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**REPORT ON THE ESTABLISHMENT  
OF WOOD INDUSTRIAL PLANTS  
IN NORTH-WESTERN INDIA**

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Prepared by the Finnish experts

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and

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Helsinki, October 1958



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## Preface

Paragraph 1 of article 1 of the agreement concluded between the Government of India and the Government of Finland on technical assistance to India, signed on June 14th, 1957, reads as follows:

"Within the terms of this agreement the preliminary arrangements being terminated and subject to the funds made available, the Government of Finland will furnish assistance to India in the form of sending two experts to the area of River Beas and also if existing possibilities allow, to the conifer forests of the surrounding regions, to study and ascertain the possibilities of setting up forest industries and the supply of raw material."

In accordance with this stipulation Mr. Kullervo Kuusela, Doctor of Forestry, and Mr. Ilmari Koskinen, an engineer of the wood industry, were sent to India in October 1957. The task of Mr. Kuusela was to study the forest resources, felling and transportation facilities and the sustained yield of the conifer forests in the area of River Beas and, if necessary, of the surrounding regions in order to ascertain the supply potential of raw material. The task of Mr. Koskinen was to investigate the advisability of building wood industrial plants, particularly pulp and paper mills, in the region mentioned above, to find the best locations for them, to decide what kinds of mills, and of what sizes, were recommendable.

Dr. Kuusela returned to Finland in May 1958 and Mr. Koskinen in June 1958 both after completing their work in India. The reports on their findings were completed in Finland, and the final texts are attached here.

Dr. Kuusela came to the conclusion that in the area referred to there is a lot of raw material, on a sustained yield basis, for the mills mentioned in Mr. Koskinen's report. In his report, Dr. Kuusela also refers to some silvicultural improvements and other measures necessary or recommendable in the event of the mills being established.

Mr. Koskinen has ascertained that pulp and paper mills are both technically and economically feasible in this area. He also recommends modern saw mills in order to utilize trees unnecessarily large for pulp. The different kinds of mills, and their sizes and locations are made clear. Calculations of the investments and production costs are included.

The region covered by the studies of Dr. Kuusela and Mr. Koskinen is, of course, not the only area in India open to this kind of development. Limitations in time and available staff made it necessary to concentrate the work in a rather small area. This area was chosen because conifer wood is an excellent raw material for the pulp and paper industry. Northern India being rich in conifer forest resources and in view of the results of my preliminary discussions in India concerning this project and of my visit to the area of the Beas River in December 1954 and January 1955.

As mentioned in Dr. Kuusela's and Mr. Koskinen's reports, both of them during their stay in India received the full support and assistance of the Indian central and local authorities, particularly those of the Forest Institutes at Dehra Dun. Without this help and co-operation it would not have been possible for them to carry out their task. The National FAO-committee of Finland, which has been in charge of the administrative work in Finland in connection with the agreement between the Government of India and the Government of Finland, considers that the task defined in paragraph 1 of article 1 and previously quoted has been carried out with the submission of this report.

The next step in the problem of establishing wood industrial plants in the area referred to will be the decisions of the Indian authorities on the basis of this report. Detailed planning of the plants can only begin after that. Such work no longer comes under this agreement.

All the same, I am sure that Finnish firms would be willing to help India in this further work. Finnish engineers and machine industries have wide international experience in planning saw mills, pulp and paper mills and other wood industrial factories and in supplying the machines and complete plants. For instance, in 1957 machines of this category were exported from Finland to 17 different countries.

I sincerely hope that the work so far completed will help the Indian authorities in their difficult economic development programmes and in this way will strengthen the ties of friendship between India and Finland, as mentioned in the preamble of the inter-governmental agreement referred to.

Helsinki, September 25, 1958

Eino Saari

Chairman of the National FAO-committee  
of Finland

CONIFER FORESTS IN THE STATES OF THE PUNJAB AND HIMACHAL  
PRADESH IN NORTH-WESTERN INDIA

as a raw material resource for forest industries

by

Kullervo Kuusela

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## Preface

Under the terms of the Agreement between the Government of Finland and the Government of India on Technical Assistance to India, which came into force on 14th June 1957, this investigation was centred on the area of the Beas River and on the conifer forests of the surrounding regions as a possible supply of raw material for industries. The author spent seven months in India from 15th October 1957 to 15th May 1958. His headquarters were in the Indian Forest Research Institute at Dehra Dun, from which several tours were made to the conifer areas, as well as visits to the nearby forest industries and administrative offices in the State Capitals of Chandigarh, Punjab and Simla, Himachal Pradesh.

The Forest Research Institute was an ideal headquarters for the study because the basic material for it—the Working Plans of all the Forest Divisions—are available in its libraries. The staff of this unique Institute and its facilities offered an inspiring and co-operative atmosphere for concentrating on the local problems, which were quite different from the circumstances under which the author had worked so far.

The Indian Government and the Forest Research Institute aided the study with collaborative guiding and research, as well as secretarial aid. The author is greatly indebted for this indispensable co-operation.

Of the Indian authorities I would like respectfully to thank Mr. G.G. Takle, Inspector General of Forests, and Mr. C.A.R. Bhadran, Deputy Inspector General of Forests, in the Ministry of Food and Agriculture. In spite of their numerous responsibilities they always had time for discussions which I found most valuable in my work.

I am greatly indebted to Mr. R.N. Datta, President of the Forest Research Institute & Colleges, as well as to many branch officers and research workers whose vast scientific knowledge and experience were for so many months at my disposal.

Mr. Niranjana Singh, officer in charge of the Logging Branch, carried the heaviest burden of the guiding and practical tour arrangements. During my last tour, when Mr. Niranjana Singh was tied

up with his duties in the Training Centre for Logging, the guiding was carried out by Mr. Jaswant Singh, an instructor from the Northern Forest Ranger College. My heartfelt thanks for their tireless efforts to help my work.

Field tours were carried out in the forests of the Punjab and Himachal Pradesh. It is my pleasant duty to express my thanks to Mr. G.S. Dhillon, Chief Conservator of Forests, Punjab, and Mr. G.S. Kaith, Chief Conservator of Forests, Himachal Pradesh, as well as to all Forest Departmental staff members of these States for the guiding and assistance which they always gave with equal readiness in the course of my work.

Helsinki, September 27, 1958

Kullervo Kuusela

## INTRODUCTION

### Present Role of Conifer Forests in the National Economy of India

Forest resources in India are very limited and the situation is characterized by a serious unbalance between demand and supply. Every piece of usable wood on the markets and on the major transportation routes is valuable and expensive. The mushrooming pulp and paper industry suffers an acute shortage of raw material. Even if the bulk of its requirements can be provided from bamboo, grasses and bagasse, wood will still be greatly in demand e.g., for newsprint and rayon. A vigorously developing India will need all kinds of pulp and paper products in enormously increasing quantities, which will have to be either produced domestically or imported. At present all the rayon pulp and most of the newsprint is imported.

On the other hand, in the Himalayan hills and mountain ranges, in a tract 1,500 miles long from East to West, there are still large areas of partly used or untapped conifer forests guarded by rough terrain and many extraction difficulties. The unquestionable importance of these forests has been emphasized many times but their value is still a mere potential. They only supply sleepers and scantlings to the markets and, compared to the obtainable yield, the quantities extracted are very small. The conversion percentage of the exploitation varies from 45 to 25, i.e., the largest part of every felled trunk is left as logging waste in the forest. Small timber, under a limiting diameter of 8 inches, has so far had no use worthy of mention. Resin tapping is the main source of revenue in the large pine areas.

The main role of the conifer forests has been to preserve the hill sides against erosion, to maintain an equable flow of water in the streams and rivers, and to provide the domestic and agricultural requirements of the local population in timber, fuel, grazing, grasses and numerous other minor forest products.

The commercial utilization of the conifers is very one-sided. It is based on a single type of product, i.e. sleepers and scantlings, which are converted from the best part of the largest trees by hand sawing beside the stump. This usage is a deep rooted custom and these

products have served requirements for a long time. But from the point of view of an independent India and her vigorously developing economy, this state of affairs is very unsatisfactory. It is time to bring the conifer forests out of their stagnation, to stop the reckless waste in conversion and to supply diversified forest products for the multiple requirements of the national economy. This can only be attained by means of an integrated utilization of wood.

## Problems in Creating an Integrated Utilization of the Himalayan Conifer Forests

The potential resources of the Himalayan conifer forests can only be in full use provided the utilization of wood is properly integrated. There should be a suitable demand for every dimension and quality of wood and every acre growing trees or suitable to grow trees should provide the maximum integrated yield.

Under the prevailing conditions the proposed task sets a jungle of compound problems. Fig. 1 illustrates the five problem groups which are considered essential and necessary. If any of them is left unsolved the whole scheme will collapse.

Forest Management deals with the means of growing trees in order to obtain the most profitable yield. The objectives of forestry, suitable tree species, the composition and structure of the desirable growing stock, the proper silvicultural system, the exploitable size and age of the trees, the locations of the different age classes, etc. must be defined in the management plan.

In this case the main problem is how to grow trees for a variety of markets keeping in mind the silvicultural conditions, logging difficulties, soil preservation and the requirements of the local population. For instance, if one size of timber is more loggable than another size, the former will be the objective of the management, provided that this more loggable size does not jeopardize the size of the total yield. The management system is not a stiff skeleton of principles but a flexible body that can find a new way to meet every new situation.

Silviculture deals with the questions of how to grow valuable crops taking into account the biological and silvicultural characteristics of the tree species in the area under consideration. The regeneration of over-mature spruce and fir crops and the reforestation of devastated areas suitable for tree growth are the main difficulties in hill forestry. The present silvicultural system of spruce and fir needs some modifications.

The problem of extraction is the most outstanding one. H u b e r's report (1953) is referred to: "The existing inefficient and wasteful methods of timber extraction must be changed into modern and partly

mechanized logging and transportation operations. This requires new tools and other equipment, new logging methods and corresponding training for the operational staff and labour."

Relations between Forestry and the Local Population call for much modification. At present the inhabitants have many rights but few responsibilities. Reckless grazing and cutting are forcing the scattered forests higher and higher up into the mountains and are destroying the national timber resources and the prerequisites of human life in the hills. A sharp line must be drawn between arable and forest land, and the inhabitants should be educated to grow wood for their own requirements. The problem has its administrative, legislative and educational aspects.

Diversified Markets can be created by building up industries which use every dimension and quality of wood. The possibilities of the existing industries and new projects for integrated wood-working industries should be considered carefully and the most realisable schemes put into effect.

The Historical and Psychological Background is the human screen on which the afore-mentioned problems are projected. Uses of wood and methods of forestry, like all human activities, are everywhere controlled by deep-rooted old customs. Certain species, sizes of logs and logging methods are used because historically they have served the needs. The usage continues in spite of the fact that the technical and economical level at which these customs came into existence has been changed long ago. Human factors are an essential part in every technical and economic development. They are often difficult to overcome but it is fatal to consider them as unsurmountable obstacles.

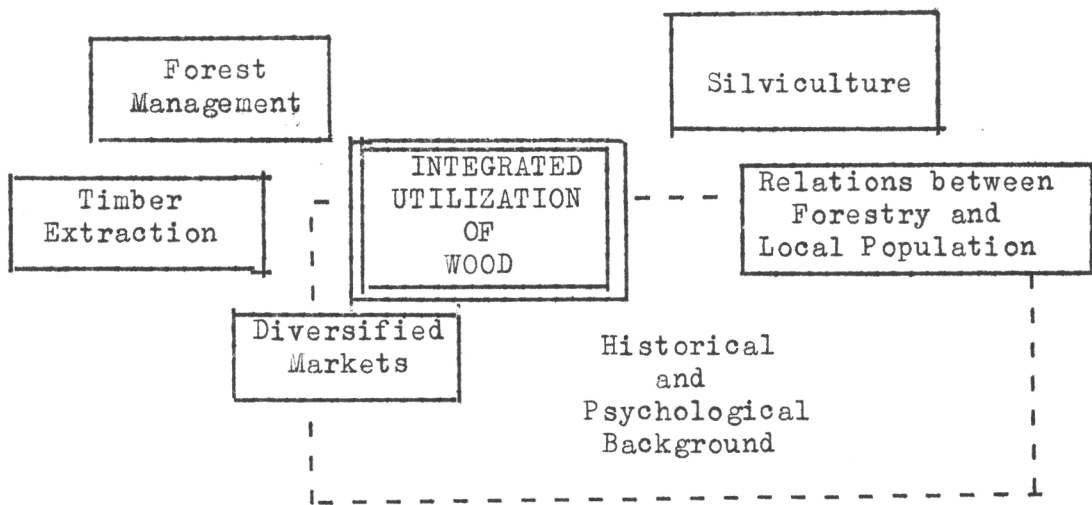


Fig. 1. Problem groups in creating an integrated utilization of wood.

## CONIFER FORESTRY IN THE BEAS BASIN

A detailed study

General Description of the Beas Basin

Geographical Situation. The conifer forests lie in that part of the Beas Basin which belongs to the Extra-Peninsular region adjoining at the Plains of the Indian Peninsula at the North. It lies between the latitudes of  $31^{\circ}30'$  and  $32^{\circ}30'$  North and the longitudes of  $75^{\circ}30'$  and  $78^{\circ}00'$  East. The Beas River rises in the Pir Panjal at the Rohtang Pass in the Great Himalayas and intersects the Dhauladhar Range of the Lesser Himalayas at Larji through a very precipitious gorge. Then it flows through the southern part of the Kangra Valley and intersects the Siwalik Range of the Sub-Himalayas at the southern border of the conifer forests.

The highest altitudes in the north-eastern corner of the catchment area are about 21,500 ft. The altitude of the Beas River is 6,500 ft. at Manali, 3,994 ft. at Kulu, 2,473 ft. at Mandi, 1,431 ft. at Dehra Gopipur and 950 ft. at the northern border of the Plains. In the Upper Beas the terrain is mountainous and the slopes and gorges are often very precipitious. In the lower part of the Basin the hills are undulating and the differences of altitude are usually less than 2,000 ft.

Climate and Rainfall. The climate varies from sub-tropical to alpine, and to permanent snow at the highest altitudes. In the Kulu Valley of the Upper Beas, rice can be grown at the bottom and within a ten to fifteen miles' walk one can pass all vegetation zones up to alpine pastures.

Average temperature records in Manali from 1935 to 1948 were ( $F^{\circ}$ ):

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
max.	64	66	71	76	76	87	83	83	82	83	75	65
min.	29	31	35	42	48	55	60	56	52	43	35	30

In Kangra the maximum temperature is about  $93^{\circ}F$  and the minimum about  $35^{\circ}F$ . In Lower Beas the maximum temperature frequently exceeds  $100^{\circ}F$  in May and June.

Rainfall ranges from 26.9 in. at Mukerian in the Plains to 134.5 in. at Lower Dharamsala at an altitude of 4,580 ft. The bulk of it comes down during the two monsoon months of July and August. The weather

Table 10. Average rainfall in inches and the number of rainy days in the Punjab, North Eastern Punjab, and in some individual stations.

State and places.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Punjab	0.92	0.93	0.79	0.53	0.53	1.67	5.28	5.30	2.52	0.28	0.12	0.44	12.31
	1.8	1.9	1.7	1.2	1.2	2.5	5.9	5.8	2.7	0.5	0.2	0.9	26.3
Punjab East, North	1.10	1.06	0.86	0.55	0.57	1.99	6.35	6.37	3.09	0.35	0.14	0.51	22.99
	2.0	2.1	1.8	1.2	1.3	2.9	7.0	6.8	3.2	0.5	0.3	1.0	30.1
Kangra	3.00	2.95	3.05	2.45	2.26	3.59	8.92	9.09	3.67	0.87	0.55	1.27	41.67
	5.4	6.0	6.4	5.3	5.4	7.2	13.5	13.6	6.4	1.9	1.1	2.4	74.6
Kulu	4.22	4.36	4.31	3.04	2.14	2.31	5.70	6.19	3.22	1.02	0.68	1.72	38.91
	6.3	6.8	6.6	5.7	4.8	4.6	9.1	9.8	4.5	1.7	1.2	2.6	63.7
Nagar	5.02	5.32	5.72	3.71	2.43	2.73	7.51	7.62	4.06	1.21	0.90	2.15	48.38
	7.2	7.3	7.9	6.2	5.0	5.8	13.2	13.8	6.4	2.4	1.5	3.4	80.1
Palampur	4.63	4.61	3.51	2.06	2.22	7.76	31.22	32.51	10.10	1.15	0.44	1.92	102.20
	6.0	6.2	5.7	4.1	4.4	8.6	20.3	21.5	10.0	1.8	0.8	2.6	92.0
Dharamsala Upper	4.05	6.40	4.30	2.58	1.52	7.69	39.48	34.30	11.66	1.72	0.37	2.17	116.24
	5.0	7.6	6.7	5.3	3.9	10.3	24.6	24.1	13.4	3.6	0.9	3.9	108.7

is bright and cloudless on most days during the remaining ten months of the year. - Average rainfalls in the Punjab, North Eastern Punjab and some individual stations are given in Table 1.

During the monsoon, the heavy rainfall often causes serious floods and landslides damaging fields and roads. During the "dry" period the rainfall is usually light, but sometimes it can be very heavy too.

Snowfall is common in the Upper Beas from an altitude of 6,000 ft. upwards in the winter months of December, January and February. A snow coverage lasting at least two months and thick enough for snow transportation occurs in the spruce and fir zone from 7,000 upwards. In Kangra snowfall is sometimes heavy but the snow does not lie any length of time below 7,000 ft. In Hoshiarpur snowfall is very rare.

Administrative Units, Density of Population and Local Economy.

