-Deodar	Fir-Spruce-Tsuga	Conifers mixed with hardwoods	Low level hardwoods	High level hardwoods
Heavy grazing	38.7	18.7	4.4	15.1	33.6	22.0
Medium grazing	28.0	26.6	4.4	19.2	32.5	26.5
Light grazing	20.1	25.0	24.5	33.5	23.5	27.2
No grazing	13.2	29.7	66.7	32.2	10.4	24.3
Total	100.0	100.0	100.0	100.0	100.0	100.0

It may be observed from these tables that almost all the forests have been affected by biotic interference.

A few photographs given at page 42-46 show the bad condition of forest due to these biotic factors.

2.2.6 Area Under Bamboo

Except over a very small area of low land hardwoods forest type the bamboos are almost absent in all the forests of the survey area. However, at higher altitudes bamboo brakes (ringals) have been observed at many places and the percentage area under bamboo brakes occurrence in each forest type is given in Table No. II.7.

Table No. II.7

Percentage forest area in different Bamboo brakes occurrence classes by Forest Types

Bamboo brakes occurrence classes	Forest Types					
	Chir	Kail-Deodar	Fir-Spruce-Tsuga	Conifers mixed with hardwoods	High level hardwoods	Low level hardwoods
Present	-	5.1	28.6	15.3	-	14.8
Absent	100.0	94.9	71.4	84.7	100.0	85.2
Total	100.0	100.0	100.0	100.0	100.0	100.0

2.3 Stand Tables

2.3.1 Stems/ha. in different Forest Types

The stems/ha. of important species in different forest types of exploitable forests have been given in Table No. II.8

2.3.2 Diameter Class-wise distribution of stems/ha.

The diameter class wise distribution of stems/ha. of the main species and rest of species of a forest type for each forest type has also been given in Table No. II.9

The diameter class-wise distribution of stems/ha. of important species for different forest types is given in Table Nos. 4 to 9 in Appendix. It may be observed from these tables that diameter class wise distribution of stems/ha. is quite satsifactory for Chir, Kail and Sal. For other species particularly Spruce, Fir, Tsuga and Oaks the distribution is far from satisfactory.

2.3.3 Total stems in different forest types

The total number of stems of important species in different forest types of exploitable forests is given in Table No. II.10.

2.3.4 Total number of stems in the survey area

The total number of stems in the exploitable forests of the survey area are 444.633 millions and their diameter class wise and species-wise distribution is given in Table No.II.11.

The diameter class-wise distribution of total stems of important species has also been given separately for each forest type in Table Nos. 10 to 15 of the Appendix.

2.4 Volume Tables

No fellings were done for the purpose of preparing local volume equations/tables. The sample tree data of survey area were compared with the data of other surveys conducted by the Preinvestment Survey of Forest Resources Organisation in similar areas in India and the local volume equations as given in Chapter V of Volume II of this Report were finally adopted. The local volume tables prepared from these volume equations and used for calculation of volume are given in Table No.II.12.

2.5 Stock Tables

2.5.1 Volume/ha. in different forest types

Volume/ha. of important species in different forest types of exploitable forests have been estimated and the same is given in Table No. II.13.

2.5.2 Diameter Class-wise distribution of Volume/ha.

The diameter class-wise distribution of volume/ha of the main species and rest of the species of a forest type has been worked out for each forest type for exploitable forests and the same is given in Table No. II.14.

The diameter class wise distribution of volume/ha of the important species in each forest type for exploitable forests has also been worked out and is given in Table Nos.16 to 21 of the Appendix.

2.5.3 Total Standing Volume in different Forest Types

The total volume of growing stock of important species in different forest types of exploitable forests have been worked out and the same is given in Table No.II.15.

2.5.4 Diameter Class-wise distribution of Total Growing Stock

The total volume of the growing stock standing over the exploitable forests of the survey area by species and diameter classes is given in Table No.II.16.

The diameter class-wise distribution of total growing stock of important species is given separately for each forest type in Table Nos. 22 to 27 of the Appendix.

2.5.5 Distribution of Growing Stock by Forest Types and Maturity Classes

The growing stock of exploitable forests has been divided into following maturity classes :

(i) Immature - D.B.H.O.B. below 60 cms for conifers and below 40 cms for broad leaved species.

(ii) Mature - D.B.H.O.B. 60 cms and above for conifers and 40 cms and above for broad leaved species.

The distribution of total volume of exploitable forests by forest type and maturity classes is given in Table No. II.17.

2.6 Stand and Stock Tables for dead and dying trees

The stand and stock tables given in paras 2.3 to 2.5.5 relate to green trees. Dying trees have been enumerated separately. The stand and stock tables i.e. stems/ha., total stems, vol./ha., total volume, basal area/ha. and total basal area of green, dead and dying trees (i.e. Tree Grade I - green trees Grade II - mortality salvagable and tree grade III - mortality not salvagable) have been worked out separately and same are given in Table Nos. 28,29 and 30 of the Appendix.

2.7 Stand and Stock tables for different catchments

The stand and stock tables of green trees have been prepared for the four catchments namely Karnali, Bheri, Babai and Rapti and same are given in Table No. 31 of the Appendix.

Note :- The volume in all the volume tables refers to under-bark volume, including cull upto a top diameter limit of 5 cms. over-bark from the base of the tree. In case of broad leaved species it is also inclusive of branch wood volume upto a limit of 5 cm. over-bark diameter.

2.8 Standard Error

The standard error percentage for area, growing stock of each forest type and total area and total growing stock of the exploitable forest is given in Table No.II-18.

TABLE NO. II. 18

Standard Error % for Exploitable area and growing stock

For each forest type

Forest type	Exploitable Area (Ha.)	S.E.%	Volume/ha. (m3)	S.E.%	Total volume (000 m3)	S.E.%
Chir	181624.5	10.21	76.252	6.60	13849.254	12.16
Kail Deodar	65733.7	18.02	125.433	11.16	8245.125	21.20
Fir-spruce-Tsuga	69517.3	17.79	319.559	11.19	22214.883	21.02
Conifers mixed with hardwoods	239888.2	8.15	150.855	8.34	36188 .375	11.66
Low Level hardwoods	326965.4	7.36	70.199	5.09	22952.504	8.95
High Level hardwoods	479116.9	5.75	130.387	5.85	62470.422	8.20
TOTAL	1362846.0	0.69	121.746	5.19	165920.563	5.24

Contents

Table II.8

Stems/ha. of important Species in different Forest Types

Species	FOREST TYPES					
	Chir	Kail-Deodar	Fir-Spruce-Tsuga	Conifers Mixed with H.W.	High Level Borad leaved	Low Level Broad leaved
Chir	109.136			22.553	1.485	8.862
Kail	0.021	214.228	15.015	31.672	1.975	-
Deodar	-	2.532	-	-	-	-
Fir	-	4.630	132.862	33.183	3.094	-
Spruce	-	6.622	18.223	13.246	0.399	-
Tsuga	-	4.630	6.506	8.450	0.211	-
Thuner	-	-	19.165	5.325	1.824	-
Cyprus(Surai)	-	5.658	34.001	-	-	-
All oaks	6.040	35.254	24.807	43.335	125.997	0.693
Bhojpatar	-	9.461	30.381	22.808	8.970	-
Kainjal	-	-	3.638	6.584	3.252	-
Sal	5.298	-	-	23.644	0.080	178.580
Sain	-	-	-	2.060	-	21.631
Dhawra	-	-	-	0.501	-	25.638
Upland hard woods	17.882	16.992	56.248	45.651	237.572	10.718
Lowland hard woods	11.623	-	-	4.786	3.130	166.784
Total Conifers	109.157	238.300	225.772	114.429	8.988	8.862
Total Broad leaved	40.843	61.707	115.074	149.369	379.001	404.044
Grand Total	150.000	300.007	340.846	263.798	387.989	412.906

Table No. II.9

Diameter Class and Forest Type-wise distribution of Stems/ha. of main species of the Forest type and other Species.