The Beas Basin belongs mainly to the State of Punjab and to the Kangra District. The south-western corner of the conifer area penetrates to the Hoshiarpur District in the Siwalik Range. Below the gorge in the Dhauladhar Range the Beas flows through the northern half of the Mandi District in the State of Himachal Pradesh. Some outskirts of the Chamba District of Himachal Pradesh lie in the catchment area of the Lower Basin.

The forests are almost all State-owned and they are divided into forest divisions. The four Punjab forest divisions, Kulu, Seraj, Kangra and Beas, form the Beas Circle with the Circle headquarters in Dalhousie. Almost all the Mandi Division and some scattered forests of the Chamba Division of Himachal Pradesh belong to the Beas Basin. The Forest Departmental headquarters of Punjab and Himachal Pradesh are both in Simla.

Table 2. Areas and populations in the Kangra District based upon the census of 1951

	Tehsils and sub-tehsils	Area in sq.mi.	Population	Population per sq. mi.
	Kangra	422	156,317	370
Kangra proper	Palampur	724	174,451	241
	Nurpur	519	97,480	188
	Dehra Gopipur	495	142,008	288
	Hamirpur	590	220,098	373
Kulu sub-division	Kulu, Seraj, Lahaul, Spiti	6 225	145,688	23
	Total	8 975	936,042	104

Table 2. and Table 3. show the population and cattle density of the Beas Basin. It should be borne in mind that the mountain tehsils of Lahoul and Spiti and some parts of the Seraj tehsil in Table 2. are outside the catchment area of the Beas River. - In Himachal Pradesh, the density of population is 94 per sq.mi. and in the Chamba District 56 per sq.mi.

The whole Basin is essentially rural. In Kangra 95 per cent of the population belong to the agricultural classes, whose life is simple and primitive. The economy is based on small-scale farming, fruit growing, sheep and goat rearing and village crafts. Road construction and other public works, as well as forest work, provide some income too.

Traffic Routes, Floatways, Power Supply and Manufactures from Wood.

In the south-western corner of the Basin the city of Pathankot is the terminus of the Northern Railway with connections to Amritsar and Jullundar. Yogindarnagar behind the Kangra Valley is connected to Pathankot by a metre-gauge rail link.

The main Basin is open for motor vehicles by metalled road to Larji. The metalling and broadening of the road up to Kulu is under way and may be finished in 1958. The maximum load allowed on most bridges upwards from Mandi is 5 tons. Dalhousie is connected by metalled road to Pathankot, and Pathankot to the principal cities in the Plains. From Kalka there is a convenient motor road to Mandi. The basic road network is sufficient for launching a venture to intensify forestry. Many remote forests need new service roads and their construction is feasible if connected with centralized logging operations. Most of the Departmental forests are provided either with jeepable roads or with inspection and contour paths sufficient for the present intensity of forestry.

The Beas River and its tributaries are the main transport routes for timber down to the Plains. The Beas down from Kulu and the lower part of the Parbatti River can carry logs of up to at least 30 in. of diameter. Sleepers and scantlings are floated in most side streams. It should be borne in mind that the present opinions about the floatability of the Beas and its tributaries are based upon data from unequipped floating operations in natural rivers.

In the Basin there is only one power station, at Yogindarnagar, with four generating units of a total installed capacity of 48,000 K.W. In the near Sutlej Basin there are two power stations each located at Gangwal and Kotla which have a total installed capacity of 96,000 K.W. One additional unit of 26,000 K.W. at each of these power stations will be available in 1959-60. Power from Bhakra will be available in 1959-60 with the installation of five generating units of 90,000 K.W. output each. - The fall of water in the mountain rivers is so steep that the potential water power resources are practically unlimited.

The bulk of wood brought down to the markets is used as railway sleepers and for constructional purposes, furniture, packing cases, etc. Manufacture is undertaken at small bench saws and in minor workshops. A preservation plant is the only large unit. Resin from the long-leaf pine provides more revenue than timber in the Kangra and Beas Forest Division. Forests provide wood for domestic use and for cottage industries.

Table 3. Demarcated Forests, Fields, Population and Domestic Animals in some Upper Beas Areas

Waziri	Total area sq.mi.	Area of demarcated forests in 1947 in square miles.	Area of cultivated land in 1945	Population Total	in 1941 Per sq.mi.	Numbers (in 1945) of Cows and bullocks	Sheep and goats
Kulu	674	201	54	65 283	97	50 274	110 048
Rupi	677	257	18	18 721	27	19 511	25 956
Inner Seraj	not known	160	19	19 843	-	11 932	20 413

Description of the Forests  
Composition of the Conifer Crops

A natural way to divide conifer forests into sub-groups or zones is based upon the altitude level and the tree species. The following three zones will serve the purpose of this study:

The chir zone in Lower Beas is situated between altitudes of 1,500 and 5,000 ft., the best forests between 3,500 and 5,000 ft.; in Upper Beas between 4,500 and 6,000 ft., exceptionally up to 7,000 ft.

The main conifer in this zone is the Long-Leaf pine (*Pinus longifolia*, Roxb.), called chir in Hindi and chil in Punjabi. Chir pine is a gregarious light demander but it is often mixed at its upper and lower limit. Its companions at upper limit are deodar, kail and oaks. Towards its lower limit it is associated with lower level sub-tropical deciduous species.

The chir is the most important species in the Lower Basin where apart from local use it is the only source of timber for export. It is the source of the resin which provides the bulk of revenue.

The average quality of the chir crops is much inferior in the Lower Beas than elsewhere. Forests are scattered and surrounded by over-grazed scrubby slopes and agricultural areas. Many chir stands are irregular and have a very low density.

Chir is still an important species in the Mandi Division but in Kulu and Seraj it is a secondary one compared to the other conifers. A large part of the chir forests in the Upper Beas have been slowly transformed into kail and deodar, very largely by nature as a result of fire protection, though the latter species have also increased considerably by artificial restocking.

The deodar and kail zone lies between 5,000 and 8,000 ft., exceptionally up to 9,000 ft., as in the Parbatti Valley.

The main species in this zone is deodar (*Cedrus deodara*, London) or Himalayan cedar. It is essentially gregarious, not as typical a light demander as pines, and occurs frequently in pure stands. Besides spruce, the commonest companion of deodar is kail (vernacular name) or blue pine (*Pinus excelsa*, Wall.). Kail is a typically gregarious light demander and a pioneer species which occupies abandoned grasslands and fields. It often flourishes with oaks.

Deodar is the most valuable timber tree in the forests from Mandi upwards. It has been the prey of the old-time exploiters and the main conifer objective of later silviculturists. One of the working-plan objectives is still "to increase the proportion of deodar trees" by natural and artificial regeneration measures.

Compared to its companion, kail is greatly inferior as a timber tree. It is more susceptible to fire damage, often lopped heavily and thus liable to fungus damage. A marked tendency has prevailed to convert kail on the best sites and cool aspects into deodar.

Deodar sleepers and scantlings provide the bulk of revenue in Upper Beas. Because deodar has been the main object of scientific silviculture its characteristics are well known and its treatment is upon a sound basis. Vigorously growing deodar seedlings in regeneration areas and young pole stands offer a convincing proof of the results which can be obtained by silviculture.

The spruce and fir zone lies between 8,000 and 12,000 ft., chiefly between 7,000 and 11,000 ft. Spruce grows occasionally on northern slopes as low as 5,000 ft.

The main species in this zone are the West-Himalayan spruce (*Picea morinda*, Link.) and the West-Himalayan low-level silver fir (*Abies pindrow*, Spoch.). Spruce is a moderate light demander (or moderate shade bearer) and gregarious but not often found pure in large areas. At its lower limit, in the so-called tension belt, it is mixed with deodar, kail and oaks. Fir is the main companion of spruce, a true shade bearer and sometimes mixed with deodar and kail in which cases it usually seeks cool and moist aspects.

Spruce and fir cover the shoulders of the Himalayan ranges. Because of rough terrain which offers many logging difficulties, they have not been exploited as heavily as the lower level species. However, they have been a valuable timber reserve for emergency demands and they provided wood for requirements during the war.

Most of the spruce and fir forests are over-mature and a high percentage of large trees produces only unsound timber. In exploited areas the stand density is low and the forests are characterized by poor or completely absent regeneration on account of grazing and raw humus formations.

Fir is the commercial name for both species. Fir sleepers and scantlings provide a large part of income in Mandi and the Upper Beas Forest Divisions. Regeneration of the over-mature spruce and fir forests is obviously the most crucial problem in the conifer silviculture.

The commonest broad-leaved companions of the conifers are oaks. *Quercus incana*, Roxb. occurs in the chir zone, *Q. dilatata*, Lindl. in the deodar and kail zone and *Q. semicarpifolia*, Smith. in the spruce and fir zone. They form almost pure stands with low density and scrubby stems in large areas. Oaks are used principally for charcoal and fuel, and their leaves for fodder.

Most of the deciduous species, too numerous to be mentioned in this connection, are usually found in damp depressions, on limestone formations, around villages, etc. Many of them produce valuable wood for special purposes but the scattered occurrence of good quality trunks makes their economical extraction difficult.

A special feature of the Kulu Valley is the extensive growth of alder (*Alnus nitida*, Endl.). It grows on fresh alluvium deposited by the river.

## Forest Areas

Table 4 gives the forest areas under State ownership according to forest divisions. There is no data available about private forests. They are mainly found in abandoned fields and their area is said to be negligibly small. (Incidentally, the only two logging operations which the writer saw in the Kulu Division in the winter of 1957-58 carried timber from private forests.)

Acreages of undermarked forests and State owned waste land are not known accurately. They are an important reserve for the demarcated forests, which form a nucleus to initiate the development towards intensive forestry.

The areas of the conifer working circles of demarcated forests are shown in Table 5. The bulk of the undemarcated forests in Kulu and Seraj are under conifers and 40 per cent of them is estimated to be under closed tree stands.

The terminology follows the usage of the Kulu & Seraj Working Plan and is more or less the same in other working plans:

Demarcated forests are separated by boundaries in legal procedures of demarcation and settlement. They are under regular working plans.

Reserved forests are either situated in places remote from habitation or consist of small areas of deodar and other forests in the vicinity of villages from which it has been possible to exclude rights. The latter, especially, are subjected to the most intensive management.

Protected forests consist of the areas considered most beneficial for tree growth. They often serve soil conservation purposes. First-class protected forests are situated within zones of human habitation. They are used by people for grazing, fire wood, constructional timber, etc. In many cases they contain valuable growing stock. Second-class protected forests are situated at higher altitude than the first-class forests.

Table 4. Forest areas in the Beas Basin in acres

Forest Division	Demarcated forests				Total	Undemarcated (III class, unclassified) forests	Grand total	Remarks
	Reserved forests	Protected forests		Total				
		I class	II class					
Kulu	20 088	40 846	452 044	492 890	512 978	353 433	866 411	Approx. 40 per cent of undemarcated forests are under closed stands
Seraj	14 448	15 664	174 652	190 316	204 764	138 212	342 976	
Mandi & Suket					117 436	33 755	151 191	Undemarc. forests are stocked with fir and oaks in Uhl
Kangra	14 807	108 205	72 830	181 035	195 842	61 249	257 091	Ilaqa in Bara Banghal belongs to Ravi Basin
Chamba					4 015		4 015	Dalhousie and Bhattiyat Working Circles
Beas	8 562			15 605	24 167		24 167	

Table 5. Areas of Conifer Working Circles (in acres)

Division	Regular W. C. (deodar, kail and fir)	Fir W. C.	Selection W. C.	Protection W. C.	Chir W. C.	Total
Kulu	26 427	45 314	19 286	421 951	-	512 978
Seraj	10 547	23 222	5 587	165 408	-	207 764
Mandi & Suket	40 581	37 450	-	-	35 506	113 537
Kangra	-	-	-	12 640	30 691	43 331
Chamba	981	-	-	-	3 034	4 015
Beas	-	-	-	-	14 189	14 189

Total 895 814

Undemarcated forests consist of all other forests and waste land not recorded in the land revenue settlement as private property. They are not under systematic management. In the settlement report from Kulu these forests are described as containing wood of no value to the State. However, from the point of view of the integrated utilization of wood they are as valuable as all other forests at the same altitude. At present they are only being used by the local inhabitants.

The Regular, Fir and Chir Working Circles make up the forests of greatest economic value. The Selection and Protection Working Circles are situated on steep slopes or at high altitudes serving soil conservation purposes. Under proper management these two Working Circles could produce considerable amounts of valuable timber.

The forest coverage is only continuous over large areas in Kulu and Seraj. In the other divisions forests are more or less scattered. For instance in Kangra the individual blocks vary from 37 to 12,601 acres and are surrounded by fields, undemarcated waste land and bushy pastures.

Site quality is best in Kulu and Seraj where the forests at lower altitudes belong to I/II quality class (according to the site classification system of F.R.I. yield tables).

The chir pine forests of Mandi and Kangra are mentioned as belonging to II/III quality class. This is likely to be an under-estimation because the site quality is defined by the dominant height and age of the present poor crops. The new, even-aged, dense crops offer a more optimistic view.

#### Growing Stock

Growing stock data are based upon the enumerations carried out for the working plans. In the Punjab they are comparatively fresh, but in Himachal Pradesh they are some 30 years old. The enumerations have only covered saw timber trees down to the limiting D.B.H. of 8 in. in the 4 in. diameter classes. Commercial volume tables have been used for pines and deodar and standard volume tables for spruce and fir. The growing stock data are by no means adequate for intensive management. Only a rough estimate can be given for the average

growing stock per acre in the most important working circles.

Regular Working Circle of Kulu & Seraj

The Regular Working Circle of Kulu & Seraj could be called the Deodar Working Circle because in it the main objective of forestry is the deodar. The Working Circle covers 36,974 acres and the saw timber volume down to a diameter of 8 in. is 76 million cu.ft. of which there is 32 per cent deodar, 36 per cent kail, 2 per cent chir and 30 per cent spruce and fir. Pines and deodar are given in commercial units and spruce and fir in Standard volume units. In order to compare the growing stock volumes to the yield table volumes the commercial units will be changed into Standard units.

On an average commercial units are 125 per cent of Standard units. This gives the growing stock as 89 million cu.ft. in Standard volume or Standard Timber which comprises the volume based upon the full basal area, including the stump but excluding the bark, down to a limiting diameter of 8 in. over bark. The growing stock per acre is 2,400 cu.ft. and 56 per cent of the normal growing stock of deodar with 120 years' rotation and E grade thinning in the I/II site quality class. Bearing in mind that only 81 per cent of the Working Circle is under conifers the average volume per acre is 3,000 cu.ft. and 69 per cent of the normal growing stock.

In the Kulu Division the volume ratios of the diameter classes are:

8"-	12"-	16"-	20"-	24"-	28"-	32"-	over	36"	Total
3.0	8.0	16.8	20.9	18.0	12.2	7.5	13.6		100.0

There are no estimates for small wood because it has been considered commercially valueless. In the yield tables the Standard small wood, the volume between the limiting diameters of 8 in. and 2 in. over bark, including bark, comprises 18 per cent compared to the normal Standard volume in the case of E grade thinning and 25 per cent in the case of C grade thinning. The area under the young age classes is unknown. On an average, the stand density of young deodar crops is comparatively high.

It is supposed that the small wood percentage, as comprehended above, is 20 %. The bark percentage of small wood is 18 %. The total growing stock in cu.ft. per acre without bark comes out as:

Standard timber	Small wood	Total
2,400	390	2,790

Fir Working Circle of Kulu & Seraj

The Fir Working Circle covers 68,536 acres and its growing stock is 205 million cu.ft. of Standard timber. Spruce and fir comprise 97 per cent of the total volume. The volume per acre is 3,000 cu.ft.

In the Kulu Division the volume ratios of the diameter classes are:

8"-	12"-	16"-	20"-	24"-	28"-	32"-	over 36"-	Total
1.0	4.5	7.3	10.8	14.0	14.4	13.4	34.6	100.0

Taking into account the fact that the young age classes are very scarce and that enumeration has only covered the sound trees (judged by their appearance), Standard small wood and unsound trees can be estimated at 15 per cent as compared with Standard timber. The bark percentage of small wood is 17 %. This gives the total growing stock in cu.ft. per acre without bark as:

Standard timber	Small wood	Total
3,000	400	3,400

Selection Working Circle of Kulu & Seraj

The area is 24,873 acres and the growing stock 42 million cu.ft. consisting of 11 per cent of deodar, 24 per cent of kail, 1 per cent of chir and 64 per cent of spruce and fir. The growing stock in Standard units is 45 million cu.ft. which gives 1,800 cu.ft. per acre:

In the Kulu Division the volume ratios of the diameter classes are:

8"-	12"-	16"-	20"-	24"-	28"-	32"-	over 36"-	Total
1.7	6.7	11.7	15.7	16.0	13.9	11.1	23.2	100.0

Chir Working Circle of Kangra

The area of the Chir Shelterwood Working Circle of the Kangra Division is 20,873 acres. The growing stock is 25.5 million cu.ft. and 1,220 cu.ft. per acre in Standard timber. It is 97 per cent of

the normal growing stock with 120 years' rotation on III site quality class and 44 per cent of the normal growing stock on II site quality class.

The volume ratios of the diameter classes are:

8"-	12"-	16"-	20"-	24"-36"	Total
4.1	18.1	28.2	25.5	24.1	100.0

In the yield tables Standard small wood comprises 30 to 40 per cent as compared with Standard timber. The bark percentage of small wood is 35 %. Thus an estimate of the total growing stock per acre in cu.ft. without bark is:

Standard timber	Small wood	Total
1,220	280	1,500

Normal, Obtainable and Prescribed Yield in Some Working  
Circles

Table 6 shows the normal yield of deodar, chir and kail according to the yield tables. Small wood is calculated from the Standard small wood using a bark percentage of 18 for deodar and 35 for kail and chir.