Forest Type	Diameter Classes in cms.									Total
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90+	
I. Chir Type (1) Chir	40.000	28.593	19.662	11.228	5.799	2.718	0.924	0.153	0.059	109.136
(2) Other Spp.	31.111	5.698	2.698	0.985	0.145	0.126	0.068	0.019	0.014	40.864
II. Kail-Deodar Type										
(1) Kail & Deodar	128.143	47.274	23.037	9.751	4.285	2.056	0.894	0.634	0.686	216.760
(2) Other Spp.	67.160	6.278	3.614	3.254	1.071	0.735	0.239	0.437	0.459	83.247
III. Fir-Spruce & Tsuga Type										
(1) Fir-Spruce & Tsuga	47.444	33.852	21.074	20.260	9.783	7.583	7.781	3.830	5.984	157.591
(2) Other Spp.	101.422	46.243	18.037	8.495	3.828	2.935	1.864	0.212	0.259	183.255
IV. Conifers Mixed with Hardwoods										
(1) Conifers	49.379	28.288	15.843	9.358	5.273	2.449	1.902	0.922	1.015	114.429
(2) Borad Leaved	87.347	32.354	11.945	9.435	3.275	2.749	1.397	0.443	0.424	149.369
V. High Level Hardwood										
(1) Conifers	2.745	2.534	1.083	0.650	0.637	0.515	0.304	0.188	0.332	8.988
(2) Broad Leaved	244. 062	74.847	29.649	14.212	7.245	4.404	2.150	1.216	1.216	379.001
VI. Low level Hard-woods										
(1) Conifers	2.840	2.306	1.717	1.257	0.433	0.222	0.027	0.050	0.008	8.862
(2) Broad Leaved	272.394	70.221	43.482	10.648	4.001	1.944	0.819	0.338	0.197	404.044

Table No. II. 10

Total Stearns (000) of Important Species in Different Forest Types

Species	Forest Types						
	Chir	Kail-Deodar	Fir/Spruce Tsuga	Conifers mixed with hardwoods	High Level Hardwoods	Low Level Hardwoods	Total
Chir	19821.524	-	-	5410.555	711.346	2897.087	28840.512
Kail	3.900	14074.016	1043.740	7602.128	946.027	-	23669.811
Deodar	-	166.465	-	-	-	-	166.435
Fir	-	304.345	9236.190	7960.044	1482.173	-	18982.752
Spruce	-	435.318	1266.929	3177.566	191.225	-	5071.038
Tsuga	-	304.345	452.240	2026.942	101.229	-	2884.756
Thuner	-	-	1332.323	1277.380	874.215	-	3483.918
Cyprus	-	371.938	2363.664	-	-	-	2735.602
All Oaks	1097.092	2317.488	1723.901	10395.488	60366.219	226.194	76126.32
Bhojpatra	-	621.918	2112.037	5471.563	4297.933	-	12503.451
Kainjal	-	-	252.904	1579.273	1557.252	-	3389.429
Sal	962.269	-	-	5671.851	38.512	58389.180	65061.812
Sain	-	-	-	494.204	-	7072.556	7566.760
Dhawra	-	-	-	120.099	-	8382.689	8502.785
Up Land Hardwood	3248.103	1116.969	3910.210	10950.655	113823.219	3503.951	136553.107
Low Land H.W.	2110.801	-	-	1146.889	1499.123	44337.798	49094.611
Total Conifers	19825.424	15656.427	15695.086	27454.615	4306.215	2897.087	85834.854
Total B.L.	7418.265	4056.375	7999.052	35630.022	181582.258	121912.368	358798.340
Grand Total	27243.689	19712.802	23694.138	63284.637	185888.473	124809.455	444633.194

Table No. II. 11

Total Stems (000) of Important Species by Diameter Classes

Species	Diameter Classes in Cms									Total
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90+	
Chir	9589.403	7881.120	5565.659	3253.075	1521.760	685.538	253.715	72.745	17.497	28840.512
Kail	13201.268	5206.472	2724.939	1302.229	669.477	299.494	152.677	61.543	51.712	23669.811
Deodar	-	-	93.671	27.592	31.374	7.917	-	-	5.911	166.465
Fir	6192.284	4946.425	2708.305	1913.962	1161.440	723.533	642.283	316.857	357.663	18982.752
Spruce	3047.468	491.760	331.964	337.539	197.648	185.128	115.789	92.379	271.363	5071.038
Tsuga	1000.324	399.303	218.169	326.102	176.053	205.202	241.846	130.700	187.057	2884.756
Thuner	1949.910	1212.166	182.220	84.240	23.504	9.315	14.388	5.031	3.144	3483.918
Cyprus	1123.519	855.770	472.679	175.581	55.733	15.347	29.252	7.721	-	2735.602
All Oaks	40912.613	14802.690	7450.823	5586.745	3064.175	2056.157	1089.588	582.998	580.593	76126.382
Bhojpatra	5684.366	3102.498	1921.748	841.003	476.207	282.898	109.899	39.016	23.816	12503.451
Kainjal	1427.976	1036.786	290.407	271.222	128.994	138.723	71.257	4.482	19.582	3389.429
Sal	47800.596	10742.931	3486.862	1814.294	706.698	328.270	115.283	52.175	14.703	65061.812
Sain	3552.510	1584.161	1066.131	689.460	283.108	202.379	108.218	42.225	38.568	7566.760
Dhawra	6216.402	1536.185	554.320	124.914	59.011	11.956	-	-	-	8502.788
Upland Hardwoods	98454.182	25683.603	8038.183	2783.861	784.269	464.509	183.646	79.169	81.685	136553.107
Lowland Hardwoods	37049.872	9009.542	1829.086	819.205	215.297	87.065	57.680	13.336	13.528	49094.611
Grand Total	277202 .693	88491.412	36935.166	20351.024	9596.748	5703.431	3185.521	1500.377	1666.822	444633.194

Table No. II - 12

LOCAL VOLUME TABLE

Species	Diameter Class In Cms.										
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-110	110-120
Terminalia tomentosa	0-081	0.267	0.589	1.062	1.702	2.519	3.525	4.730	6.142	7.769	9.619
Anogeissus latifolia	0.093	0.314	0.667	1.150	1.764	2.510	3.387	4.394	5.533	6.802	8.203
Quercus incana	0.068	0.239	0.552	1.023	1 766	2.496	3.529	4.779	6.260	7.988	9.978
Betula utilis	0.125	0.381	0.796	1.379	2.129	3.083	4.216	5.544	7.071	8.802	10.739
Pinus roxburghii	0.055	0.267	0.711	1.400	2.348	3.569	5.075	6.881	9.000	11.445	14.230
Pinus wallichiana	0.100	0.387	0.907	1.678	2.715	4.027	5.621	7.504	9.681	12.154	14.928
Picea smithiana	0.133	0.400	0.842	1.507	2.439	3.683	5.286	7.291	9.745	12.693	16.180
Machilus duthies	0.090	0.309	0.657	1.134	1.742	2.479	2.346	4.343	5.470	6.726	8.113
Quercus semecarpifolia	0.065	0.311	0.740	1.353	2 150	3.130	4.293	5.640	7.170	8.884	1 782
Quercus dilatata	0.103	0.313	0.698	1.283	2.087	3.124	4.405	5.938	7.731	9.789	12.118
ABIes pindrwo	0.150	0.439	0.889	1.506	2.293	3.256	4.395	5.715	7.216	8.901	10.772
Tsuga dumosa	0.113	0.380	0.844	1.532	2.467	3.668	5.152	6.935	9.031	11.453	14.214
Rhododendron arboreum	0.051	0.185	0.409	0.725	1.136	1.642	2.244	2.943	3.739	4.632	5.627
Pieris ovalifolia	0.059	0.184	0.388	0.670	1.029	1.464	1.975	2.561	3.223	3.961	4.773
Shorea robusta	0.059	0.221	0.519	0.970	1.585	2.372	3.337	4.484	5.819	7.343	9.061
Rest of spp.	0.066	0.244	0.567	1.052	1.710	2.548	3.574	4.790	6.202	7.813	9.625

N. B. Figures underlined are extrapolated.

Table No. II.13

Volume/ha. U.B. (m^3) of important Species in different Forest Types

Species	Forest Types					
	Chir	Kail-Deodax	Fir/Spruce Tsuga	Conifers mixed with hardwoods	High level hardwood	Low level hardwood
Chir	70.079	-	-	16.357	1.545	6.258
Kail	0.136	95.798	14.265	20.311	0.976	-
Deodar	-	3.065	-	-	-	-
Fir	-	-	156.776	30.986	5.686	-
Spruce	-	12.318	55.512	7.484	2.031	-
Tsuga	-	-	34.598	14.468	1.545	-
Thuner	-	-	3.557	0.594	0.808	-
Cypress	-	0.458	14.379	-	-	-
All Oaks	1.251	8.092	18.911	35.253	70.832	0.485
Bhojpatra	-	1.905	15.899	11.493	6.908	-
Kainjal	-	-	1.619	4.055	1.479	-
Sal	1.949	-	-	3.291	0.028	26.685
Sain	-	-	-	0.191	-	11.587
Dhawra	-	-	-	0.063	-	4.899
Upland Hardwoods	1.546	3.796	4.044	6.019	38.049	0.953
Lowland Hardwoods	1.295	-	-	0.293	0.524	19.333
Total Conifers	70.215	111.639	279.087	90.200	12.591	6.258
Total B.Ls.	6.041	13.793	40.473	60.658	117.820	63.942
Grand Total	76.256	125.432	319.560	150.858	130.411	70.200

Table No. II 14.

Diameter Class and Forest Type-wise Distribution of Volume/ha. (U.B. in m^3) of Main species of the Forest types and other species

Forest Type and corresponding spp.	Diameter classes in cms.									Total
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90+	
I. Chir type										
(1) Chir	2.300	8.237	13.855	16.162	13.783	9.614	4.577	1.016	0.535	70.079
(2) Other Spp.	1.665	1.140	1.366	0.991	0.214	0.314	0.306	0.088	0.093	6.177
II. Kail-Deodar Type										
(1) Kail & Deodar	7.740	18.530	20.857	16.262	11.183	7.729	5.102	4.818	6.642	98.863
(2) Other Spp.	4.444	1.846	2.267	3.891	2.095	2.667	1.318	2.856	5.185	26.569
III Fir-Spruce & Tsuga Type										
(1) Fir-Spruce & Tsuga	8.772	14.842	20.302	30.613	22.722	25.765	35.888	23.163	64.819	246.886
(2) Other Spp.	6.410	12.998	14.522	10.589	8.096	9.070	7.916	1.194	1.879	72.674
IV. Conifers mixed with hardwoods										
(1) All Conifers	4.322	10.745	13.518	14.250	12.969	8.678	9.545	5.928	10.245	90.200
(2) Other Spp.	5.671	8.605	8.064	11.702	6.921	7.894	5.813	2.366	3.622	60.658
V. High Level Hardwood										
(1) All Conifers	0.322	0.845	0.799	0.919	1.510	1.754	1.393	1.189	3.860	12.591
(2) Other Spp.	13.963	17.842	17.426	15.825	13.605	12.278	8.581	6.680	11.620	117.820
VI. Low Level Hardwoods										
(1) All Conifers	0.166	0.643	1.251	1.792	1.034	0.813	0.132	0.353	0.074	6.258
(2) Other Spp.	11.784	15.044	10.791	9.772	6.225	4.609	2.946	1.463	1.308	63.942

Table No. II. 15

Total Volume U.B. (in '000' m^3) of important Species in different Forest Types

Species	Forest Types						Total
	Chir	Kail-Deodar	Fir/Spruce Tsuga	Conifers mixed with hardwood	High level hardwood	Low Level hardwood	
Chir	12727.907	-	-	3923.556	740.225	2046.135	19437.823
Kail	24.727	6297.136	991.647	4872.541	467.848	-	12653.899
Deodar	-	201.461	-	-	-	-	201.461
Fir	-	-	10898.576	7433.556	2724.304	-	21056.436
Spruce	-	809.674	3859.048	1795.312	973.447	-	7437.481
Tsuga	-	-	2405.184	3470.787	740.142	-	6616.113
Thuner	-	-	247.247	142.489	387.751	-	777.487
Cyprus	-	30.135	999.578	-	-	-	1029.713
All Oaks	227.113	531.975	1324.714	9486.379	33935.921	159.006	45665.108
Bhojpatar	-	125.238	1105.241	2756.978	3311.029	-	7298.486
Kainjal	-	-	112.565	972.495	695.300	-	1780.360
Sal	353.986	-	-	789.524	13.544	8725.259	9882.313
Sain	-	-	-	45.829	-	3788.353	3834.182
Dhawra	-	-	-	15.195	-	1602.062	1617.257
Upland Hardwoods	280.533	249.624	281.130	1443.626	18229.799	311.034	20795.746
Lowland Hardwoods	235.016	-	-	70.189	251.184	6312.926	6869.315
Total Conifers	12752.634	7338.406	19401.280	21638.241	6033.717	2046.135	69210.413
Total B.Ls.	1096.648	906.837	2823.650	15580.215	56436.777	20898.640	97742.767
Grand Total	13849.282	8245.243	22224.930	37218.456	62470.494	22944.775	166953.180

Table No. II 16

Total Volume U.B. (000 m^3) of Important Species by Diameter Classes

Species	Diameter Classes in cms.									Total
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90+	
Chir	538.924	2280.385	3988.647	4684.207	3627.291	2417.932	1246.816	498.216	155.405	19437.823
Kail	940.710	2106.077	2523.571	2160.468	1776.897	1196.425	868.465	460.244	621.042	12653.899
Deoda	-	-	57.251	32.223	51.222	18.032	-	-	42.733	201.461
Fir	936.715	2074.463	2568.715	2838.578	2720.349	2347.158	2816.747	1827.536	2926.475	21056.436
Spruce	264.279	214.899	295.739	536.187	494.421	677.061	631.367	667.235	3656.293	7437.481
Tsuga	89.427	172.762	193.134	540.073	454.859	772.559	1267.356	865.550	2260.393	6616.113
Thuner	124.813	326.331	94.843	90.638	39.050	54.450	-	22.799	24.563	777.487
Cyprus	46.630	230.368	297.428	176.751	97.254	33.624	109.651	38.007	-	1029.713
All C s	2515.265	4246.432	5158.716	7019.881	10.808	6147.830	4545.650	3271.410	5619.116	4 05.108
Bhojpatra	755.156	1124.037	1527.485	1111.852	1067.617	874.046	466.689	212.500	159.044	7298.486
Kainjal	120.064	248.917	160.028	289.377	214.930	374.704	257.196	23.276	118.868	1780.360
Sal	1420.082	2304.402	1802.346	1769.044	1108.860	767.233	385.71	230.132	94.504	9882.313
Sain	235.121	466.454	598.858	694.970	473.139	518.142	394.232	205.800	247.466	3834.182
Dhawra	530.531	457.455	366.629	136.198	97.921	28.523	-	-	-	1617.257
Upland Hardwoods	5203.180	5389.181	3924.930	2405.805	1200.294	975.435	627.295	350.773	718.853	20795.746
Lowland Hardwoods	2004.559	2075.316	995.174	847.374	357.586	217.125	205.727	63.814	102.640	6869.315
Grand Total	15725.456	23717.539	24553.494	25333.626	20922.498	17397.279	13822.901	8737.292	16747.095	166953.189

Table No. II 17

Total volume U.B. (in 000 M^3) of Exploitable Forests by Forest Types & Maturity Classes.