The obtainable yield is assumed to be 80 per cent of the normal yield on account of the small gaps and stand boundaries which are unavoidable in actual forests. The obtainable yield of Standard timber for deodar, spruce and fir, and chir is shown in Table 7. There are no yield tables for spruce and fir and the yield of these species is supposed to equal the yield of deodar on II site quality class (which is likely to be an underestimate).

The obtainable yield is compared to the prescribed Working Plan yield in connection with Standard timber only, because small wood is outside the scope of the present management. The prescribed yield turns out to be hardly one fifth of the obtainable yield. In addition, all small wood is considered as waste.

In Kulu & Seraj the percentage of conversion in logging has been 49 for deodar, 39 for kail, 30 for chir and 25 for spruce and fir. Using these conversion percentages, the prescribed yield in sleeper and scantling form turns out to be the same as in Table 7.

The prescribed yield per acre to be actually extracted is 6.1 cu.ft. in the Regular Working Circle of Kulu & Seraj, 3.4 cu.ft. in the Fir Working Circle of Kulu & Seraj and 2.7 cu.ft. in Chir Working Circle of Kangra. In the case of failure in logging operations, for instance, due to the shortage of labour, the actual yield may be still smaller. And 10 to 40 per cent of the floated sleepers and scantlings are lost or broken. In the light of these figures, the wastage of wood in conifer forestry is fantastic.

Table 6. Normal yield in cu.ft. per acre without bark using 100 years' rotation for deodar and chir and 80 years' for kail

Site quality	Deodar		Chir		Kail	
	St. timber	Small wood	St. timber	Small wood	St. timber	Small wood
I	157	32	131	41	190	29
I/II	132	32	-	-	-	-
II	107	32	85	29	132	26
III	62	33	52	22	88	22
IV	25	29	-	-	-	-

Table 7. Obtainable and prescribed yield of saw timber in cu.ft. per acre in some working circles

Working Circle	Obtainable yield	Prescribed yield	Prescribed yield	
			percentage from obtainable yield	in sleeper and scantling form
Kulu & Seraj Regular Working Circle, site quality I/II	106	20	19	6.1
Kulu & Seraj Fir Working Circle, site quality II	85	13	15	3.4
Kangra Chir Working Circle site quality II	67	10	15	2.7
- " - III	42		24	

## Principles and Possibilities of Forest Management

### Management Objectives

In the revised Working Plan for the forests of the Kangra Division the chapter dealing with the objectives of the forest management starts with the quotation of a speech delivered by Sir Michael O'Dwyer, the Lieutenant Governor, in Kangra, 1916:

"The general policy of Government is to maintain a reasonable proportion of forests for the use of future generations; The main object is not to derive revenue from the forests, but to protect adequately such share of them as is necessary for future generations."

The present management objectives are still based upon these principles expressed as early as 1916. Summarized from the latest working plans they are:

1. To preserve the demarcated forests and other hill sides against denudation and to preserve an equable flow of water in streams and rivers, provided that reasonable use of the forests for grass and grazing is not interfered with.
2. To provide for the domestic and agricultural requirements of the local inhabitants.
3. To bring the growing stock to a condition nearer to that of normal forest.
4. To replace inferior species by more valuable ones, for instance, to replace diseased kail by deodar.
5. To obtain the highest possible sustained yield of timber.
6. In chir pine forests, to produce the maximum permanent yield of resin.

These principles and their order of importance may have been sound in the time of the British Administration. The local inhabitants, shortsighted in their domestic economy, have certainly been content with them. But they are deleterious to the present efforts to build up a self-supporting nation. The main objectives defined and their order of importance are pronouncedly conservative and anachronous.

As seen in the results of past management, these principles turn out to be detrimental to the long term requirements of the local inhabitants, too:

"The destruction of forests by heavy incidence of grazing and browsing, repeated forest fires and intense logging has caused and continues to cause erosion and denudation to an extent which seriously threatens the welfare of an overwhelmingly agricultural district like Kangra. Grazing destroys large areas of invaluable protective forests with the result that whole hillsides are being rapidly eroded to the serious detriment of villages at foot-hills."

"Old perennial streams are now dry except during monsoon when they become raging torrents. In the years 1944 and 1947 concentrated heavy rains during the monsoons on the heavily grazed Dhanta-dhar resulted in serious floods, dislocating traffic and destroying cultivation, bridges, roads and irrigation channels" (Kangra Working Plan, 1952).

Whole hill-sides are rolling and destroying roads, fields and even villages in Chamba.

// The unclassed and undemarcated forests have suffered the most and increasing demand for forest produce has put such a strain on demarcated and reserved forests that in many cases they are unable to stand" (Kangra Working Plan, 1952).

In regard to grazing: "Thoroughly useless weeds like *Zanthium* spp. and poisonous plants like *Brojplyth* spp., are spreading on to the grazing grounds and it is only a question of time when grazing ousted from such areas" (Singh, 1958).

The reserved and demarcated protected forests make up a scattered cluster of bright spots against the general, highly unsatisfactory condition of forest land. They have been exploited on a cautious sustained-yield basis for several decades and treated with developed silvicultural and management technique for the fulfillment of specified management objectives. Results are best in favourable extraction conditions and in deodar and pine forests. Almost all the spruce and fir crops are mature or over-mature.

In order to create the pre-requisites for intensive forestry, the principle of sustained yield must be modified. Under present circumstances it means maintaining conditions that are not the best ones.

The principle of progressive yield is a much more exacting basis for the management. In this case it challenges the management to work out and put into effect the following principles:

1. to exploit the existing over-mature growing stock without jeopardizing the permanent annual cut, and
2. to define the rotations of maximum integrated yield per acre for young crops.

The first item is based upon the fact that it is hopeless to wait for over-aged trees to reach large exploitable sizes. Keeping them standing will result in a loss in the growing capacity of the soil and increasing waste on account of the rot inside the trunks. On the other hand, the exploitation of the old growing stock will furnish the initial funds needed for building up intensive forestry.

The objectives of forest management based upon the principle of the progressive yield can be defined for the Himalayan conifer forestry as follows:

1. To bring the forest areas into a condition of being able to produce the highest integrated yield consisting of the most profitable ratios of large and small-sized timber. Resin is evidently an important component of the integrated yield in the chir pine forests.

2. Silvicultural systems must be modified in such a way that the forests will serve the purposes of soil conservation. In most cases forests under regular silvicultural cuttings are also the best forests for protection.

3. Every open acre which would be most profitable under a tree growth should be afforested.

4. The area defined as forest land should be allowed to satisfy the wants of the local inhabitants only to an extent which does not jeopardize the highest integrated yield. It should be realized that forest land under vigorous tree growth is the most beneficial to the inhabitants too.

### Rotation

Rotation specifies the age at which the tree or even-aged stand is exploitable. Demand should exist for the average size of the trees at that age and the crop should show satisfactory results.

In past and present working plans, the exploitable size is based upon the yield of a single tree. The aim has been to determine the most profitable size of the single tree for converting it by hand sawing into sleepers and scantlings beside the stump. The exploitable D.B.H. is found to be between 24 in. and 28 in. and the corresponding rotation according to the available yield studies has been 120 years for chir pine and deodar and 150 - 180 years for spruce and fir.

The correct basis of rotation for the integrated utilization of wood is the maximum yield per area unit. Rotation based upon the yield of a single tree is detrimental to the maximum yield per acre even if the rotation is a technical one having as its objective to grow saw timber only. This is illustrated by the following numbers from the deodar yield tables, quality I site, E grade thinning, final crop over 12 in. of D.B.H.

Age in years or rotation	Average D.B.H. in inches	Average volume in cu.ft. per stem	Mean increment per acre
120	27.8	147	88
110	23.5	133	90
100	22.2	114	94
90	20.9	96	95
80	19.4	79	99
70	18.0	60	99
60	16.4	50	93

Even if the aim is to grow large size timber with D.B.H. more than 12 in. and if the rotation is based upon the maximum volume yield of the final crop per acre, the most profitable rotation will be 80 years. After this age the yield per tree naturally increases but the mean increment or annual yield per acre decreases. To grow trees beyond a certain limiting diameter results in decreasing the total yield per acre.

Growing very large trees can be disadvantageous from the point of view of timber extraction too. The products of the present management are definitely too large for extraction in the form of logs without heavy machinery. The smaller the trees with a proper demand are, the easier their extraction is in mountainous terrain.

However, even the technical rotation producing sawing timber only is one-sided and archaic. The aim should be the financial yield per acre providing the maximum forest rent. At present it is not feasible to calculate financial rotations for the Himalayan conifers on account of the changing technical and economical conditions. Using the present prices and costs for rotation calculations would be a sheer play with numbers. Final rotation calculations cannot be carried out until new logging methods and the integrated utilization of wood are introduced and the price and cost level confirmed with them is stabilized.

The time is ripe for a separate branch to be set up in the Forest Research Institute in Dehra Dun for rotation studies, as well as numerous other economic problems.

In this connection it may be mentioned that rotation should not be defined according to any exploitable diameter. Above a certain minimum, every diameter is exploitable for the integrated utilization of wood. The only valid basis is the yield per acre.

Based upon experience obtained in foreign forestry and keeping in mind that large size timber for sawn products is likely, at least in the near future, to fetch much better prices on the markets than raw material for pulp and paper, the following rotations are recommended:

for deodar 80 to 100 years  
for chir pine 100 years  
for kail pine 60 to 80 years  
for spruce and fir 100 years

120 years' rotation or even longer than that may be justified for deodar in limited areas on account of the enormous value of large deodar trees. Remembering war time experiences, it is always good to have reserves of large-size timber for cases of national emergency. A comparatively long rotation for chir pine is necessary for resin tapping.

Rotation is usually shortest on the best sites and longest on poor soils. The recommendations given above are considered suitable for site quality classes I and II.

Long-Term Cutting Budget for the Fir Working Circle  
of Kulu & Seraj

Preparing a cutting budget for the whole divisions or for the forests of the Beas Basin is not feasible in this study because the necessary detailed data are lacking. The purpose is only to throw light on the main problems and the possibilities. Final and precise calculations cannot be made until a proper inventory of the forest resources is carried out.

A cutting budget is a harvesting plan. It specifies the allowable annual or periodic cut which can be broken down into specific parts. For instance, the allowable cut can be calculated separately for every tree species, periodic block and age class. It is usually prepared for a budget period of 10 to 20 years and based upon the inventory data and yield tables. The cutting budget may follow the scheme expressed in Table 8.

The total growing stock is broken down into periodic blocks or age classes. Every sub-part is further divided into two components:

Growing stock at the beginning of the budget period=  
developable stock + exploitable stock.

The developable stock consists of the trees which will grow in the forest throughout the budget period. A forecasted 10 years' increment added to it makes up the growing stock for the next period.

The exploitable stock consists of the trees which will be cut during the budget period. On an average, these trees will be growing for half the number of the years in the whole period. The corresponding increment is added to the exploitable stock and the summation gives the final cut. The summation of the final cuts from each periodic block (or age class) is the allowable cut for the whole tract. Divided by the number of years in the budget period it gives the annual allowable cut.

The initial volume of the exploitable growing stock is estimated and fixed in accordance with the silvicultural condition of the growing stock, its rate of growth and degree of stocking, amounts of wood expected by the dependent industries and communities, etc. The aim is to develop the growing stock towards a desirable condition and to guarantee a constant or, preferably, a gradually increasing total annual cut.

Table 8. Scheme of a Cutting Budget for a 10 Years' Budget Period from 1958 to 1968

Periodic block (age class)	Growing stock in 1958	Exploitable stock in 1958	Periodic increment of 5 years	Final cut	Developable stock in 1958	Periodic increment of 10 years	Growing stock in 1968
IV (1 - 30)							
III (31 - 60)							
II (61 - 90)							
I (91 - 120)							
Total							

Growing stock in 1958 = Exploitable stock in 1958 + Developable stock in 1958  
 Growing stock in 1968 = Developable stock in 1958 + Periodic increment of 10 years  
 Final cut = Exploitable stock in 1958 + Periodic increment of 5 years  
 Allowable periodic cut = Summation of the final cuts from each periodic block

Besides the usual cutting budget for short-term, it can be prepared for a long period, too, in order to study the general possibilities of utilizing the existing resources. The following long-term cutting budget is calculated to illustrate the principles of long-term management as well as the procedure and necessary data needed for it. As it turns out, the bulk of important data is lacking and it is substituted by the best means at disposal. This shows again why a proper resource inventory must be the first step towards intensive forestry.

Over-mature spruce and fir growing stock is the crucial problem in the Himalayan conifer forestry. Thus the growing stock of the Fir Working Circle of Kulu & Seraj is chosen to be the object of this long term cutting budget.

Constitution of the Growing Stock. Referring to p. 20, the growing stock in cu.ft. per acre, solid wood without bark, is:

Standard timber	Small wood	Total
3,000	400	3,400

"The forests are very much understocked and there is a large preponderance of mature and overmature stock, more particularly of trees 36 in. and over in diameter. Many of the huge trees are unsound ... sometimes fellings had borne on the I-A and I-B trees (24 to 28 in. and 28 to 32 in. of D.B.H.) leaving the overmature stock merely because their felling would give no timber ... The general impression that younger-age classes are absent is, however, not borne out by detailed examination of these forests. Although these classes are undoubtedly somewhat deficient, but frequently a fair amount of advance growth and poles is present wherever the canopy is lightly opened and the soil is sloping and well drained ... Indeed, their proportion is fairly good, especially of silver fir in several forests considering that no attention had been paid to these forests either to tend the natural regeneration that had come in or to protect the tender seedlings from grazing and browsing or from being smothered by heavy weed growth " (Kulu & Seraj Working Plan, Aggarwal, 1949).

In accordance with the above description and the principle of the progressive yield the only sensible way to manage these forests is to exploit and regenerate them during the shortest possible period which guarantees a constant or increasing annual cut. Using preliminary calculations, the exploitation period is fixed at 70 years with 10-year sub-periods.

Additional data for the Cutting Budget. The lacking data are substituted by the deodar yield tables, which obviously are much more suitable for spruce and fir than the pine yield tables. The site quality is presumed to be class II, thinning rate E and rotation 100 years.

Annual Increment. In the yield tables the normal mean annual increment is 139 cu.ft. per acre (all volumes are given in solid wood without bark). The increment obtainable is 80 per cent of this, or 111 cu.ft. According to North-European growth studies the increment of the actual forests varies from 50 to 70 per cent of the yield table increments. In this case the percentage is supposed to be 50 per cent on account of the old age and poor silvicultural condition of spruce and fir crops. Thus the actual increment is 70 cu.ft. per acre.

Thinning Yield. Thinning yield is needed for the new age classes which will develop during the exploitation period. The new tree stands are assumed to be in proper silvicultural condition and the obtainable thinning yield in cu.ft. per acre at different ages is:

age	thinning yield
30	100
40	490
50	430
60	750
70	790

Development of Standing Timber in New Tree Stands. The development of standing timber must be forecasted in order to carry the cutting budget over the transition period from the old stock to the new one. Based on the same considerations as above, the standing timber and its annual increment in cu.ft. per acre are:

age	standing timber	annual increment
50	2,700	90
60	3,600	80
70	4,400	70
80	5,100	

Course of the Cutting Budget. The unit area is 700 acres. Thus the area to be exploited and regenerated during every 10 years' sub-period is 100 acres. (These areas are only part of the calculation technique and they do not specify the cutting areas for centralized logging operations.)

The regeneration period is fixed at 10 years. This is only one third of the present 30 years' period but it should be borne in mind

that a 10 years' regeneration period is long enough in many growing conditions less favourable than those which prevail in the Himalayan conifer areas.

All the cutting budget calculations are shown in Table 9. In the formula for sub-period I, from left to right, 100 is the area in acres of the first block to be regenerated, 3,400 is the exploitable stock per acre at the beginning of the sub-period and  $5 \times 70$  the sub-periodic increment of the exploitable stock. The second addendum in the numerator is that part of the sub-periodic cut which comes from the area under the developable stock and it consists of the thinnings, preparation cuttings for regeneration, salvage and improvement cuttings. In sub-period I, it is supposed to be 60 per cent of the total sub-periodic increment in the area of 600 acres under the developable stock. The remaining 40 per cent of this increment is left to accumulate on the trees that are silviculturally and technically the best developable. The total summation gives the cut for sub-period I. Divided by 10, which is the number of years in the sub-period, it gives the allowable annual cut.

The contents of the second formula are the same as in the case of sub-period I. 280 in the first addendum of the numerator is the increment per acre left to accumulate on the developable stock in sub-period I. This time 70 per cent of the increment in the area under the developable stock is included into the sub-periodic cut and the remaining 30 per cent is left in the forest.

In the end of sub-period IV the trees regenerated in the first 100 acres' block are 30 to 40 years old. It is assumed that this 35-years-old spruce and fir stand will give the same thinning yield as the 30-years-old deodar stand. This gives 1,000 cu.ft. of small wood for the annual cut. With such volume, the young and vigorously growing new tree generations will start to redeem the promises of progressive silviculture and good management.