Species/ Group of Species	Forest Types						Total
	Chir	Kail-Deodar	Fir-Spruce-Tsuga	Conifers mixed with hardwoods	High level hardwoods	Low level hardwoods	
Chir							
(1) Immature	9868.885	-	-	3268.292	384.749	1597.528	15119.454
(2) Mature	2859.022	-	-	655.264	355.476	448.607	4318.369
(3) Total	12727.907	-	-	3923.556	740.225	2046.135	19437.823
Kail-Deodar							
(1) Immature	-	4891.859	824.166	3589.607	332.787	-	9638.419
(2) Mature	24.727	1606.738	167.481	1282.934	135.061	-	3216.941
(3) Total	24.727	6498.597	991.647	4872.541	467.848	-	12855.360
Fir-Spruce-Tsuga							
(1) Immature	-	177.617	6760.580	6386.098	1070.305	-	14394.600
(2) Mature	-	632.057	10402.228	6313.557	3367.588	-	20715.430
(3) Total	-	809.674	17162.808	12699.655	4437.893	-	35110.030
Thuner & Cupressus							
(1) Immature	-	30.135	1031.502	142.489	320.040	-	1524.166
(2) Mature	-	-	215.323	-	67.711	-	283.034
(3) Total	-	30.135	1246.825	142.489	387.751	-	1807.200
Bhojpatra & Acer							
(1) Immature	-	125.238	487.551	1511.067	1811.891	-	3935.747
(2) Mature	-	-	730.255	2218.406	2194.438	-	5143.099
(3) Total	-	125.238	1217.806	3729.473	4006.329	-	9078.846
Sal, Sain & Dhaura							
(1) Immature	222.102	-	-	639.852	13.544	7306.380	8181.878
(2) Mature	131.884	-	-	210.696	-	6809.294	7151.874
(3) Total	353.986	-	-	850.548	13.544	14115.674	15333.752
Upland hardwoods							
(1) Immature	280.533	209.113	182.073	1174.777	12422.706	284.985	14554.187
(2) Mature	-	40.511	99.057	268.849	5807.093	26.049	6241.559
(3) Total	280.533	249.624	281.130	1443.626	18229.799	311.034	20795.746
Low land hardwoods							
(1) Immature	190.305	-	-	48.242	177.286	4659.216	5075.049
(2) Mature	44.711	-	-	21.947	73.898	1653.710	1794.266
(3) Total	235.016	-	-	70.189	251.184	6312.926	6869 .315
Oaks							
(1) Immature	64.306	168.892	443.725	2014.620	9149.596	49.274	11890.413
(2) Mature	162.807	363.083.	880.989	7471.759	24786.325	109.732	33774.695
(3) Total	227.113	531.975	1324.714	9486.379	33935.921	159.006	45665.108

CHAPTER - III

MARKET STUDIES AND CONSUMPTION PATTERN

3.1 Demand Zone

There is no timber market in and around the survey area. Almost all quantity of timber felled is utilised locally for house construction agricultural implements, furniture and fixtures, fuel wood etc;. There is hardly any export of wood outside the survey area to meet committed demand from Wood Based Industries or local population. Therefore, only population inside the survey area including the wood based industries is considered to be the demand zone. Low intensity house sampling was done to estimate the present level of wood consumption for different purposes. The variety of species, per capita income, numerous sizes in demand, different prices for different grades of timber, availability of substitute of wood etc. make the demand picture, rather, complex and therefore, the estimates of consumption are indicative only. All the data in this chapter, unless otherwise indicated, pertains to year 1979-80 when the survey was undertaken.

3.2 Methodology of consumption survey

Initially it was proposed to collect the information on the :

i) total annual production/removal of wood from all the forests i.e. Government as well as private forests by all the agencies.

ii) annual import of wood into and export outside survey area.

iii) annual wood consumption by wood based industries, government departments, etc.

iv) annual consumption of wood by local people for house construction, fire wood etc.

During the course of inventory survey it was revealed that no commercial fellings are being done and only a small amount of timber is removed annually to meet the demand of local people for domestic purposes. The full details of supply of timber to meet the local demand were not available with the forest department. There are hardly any import or export of timber and there is no wood based industry in the survey area worth the name. The annual requirement of wood by government departments is also very very small. Keeping in view the above facts, main emphasis was laid on estimating the wood consumption for domestic purposes by local people living in the survey area. A low intensity house sampling survey was done to estimate the existing annual wood consumption by local people for :

a) house construction repair and replacement
b) furniture and fixtures.
c) agricultural implements.
d) fuel wood

A total of 655 house-holds spreading over 193 villeges of 20 districts falling in the survey area were surveyed. Detailed data on types of houses, plinth area, number of members in the family, frequency of repairs, life of houses and timber used for house construction, agricultural implements, fire wood etc., was collected for each sampled household. The full details of methodology of house sampling survey have been given in chapter 2 of volume II of this report.

3.3 Wood consumption by local people for domestic purposes

An abstract of per capita/household/piece consumption of wood for different purposes as estimated from this house sampling survey is given below :

i) Total number of districts surveyed - 20
ii) Total number of villeges surveyed - 193

iii) Total number of households surveyed - 655

iv) Number of surveyed villages lying within 1 Km. distance forests - 78

v) Numbwe of surveyed villages lying 1 to 5 km. from forests - 107

vi) Number of villages lying beyond 5 km.from forest - 8

vii) Averagé number of persons per house-hold - 6.60 m^2

viii) Average plinth area per household - 58.41 m^2

ix) Average life of house - 80 years

x) Average frequency of repairs of houses - 9 years to 10 years

xi) Wood used for house construction per household - 16.121 m^3(WRE)

1) Conifers - 9.994 m^3 (WRE)

2) Broad leaved - 6.127 m^3 (WRE)

Total - 16.121 m^3 (WRE)

xii) Wood consumption for furniture and fixtures per house-hold

1) Conifers - 0.282 m^3(WRE)

2) Broad leaves - 0.177 m^3(WRE)

Total - 0.459 m^3(WRE)

xiii) Annual fuel wood consumption per house-hold :

1) Conifers - 2351 Kg.

2) Broad leaves - 4231 Kg.

Total - 6582 Kg

xiv) Per capita annual fuel wood consumtion :

1) Conifers - 356.21 Kg

2) Broad leaves - 641.06 Kg.

Total - 997.27 Kg.

xv) Wood used for agricultural implements :

1) Yoke - 0.012 m^3(WRE) per piece
2) Plough(Hal) - 0.030 m^3(WRE) per piece
3) Halas - 0.014 m^3(WRE) per peice
4) Leveller - 0.056 m^3(/RE) per piece

xvi) Average life of agricultural implements :

1) 'oke and halas - 10 years
2) Plough(Hal) - 3 years
3) Levellèr - 4 years

xvii) Number of agricultural implements per household :

1) Yoke & Plough - 1.3145
2) Leveller - 1.1389

3.4 Population and number of house-holds :

District is the lowest administrative unit for which population figures were available. While many districts fall wholly inside the survey area, there are a few which fall partly inside and partly outside. The population of the districts which fall, partly in the survey area has been apportioned in proportion to the geographical area falling inside the survey area. On this basis the total population of the survey area as per 1971 census works out to 1605.350. Taking 6.60 persons per household and also presuming the rate of growth of population as well as households as 2.28% per annum which was the rate of growth of population of Nepal between 1961 & 1971, the population and number of households in the survey area in different years are estimated to be as under :

Year	Total population	Total number of households
1971	16,05,350	2,43,235
1980	19,35,000	2,93,182
1990	23,76,000	3,60,000
2000	29,18,000	4,42,121

3.5 Present consumption of wood (i.e. during 1980)

3.5.1 House construction & repairs

a) New additions : Presuming the annual growth rate of households same as the population, i.e. 2.28%, about 6685 new houses are to be constructed in 1980 in the survey area. Annual wood requirements for these new construction is as under :

Conifers	-	66810 m^3(WRE)
Broad leaved	-	40960 m^3(WRE)
Total	-	107770 m^3(WRE)

b) Replacements : Presuming average life of a house as 80 years, houses need to be reconstructed in 1980 in the survey area. Thus annual wood requirement for reconstructing these new houses will be as under :

Conifers	-	36628 m^3(WRE)
Broad leaved	-	22455 m^3(WRE)
Total		59083 m^3(WRE)

c) Repairs : Presuming that 10% of the timber required for constructing a house is required for repairs every 10th year, total annual wood consumption for repair of houses in 1980 will be as under :

Conifers	-	28263 m^3(WRE)
Broad leaved	-	17327 m^3(WRE)
Total	-	45590 m^3(WRE)

Thus, the total annual requirement of wood for house construction, replacements and repairs will be :

Conifers	-	131701 m^3(WRE)
Broad Leaved	-	80742 m^3(WRE)
Total	-	212443 m^3(WRE)

3.5.2 Agricultural Implements

Presuming that every new household would need the same quantum of agricultural implements, as the existing households, the annual requirement of wood for new agricultural implements will be 918 m^3(WRE). In addition to this, timber is also required to replace the old implements which become unfit for use due to normal wear and tear. The average life of each implement, has been given in para 3.3 of this Chapter. Taking into account the life of implements and wood required for each implement, the annual requirement of wood for replacing old implements comes to 9313 m^3(WRE). Wood used for repairs is negligible and therefore this has been omitted from calculations. Thus, total annual requirement of wood for agricultural implements is 10231 M^3(WRE). Almost entire quantity of wood for agricultural implements comes from broad leaved species.

3.5.3 Furniture & Fixtures

Presuming that every new household would need the same quantum of furniture & fixtures, as the existing households annual requirement of wood for furniture & fixtures will be as under :

Conifers	-	1885 m^3(WRE)
Broad leaved	-	1183 m^3(WRE)
Total	-	3068 m^3(WRE)

In addition to the new households, the furniture & fixtures are to be replaced in old households. Taking average life of furniture and fixtures as 20 year, annual requirement of wood for replacement of furniture & fixtures will be as under :

Conifers	-	4039 m^3(WRE)
Broad Leaved	-	2536 m^3(WRE)
Total	-	6574 m^3(WRE)

Wood requirement for annual repairs is very small and hence omitted. Thus, the total annual requirement of wood for furniture & fixtures is :

Conifers	-	5924 m^3(WRE)
Broad leaved	-	3718 m^3(WRE)
Total	-	9642 m^3(WRE)

3.5.4 Fuel Wood

Fuel wood is used for cooking food and also for keeping the houses warm in winter. Total annual requirement of wood for this purpose is as under :

Conifers	-	689266 tons = 1102825 M^3(WRE)
Broad leaved	-	1240451 tons = 1984725 m^3(WRE)
Total	-	1929717 tons = 3087550 m^3(WRE)

All the fuel wood consumed by local people does not come from the assessed growing stock. Quite a substantial quantity of fuel wood comes from the bushes, shrubs, branches of trees, fallen wood etc.. which have been excluded from the assessment of growing stock while surveying the forest, Besides, the trees standing in agricultural lands which have been excluded from surveys contribute towards meeting the demand for fuel wood. It is difficult to pin-point exactly the amount of fuel wood which comes from the assessed growing stock to meet the local demand for fuel wood. However, from experience in similar areas it can safely be assumed that atleast 50% of the fuel wood demand is met from the assessed growing stock. Thus the total annual wood required to meet fuel wood demand will be :

Conifers	-	551412 m^3(WRE)
Broad leaved	-	992363 m^3(WRE)
Total	-	1543775 m^3(WRE)

Thus, the total annual drain on the assessed growing stock for meeting the local demand of wood for house construction, furniture & fixtures, agricultural implements and fuel wood is as under :

Table No.III.1.

Total Demand of wood in 1980 to be met from the growing stock of survey area

Unit : m^3(WRE)

Purpose	Annual Wood consumption		
	Conifers	Broad Leaved	Total
1. House construction repairs & replacements	131701	80742	212443
2. Agricultural implements	-	10231	10231
3. Furniture & Fixtures	5924	3718	9642
4. Fuel wood	551412	992363	1543775
Total	689037	1087054	1776091

3.6 Future Demand Trends

Future demand of wood may be affected by many factors such as growth of population, changes in income structure, price trends of various commodities, changes in utilisation pattern of wood, availability of substitutes, consumer's preference etc.. The rural population which accounts for almost entire consumption of wood is scattered all over the area and no replacement of wood is likely to be available to these people firstly due to non-availability of any alternative and secondly due to transportation and distribution problems. The availability

of forest resources near their homes is another factor which plays important role in consumer's preference. Therefore, per capita/household consumption of wood for different domestic purposes is presumed to remain same in future and, therefore, the increase in consumption of wood will be in proportion to increase in population. The estimated demand of wood for different purposes in future years is given in Table No.III.2

Table No. III.2

Future Demand of Wood to be met by growing stock from the survey area

Unit - m^3(WRE)

Purpose	YEAR 1990			2000		
	Conifers	Broad leaved	Total	Conifers	Broad leaved	Total
House construction repair & replacements	161829	99151	260980	198726	121757	320483
Agricultural Implements	-	12564	12564	-	15429	15429
Furniture & Fixtures	7275	4566	11841	8934	5607	14541
Fuel Wood	677174	1218622	1895796	831521	1496468	2327989
Total	846238	1334903	2181181	1039181	1639261	2678442

CHAPTER - IV

GROWTH RATE AND POTENTIAL ANNUAL CUT

4.1 Growth Rate

The growth rate of Chir, Kail & Fir has been studied with the help of pressler borer. Although efforts were made to study the growth rate of all the conifers, but due to limited availability of pressler borers and sparse occurrence of some of the conifer species adequate number of sample trees of Conifer and other than Chir, Kail and Fir for the purpose of studying growth rate were not available. Therefore, the growth rate of Chir, Kail & Fir only have been reported here. By measuring the thickness of last 10 years annual rings of a large number of randomly selected sample trees, the annual basal area increment percents of chir, Kail and Fir in different diameter classes have been worked out. Presuming that the volume increment percent in any diameter class is equal to the basal area increment percent of that diameter class, the average (weighted) annual volume increment percent of these species spread over the entire survey area have been worked out and same are given below :

Species		Average Annual Volume Increment Percent (A.A.I.%)
Chir	-	1.91
Kail	-	2.37
Fir	-	1.1

For estimating the potential annual cut the growth rate of Spruce-Tsuga, Thuner and Cyprus has been assumed to be equal to that of fir,.The growth rate of Deodar has been taken from News-Print Catchment Report. Thus, average annual volume increment percents used for estimating the yield are given below :

Species		Average Annual volume Increment percent (A.A.I.%)
Chir	-	1.91
Kail	-	2.37
Deodar	-	1.74
Fir, Spruce Tsuga, Thuner & Cyprus	-	1.11

The diameter class-wise basal area increment percents of Chir, Kail & Fir have been given in Table No.32 in the Appendix.