When the old growing stock is exploited the eighth 10 years' period will present quite a new and entirely different situation. The annual cut will be drawn from the new crops and it will be large enough for a permanent supply for the dependent industries and other users. The obtainable annual thinnings calculated are thus 37,800 cu.ft. less than the average annual cut in the past:

$$7900+7500+4300+4900+1000=25\ 600$$

$$25\ 600+37\ 800=63\ 400$$

Table 9. Long Term Cutting Budget for 70 years' Exploitation Period

10 years' sub-period	Calculation	Annual out
I	$\frac{100 \times (3400 + 5 \times 70) + \frac{60}{100} \times 600 \times 10 \times 70}{10}$	62 700
II	$\frac{100 \times (3400 + 280 + 5 \times 70) + \frac{70}{100} \times 500 \times 10 \times 70}{10}$	64 800
III	$\frac{100 \times (3680 + 210 + 5 \times 70) + \frac{80}{100} \times 400 \times 10 \times 70}{10}$	64 800
IV	$\frac{100 \times (3890 + 140 + 5 \times 70) + \frac{90}{100} \times 300 \times 10 \times 70}{10} + 1000$	63 700
V	$\frac{100 \times (4030 + 70 + 5 \times 70) + 200 \times 10 \times 70}{10} + 4900 + 1000$	64 400
VI	$\frac{100 \times (4100 + 5 \times 70) + 100 \times 10 \times 70}{10} + 4300 + 4900 + 1000$	61 700
VII	$\frac{100 \times (4100 + 5 \times 70)}{10} + 7500 + 4300 + 4900 + 1000$	62 200
On an average		63 400

This deficit could easily be covered by adopting a 70 years' rotation. But if the value of large-size timber is still as high as it is now compared with the value of small wood, the 70 years' old crop will be at its highest rate of the value increment and its exploitation would be uneconomic. On the other hand, a permanent supply for wood users will be guaranteed, which will justify the sacrifices on the part of future revenue. In the transition periods of progressive forestry it is permissible to exploit a part of the immature crop for the sake of a present urgent need, though the highest attainable yield will thereby be reduced in future.

The deficit stated above can be covered by exploiting a part of the oldest growing stock or reducing its volume per acre below the optimum. For instance, the permanent annual cut is obtained by exploiting one half of the 70-80 years' old crop,

$$\frac{50 \times (4\,400 + 5 \times 70)}{10} = 23\,750,$$

and by drawing the remaining 14,050 cu.ft. from the developable stock in the form of heavy thinnings.

After this transition period, development will continue towards a desirable growing stock with 100 years' rotation (or whatever the most profitable rotation will be at that time) and the annual yield will gradually increase up to the obtainable 111 cu.ft. per acre.

The exploitable trees will naturally be much smaller after the 70 years' exploitation period than they were during it. From the point of view of saw milling this is by no means alarming. The concept of the saw timber tree will certainly change during these 70 years. The present sleeper and scantling production will gradually give place to modern methods by which the 70 to 100 years' old trees will be converted into sawn products much more profitably than those which are produced now by handsawing over-large trees.

The annual cut based upon the principle of the progressive yield is roughly 63,000 cu.ft. per 700 acres, or 90 cu.ft. per acre and 6,200,000 cu.ft. for the whole Working Circle. The annual yield is 80 per cent of the yield obtainable from a normal forest and 72 per cent of the mean increment of the yield table.

This outline of future management is based upon the utilization of the existing over-mature growing stock as well as upon the growth

of future tree generations. Compared to the prescribed working plan yield for the Beas felling series, which is 922,000 cu.ft. of Standard timber, the yield calculated above is 6.7 times larger. This gives an idea of what the yield of the spruce and fir forests would be under the progressive management.

The total yield consists of Standard timber and small wood down to the limiting diameter of 2 in. without bark, solid measure. The waste percentage of the stems from the stump to the top is usually less than 10 per cent in Northern Europe. Keeping in mind the high value of wood in the Indian economy, a logging waste as low as 20 per cent, caused by stumps and felling losses, should be attainable. Referring to the previous consideration, the small wood waste percentage is presumed to be 10 and the conversion percentage for sawn products 40 per cent. They give:

sawn products	1,800,000 cu.ft.
small wood and sawing waste suitable for pulp	3,160,000 "
unavoidable logging waste	1,240,000 "
	<hr/>
total annual yield	6,200,000 cu.ft.

The last but not the least striking conclusion of this reasoning is: If the unavoidable waste wood is given to the local inhabitants for their domestic use, they will receive more wood from forests managed in accordance with the principle of the progressive yield than from forests in stagnation.

## Outline of a Proper Inventory of Forest Resources

At least H u b e r (1953), C h i a r i n i and L e s c o v i c (1952) have previously stated in their reports that the data on conifer forests are insufficient for planning forest industry. In spite of their suggestions to establish a full and statistically reliable inventory as soon as possible nothing has been done so far. Though the existing data, if properly interpreted and understood, make the initiation of industrial ventures a possibility, they are not only an insufficient but also a misleading basis for concluding the final scope of these ventures. The obvious underestimates of the actual and potential forest resources keep up an ambiguous atmosphere in which nobody is willing to take the risk of a large-scale industrial venture using conifer raw material. As long as the taking of a complete and reliable resource inventory is postponed, there will be a permanent discrepancy between the prevailing opinions concerning forest resources and corresponding industrial prospects.

The following minimum data will be necessary for any consideration of the industrial possibilities in their final scope:

1. Area under forest and area where the most profitable use of land is to grow trees.

2. Sub-areas of every ownership category, their legal position and the legal measures which are necessary and possible for guarding the interests of forestry.

3. Areas of accessible and inaccessible forests and the characteristics of the terrain from the point of view of timber extraction. (It should be borne in mind that the concept of accessibility will change rapidly with the development of markets, logging methods and transportation facilities.)

4. Areas of forest types, segregated according to the site quality and composition of the crop.

5. Areas according to age classes.

6. Growing stock, in each sub-area mentioned above, measured in volume units comparable to standard yield tables, composition and quality of the crop, volume distribution into diameter classes and bark percentages.

7. Silviculturally obtainable cut per tree species and diameter classes as well as the waste percentages.

8. Annual increment for every sub-group of growing stock. (If the tree stands are irregular, overmature, low in density, etc., growth data collected by borings and other field observations will be required. Permanent sample plots and the yield tables provide valuable growth data for regular tree stands.)

9. Mortality. (Volume losses caused by fire, insects, fungi, etc. must be known for reliable cutting budgets and increment forecasts. Mortality data are usually collected by permanent sample plots.)

Comparing the above list to the data available at present will certainly make it clear why the immediate establishment of a complete resource inventory is an absolute must.

The present management plan inventory method, with stock-mapping and partial enumeration, corresponds logically to the management system based upon the most profitable sleeper yield of single trees and as such it has served its purpose well. But for progressive forestry, it is out of date.

A complete enumeration of growing stock is not feasible in the Himalayan forestry. Enumeration as an inventory method can only be recommended in small management units where single large trees are exceptionally valuable. Thus the partial enumeration of the deodar forests can be justifiable. For every other purposes, and especially for a large-scale inventory of resources, statistical sampling methods are cheaper, faster and sufficiently reliable.

If a serious effort is to be made to bring all suitable areas under intensive forestry and to build up wood-working industries in the Beas Basin (or in any other river basins), the first step should be to fly an aerial photographic coverage for the whole tract. The existing topographic maps in a scale of a quarter inch or an inch to the mile with 100 to 500 feet contour intervals and the working plan stock maps of the Governmental forests have been sufficient for the extensive use of land. Modern industrial planning and efforts to develop forestry require masses of new data which can be obtained most economically by aerial surveys. The aerial photographic coverage seems costly but it should be borne in mind that it is very economical compared to the overall costs of large-scale economic and landscape planning. It is a 10 to 20 years' investment and every other means of collecting the necessary data will turn out to be more expensive in the long run.

This recommendation to introduce aerial photography into the hill forestry may not accord with the prevailing opinion amongst Indian forest officers. If so, the reason for this is the unavoidable discrepancy between the working methods of extensive and intensive forestry. Aerial photography is certainly too expensive if nothing or little is happening in the forests.

In the hills and for the purposes of forestry the most economical photographic scale using the latest cameras is about 1:30,000 allowing enlargements on scales of 1:15,000 to 1:10,000 for field use. The scale for the coverage of industrial sites, roadlines, floatways, etc., varies from 1:20,000 to 1:10,000 or even to 1:2,000.

The aerial resource inventory can be either a basin-wide procedure, in which case statistical sampling is applied at every step, or a division-wide procedure, in which stock maps are prepared on photographs for the whole division and the stock data are collected by statistical sampling. If aerial photographs are available, the following steps can be distinguished in the basin wide inventory:

Photo Interpretation. A grid of photo plots is laid on the photographs. The number of the photo plots required in every unit area corresponds to the degree of accuracy required in the statistical sampling. (E.g., if the approx. forest percentage is 40 and the level of significance of statistics is 5:100, a maximum error of 2 per cent for the forest area will be attained by taking approx. 15,000 photo plots.)

Experienced photo interpreters (forest officers who know the photogrammetric technique and are thoroughly acquainted with the terrain and forest types) examine the photo plots and classify them according to the apparent land use class. The number of plots falling in each class of land use provides a preliminary estimate of the land area in every class. Using the existing ownership maps the forest area can be divided into ownership classes. If the interpretive ability of the surveyors allows, the plots falling on forest land are stratified into broad tree stand classes, e.g., into open areas, seedling and sapling, pole and saw timber stands. The extractional qualities of the terrain are studied on every photo plot, i.e., the degree of slope, drainage, soil type, etc.

Field Check on Land Use Classification. A fixed proportion of the photo plots are checked on the ground and the possible corrections inferred into the photo interpretation results.

Field Check of Tree Stand Classification and Ground Sample Plots. In places of a fixed proportion of photo plots, a sample plot is measured in order to check the tree stand classification and to obtain stock data.

For a division-wide inventory the provisional stock maps are prepared by photo interpretation, the land-use classes and the tree stands are delineated and stratified into sub-groups in accordance with the crop composition, stand height, stand density and site, and the sub-groups are marked with appreciable symbols.

In due accordance with the variety of the stand composition, stand volume and other characteristics, a fixed number of sample plots is measured in the field, providing detailed stock data. Photo interpretation is checked and the stand boundaries as well as the stand symbols are definitely fixed.

If aerial photographs are not available or if photogrammetric methods are not possible on account of insufficient training of the inventory staff, the resource inventory can be based upon the existing maps. Either a representative (random sampling) or a complete land-use classification and stock mapping is carried out in the field. The tree stands are stratified into sub-groups by ocular estimation. The stock data for the different stratas are collected by sample plots.

### Silviculture

Pines and deodar have up to now been the main objects of the timber extraction, management and silviculture in the Himalayan conifer forestry. The textbooks on the subject as well as the regeneration areas and the young tree stands are a convincing proof of the sound and scientific methods of their silviculture. In regard of these species, only some minor suggestive recommendations can be offered.

The 10 years' cutting cycle in thinning the young stands even on the best sites seems to be very long. For this reason many young stands appear to be over-dense. Over-dense young stands are a characteristic feature of extensive forestry, because there is no demand for small

wood. On the other hand self-pruning of pines and deodar offers some difficulties and side branches persist even in dense crops. But the rate of growth and the potential value of even the smallest timber are so high that they justify an early commencement of thinnings carried out lightly and repeated at fairly frequent intervals. A cutting cycle of 5 years is recommended at least as an experiment.

The presence of numerous and large knots is often mentioned in descriptions of the technical quality of conifer wood, the bulk of which obviously comes from irregular and natural stands. The high price of sawn timber justifies the artificial pruning of the best young crops which are assigned to produce saw timber. Large and knotless deodar base logs would be of enormous value in the markets.

Chir pine regeneration presents some difficulties in limited areas where the bushy ground vegetation kills natural seedlings. In the inspection records one can find recommendations to change the species and to regenerate the problem areas with broadleaved trees. Though some isolated experiments to plant chir pine have been mentioned as failures, planting seems to be the only way to overcome this difficulty. There is hardly any broadleaved species, in spite of their fast growth in young age, which can produce more wood per acre than the chir pine in the same localities. Thus one of the main targets in the research work on chir silviculture should be to work out a proper planting technique.

The high value of conifer timber and the fast growth of these species in the Himalayan hills justify their artificial regeneration on a much larger scale than is used now. Long regeneration periods and irregular seedling stands result in considerable losses of time and of the growing capacity of the soil, which are part and parcel of the extensive forestry. A 10 years' regeneration period for pines and deodar should be enough. A longer period is only justified in the case of chir mother trees under resin tapping.

Spruce and fir forests offer a quite different silvicultural picture from pine and deodar forests. Their location on high hills and inefficient logging methods have kept them outside the interest of silviculture. A typical spruce and fir forest consists of large and over-mature trees with dry tops and rotten stems. Pole size trees are either single or in small groups, usually comparatively old, suppressed

and often with inside rot too. Seedling and sapling stands are very rare. Small seedlings are often very badly browsed ~~over~~ and infected by fungus attacks. Wind falls and other climax calamities are common. Immediate research and experimental regeneration should begin in these forests.

The spruce and fir forests are under the selection system or the Punjab Shelterwood System. In Kulu and Seraj the average exploitable diameter is 26 to 28 inches. In the latest working plan revision the former rotation of 150 years was found too short to produce timber of that size and the present working plan is based upon a rotation of 180 years. But most of the old trees will never reach this prescribed exploitable diameter. Spruce, at least, is not enough of a shade bearer for the trees formerly dominated to reach the same size as the dominant trees had at the time of their exploitation. Because of this the selection system has been a failure in most cases.

Under the Punjab Shelterwood system all healthy advance growth is to be retained to form a part of the future crop. As a result of this, seemingly healthy and young but actually comparatively old trees which are under the exploitable diameter have been left in the regeneration areas. In most cases these trees are incapable of growing, but merely form an obstacle to regeneration.

The sound silvicultural rule for old spruce and fir crops, which are in increasing danger of being destroyed by climax calamities, is to liquidate them as fast as possible and to regenerate the areas.

In addition to the distant location of the spruce and fir forests, grazing, heavy weed growth and the accumulation of deep raw humus layers are mentioned as factors inimical to regeneration. One may add that their location at high altitudes has not attracted men with an interest in silviculture to work there.

The silvicultural conditions in the spruce and fir forests are obviously very adverse to natural regeneration and the only method may be to plant the bulk of them. The first step in bringing these forests out of stagnation is to establish nurseries for spruce and fir. In the Kulu Division there were 1,000 beds under conifer seedlings in 1957 and the 3 years' target was 5,000 beds. Most of the existing beds were under deodar seedlings. Though the urgent need of artificial regeneration is already realized, there just cannot be too many spruce and fir seedlings available in the near future.

The costs of artificial regeneration for spruce and fir were estimated in rupees per acre in 1951:

nursery	15	fencing	20 - 40
debris collection and burning	10	weedings	5
sowing	10	cleanings	5
planting	10	establishment and miscell.	5
		total	<hr/> 80 - 100

Trained labour and progressive methods may cut down these figures considerably.

Side by side with determined and prompt artificial measures it is recommended to use natural regeneration on as large scale as possible to experiment with hoeing ground, burning litter and humus, weedings, etc. Obviously, natural regeneration can be attained by proper seeding cuttings in large areas under mixed crops, in tension belts and on sites where the steep nature of the ground, good drainage and the absence of thick raw humus make it possible.

The selection system is unsuitable for spruce and fir wherever these species can be grown in closed stands. It can be used on very steep slopes and at high altitudes. A modified uniform system with clear seeding fellings and more or less even-aged crops seems to be suitable for these species. When the biological and silvicultural characteristics of spruce and fir are thoroughly studied, it may turn out to be possible to apply the highly developed and intensive Middle-European selection system (Control Method) for the new crops, but at present and with existing crops it will not work. It would be desirable to get a limited amount of some secondary species, for instance, *Populus* spp., as a mixture into new crops in order to facilitate their natural regeneration.

## Timber Extraction

A detailed treatment of timber extraction and transportation is not feasible in this study. Only some general ideas and recommendations will be laid down. For detailed data, it is best to refer to the exhaustive reports of H u b e r (1953), K o r o l e f f (1956) and C h a n d r a (1957), and to the recommendations of W i n k e l m a n n (Training of Forest Workers ...).

Present Situation. All trees to be exploited are marked silviculturally. Forest Departmental extraction is applied in East Punjab and sales on stump to private contractors at public auctions is the common practice in Himachal Pradesh.

Trees are felled and cut into proper length by hired labour and hewn and sawn by hand tools beside the stump into sleepers (standard size 10 ft. x 10 in. x 5 in.) and scantlings. Timber is carried on human backs to the nearest floatable river or to the upper head of Donald wire ropeways. In the latter case the timber is roped down to the river side. In small streams the floating commences during the monsoon, usually at the end of September. In streams with little water, elaborate systems of "telescopic" and "wet slides" are being applied.

In large side streams and in the main Beas the floating is free, uncontrolled and unequipped down to Dehra Gopipur. Sleepers and scantlings are taken to the stream and the floating crew follows them, breaking up jams and pushing stranded timber back into the water. The speed of floating is very slow, e.g.,  $3/4 - 1 \frac{1}{2}$  mi. in every 24 hours in a stream where the speed of the water is said to be 15 mi. per hour. From Dehra Gopipur to Dhilwan the sleepers are floated in rafts of about 300 sleepers with a crew of 2 men per craft. This rafting distance of about 110 mi. takes 10 days to cover. The total length of floating in the main Beas is about 200 mi.

In the old days, timber was floated in the form of logs. After the river side forests had been exploited, the logging moved to higher altitudes and developed into sleeper extraction.

The loss of timber in floating is usually under 5 per cent. In the event of bad side streams or flood it can be much higher. According to information from Dhilwan, the average damage percentage (proportion of floated timber which cannot be used as sleepers) varies from 10 to 20 per cent and it may be as high as 40 to 50 per cent. The damage percentage is highest for spruce and fir.

Truck transportation is used on a much smaller scale than floating except in the Lower Beas Divisions.

"Labour is extremely cheap and their standard of living very low. The workers take shelter under a rock or cliff, have their simple meals twice a day. Clothing is by no means adequate for the heavy work and tools are most primitive, consisting of a crude village-made axe, some primitive crosscut saws, a wrapping saw and perhaps a stick for turning the logs, if required. Apparently not much, if any, attention has been paid to the labour conditions in the past." (H u b e r, 1953)

Daily wages in the forest work vary from 1.5 to 3 rupees and a good sawer can make 5 to 6 rupees per day.