4.2 Rotation

The rotation depends upon the objects of management which are not very clearly defined in the present case. Although the main objective of survey was to estimate the pulpable volume yet it is difficult to conclude that all the forests will be managed to feed the pulp and paper mill only. The main purpose of discussing the rotation here is only to calculate the potential annual cut.

Kail, Deodar and chir are important structural grade timbersand, therefore, it would be advisable to manage them under long rotation so that they reach exploitable size of 60 cms. diameter at breast height over bark or above before resorting to final felling. Besides, being suitable for construction timber chir is also likely to be used by Match Wood Factory to be established near Dhangarhi. Therefore, keeping in view the exploitable diameter and growth rate the following rotations for chir, Kail and Deodar are used for estimating the yield.

Chir	-	120 years.
Kail & Deodar	-	150 years.

In case of Fir spruce and Tsuga which do not find much use as construction timber but are suitable for pulping, the object of management should be the maximum volume production. From stand volume and yield tables for the Silver Fir published by FRI, Dehradun it may be seen that the total stem timber MAI culminates at the age of 90 years. The standard stem timber MAI, however, culminates at the age of 120 years. Reliable growth statistics of most of the broad leaved species occuring in the area are not available. Except Oak most of the broad

leaved species occur either in mixture with conifers or in small pure patches along nalas. The present trend of management of forests is towards concentrated fellings leading to more or less clear fellings. Therefore, it may be difficult to manage the broad leaved species at a rotation different from that of the conifers of their respective zones. Keeping in view the above observations the following rotations have been adopted for calculating the yield.

Chir	-	120 years
Kail & Deodar	-	150 years
Fir, spruce, Tsuga & all other species	-	120 years

4.3 Potential Annual Cut

The yield from forests depends upon the silvicultural system, the objects of management, the condition of growing stock, rotation, growth rate, mortality etc. Therefore, in order to estimate the yield precisely a more detailed study of growing stock and its condition in each management unit is necessary which is beyond the scope of this study. Therefore, only three para-meters namely growing stock, its age and growth rate have been kept in view while estimating the potential annual cut of conifers. For broad leaved only the growing stock and rotation have been used to estimate the potential annual cut.

It may be noted from Table No.II.17 that proportion of mature stock of fir-spruce and Tsuga is quite high (60%) and that of chir, kail and deodar, is very low (about 25%). Therefore, comparatively higher yield should be available from Fir, Spruce and Tsuga forests. In chir, Kail and Deodar forests not only the proportion of mature stock is low but the stocking also is poor as compared to similar forests in India. Thefefore, in case of these

species, a part of increment should be retained to build up the stock. In order to give an idea of the stocking of forests a comparative information giving volume/ha. in different forest types in similar forests surveyed by Preinvestment Survey of Forest Resources Organisation is given in Table No.IV.I.

Table No.IV.1

Growing Stock/ha. in Western Nepal Survey Area and other similar survey areas in India

Unit - M^3

Forest Type	Name of the Project Area				
	Chenab Valley (J&K)	Bhagirathi, Bhilangna Catchment (U.P.)	News-Print Catch-ment (H.P.)	North Western Bhutan	Western Nepal
Chir	127.51	130.33	-	81.89	76.26
Kail	205.23			70.65	
		275.09*	183.26**		125.43*
Deodar	278.76			-	
Fir/ Spruce	351.40	280.76	394.59	357.34	319.56
Conifers with B.Ls.	-	-	299.04	241.17	150.86
Upland hardwoods	-	193.97	-	272.48	130.41
Lowland hardwoods	-	48.83	-	-	70.20

* These are average figures for Kail-Deodar Forest Types.

** This figure is average for Chir-Kail & Deodar Forest Type.

All the forests of the above project areas except Bhutan are under regular management. The poor stocking in Nepal forests belies the claim of conservationists that the forests left to themselves have better protection.

Thus, keeping in view the annual growth, growing stock/ha. and the proportion of mature growing stock of different species, the following formulae have been used for estimating the yield.

1. Chir, Kail & Deodar

   Yield = ½ (AAI)

2. Fir-Spruce & Tsuga

   $$\text{Yield} = \text{AAI} + \frac{\text{VM}}{\text{Rotation}}$$

   where - VM is the growing stock above 60 cm. dbhol.

3. Cyprus & Thuner

   Yield = AAI

4. All other Species

   Yield = 2 x growing stock/rotation

4.4 Cull

Cull means natural defects in wood which makes it unsuitable for any purpose. No fellings were done in the area to study the cull. However, from fellings done in similar areas in India it is observed that the cull volume is negligable in case of Chir, Kail and Deodar, but it is quite high in case of Fir, Spruce, Tsuga and Oaks. Even if the cull percentage in each species is known precisely it becomes difficult to estimate the net yield because, the percentage of unutilizable volume (cull volume) will depend upon manner of removal of yield also. For example in case selection fellings are done the percentage of cull volume will be more but if clear fellings are done there will be sufficiently higher proportion of trees of lower diameter class and hence percentage of cull volume will be less. Though it is difficult to arrive at correct figures of cull volumes but still it is necessary to give an indication of the net yield by making necessary reduction in gross yield due to cull volume. In order to arrive at net yield, the gross yield is, therefore, reduced by 20% in case of Fir-Spruce, Tsuga and Oaks

and 5% for all other species except chir, kail and Deodar. For chir, kail and deodar no reduction is done. These cull factors are based on the studies done in similar areas in India.

The gross and net potential annual cut of the major species of the survey area arrived at by using the formula indicated earlier are given in Table No.IV.2.

Expected Potential Gross and Net Annual Cut of different Species

Unit - M^3

Species	Total growing stock	Increment Percent	Rotation	Yield formula	Gross yield	Cull %	Net yield
Chir	19437823	1.91	120 years	½ AAI)	185631	-	185631
Kail	12653899	2.37	150 years	½ (AAI)	149949	-	149949
Deodar	201461	1.74	150 years	½ (AAI)	1753	-	1753
Fir	21056436	1.11	120 years	AAI + $\frac{VM}{Rotation}$	316373	20	253098
Spruce	7437481	1.11	120 years	AAI + $\frac{VM}{Rotation}$	129489	20	103591
Tsuga	6616113	1.11	120 years	AAI + $\frac{VM}{Rotation}$	116488	20	93190
Thuner	777487	1.11	120 years	AAI	8630	5	8198
Cyprus	1029713	1.11	120 years	AAI	11430	5	10858
Oaks	45665108		120 years	2 x gross stock/ rotation	761085	20	608868
Bhojpatra	7298486		120 years	2 x growing stock/ rotation	121641	5	115559
Acer spp.	1780360		120 years	2 x growing stock/ rotation	29673	5	28189
Sal	9882313		120 years	2 x growing stock/ rotation	164705	5	156470
Sain	3834182		120 years	2 x growing stock/ rotation	63903	5	60708
Dhawra	1617257		120 years	2 x growing stock/ rotation	26954	5	25606
Upland hard woods.	20795746		120 years	2 x growing stock/ rotation	346596	5	329266
Lowland hardwoods	6869315		120 years	2 x growing stock/ rotation	114489	5	108764
Total ...	166953180				2548789		2239698

Abstract of Gross & Net Annual Potential Cut

		Gross Yield	Net Yield
1.	Chir	185631	185631
2.	Kail-Deodar	151702	151702
3.	Fir-Spruce-Tsuga	562350	449879
4.	Cyprus	20060	19056
5.	Hardwoods	1629046	1433430
	Total ...	2548789	2239698

CHAPTER - V

ECONOMIC AVAILABILITY AND COST OF RAW MATERIAL DELIVERY

5.1 Why Cost Studies ?

The raw material though available in plenty, but if its transport cost is too high, it becomes of little relevance to the industry. Therefore, besides acquiring knowledge about the total wood, the information as to the availability of raw material within reasonable economic limits is also very important. Since the regulation of removal from forests is beyond the scope of present survey, it will not be possible to co-relate the logging costs with cuts and removals. A simple study, therefore, has been undertaken to determine the accessibility and cost of delivery of wood from forests to tentative industrial sites. For this study only one site namely CHISAPANI in foot hills on the river bank of Karnali river has been taken into consideration.