Timber is sold and cut in comparatively small lots of approx. 2,000 trees and the extraction has to be completed within 1 to 2 years. This practice prohibits any long-term interest and investment on the part of the purchaser.

Desirable Sorts of Raw Timber. The sorts of raw timber are the forms and sizes into which the tree stems are converted for transport from the forest to the markets and consumers. The ideal form of raw timber would be round log bucked into proper length. For floating they are usually debarked either in the forest or on the bank of the floatway. Fuel wood is bucked into proper length and large blocks are cleaved to make them dry faster.

In the case of timber for pulp and paper the only sensible way is to transport it in the form of logs in lengths of 4 to 12 ft. Logs to be floated are debarked in the forest. The average diameter of round pulp wood seems to be 6 - 10 in. or even more in the Himalayan conifer areas. Additional large quantities of pulp wood will come from very large trees in the form of sawing waste.

Considerable advantages will come from transporting the raw timber for saw mills in the form of logs too. It would make it possible to centralize and mechanize the sawing, reduce sawing waste, use the waste for pulp and eliminate the losses and damage which the sawn timber now suffers in floating.

At present it is considered impossible to extract logs. Though the bulk of these "impossibilities" can be surmounted by introducing modern logging methods and equipment, and a pioneering spirit and courage to meet the challenge of nature, the largest trees and the

mountainous terrain undoubtedly offer serious logging problems. The aim should be to transport wood in as large units as possible, but in limited areas at least, portable saw mills or blasting will have to be used for splitting the largest blocks into smaller units of raw timber.

Felling, Bucking and Debarking. Hand tools will evidently play the main role in felling, bucking and debarking. The present tools should be developed or changed into new and more efficient ones. Permanent designing and testing activity for introducing new tools and a proper technique of using and maintaining them must be established.

Though prevailing opinions are against the use of motor saws in Indian forestry there is no doubt that motor saws will become more and more important in the future. Experimenting with them side by side with the manual tools is recommended, so that they can be introduced as soon as they turn out to be profitable and the technical level of the labour allows it.

Minor Transportation. The transportation of wood should be taken off the human back and heaped on to a flexible combination of wheels, sledges, dry and wet slides, flumes, ropeways and caterpillar tracks. It is a most astounding and appalling experience for a Northern European to see human beings carrying heavy sleepers several miles in an area where there is a permanent snow coverage lasting from 1 to 3 months. And when the first snow falls all transport operations stop.

Snow transportation can be very effective wherever there is a snow coverage with a minimum thickness of 1 ft. and lasting at least one month but it cannot be introduced until the labour, forest departmental staff and contractors overcome their irrational fear of cold weather. The first snow fall or even a cold rain can paralyze all outdoor activity in hill forestry in spite of the well known fact that man can endure out-of-door work amid permanent ice and snow. As long as snow is taken as a hostile element and not as an aid to work and as long as there are no proper housing facilities and clothing for the labour, forest work in snow will be impossible.

Under the present conditions it is not recommendable to take over-mechanization as a short-term aim. A steady progress to better and more efficient transportation methods will be attained by developing the existing methods of ropeway carriage, dry and wet slides and

flumes, introducing wheel carts and sledges for hauling on snow or bare slopes and experimenting with highline cranes and tractors.

Suitable mountain tractors which can haul timber and push roads through terrain would be useful. The introduction of proper vehicles and the construction of forest roads will offer improvements at every step in logging operations. Contractors can be obliged to construct new roads in connection with centralized logging operations.

Major Transportation. Long distance floating, trucks and railway wagons are the principal methods of major transportation. In the near future floating will be the most important one in exploiting the Himalayan conifers.

It is necessary to build up the floatways and to introduce booms and other floating equipment, as well as motor towing of rafts in lower streams. Floating as a developed activity seems to be so unknown in the Himalayan streams that the building up and equipping of one river by an expert would be very helpful. According to ~~a~~ strong body of opinion, the monsoon makes it impossible to build up the rivers and to develop floating methods. It may be justified to remind ~~them~~ of the famous dams built to harness many Indian rivers for irrigation and power projects. Building up a river for timber floating should be easy compared with the construction of control dams and irrigation channels.

At present enterprisers are floating their timber separately. It is in nobody's interest to construct a floatway and equip it with floating facilities. It is recommendable to arrange floating operations under one privat contractor or floating association.

Truck transportation will meet many difficulties in the hills, but being flexible and fast it should be used in exploiting roadside forests wherever it can compete with floating. Railways are suitable mainly for the long-distance transport of timber to consumers not located on floatable waterways.

Extraction Costs. A detailed analysis of the past extraction costs in the Kulu Division is given in Table 10. The average cost for sleepers and scantlings from the stump to the depots in the Plains has been 1.75 rupees per cu.ft.

Table 10. Average extraction costs in annas per cu.ft. for sleepers and scantlings from the Kulu Forest Division to Dhilwan Depot.

Nature of work	1941-1947	1952	1954	1956
Marking and felling	0.276	0.978	0.121	0.031
Sawing and sniping	3.054	12.991	10.542	10.131
Sawing and carriage	1.039			
Carriage with ropeway	3.415	10.183	4.474	3.677
Floating	1.935	3.659	3.685	4.098
Loss in transit	0.490	0.682	1.337	1.189
Miscellaneous	0.231	2.555	0.555	0.663
Establishment of regeneration areas	0.260	1.081	0.782	0.439
Miscellaneous Depot Division	0.425	1.902	1.118	0.635
Rafting	1.809	3.222	2.904	3.609
Distributive				
a) Forest Division	0.815	0.620	1.374	1.289
b) Depot Division	0.538	2.234	2.617	2.216
<b>Total</b>	<b>14.287</b>	<b>40.107</b>	<b>29.505</b>	<b>27.979</b>

Floating from Manali to Dehra Gopipur                   120 miles  
Rafting from Dehra Gopipur to Dhilwan                   110 miles  
Distance from Dehra Gopipur to Mirthal                   45 miles  
(Distances are measured from a large scale map)

According to the report of Chiarini and Teskovic the extraction costs per ton (or 66 cu.ft.) of fir timber in Uttar Pradesh in 1955 were:

	per ton	per cu.ft.
for cutting and conversion in forest	40 R.	0.60 R.
for transporting to the river bank	40 "	0.60 "
for floating and rafting	40 "	0.60 "
for royalty	25 "	0.38 "
	<hr/>	
total	145 R.	2.18 R.

These costs refer to the part of the wood which is converted into sleepers and scantlings. In the above mentioned report they were considered too high for pulp and paper industry. They certainly are too high. For instance, they are roughly 3 times higher than the extraction costs for pulp wood in Finland, where labourers' wages are at least 7 times higher than in India. However rough and out of place this comparison of costs and labour efficiency may be, it shows that the present extraction costs for Himalayan conifer sleepers cannot be used as a basis for calculating the profitability of any industrial venture. The indispensable new logging methods, when they are introduced, will change the cost level thoroughly and advantageously.

As a matter of fact, in an experimental extraction of some hundred fir logs from Kulu and Seraj to Dhilwan, carried out in 1951, the extraction costs were 40 R. per ton for timber from Kulu and 50 R. per ton for timber from Seraj. In the attached note (Singh, 1951) it was concluded that the extraction costs would not be more than 75 R. per ton. A large-scale extraction with modern working methods should certainly be still more advantageous than this limited experiment.

The transport rate by truck from Kulu to Pathankot (173 mi.) was 2 Naya Paise (0.02 R.) per cu.ft. and mile in 1957. The rate by truck from Mandi to Yogindarnagar (35 mi.) was 2 R. per sleeper (3.5 cu.ft.) and from Mandi to Pathankot (130 mi.) 3 R. per sleeper. As an example of railway rates, that for pine pulp wood to a paper mill in Saharanpur in Uttar Pradesh was 14 R. per ton and per 170 mi. (0.82 R. per mile) in 1957.

Centralization of the Logging Operations. Scattered and small cutting areas are one of the main obstacles in developing logging methods. As a matter of fact, "The Code of Working Plan Procedure in the Punjab"

recommends distributing forest work of all kinds over all ranges: "There is no necessity to concentrate large areas under regeneration and this policy has every disadvantage: the fire hazard is greater, it is impossible to close the grazing, no local supplies of timber will be available once the area has been regenerated and the work of regeneration is not distributed amongst the staff." One more reason for the present usage is the selective exploitation of the largest trees. In an extreme case a single tree can be said to form an individual cutting area.

There will evidently be many grave difficulties in centralizing the logging operations but the worst one is deep-rooted custom. Centralized logging is an indispensable prerequisite to creating efficient working methods and cutting down the high extraction costs. Much research and experimental work and a radical change in the prevailing policy of selling mountain timber in small quantities and for short terms are needed.

Labour Conditions. New tools, mechanized logging methods and centralized operations do not solve the extraction problems if the man behind the tools and machines is neglected. In this connection H u b e r's report should be referred to and it can only be emphasized that it is indispensable to provide proper living conditions including food, clothing and shelter for labour. Every logging operator will be considered, and if necessary, forced by law, to be responsible for the living and working conditions of his labour.

For carrying out indispensable seasonal work in forest divisions it is recommendable to train and employ permanent workers who can be used in logging and in silvicultural work.

Research and Training. The recently established Logging Branch in the Forest Research Institute and its Training Centre with proposed research and training aims have definitely not come too early. Research and training is necessary not only for introducing new and efficient logging methods but also for keeping even the most modern condition of logging affairs up to date.

The essential objectives of the research and training work carried out by the Governmental agencies are the technical problems, testing new tools and methods and teaching the basics of logging as

a trade and profession. It is doubtful whether the problem of timber extraction as an economical venture can be solved by this activity.

Timber Extraction as an Economical Venture. The fastest and surest way to solve the administrative and organisational problems involved in timber extraction is to hand them down to private and industrial enterprisers. A logging operation is likely to succeed if its success is a vital pre-requisite for the enterpriser's existence. It is recommended <sup>to</sup> ~~granting~~ long term concessions of at least 20 years to industrial and other dependable enterprisers to exploit timber. The State agencies should only plan and centralize the cutting areas in accordance with the principles of the progressive yield, control the timber amounts exploited as well as the cutting methods and put into effect the necessary silvicultural and regeneration measures. The State agencies may run some operations of their own in order to control the affairs, especially royalties or stumpage prices, and to gather experience in logging. If they are able to compete profitably with private enterprisers, they can always increase their logging activity.

## Relations between Forestry and Local Population

In most cases , forests owned by the State are burdened with numerous rights enjoyed by the local population. These rights are classified as follows:

1. Grazing or pasture.
2. Grass cutting.
3. Lopping and leaf gathering.
4. Wood rights.
5. Right to fallen leaves for litter and manure.
6. Rights to other forest produce.
7. Hunting and fishing.
8. Temporary and shifting cultivation.

The forest rights are repeatedly said to be insurmountable obstacles in the way towards the intensive utilization of the forests. This ~~is~~ <sup>one</sup> sided recognition of rights without corresponding obligations is highly ~~advance~~ detrimental to the public interest and in final end, too, to private interests.

The present situation is a heritage from former days when the Government allowed the rights to grow up in order to keep the people content and only retained something less than full public ownership over unoccupied waste and reserved limited forest areas for future use and for soil conservation purposes. However, the effective principles laid down in the Indian forest law make it possible to regulate the rights with proper regard to the interests of up-to-date forestry (J a g d a m b a, 1950):

"Rights of the user over forestry must be dealt so as to secure the enjoyment without impairing the maintenance of the forests which support them."

"To possess a right does not entitle the possessor to a share of the property. No right can be exercised to such an extent as to swallow up the property or even to render it useless or valueless to the owner."

"The waste always belonged to the governing power, but people who had access to it took what they wanted. However, whenever the government wanted the waste for any purpose, the exercise of grazing and other use had simply to cease."

"When the public interest requires the private interest must go away. A full and fair compensation must, however, be given, and the government is the judge whether the land is wanted for public purposes or not."

"The rule is that the right can always without compensation be restricted to what the forest will bear without either 1) injuring it, if it is at present in good state, or 2) preventing its restoration or improvement, if in bad state."

At present, intensive forestry is the most beneficial not only to the national economy but also to the local inhabitants. It will produce more wood for local needs and create new opportunities to work in forests as well as in the form of the numerous services which always follow on the heels of increased economic activity. It will bring forth new roads and stimulate every aspect of the present backward life.

Naturally there will be serious clashes, for instance between forestry and grazing. But they will gradually die down when it is recognized that forestry pays better than reckless pasturing.

The benefits of intensive forestry, if fully realized, should set efforts afoot to change customs and laws that no longer conform to economic development. For instance, the riparian inhabitants have an old right to pick up drift wood under fixed girth and length limits for their household wants. Because of this right it is said to be impossible to float pulp wood in the form of logs 4 feet long, which happens to be the maximum length limit for free drift in the Punjab. This kind of right must be abolished by legislation and not honored as an unsurmountable obstacle.

Side by side with legislative measures the local inhabitants should be educated to realize the benefits of good forestry. If people have the right to utilize forest land, they must be responsible of its producing capacity too. Trees are no longer merely a gift from God but are also product of silviculture and management practised by human beings. Owners, administrators and exploiters must be obliged by law to treat every young and growing tree stand in accordance with silvicultural principles and secure a dense re-growth of proper tree species, so as to replace the mature crops exploited. The local inhabitants must be compelled to grow trees for their own use, just as they are obliged to grow grain and fruit, and not to expect to receive timber from State forests indefinitely.

These elementary principles of good forestry should belong to the school programme in every hill village. Everything must be done to

encourage and advise the inhabitants to take care of private and village forests, In areas where the right to utilize large forests belongs entirely to the inhabitants, the holders of the right will be transformed into share-holders, i.e., they will be allowed to sell all the surplus wood they can produce. In Kulu and Seraj III class protected forests are quite large. If they are considered entirely from the viewpoint of the wants of the local people, they could produce timber in considerable amounts for the foreign markets. Pecuniary reward is the surest and fastest way to teach the people to understand the advantages of good forestry, and guaranteed ownership or the right of utilization is an essential pre-requisite for a feeling of one's own responsibility.

Some problems may be solved by separating special areas for the local needs. For instance, the scattered and fast growing alder stands in the Upper Beas would produce excellent fuel wood under proper management (clear felling and vegetative regeneration) thus decreasing the use of more valuable timber for heating and cooking purposes. Every tree species and every kind of wood should cover the need for which it is most suitable.

The present conditions of administration and ownership are not satisfactory. The inhabitants have a tendency to take trees as nobody's property guarded by the forest departmental staff. They miss no opportunity to exploit the forests without the slightest care for silviculture, management or for their own future needs. It is essential to lay down definite boundaries of land use, ownership, rights and responsibilities, and to enforce them.

### Diversified Markets

#### Technical Qualities, Present Use and Sale Prices of Conifers

Pinus spp. The weight of chir wood averages 38 lbs. per cu.ft. and the weight of kail wood 32 lbs. per cu.ft.

Sapwood yellowish-white. Heartwood yellowish or reddish buff. Odour characteristically resinous. Usually straight-grained. Twisted-fibred chir is common in a few localities. Texture varies from fine to coarse. Large knots usually present in excess.

The wood is easy to season if stacked in well ventilated open piles, preferably under cover of shade. It dries out without any appreciable deterioration. If stacked out in the open in the full sun, a certain amount of cracking and splitting can be expected, and if closepiled in a damp atmosphere, fungus attacks result. Timber can be kiln-dried without difficulty.

Chir and kail are approx. of the same strength. Kail is usually slightly lighter than chir, both being about 75 per cent the weight of teak. There are considerable differences in the strength of chir wood from different localities. Both are reasonably strong for their weight.

They are not very durable, and for sleepers and other outdoor work they should be treated. Chir sapwood treats readily but the heartwood is variable in this respect. Kail is more difficult.

Both are easy timbers to saw and work. They can be brought to a fine smooth surface, but are more suitable for paint and enamel finishes than for polish work.

Next to deodar, chir and kail are the woods most used in Northern India. They are very well known as joinery woods. Treated railway sleepers last 16 to 17 years. They are used for shingles, packing cases, building and construction, light furniture and household fittings. Kail is considered to be slightly superior to chir. These woods are good for pattern making, as cores for laminboards, and for drawing boards and plane tables, but neither is considered suitable for commercial plywood.

Deodar. Air-dry weight is about 35 lbs, per cu.ft. It is a medium-weight wood, very steady in use and durable. Its colour is yellow-brown

and it has a distinctive odour. Usually even-grained and of medium to fine texture. The presence of large knots is common.

Deodar is an easy wood to air-season. It may suffer a little in seasoning from surface-cracks and some splitting if dried too quickly. It is best seasoned under cover. The wood contains a volatile oil from 3 to 10 per cent of the dry weight.

The strength of deodar wood is very high, about 20 per cent less than teak. Weight for weight both are about the same strength. It is reasonably hard, 70 per cent as hard as teak.

The seasoned heartwood is very durable but it may be attacked by termites and fungi. The sapwood is not durable. It treats fairly readily but penetration is erratic.

Deodar is an easy timber to saw and work to a smooth finish. It is not suitable for polish or paint, as the oil in the wood, especially near the knots, seeps through such finishes and discolours them. The frequent large knots make it unsuitable for veneer and plywood.

Deodar is mainly used for railway sleepers and constructional work. It is the most important wood in Northern India and eminently suitable for beams, floorboards, posts, electric poles, window frames, light furniture and shingles. The railways use it for carriage and wagon work. It makes an excellent pattern wood, being very steady if well seasoned.