5.2 Objectives

The main objective of the study is to determine broadly the cost of raw material (excluding royalty) at tentative mill site (Chisapani) and indicate broadly the distribution of total growing stock into various cost classes assuming that the current wage-rate, price and the logging techniques will continue to prevail throughout the first conversion period. The objectives also included :-

(a) Terrain study

(b) Study of floatability of rivers for floating the logs or splits.

(c) Optimum methods to be adopted in mechanised and conventional logging.

(d) Identification of equipment including mechanised equipment required for logging.

5.3 Premises Adopted

The sampling design for the study can be described to be the systematic point sampling. The same sampling frame as the one adopted for ground inventory was used for the study. The only difference was that in place of three plotswas done in ground inventory, cost structure was studied only at one plot at the cross section of 6,000 yards x 6,000 yards grids. For each sampling unit the logging costs were worked out as per the description in the following paragraphs. The logging costs for each sampling unit have been worked out on the presumption that under the existing conditions only coniferous raw material can be extracted by conventional methods. On the basis of total logging costs for each sampling unit of Karnali and Bheri catchments, the units were grouped into different cost classes. Depending upon the proportion of sampling units of these two catchments in each cost class, the total growing stock of these two catchments was apportioned into different cost classes. Since there is very little coniferous raw material likely to be available from Babai and Rapti catchments, these two catchments have been omitted from cost calculations.

The wage rates of Rs.15/- per day for skilled and Rs. 10/- per day for unskilled workers have been adopted for arriving at various logging costs.

5.4 Logging Operations

Logging costs are defined normally as the costs incurred on various operations carried out and contingencies to help handling of wood from stump to mill site. No regular fellings are being done presently in the survey area.

However, usually recognised logging operations in similar areas in India are :

(i) Felling and cross cutting of trees which includes following operations :

(a) Lopping
(b) Roping
(c) Felling
(d) Cross cutting into logs
(e) Debarking
(f) Site Sawing/Splitting
(g) Engraving property marks and numbering the pieces.

(ii) Off-road transport i.e. transport of material to the road site/launching site by man/animal carriage, dry slides, wet slides, khad vahan etc.

(iii) Road Transport.

(iv) River Transport.

(v) Loading and un-loading of trucks.

(vi) Launching, rafting etc. in case of floating.

5.5 Logging Costs

Since commercial fellings are not being done at present in the survey area, therefore, it could not be possible to ascertain the logging costs correctly. However, many logging studies have been done by Preinvestment Survey Organisation in similar areas in India to ascertain the factual logging costs prevalent in different areas. Basing on the logging costs in similar areas in India, following rates for different logging operations have been used to calculate the total logging costs at each sampling unit :

1.	Felling including lopping and roping.	=	0.18 man days/m^3 = Rs. 2.70/m^3
2.	Cross cutting including delimbing & debarking	=	1.00 man days/m^3 = Rs.15.00/m^3.
3.	Sawing/splitting into hakaries and assorted sizes.	=	2 man days/m^3 = Rs.30.00/m^3
4.	Engraving property hammer marks and numbering the pieces.	=	0.06 man days/m^3 Rs.0.90/m^3

5.6 Transport Cost

For estimating the cost of off-road and on-road transport the net work of existing roads/rivers/nalas has been taken into consideration. There is hardly any road worth the name which can be used for timber transport. Therefore, for the present rivers are the only mode of transport of timber by way of floating the logs/splits into the rivers and only coniferous raw material can be transported by this method. Since no commercial fellings are being done in the survey area or in similar areas of Nepal, the information on the costing and the methods of transport of timber was not available.

However, the established practice in similar areas in India is to resort to site sawing/splitting the timber into convenient sizes, carrying it to nala/river head either by man or animal carriage or by gravity ropeways and floating into rivers/nalas upto consumption centres. At places where a good net work of roads exist, the timber is carried to road heads in round form by skyline cranes and then transported to consumption centres either by road or combination of road and river transport. The cost of transportation of timber by different modes of transport, as adopted from similar areas in India is given below and same is used for estimating the

total cost of transport of wood for different sampling units :

(i)	Dry slides/rolling man carriage from stump site to wet slide/launching site	= 2 man days/m^3/km = Rs.20.00/m^3/km
(ii)	Wet slides	= 1.0 man days/m^3/km = Rs.10.00/m^3/km
(iii)	Khat vahan (khad floating) including cost of launching and collection.	= 0.25 man days/m^3/km = Rs.2.50/m^3/km.
(iv)	River floating including launching rafting etc.	= 0.02 man days/m^3/km = Rs.0.25/m^3/km
(v)	Collection at boom & stocking or loading into trucks.	= 0.8 man days/m^3 = Rs.8.00/m^3
(vi)	Boom making charges	= Rs. 2.00/m^3
(vii)	Overhead/supervision charges	= Rs.20.00/m^3

5.7 Transport distance

The modes of transport and the distances which timber has to travel from each sample unit to mill site have been studied from 1"=1mile topo sheets. For the purpose of estimating the average logging costs and dividing the growing stock into cost classes, it is presumed that timber will first be felled and converted into convenient sizes. This will then be transported by man carriage from stump site to the nearest perennial nala. From there it will be transported by making wet slides in or along the nalla upto a point from where the water discharge of nala can push the timber by its force. This pushing of timber by water force, which needs constant help from man is called khadvahan.

After Khad Vahan, timber enters into river for floating and collected down below near mill site by erecting a boom on the river. The average horizontal distance of different modes of transport which timber has to travel from each sampling unit to mill site alongwith assumed winding factors are given below :

KARNALI CATCHMENT

Mode of transport	Average horizontal distance	Winding factor (estimated)	Average working distance (km).
1. Dry slides/ mancarriage	0.70	2.0	1.40
2. Wet slides	3.14	2.0	6.28
3. Khadvahan	8.88	1.2	10.66
4. River floating	211.00	1.0	211.00

BHERI CATCHMENT

1. Dry slides/ man carriage	0.83	2.0	1.66
2. Wet slides	7.22	2.0	14.44
3. Khad Vahan	4.90	1.2	5.88
4. River floating	167.0	1.0	167.00

The average mill delivered cost (excluding royalty) of conifers by conventional methods is expected to be Rs. 248.80/m^3 for Karnali Catchment & Rs. 312.65/m^3 for Bheri catchment.

Very little material is likely to be available in Babai and Rapti catchments and whatever is available that shall have to be brought by road because these two rivers do not meet Karnali river before proposed mill site. Therefore, for Karnali and Bheri catchments only average working distance for different modes of transport has been worked out and same is given below :

Dry slides/Man carriage	- 1.49 kms
Wet slides	- 9.16 kms
Khad Vahan	- 8.97 kms
River transport	-193.27 kms

The average mill delivery cost (excluding royalty) of wood for the two catchments by conventional methods is Rs. 270.74/m^3. This cost excludes the river losses in transit which may go upto 5% of value of wood transported.