Fir, Air-dry weight is about 33 lbs, per cu.ft. The wood is creamy white to light buff and there is no difference between heartwood and sapwood. It is inclined to be knotty and clear timber in good lengths is rare. The wood is fairly soft and very easy to saw and work.

Fir is an easy wood to air-season. It is very prone to fungus and white ant attacks and should therefore be dried quickly after conversion. It can be stacked in the open, but should be protected with shades against sun and rain to minimize heart and surface cracking. It kiln-seasons easily.

Fir is similar to chir in strength and stronger than spruce. It is not a durable wood. If used for railway sleepers or in exposed positions, it should always be treated with a good preservative. It is difficult to obtain good penetration without incision.

Fir is very suitable for packing cases, containers and fruit crates. It is good for purposes where fair strength combined with

lightness is a consideration. If treated it is excellent for shingles. It is used for treated sleepers and in limited amounts for battery isolators. Fir can be peeled on a veneer lathe but the knottiness of the wood makes peeling difficult. It is suitable for paper pulp but not very good for matches.

Spruce (in trade usually under the name of fir). Air-dry weight varies from 21 to 39 lbs, per cu.ft. the average being 29 lbs. The wood is white or buffish white with little differentiation between sapwood and heartwood. A false heartwood is found in some trees which makes the floating of timber difficult without proper drying. A very slight resinous odour. Straight-grained and of even texture.

Spruce is more or less like fir for air and kiln seasoning as well as in regard to its durability. It is a difficult wood to treat.

Spruce is extremely easy to work and saw. It is apt to have an excessive number of large knots, which detracts from its value as a carpentry wood. It can be brought to a good finish but has been unsatisfactory for rotary cut veneers.

The wood is used for planking in ceilings and floors, general joinery, cheap furniture, boxes, crates and battery isolators. The bulk of it goes to the railways as treated sleepers. It is suitable for making good quality wood pulp. (Descriptions based upon Trotter, 1944).

Sale Prices of Conifers. The average sale prices in rupees, annas and pies per cu.ft. of sleepers and scantlings Dhilwan Depot were:

Year	Chir	Kail	Deodar	Fir and spruce
1952	1-4-2	3-12-10	5-10-5	2-10-0
1953	1-5-7	3-11-3	4-1-0	2-8-2
1954	2-10-7	3-8-3	5-4-11	2-12-5
1955	2-7-10	4-9-4	5-3-3	3-6-11

In 1957-58 the sale prices for kail varied from 4.5 to 7.0, for deodar from 6.0 to 10.0 and for spruce and fir from 2.5 to 4.5 rupees per cu.ft. In Pathankot the price of deodar was said to be as high as 11 rupees per cu.ft.

Official prices in rupees per cu.ft. at the Kulu Sale Depot in 1957 were:

Specification	Kail	Deodar	Spruce and fir
Sleepers	2.62	3.50	2.25
Planks 2 in.	2.87	3.75	2.50
Planks 2 1/2 in.	3.00	3.87	2.62
Other sizes	3.12	4.00	2.75
Axed ballas	2.37	3.00	1.75

Resin Tapping of Chir Pine. In the Lower Beas Divisions the resin tapping of chir is the main source of revenue. The income from resin makes up 74 per cent and the sale of conifer timber only 9.7 per cent of the total revenue in the financial estimate of the Kangra Division for the period starting in 1951-52. The area under chir is 31,691 acres, the estimated annual output 36,000 mounds (1mound = 82,284 lbs.), and the sale price 20 rupees per mound.

The total production of resin from Jammu and Kashmir, the Punjab Himachal Pradesh and Uttar Pradesh is estimated to be 650,000 mounds per year. The number of tapped trees is 30 to 35 per acre and the yield of resin 6 lbs. per tree for a season of 8 to 9 months. Thus the total number of trees under tapping works out at 9 million and the area at 260,000 to 300,000 acres. The average size of the trees under tapping is 16 to 19 in. at D.B.H.

#### Development of Markets

The diversification of markets is mainly dependent on three items:

1. Extraction of timber in the form of logs and their centralized fabrication.

2. ~~Extraction~~ Extraction and use of small timber.

3. Building up industries which use all sizes of timber.

The extraction of logs is a logging problem and the centralized fabrication of wood requires modern sawmilling. Modern logging and sawmilling will reduce waste and provide more efficient sawing and better quality sawn products than the present sleeper-benchsaw procedure. Trees down to 7 in. diameter could be used in sawing, which would result in increased production of sawn goods. To consider trees with a diameter under 8 in. as waste is only a deep-rooted custom. The extraction of small timber, once commenced will turn out to be profitable at all times.

The pulp and paper industry is the most important mass consumer of small timber and sawing waste. Building up the pulp and paper

industry is the key item in developing the Himalayan conifer forestry.

Industrial projects, however, are the subject of another study and their development is not treated further here,

#### Historical and Psychological Background

An undeniable fact is that only a fraction of the yield obtainable from the Himalayan conifer forests comes to the markets at present. Increasing the actual yield is of first rate importance to the national economy of India. Though there are serious technical, economic and administrative aspects in the conifer problem, the most crucial one seems to be the human factor: Is man able and willing to overcome these difficulties? The present situation, as well as the recommendations of this paper, may become more understandable when the writer puts down some of his impressions and ideas concerning the historical and psychological aspects of the Himalayan conifer problem.

The present state of affairs is a heritage from the time of the British Government in India. The main objectives at that time seem to have been:

1. To satisfy the primitive needs of the hill population.
2. To reserve limited forest areas for soil conservation purposes and in case of war or other emergencies.
3. To produce sleepers for railways, which were the backbone of the administration.

Obviously there was no great interest in the requirements of intensive forestry because all pulp and paper products, for instance, could be imported to India from the United Kingdom. As long as the railways were provided with sleepers, there was no need to develop logging methods, intensify forestry and educate the inhabitants to grow trees for their own use.

The present State administrators and forest departmental staff are very well aware of different and better ways of utilizing forests but they are under the spell of the sleeper heritage. It is always difficult for man to free himself from deep-rooted customs and it will certainly not be easy in India where the national customs are honored and cherished more than in many other countries. One may ask, however, is the present utilization of the Himalayan conifers a custom worth maintaining or just a habit detrimental to the efforts being made to

develop a self-supporting nation.

The attitude of the administrators, industrialists and forest officers in regard to the conifer forests is influenced by their location at the frontiers of the Indian continent and in the mountains, which differ thoroughly from the Plains where the cultural and economic centres are. This fact makes it quite understandable that conifer species have a minor role in research work, compared to the tree species in the Plains. Many researchmen, even some of the forest officers in the hills don't believe in conifers as raw material for pulp and paper industry. They tend to think that the pulp and paper industry can only be based upon bamboo, bagasse, grasses and fast growing broadleaved trees to be planted in the low hills and in the Plains. But, for a change in the angle of view:

1. Are there empty areas in the low hills and in the Plains which were more profitable under the tree growth than in the hills proper?

2. If there are already trees waiting either to be utilized or to rot on their stumps, is it wise to leave them unused and to start the planting of the open areas, which requires time and investments?

It is a natural human tendency for the industrialists and other enterprisers to prefer to work in the Plains and in the neighbourhood of the cultural and economic centres. Even forest officers are not always over-enthusiastic about devoting themselves to the mountains where everything is strange compared to the conditions down in the Plains, and where the difficulties are seemingly impossible to overcome. A prejudice is often more difficult to overcome than a material obstacle and in many cases rich resources are being left unused in remote areas because life is more familiar and comfortable in the neighbourhood of the principal cities and traffic routes.

In order to guarantee the available benefits to the national economy, a fair chance must be given to unprejudiced enterprisers to utilize the conifer forests. More forest officers are urgently needed who are willing to put their profession before their private pleasures and endure the rough conditions in the hills; who have the courage to meet the challenge of the difficulties; and who are able to trust themselves and to look forward to a promising future which can only be attained through strenuous work and hardships. Without these human qualities the future of the Himalayan conifers will be stagnation without end.

CONIFER TIMBER AVAILABLE IN THE PUNJAB AND HIMACHAL PRADESH

Conifer Timber Available in the Beas Basin

As stated earlier, the inventory data are not exhaustive enough for accurate estimations of the raw material available for industrial use in the Himalayan conifer area. The management plans were comparatively fresh in the Beas Basin and therefore the estimation of the available timber, based upon the land areas and stock data as well as the prescribed and actually drawn yields, can be more detailed than in other river basins.

Table 11 gives estimates of the available annual yield from the demarcated conifer forests in the Beas Basin. The total yield is divided per tree species in those working circles where the inventory data have rendered it possible. The estimates are based upon the working plan data, yield tables, the considerations presented in the previous chapter and experience gathered in foreign countries where intensive forestry is an every day practice.

Using the estimated waste, small wood and conversion percentages from Table 12, the total yield breaks up into the following sub-groups (cu.ft. solid wood, without bark):

Sawn products		9,600,000
Sawing waste	12,731,000	
Small wood	<u>11,622,000</u>	
Raw material for pulp and paper		24,353,000
Unavoidable waste		<u>6,957,000</u>
		40,910,000

The estimates in Table 11 are likely to be cautious, which is the right tendency in conditions where the basic data are insufficient. Only the yield from the Protection Working Circles may be an over-estimate because there are no stock data available. If so, the balance can easily be drawn from the undemarcated forests which are not included in these estimates and which cover in Kulu and Seraj alone 492,645 acres, comprising 40 per cent of the total area under closed tree stands. Though large areas are considered inaccessible at present, these conifer resources can easily support wood working industries to

a notable extent.

The size of the available timber is very large (compare pp. <sup>19</sup>22 - <sup>20a</sup>24). At least 50 per cent of the standing stock belongs to diameter classes greater than 20 in. More than 25 per cent of the standing spruce and fir have D.B.H. of 36 in. or more.

The technical quality of the spruce and fir trees is very low. The logging and conversion of these large trees with numerous side branches, knots and inside rot will offer many difficulties.

The proportion of small wood (diameter about 6 to 10 in.) is evidently small. But when the forests come under intensive management and centralized regeneration measures, the amount of small timber is likely to be unexpectedly large.

The potential wood producing capacity of the soil is very high in the exceptionally favourable climatic conditions of the Himalayan hills. As an example, 40,000 to 50,000 acres of forest land belonging to I site quality class could produce chir and kail wood sufficient for a sulphate mill with 100 tons' capacity per day.

#### Minimum Estimates of the Conifer Timber Available in the Punjab and Himachal Pradesh

Estimating the available conifer timber in other river basins of the Punjab and Himachal Pradesh turned out to be more difficult than for the Beas Basin. Even the basic data on land areas and stock composition were deficient and incomplete. Therefore it was only possible to estimate the total yield for the river basins of Ravi and Sutlej.

Yield numbers in Table 13 are called minimum estimates because only the demarcated forests are included in it. All the undemarcated and private forests as well as the Protection Working Circles have been left out of these estimates. These amounts of timber are considered extractable provided the five essential problem groups described in the introduction (p. 3) are solved first of all.

In Himachal Pradesh the yield per tree species is based upon the proportional areas under different species. Thus the sub-groups of the total yield give only a rough idea of their proportions.

In the Ravi Basin there are conifer areas in Jammu & Kashmir which will produce some amounts in addition to the total yield given in Table 13. The timber from Ravi and Beas Basins can be pooled for the same industrial units in the area around Pathankot and Mirthal.

The conifer yield from Uttar Pradesh may increase the total yield in the Yamna Basin by some 50 per cent.

Small wood consists of the tree stems and parts of stems which are under 8 inches in diameter. Sawed products and sawing waste come from stems more than 8 inches in diameter. Thus all round logs over 8 inches in diameter which can be used most profitably for pulp and paper come under the heading "sawing waste". In spite of this, obviously the bulk of spruce and fir pulp wood will be in the form of actual sawing waste and parts split from large over-mature trees too low in quality for sawing timber.

For judging the quality of the timber and distributing it among the diameter classes, the previous chapter and the descriptions of the forests in the Beas Basin are referred to. The quality and composition of the conifer crops is obviously more or less alike in these four river basins.



Table 12. Waste, small wood and conversion percentages

Division	Working circle	Unavoidable waste	Small wood	Conversion to sawn products
Kulu and Seraj	Regular	10	20	60
	Fir	20	10	40
	Selection	10	20	50
	Protection	20	50	40
Mandi	(average)	15	20	50
Kangra	Chir	10	40	40
	Protection	20	50	40
Chamba	(average)	10	30	50
Beas	Chir	10	40	40

Example: The total obtainable yield of spruce and fir from the Fir

Working Circle of Kulu & Seraj is 6,014,000 cu.ft.

Unavoidable waste  $20/100 \times 6,014,000 = 1,200,000$

$6,014,000 - 1,200,000 = \downarrow$

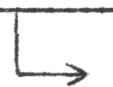
Small wood  $10/100 \times 4,814,000 = 480,000$

$4,814,000 - 480,000 = \downarrow$

Sawn products  $40/100 \times 4,334,000 = 1,730,000$

Sawing waste  $4,334,000 - 1,730,000 = 2,604,000$

Raw material for  
pulp and paper



3,084,000

Total

6,014,000

Table 13. Minimum Estimates of Conifer Timber Available  
in the Punjab and Himachal Pradesh

River basin	Available annual yield in cu.ft. solid measure, without bark					
	Total	Per tree species				
		Total	Sawn products	Sawing waste	Small wood	Unavoidable waste
Ravi	8 700 000	Deodar Pines Spruce & Fir				
Beas	22 930 000	Deodar Pines Spruce & Fir	2 002 000 1 645 000 3 076 000	1 335 000 2 466 000 4 615 000	834 000 2 741 000 855 000	463 000 761 000 2 137 000
Sutlej	9 700 000	Deodar Pines Spruce & Fir				
Yamna	17 400 000	Deodar Pines Spruce & Fir	3 900 000 4 500 000 9 000 000	1 150 000 1 460 000 3 890 000	700 000 1 620 000 720 000	390 000 450 000 1 800 000

SUMMARY OF THE BASIC FACTS AND RECOMMENDATIONS FOR THE  
DEVELOPMENT OF CONIFER FORESTRY

Facts

1. The present actual yield coming onto the markets varies from 30 to 10 per cent of the yield obtainable under intensive management and integrated utilization of wood.

2. Minimum estimates of the obtainable conifer timber from the demarcated forests, excluding Protection Working Circles, in the Punjab and Himachal Pradesh are 8,700,000 cu.ft. in the Ravi Basin, 22,930,000 cu.ft. in the Beas Basin, 9,700,000 cu.ft. in the Sutlej Basin and 17,400,000 cu.ft. in the Yamna Basin. These figures can be increased considerably with timber from large undemarcated forests and in the Yamna Basin with timber from the forests in Uttar Pradesh. Thus the obtainable timber can support comparatively large-scale sawmilling in the Beas, Sutlej and Yamna Basins as well as pulp and paper units in the Beas and Yamna Basins.

3. The existing sawing timber trees are very large, having average diameters breast height of 24 to 28 inches and, in the case of spruce and fir even more. The quality of the trees is often marred by large and numerous knots and in the case of kail, spruce and fir by inside rot. The best deodar crops are of comparatively high quality.

4. Large quantities of thinning material and trees of inferior quality are available for pulp and paper. On the other hand the bulk of the largest spruce and fir trees can only be used for pulp and paper, because of their poor quality. The dominant diameter of spruce and fir trees varies from 20 to 30 inches or more. Inside rot is common in the largest trees but it may be found in small trees too.

5. The silvicultural condition of the forests is characterized by over-dense young and middle age crops which are crying out for thinning, huge areas of pastured forests with very low stock-density, and over-mature spruce and fir forests. Practically all the spruce and fir forests are composed of old and large or suppressed trees which have lost their growing power to reach the present exploitable sizes within a reasonable time. Wind-falls and other climax calamities

are liable to destroy spruce and fir crops in the future. The only sensible way to treat these forests is to exploit and regenerate them as fast as possible.

6. Exploited amounts of wood are dependent on the forest management system, logging methods, regeneration activities, relations between the forestry and local population, forest administration and sale policy which must be developed simultaneously with increasing the exploited amounts.

#### Recommendations

1. All existing data about the conifer resources should be collected at a single place where they will be immediately available for every possible use in the future.

2. Basin-wide resource inventories should be made.

3. The management systems should be modified to concord with the principles of the progressive yield and integrated utilization of wood. The spruce and fir forests should be considered to form working circles of centralized regeneration.

4. Scientific research work for rotation studies and connected forest economics should be initiated.

5. The large scale establishment of nurseries and the regeneration of spruce and fir, as well as determined measures to afforest open areas, should all be put under way.

6. Experimental centralized logging operations with developed methods and equipment should be carried out. Long-term concessions to exploit timber should be granted to private enterprisers under forest departmental control and the enterprisers should be encouraged to develop logging methods.

7. Modern and centralized sawmilling units should be established and portable saw mills introduced where the extraction of large logs is impossible.

8. Pulp and paper industries should be set up. At the same time as the pulp and paper units are being planned and built, logging and forest regeneration methods must be worked out, because large scale exploitation is dependent on them.

Appendix:

Tables of Currencies and Measures

Currencies

1 rupee (R.) = 16 annas or 100 Naye Paise.

1 anna = 12 pies

1 R = 0.21 US \$ = 67.50 FMK (Finnish Mark)

Lengths

1 mile (mi.) = 1.6093 kilometer (Km) = 5280 ft.

1 foot (ft.) = 0.3048 meter (m.) = 12 in.

1 inch (in.) = 0.0254 m.

Areas

1 square mile (sq. mi.) = 2.590 km<sup>2</sup> = 640 acres

1 acre = 0.4047 hectare (ha.)

1 square foot (sq. ft.) = 9.29 x 10<sup>-2</sup>M<sup>2</sup>

Cubic measures

1 cubic foot (cu.ft.) = 0.0283 cubic meter (m<sup>3</sup>)

Standard cubic measure per 1 ton of air-dry conifer wood

(moisture content 12 per cent) = 66 cu.ft.

1 m<sup>3</sup>, solid measure = 35.315 cu.ft. = 1.4 m<sup>3</sup>, stacked measure.

Weights

1 ton long ton) = 1016 Kilogram (Kg.) = 2224 lb.

1 pound (lb.) = 0.4536 Kg.

1 mound = 82.284 lb.

Temperature

F<sup>o</sup> = 9/5 x C<sup>o</sup> + 32

C<sup>o</sup> = 5/9 (F<sup>o</sup> - 32)

Conifer raw wood, clean-barked, solid measure, needed  
for a metric ton of pulp

Process	m <sup>3</sup>	cu.ft.
Mechanical	2.3	81
Chemical	4.3-4.7	152-168

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PROJECT FOR FOREST INDUSTRIES  
IN NORTH-WESTERN INDIA

by

Ilmari Koskinen

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## Preface

I want to express my sincere gratitude for all the help and advice I have received during my stay (from October 15, 1957 to June 15, 1958) in India. My thanks are due particularly to the following:

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Ilmari Koskinen

## INTRODUCTION

Under an agreement concluded between the Government of India and the Government of Finland, I arrived in India on October 15th, 1957 in order to investigate the possibilities of developing paper industries using the coniferous forests of the Himalaya for raw material. The manufacture of newsprint and cheaper printing paper was of special interest in this survey. I travelled together with Mr. Kullervo Kuusela, Doctor of agriculture and forestry, and I left India on June 15th, 1958.

In order to familiarize ourselves with the matter in question we made a study trip to the forests around the upper course of the river Beas. During most of the time our quarters were in Manali, Kulu, Nagar and Mandi. From Mandi we also made a trip, among other places, to see the hydro-electric plant at Joginder nagar. Our trip to the mountains took place from Nov. 8th - Dec. ~~12th~~<sup>6</sup>th, 1957. In order to discover a location for a paper mill I travelled to Pathankot and from there to Mirthal, Mukerian and to "Pang Dam", the place where the dam is to be built on the river Beas, and also to Ambala. I further travelled to Paonta on the river Yamna, as Paonta had been mentioned by the Conservation of Forests of Himachal Pradesh in Simla as a suitable location for an industrial plant, and to Jagadhari, located on the shore of a canal of the same river. Jagadhari is already the location of the Shree Gopal Paper Mill, with an annual output of approximately 15,000 tons a year. At present the mill is being modernized, and its production is, at the same time, being increased to 30,000 tons a year. The raw material used is grass. With a view to increasing the output, the use of wood in addition to grass and sugar cane is being considered.

In Saharanpur, which also belongs to the area of the river Yamna, there is a paper factory, the Star Paper Mill, with a capacity of 15,000 tons a year which also uses grass as raw material. This plant, too, is being modernized, and its output will increase to 30,000 tons a year. The use of coniferous wood as raw material in this plant is being seriously considered.

In Nepanagar, in the State of Madhya Pradesh, there is a paper plant, Nepa Mills, for manufacturing newsprint. The plant is brand

new and modern. It has been built for an annual output of approximately 30,000 tons a year. Bamboo and salai hardwood are used as raw material. Salai wood is ground in American grinders. As the mechanic pulp obtained in this way is brown it has to be bleached. Bamboo is cooked using the sulphate method and the pulp thus obtained is bleached. The finished product has a content of 40 per cent bamboo cellulose and 60 per cent pulp.

Taking into consideration the results of Dr. Kuusela's survey concerning available raw wood and my investigations concerning the possibilities with regard to location, etc., of industrial plants I wish to make the following suggestions:

1. The establishment of a paper mill center for the forests of the river Beas in Mirthal.

2. The establishment of another paper mill center to utilize the forest resources of the river Yamna in Paonta or in Jagadhari.

3. The establishment of a saw mill to utilize the timber resources of the river Sutlej and the building of a saw mill in connection with the paper mill plant near the river Beas.

Each of these three recommendations is discussed separately here.

In carrying into effect these industrial projects, the plants should be planned in such a way that they can easily be enlarged and that other plants in the same line of industry can be built, in order that the introduction of bleaching, for instance, can be brought about without holding up normal operations.

The forest estimates were made very prudently. As the effects of the reforestation planned and implemented by the Indian Government, and of the organization of transport begin to be felt, the enlarging of the operations of the industrial plants will become a question of the moment.

The volume of available raw material is entirely sufficient to ensure the production of these factories, provided, however, that forest work and transport techniques, including floating, are organized efficiently. There are already schemes to this effect. Excessively large trees, with a diameter of more than 30 " should be removed, in order to make place for a new, more productive forest and give it a chance to grow. The cutting into lengths, splitting and preparation for transport of big trunks is more expensive, but, on the other hand these trunks give abundant raw material, and the future will prove the usefulness of this reforestation.

As sleepers and scantlings can be floated even now, the floating of logs and smaller round wood should not involve any difficulties. Floating from Dehra Gopipur to Mirthal, and even from some distance above Dehra Gopipur, could be rationalized by using motor-driven tugs.

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In the appendices I present cost estimates for each branch of the industry, and at the same time, the production cost estimates. These are merely estimates and should only give a general idea of the possibilities. More exact calculations should be made when the real planning is begun.

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When planning factories, attention should be paid to ensuring the continual delivery of raw material under long-term delivery contracts of at least 25-30 years. This is an indispensable condition for the existence of an industry.

Furthermore, the factories should also, for instance, take an interest on their own initiative, in developing the most economical methods of transporting raw materials.

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## THE PAPER MILL CENTER ON THE RIVER BEAS

### General Consideration

In my opinion, a paper mill using the forest resources of the water area of the river Beas should be built in Mirthal, which is approximately 20 miles from Pathankot.

This location presents the following advantages:

1. It is right on the shore of the river Beas,
2. There is enough space for the plant and for the stocking of raw material,
3. Water-storage space for raw material is easy to arrange in the immediate vicinity of the river Beas. Storage in water is important for raw material for pulp, as its content of dry substance should not exceed 50 per cent. There is also space for logs and for the feeding reservoir proper of the saw mill.
4. There is a satisfactory supply of good quality water. The Director of Industries of the Punjab states in a letter dated May 28th, 1958 that the water supply from the river Beas is at the most 180,000 cu.ft./sec. and at the least 4,500 cu.ft./sec. This is the equivalent of at the most 5,100 m<sup>3</sup>/sec. and at the least 127 m<sup>3</sup>/sec. The requirement of a combined sulphite cellulose and paper mill is at the most 2 m<sup>3</sup>/sec.
5. There is a railroad from Pathankot to Mirthal, and the river Ravi, too, is linked to the river Beas. Thus, it would be possible to enlarge the activities of industrial plants located in Mirthal and to make their production more varied. The water supply in the river Ravi is, according to the afore-mentioned letter from the Director of Industries of Punjab, at the most 147,000 cu.ft./sec. corresponding to 4,100 cu.m./sec., and at the least 2227 cu.ft./sec., corresponding to 62.5 m<sup>3</sup>/sec. During the main part of the year the water supply from the river Chakki is rather small. According to the report in question the largest water supply is 80,000 cu.ft./sec., corresponding to approximately 2,250 m<sup>3</sup>/sec., and the smallest is only 22 cu.ft./sec., corresponding to 0.62 m<sup>3</sup>/sec.

The transport costs of the raw material are, according to the information available, Rs-2/10 by rail and Rs-3/- by road per maund, equivalent to 7,2, respectively 7,6 NP per cu.ft. if the volume per

weight of the air-dried wood is 66 cu.ft./ton, and approximately  $2\frac{1}{2}$  - 3 times more for fresh, recently floated wood.

6. According to information supplied, "Labour conditions at Mirthal are satisfactory".

7. The supply of electric power is ensured by the hydro-electric power plant at Joginder nagar. According to information supplied by the Punjab P.W.D., Electricity Branch, on 27.11.1957, this plant can supply 48,000 kW of power. With the installation of new machines it would be possible to double this output at comparatively low cost, since the other equipment required for the power plant - for example the water pipes - has been built with a view to possible future enlargements.

In my opinion Mirthal is the most advantageous location of all the places I visited. There is one drawback: a dam approx. 50 m. 165 feet high, the Pang Dam, is being built on the river Beas in Mukerian. The comparatively small volume of water used by the plant can easily be transported the distance of approximately 20 miles, but during the dry season the transport of the raw material by floating may cause certain difficulties. However, the water supply required for timber-floating is not very big:  $3 \text{ m}^3$  or approximately 100 cu.ft./sec. should be ample if a special floating channel is built for this purpose.

The area of the Pang Dam was also recommended to me as a location suitable for the plant. A railroad to this place is to be built, too. However, the building of an industrial center with dwelling-houses, industrial plants and levelled-out ground would be more expensive than the arrangements necessary to ensure a water supply at Mirthal. Besides, the completion of the Pang Dam will take rather a long time; it is calculated to last 7 years. The railroad from Pathankot to the Pang Dam will, besides, be approximately twice as long as it is to Mirthal and, accordingly, rates will be more expensive.

If the Pang Dam area is considered more convenient, notwithstanding its disadvantages, the location of the industrial plant should be above the dam and not, as proposed in some instances, below the dam, because in the latter case the finished product would have to be hoisted to the level of the railroad by means of an elevator. It would also be easier to build a saw mill with a reservoir for logs above the dam.

30,000 tons' Paper Mill

Requirement: pulp 24,000 tons a year  
cellulose 6,000 " " "

The raw material required for mechanical pulp is approximately 2.4 solid cu.m., or about 85 cu.ft. per ton.

For sulphite-cellulose the raw material required amounts to approximately 4.5 solid cu.m. or about 160 cu.ft. per ton.

Thus, the pulpwood required for a 30,000 tons' newsprint mill would be:

for pulp	$2.4 \times 24,000 = 57,600$	solid cu.m. or approx.	2,000,000 cu.ft.
" cellulose	$4.5 \times 6,000 = 27,000$	cu.m. or approx.	<u>950,000 cu.ft.</u>
Total	84,000	cu.m. or approx.	2,950,000 cu.ft.

The total raw material requirement of the newsprint mill is, thus, approximately 3,000,000 cu.ft. or, per ton, approximately 2.8 solid cu.m. equivalent to approximately 100 cu.ft.

The raw material required by a printing paper plant, provided that approximately 40 per cent cellulose and 60 per cent pulp is used, would be as follows:

for pulp	$2.4 \times 18,000 =$	43,200 cu.m. or approx.	1,560,000 cu.ft.
for cellulose	$4.5 \times 12,000 =$	<u>54,000 cu.m. or approx.</u>	<u>1,900,000 cu.ft.</u>
Total		97,200 cu.m. or approx.	3,460,000 cu.ft.

The raw material required for the manufacture of one ton of printing paper would be approximately 3.3 cu.m equivalent to approximately 115 cu.ft.

According to Dr. Kuusela's report there are enough varieties of spruce in the logging area on the river Beas to cover the requirement of a sulphite-cellulose plant with an output of approximately 30,000 tons a year. It is not profitable to build a cellulose plant for an approximate annual output of only 6,000 tons or less. The output of such a plant should be at least 30,000 tons a year. With newsprint and cheaper printing paper in view, it would be justified, at the beginning, to build only a mechanical pulp mill and a paper mill, and to buy unbleached sulphite cellulose or bleached sulphate cellulose. Later on, when the road transport and floating of timber have been arranged, it would be appropriate to build a cellulose plant.

The raw material requirement of a sulphite cellulose plant is 4.5 cu.m. per ton - for 30,000 tons 135,000 cu.m. or approximately 5,000,000 cu.ft.

According to these calculations the yearly raw material requirement of the paper and cellulose factory centre here proposed would be:

Mechanical pulp mill	24,000 tons	approximately 58,000 cu.m. or 2,000,000 cu.ft.
Cellulose mill	30,000 tons	135,000 cu.m. or 5,000,000 cu.ft.
Total approx. 193,000 cu.m. or approx.		7,000,000 cu.ft.

As it is possible to arrange for a supplementary supply from the river Ravi at the height of Pathankot, the supply of raw material to Mirthal is fully ensured, even for a 30,000 ton cellulose mill. Accordingly, it is recommended that a sulphite cellulose mill should be built later on. This method presents the advantage that the pulp is white, which makes a bleaching plant unnecessary. Another advantage consists in the easier and less complicated management of the plant. Sulphite cellulose should definitely be bleached, and the equipment for a bleaching plant amounts to approximately 400,000 US \$, the buildings to approximately US \$ 180,000.

By using the sulphite as well as the sulphate method, recovery of warmth and chemicals is practised, and the costs for this equipment are about the same.

At present the sodium sulphate (Glauber salt) required in the sulphate industry is imported into India, and so is sulphur.

The sulphur necessary for the sulphite industry is obtained from elemental sulphur or from sulphur ore. The use of elemental sulphur is recommended in view of the cheaper transport costs and because the equipment required for the manufacture of sulphite acid is less complicated, the handling is easy, and the price of the equipment is only a part of the price of the ovens to be built for roasting pyrites and of the plant necessary for handling the gas.

Silver fir (*Abies pindrow*) and spruce (*Picea morinda*) are suitable raw material for mechanical pulp, as white pulp can be obtained from them without bleaching.

The same raw material can be used for preparing cellulose and, using the sulphite method, a cellulose is obtained which can also be used without bleaching for the manufacturing of paper.

In addition to fir and spruce, aspen, some species of poplar and alden are equally good as raw material. Salai and sal, and other hardwood too, make good cellulose using both the sulphite and the sulphate method. Accurate data on the supply of hardwood are not available, but according to verbal statements the supply of these varieties is so ample that it would be an important supplement to the raw material balance.

The raw material to be used in the mill should be at least partly barked by hand in the forest and rebarked in the barking machines or drums at the plant.

For the purpose of floating, the logs should be cut to 1 m., 2 m. or 4 m. lengths. After the barking at the mill the logs should be sawn to 1 m. lengths, since grinders are designed for a standard measurement of 1 m.

For the chipping of cellulose wood, the most usual lengths are 1 and 2 m.

The diameter of the wood is not a factor of decisive importance. A diameter of 4-8", however, is considered to be ideal. Nowadays, however, raw material with a diameter of only 2" can be used. The maximum dimensions are determined according to the details of the handling methods. There should be no difficulties with diameters up to 14-16". As far as the machinery is concerned even thicker material can be used.

For rebarking the raw material at the mill, revolving barking drums have been used and are still in use. They are placed in the water reservoir, and the logs chafe against each other in such a way that the bark is detached. Barking in the drum presents i.a. the advantage that the wood need not necessarily be round, it may even be split. Where split wood is used, dangerous heart rot is removed from it together with bark.

It should be mentioned that nowadays barking machines with positioned cutting-edges to remove the bark are being more and more used. These machines are considerably cheaper and do not necessitate large, expensive buildings. Another advantage consists in the fact that the bark removed is drier than bark obtained by using the earlier mentioned machines, and that it can be burnt more easily. However, with these machines only wood in round form can be barked.

As previously mentioned the dry substance content of mechanical pulpwood should not exceed 50 per cent.

Four grinders should suffice to grind the necessary quantity of wood. Screens, units for precipitation, pumps etc., are also required.

In preparing newsprint, pulp is usually ground to 65-75, and for fine paper to 75-85 Schopper Riegler degrees.

Pulp is pumped directly to the paper mill, where it is usually beaten either in a hollander or in a Jordan mill together with cellulose. Jordan mills and comparable equipment are being used more and more because, among other reasons, they do not take up so much space.

The equipment required in a paper mill is as follows:

#### Mechanical Pulp Mill

##### Wood handling:

1. Storing of wood. Mechanical pulpwood is most advantageously stored in water in order to avoid drying. The reservoir should have an area of 2 ha.

2. Wood barking equipment. Two barking drums, both measuring 6 m. in diameter and 14 m. in length.

3. Transport equipment

Pulp mill proper: Required space 15.000 cu.m.

1. Grinders, linked together two and two,	total 4
2. Electric motors with disjunctors and regulators	2
3. Grit removers № 4	2
4. Hydraulic system	1
5. Motor governors	2
6. Vibratory coarse screens	2
7. Centrifugal fine screens № C-III	2
8. Thickeners U200/4	2
9. Shredder	1
10. Refiners	3
11. Chest agitator for 500 cu.m. chest	1
12. Consistency regulator	1
13. Pulpstones	4
14. Pumps	
15. Half automatic equipment for grinders	8

## Sulphite Pulp Mill

### Wood handling.

1. Storing of wood. The wood is stored piled. Area approximately 4 ha. Rail-crane, spring interval estimated at approximately 60-90 m.
2. Wood barking. If a cellulose mill is built in connection with the paper mill, as proposed in this report, one more similar drum is required for the barking unit to be located beneath the pulp mill.
3. Chipping and screening.
4. Stock of chips, either a common container or a separate container for each digester, located above it.
5. Equipment for the transport of chips.

### Preparation of cooking liquor.

1. Sulphur roasting. Three revolving, recumbent, iron kilns diameter 1.0 m., length approximately 4.5 m. Chamber for reburning, diameter approximately 1.5 m., height approximately 2.5 m., iron. Cooling in recumbent or erect leaden cooling units.

2. Acid tower - two towers. Height 40 m., net diameter at base 2.5m., at the top 2.2 m. Usually built of reinforced concrete and the inside lined by acid resistant masonry, approximately 80 m/m thick. The towers are filled with limestone blocks, diameter approximately 25 cm. At the base of the tower at a height of approximately 2.5 m. a wooden grate, in which the free intervals are approximately 50 mm. At approximately 50 cm. above this grate there is another, made of thicker timber and with openings 15-20 cm. wide. The limestone pillar is loaded on the last-mentioned grate. Between the grates there is an opening in the tower permitting the removal of undissolved limestone waste.