5.8 Cost Classes

Following four cost classes have been recognised for the purpose of dividing the growing stock into different cost classes.

Cost Classes	Range of cost/m^3
Low (A)	Less than Rs. 200.00/m^3
Medium (B)	Rs.200.00 to less than Rs.300.00/m^3
High (C)	Rs.300.00 to less than Rs. 400.00/m^3
Very High (D)	Rs.400.00/m^3 and above.

5.9 Distribution of Growing Stock into Cost Classes

For the reasons given earlier cost calculations have been done only for Karnali and Bheri Catchments. The percentage growing stock of these two catchments into different cost classes is given below.

Cost Classes	Percentage Growing Stock of Karnali Catchment.	Percentage Growing Stock of Bheri Catchment
Low (A)	29.49	23.60
Medium (B)	47.80	32.92
High (C)	17.29	18.63
Very High (D)	5.42	24.85

It may be observed from the above table that the transport of raw material from Bheri Catchment will be some what costlier as compared to Karnali Catchment. The reasons for high cost of extraction from Bheri Catchment is due to low water availability in feeder nallas etc. required for Khad Vahan and the timber, therefore, has to be carried by dry slides and wet slides for longer distances.

5.10 Floatability of Rivers

One Crew was deployed for studying the floatability of rivers. Since Babai and Rapti river catchments are likely to have very little surplus raw material, only Karnali and Bheri rivers and their tributaries were visited for the purpose of studying floatability. In order to arrive at conclusions regarding floatability or otherwise of a river, various parameters such as rate of discharge, speed of flow, presence of obstacles etc. are required to be studied in different periods of the year. Due to shortage of time and limited man power it was not possible to carry out the detailed investigations regarding discharge/rate of flow eto.. The rivers and their tributaries were visited only to spot the hinderences/obstacles, if any, in the river course which could make floatability diffioult.

The rate of discharge and speed of flow was observed ocularly. It has been observed that both rivers and some of their tributaries have sufficient water discharge even in lean periods to facilitate floating. The flow generally is very smooth and there are not many obstacles in the rivers. Thus both the rivers and their major tributaries can be considered to be suitable for timber floating. This observation is further confirmed by the fact that about 20 years back quite a substantial quantity of timber mainly Chir and Kail was floated to India in both the rivers by an Indian Contractor from as far off places as Jumla, Dolpa etc..

5.11 Terrain Study

The slope and also the presence of big boulders (above 25 cm. diameter) was measured/observed at each sample point and the sample points were classified into following classes of slope and stoniness.

Code	Degree of slope
1	60° and above.
2	45° to less than 60°
3	30° to less than 45°
4.	20° to less than 30°
5.	Less than 20°

Code	Stoniness
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.

The percentage area in different slope and stoniness classes is given below :

Percentage Area in various Slope/Stoniness Classes

Stoniness Class	Slope Classes 1	2	3	4	5
1	-	2.3 (.5)	3.1 (1.6)	5.7 (1.0)	7.0 (.4)
2	60.0 (.5)	36.5 (8.2)	26.9 (14.5)	23.0 (4.1)	22.8 (1.1)
3	30.0 (.3)	57.7 (12.9)	66.8 (36.0)	60.8 (11.0)	63.2 (3.1)
4	10.0 (.1)	3.5 (.8)	3.0 (1.6)	9.6 (1.7)	7.0 (.3)

N.B.: Figures in the brackets are percentage based on total area.

So far as mechanised means i.e. skyline cranes and gravity rope-ways are concerned the stoniness has little influence on working the forests. The slope, however, plays an important role. It may be observed from this table that most of the forests can conveniently be worked by skyline cranes/gravity rope-ways.

5.12 Scope of Mechanisation

Mechanisation of logging operations certainly leads to economy in logging cost as well as wood utilisation. By conventional methods, explained earlier, only coniferous wood can be extracted, but the mechanication can facilitate extraction of hardwoods also. The survey area, however, is lacking in necessary infrastructure facilities required for mechanisation.

Contents

The local people are also not used to handle machines required for mechanised logging. Even the use of saws is restricted in the area. Local population uses axes to cut the timber from forests to meet their domestic needs. Under such conditions it is not advisable to resort to mechanisation. Therefore, for the present the timber may be extracted by conventional methods explained earlier. By the conventional methods, however, only coniferous wood can be extracted to mill site and the broad leaved species may be utilised for meeting the demand of local people for domestic purposes.

At a later stage, if communication system improves, the possibilities of mechanised logging may be explored. This further will depend upon various policy decisions such as intensity of felling, method of regeneration, the nature and sizes of the forest produce to be utilised by the mill etc..

CHAPTER VI

WOOD BALANCES AND RECOMMENDATIONS

6.1 Wood balances

The expected potential net annual cut has been given in Table IV.2 of Chapter IV. The demand of wood for 1980 is given in Table No.III.1 and the future demand for the years 1990 and 2000 has been indicated in Table III.2 of Chapter III. It is presumed that the potential annual cut will not increase unless steps are taken to improve the existing growing stock in these forests. As the population will increase and the major demand of wood is from the local population this demand will also increase enormously as worked out in Table III.2. Basing on this data the present and future wood balances position is given in Table NO. VI. I:

Table No. VI.1

PRESENT AND FUTURE POSITION OF WOOD BALANCES

Unit - m^3

Year	Total yield (Net)		Demand of wood		Surplus (+) Deficit (-)		Total Surplus (+) Deficit (-)
	Conifers	B. L.	Conifers	B.L.	Conifers	B. L.	
1980	806268	1433430	689037	1087054	(+) 117231	(+) 346376	(+) 463607
1990	806268	1433430	846238	1334903	(-) 39970	(+) 98527	(+) 58557
2000	806268	1433430	1039181	1639261	(-) 232913	(-) 205831	(-) 438744

From the above table it is seen that though there is surplus of wood in 1980 to the tune of 463607 m^3 per annum but it will be eaten away by increase in demand and in 1990 the surplus will be very small whereas in 2000 the area will be deficit of wood approximately to the same tune as it is surplus in 1980.

6.2 Recommendations

The main objective of this survey was to assess pulpable volume in the two forest types of (i) Chir pine and (ii) Fir spruce Tsuga. From the above wood balances position it will be seen that the area is having wood surplus only in 1980 and this surplus is only for a short period of 10 years and the quantity of surplus will go on decreasing every year. Presuming that the present wood surplus will be entirely of those species which are pulpable i.e. chir, fir spruce and tsuga the per day availability of raw material presuming that the mill works for 300 days a year will be about 1550 M^3.

However it is quite unlikely that such a large area (about 15000 km^2 forest area and about 51000 km^2 geographical area) will be set apart to cater to the raw material requirement of a paper mill. Only a small area can be committed for industrial supply and from the forest types map prepared by the PIS as well as population information and field survey it has been found that some districts like Jumla, Mugu, Tibrikot, Humla and parts of Doti and Achham have comparatively high percentage of forest and sparse population. It may be better if some compact forest areas in these districts are delineated and the field data of the present survey is reprocessed to know the wood surplus from these compact and small areas or in the alternative to arrive at a still more reliable conclusion re-survey of these areas may be done by adopting revised sampling design i.e. sampling units may be spaced closer. Also thorough photo interpretation of the aerial photography available for these areas may be done for pre-stratification purposes before taking up the inventory survey. This suggestion is made keeping in view the fact that 85% of

...../82

the domestic consumption of wood is for fuel wood and it will not be possible to supply fuel wood to the far-off deficit areas in the survey zone from these areas as transport will be a problem and costly affair.