After cooling the sulphur dioxide gas is blown into the base of the tower and water is sprinkled through the upper part. The  $SO_2$  solution obtained in this way dissolves limestone and so-called raw tower acid is obtained and pumped into reservoirs arranged for this purpose. Usually four or five reservoirs are built in connection with the acid unit, of which one takes higher pressures. Their capacity is approximately 150 cu.m. (approximately 10 m. high, the diameter being approximately 4.5 m.), except the pressure acid reservoir, which has a capa-

city of approximately 200 cu.m., approximately 12.5 m. high and with a diameter of approximately 4.5 m. During the cooking of cellulose, gas with a high sulphur dioxide content evaporates from the digester. The large volume of gas evaporating from the digester during the cooking of cellulose has a high sulphur dioxide content and is first conducted into a pressure reservoir of acid, the excess is led into the other acid reservoirs, from where the transition gas proceeds into the acid tower. The tower acid, containing approximately 1.2 per cent CaO, and with a total SO<sub>2</sub> content of approximately 2½ per cent, is concentrated from cooking gas into cooking acid, the consistency of which is approximately 1 per cent CaO and 5 per cent SO<sub>2</sub>.

Cooking department.

1. Digesters of 175 cu.m. each, made from compound steel 4 pieces
2. Calorisators, one for each, acid resistant steel 4
3. Digester feeding unit, transportable 1
4. Acid pipes, acid-resistant steel
5. Cooking gas circulation pipes, acid-resistant steel
6. Waste gas coolers, acid-resistant steel
7. Discharging pipe system

8. Pulp storing reservoirs. Recumbent, covered reservoirs. The discharging pipe system should be arranged in such a way that each of the digesters can be discharged into any of the reservoirs. Capacity of each of them approximately 400 cu.m. Width 6 m., height 5-6 m., length 12 m. masonry walls, the bottom laid with hollow bricks. 4 pieces.

Reservoir

9. Pulp emptying units 12 pieces
10. Pumps for discharging pulp from the reservoirs into the screening unit 2

Screening unit

1. Discarding branches
2. Sandtraps, 2m. wide, 8 m. long 2 pieces
3. Revolving screens
4. Pulp precipitation unit
5. Pulp reservoirs
6. Pumping system to the paper mill
7. Transport to drying machine

Wet machine, moisture content about 50 per cent

1. Suction cylinder, diameter approximately 1.5 m., length 3.2 m.  
2 pairs of rifled high pressure cylinders. At the end of the machine cutters.
2. Baling machines 2 pieces
3. Pulp transport system
4. Pulp storing space for approximately 1,000 tons of air-dried pulp

Alternatively

Drying machine with complete equipment. This, however, is expensive, the price being approximately 1,250,000 US \$. Wet pressing machines with corresponding equipment cost only about 200,000 US \$.

Paper Mill

1. Paper machine with drive, length approximately 80 m., width of ground rails 6 m., working width of machine 3.7 m., height 9 m.
2. Calendar reel with drive
3. Rolling machines, rolling pressing machines, scales etc.
4. Cutters with drive
5. Packing machines
6. Ventilation system
7. Knot screens
8. Equipment and basins for preparing chemicals (alum, resin, China clay etc.)
9. Mixing and machine tanks
10. Sorting room for paper sheets
11. Storehouse with truck transport units
12. Transport trucks

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For the storage of raw material, requisites and manufactured goods an area of approximately 30 ha. or 75 acres is required in such a paper and cellulose mill.

As water is rather muddy in India during the monsoon period, with a particularly high clay content, mechanical filters are required, and these are comprised in the summary table.

### THE PAPER MILL CENTER ON THE RIVER YAMNA

A similar paper mill and mechanical woodpulp factory could be built for exploiting the spruce raw material on the river Yamna, too. They could be located either at Paonta or at Jagadhari. (Here, however, it would be unnecessary to build a sulphite cellulose factory, as the Mirthal sulphite cellulose factory could fill the cellulose requirement of both paper mills. The raw material which might be obtained from Uttar Pradesh is not taken into account here.) Both these places are suitable as locations for a factory. Jagadhari offers the advantage, that there is already a railway running to it. The area necessary for the factory and its wood store is approximately 30 ha, not including dwelling-sites.

The raw material required for a paper mill located in Jagadhari or Paonta is approximately 58,000 cu.m. or approximately 2,000,000 cu.ft. for a yearly pulp output of 24,000 tons.

As already mentioned, Mirthal could supply the required sulphite cellulose. Water power would probably be available in Bakhra-Nangal.

The raw material available in the area of the river Yamna would also be sufficient, for a craft paper factory with an annual capacity of 30,000 - 50,000 tons as well as for the two above-mentioned factories. The resources of the Uttar Pradesh area have not been taken into account in these calculations. As pine and spruce species are equally suitable as raw material for the manufacture of craft paper, the building of a craft paper factory would be entirely justified.

The raw material requirement of a craft paper factory is approximately 4.7 <sup>solid</sup> cu.m. or 165 cu.ft. per ton of manufactured paper, which means that the annual requirement of a 50,000 ton factory would amount to approximately 230,000 cu.m. or approximately 8,200,000 cu.ft.

#### Craft paper mill

Wood handling and stocking: The same as for the sulphite cellulose mill.

Cooking department	175 cu.m. digesters	4 pieces
	Feeding system	1
	Blowing reservoirs	

Recovery of the blowing heat

Washing

Screening

Storage space for high consistency pulp

Craft paper machine, complete with cutters, packing press, trucks etc.

Liquor sections, complete with soda boilers, electric filters, evaporators (condensators) etc.

Glauber-salt (Salt cake) and  
lime store

Other ~~departments~~ with extra boiler, turbine, generator, feed water  
treatment, electrification etc.

Repair shop

Laboratory

## SAW MILLS

During the discussions which took place in Chandigarh on January 1st 1958 it was mentioned, that at least 1 million cu.ft. coniferous saw logs a year would be available in the Sutlej river area. However, the survey made by Dr. Kuusela indicates that a considerably bigger volume is available.

This wood could be most advantageously used for sawing. The best result is obtained by using a single lined frame saw. The above-mentioned volume of 1 million cu.ft. corresponds to an annual output of approximately 4,000 std.

Required machinery and space:

1. 2 frame saws, each measuring 28". These can saw logs measuring 19" at the top.
2. 1 band saw for the preparatory sawing of larger logs.
3. Auxiliary equipment, transport equipment, trimming saw, electric motors.
4. Log moving equipment.
5. Saw mill area approximately 5 ha.
6. Area for 37,500 logs, approximately 4 ha.

Sawing can be recommended in the Beas river area, too, in connection with the paper mill. Besides coniferous wood proper it is at the time being possible to saw deodar wood in the same plant, too, more efficiently and using the raw material more economically than previously. The sawing waste obtained in sawing can be utilized in the steam power center. Approximately 11 cu.m. of ~~piled wood~~ waste is obtained from 1 std. ~~sawn goods~~.

The cost of the complete equipment required for a 4,000 - 5,000 std. saw mill is approximately US \$ 120,000. The space required by the saw mill is about 16,000 cu.m. and the building costs together with the installation of the machinery, are estimated at approximately US \$ 80,000.

The number of workers required is approximately 60, of whom 12 would work in the log yard, 21 for the sawing proper and sorting, 15 in the lumber yard and 12 for dispatch and shipping.

The electric power required is approximately 150 kWh/std., viz. 600,000 kWh a year.

A 4,000 standard saw mill produces approximately ~~4~~4,000 cu.m. of waste, giving approximately 23,000 tons of 40 atm. steam a year.

The necessary power will be provided entirely by burning the waste from sawing. If all the waste is burnt the amount of electric energy will be 3.5 - 4.0 million kWh a year.

In order to obtain the amount of kWh required for the operation of the saw mill it is necessary to install a condensation turbine with generators with a capacity of approximately 500 kW and a steam boiler producing approximately 3 tons of high pressure steam per hour.

On the other hand saw waste is an excellent raw material for sulphate cellulose. By using half of the waste, chipped and screened, approximately 22,000 cu.m. cellulose chips could be obtained, from which about 1,500 tons of sulphate pulp could be manufactured. The remainder would be sufficient to produce about 10,000 - 11,000 tons of steam a year, from which approximately 2 million kWh a year can be obtained.

SUMMARY

On the basis of calculations concerning raw material available, paper and cellulose plants, and saw mills can be built on the rivers Beas, Yamna and Sutlej, among other locations.

It is recommended, that

1. a newsprint mill (including a wood-grinding plant and facilities for producing printing paper, too) and a sulphite cellulose mill, each with an annual capacity of 30,000 tons, should be built in the Beas basin, together with a modern 2-frame saw-mill with an annual capacity of 4,000 - 5,000 standards. The location recommended for this industrial centre is Mirthal.

2. in the Yamna basin, a paper mill as described above with a capacity of 30,000 tons a year, a sulphate cellulose mill with craft paper machines-annual capacity 50,000 tons-, and a saw mill with a capacity of 4,000 - 5,000 std. per year should be built. It is proposed that the industrial centre be located in Jagadhari or Paonta. There is a railway to Jagadhari, which must be considered an advantage.

3. in the Sutlej basin a saw mill should be established, with an annual output of about 4,000 - 5,000 std., located at the Bakhra Dam.

Fir and spruce are suitable as raw material for the paper mills and in addition to these, aspen and alder can be used for the sulphite cellulose mill. As raw material for sulphate cellulose fir, spruce and Pinus-varieties, and practically all hardwood varieties are suitable. All varieties of wood can be used for sawing.

If a saw mill is established in connection with the paper and cellulose mills, there will be the advantage that sawing waste can be used for the production of steam and power, and, chipped and screened, as raw material especially for the manufacture of sulphite pulp.

The location of an industrial plant is determined by:

1. the supply of raw material
2. adequate supply of water
3. the supply of electricity
4. the solving of transportation problems
5. the supply and housing of the labour force

As it is presumed that the plants are to be enlarged in the future, they must be designed in such a way that their expansion and development can be accomplished without difficulty.

A rough estimate of costs:

the industrial centre in Mirthal	U.S. doll. about	19,050,000.-
the sulphate mill	" "	13,200,000.-
the paper mill and ground pulp mill	" "	12,000,000.-
the saw mill	" "	200,000.-

Detailed estimates of the costs are to be found in the Appendices.

Appendix

I ROUGH ESTIMATE OF MACHINERY PRICES (FOB EUROPEAN HARBOUR)

FOR MILL INTEGRATION:

100 daily tons of unbleached sulphite pulp, and  
100 daily tons newsprint.

A Chemical pulp mill (20 tons daily in slush form, US \$  
80 tons daily dried, in bales)

1. Wood handling system, incl. log  
splitting, drum barking chipping etc. 450,000:-
  2. Cooking department, SO<sub>2</sub> making and re-  
covery, incl. 4 st.st. digesters of 175  
cu.m. with cooking liquor circulation  
& heating and instrumentation, 1 acid  
pressure tank of 200 cu.m. acid system,  
pumps and instrumentation, 2 rotary  
sulphur roasters & SO<sub>2</sub> washing towers,  
piping etc. 975,000:-
  3. Screening department, including flood-  
ing discharging system for the digester  
bins, high density storing for I:a pulp,  
fresh & white water and stock piping  
systems etc. 575,000:-
  4. Fourdrinier drying machine with drive,  
trim 3500 mm, including centricleaner  
station, wire section, press section,  
drying section, sheet cutter, baling  
press, room ventilation, suction pumps,  
chest agitators, piping, erection &  
bale storing cranes etc. 650,000:-
  5. Piping systems between pulp mill departments 150,000:-
  6. Electrification, including motors,  
transformers, power & lighting wiring etc. 150,000:-
- Chemical pulp mill, in total items I/1-6 2,950,000:-

US \$

B Mechanical pulp mill (80 tons daily air-dry)

1. Wood handling, including log splitting and barking, groundwood mill infeed and distribution	250,000:-	
2. Two double stone (1550 mm $\phi$ ) grinder units, each of 4000 HP, with stone mounting equipment etc.		
3. Coarse screens, four centrifugal screens, two gravity deckers, equipment for coarse fraction re-fining etc.		
4. Fresh & white water, stock and coarse fraction pumps and pipings, chest agitators etc.		
5. Ventilation of groundwood mill, cranes etc., items 2-5 in total	350,000:-	
6. Electrification, including el. motors (also for grinders), power wirings, lighting, instrumentation etc.	150,000:-	
Groundwood mill in total, items II/1-6	<hr/> 750,000:-	750,000:-

C Newsprint (Printing paper) mill (100 tons daily, 95% dry content)

US \$

1. Stock proportioning and broke recovery (and white water fibre) including gravity thickener, Waco type fibre recovery unit, stock proportioner, size, colour and mineral filler systems & proportioners, consistency regulators, chest agitators, pumps & piping, instrumentation etc. 125,000:-
2. Chemical pulp preparation, including chest agitators, gravity thickener, refiners, instrumentation, pumps & piping etc. 75,000:-
3. Paper machine with drive, trim 4200 mm, including one jordan refiner, centri-cleaner station, mixing pumps, knotters, pressure head box, wire section, press section, drying section (40+8 cylinders of 1500 mm diameter), with steam infeed & condensate removal systems, calendar stock & pape reel, circulating oiling system, compressor station, hydrapulper, wet broke chest agitator, ventilation system, etc. 1,900,000:-
4. Broke stock and white water pumps & piping, pressure air, lubricating oil and suction pump pipings, condensate station for boiler house, cranes etc. 100,000:-
5. Finishing, shipping and storing equipment, including paper roll conveyors, rewinder with drive, paper roll packing equipment and scales, core equipment, storing cranes etc. 200,000:-

Carried forward 2,400,000:-

Carried forward 2,400,000:-

6. Electrification including Leonard aggregates for PM & rewinder drives, transformers, power wiring, lighting, instrumentation etc. 100,000:-

Newsprint mill in total, items III/1-6 2,500,000:- 2,500,000:-

D Steam and Power Station (without condensing turbine power generating)

US \$

1. Two coal fuelled boilers 50 atm./450°C, each of 35 tons of steam hourly generating capacity (one as reserve), also suitable for sulphite waste liquor burning in the future, including fans, coal conveyors & bunkers, combustion control equipment and instrumentation 750,000:-
  2. Feed water preparation system and pumps 100,000:-
  3. Back pressure turbine unit, 45/3 atm., 5000 kW, with pressure reducing and de-superheating station, crane, hoists etc. 150,000:-
  4. Piping for water, steam, condensate, pressure air etc. 100,000:-
  5. Diesel generator stand-by set 40,000:-
  6. Electrification including el, motors, power wiring, lighting, etc. 80,000:-
  7. Purchased el. power main substation and 60 miles infeed line, 10000 kW, 300,000:-
- 
- Steam and power station in total, items IV/1-7 1,500,000:- 1,500,000:-

E General Services

US \$

1. Machine shop, including blacksmith and electrical departments, and foundry	450,000:-
2. Garage, offices, laboratories, first aid, lavatories	100,000:-
3. Fresh water pumps (3 x 10000 1/min) with purification equipment and main pipe line (500 m)	250,000:-
4. Steam and fresh water distribution, condensate return etc.	100,000:-
5. Fire protection systems	50,000:-
6. General electrification, including out- door lighting, telephone and autocall system etc.	250,000:-
7. Wood purchasing and other transport equipment	100,000:-

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General services in total, items V/1-7 1,300,000:-

F Unforeseen (spares etc.), 1,200,000:-

G Summary of Machinery Fob Prices

I Chemical pulp mill	US \$	2,950,000:-
II Mechanical pulp mill	"	750,000:-
III Newsprint mill		2,500,000:-
IV Steam and power		1,500,000:-
V General services		1,300,000:-
VI Unforeseen		1,200,000:-

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I-VI, Grand total US \$ 10,000,000:-

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II INVESTMENT COST ESTIMATE FOR PULP AND PAPER MILLS

Fob prices of machinery (table I) <u>US doll</u>		10,000,000
Overseas freight and inland transport, about 20%		2,000,000
Erection, about 15%		1,500,000
Buildings, incl. engineering, equipment foundations etc.		
Sulphite pulp mill	80,000 m <sup>3</sup>	
Groundwood mill	15,000 "	
Paper mill	50,000 "	
Steam and power plant	35,000 "	
Storage room for pulp and paper	<u>20,000 "</u>	
	200,000 m <sup>3</sup> à 12/-	2,400,000
Preparation of mill site		150,000
Mill design and supervision		<u>400,000</u>
		16,450,000
Interests during building period		600,000
Working capital		<u>2,000,000</u>
	Grand total	19,050,000

### III MISCELLANEOUS

All the figures in this table refer to the integrate complex of Table II.

#### Steam for working, tons

	<u>per ton</u>	<u>per 24 h</u>	<u>per h</u>	
Cellulose mill				
Cooking	1,7	170	7,1	
Drying	1,7	170	7,1	14,2
Paper mill				
drying	2,8	280		11,7
Power Station		120		5,0
		60		2,5
		<hr/>		
		766		<u>33,4</u>

Coal per year 130 tons/24 h = 43000 tons/330 days.

#### Electric power kWh

	<u>per ton</u>	<u>per 24 h</u>	<u>per h</u>
Cellulose mill with pumping of water	400	40,000	1670
Ground pulp mill	1400	120,000	5000
Paper mill	300	30,000	1250
Engineering shop, lighting etc.			<hr/> 280
		<u>Average loading</u>	<u>8200 kW</u>

Water power 5000 kW

Electric line to be built 10000 kW

IV ROUGH ESTIMATE OF MACHINERY PRICES (fob European Harbour)  
FOR CRAFT PAPER MILL

150 tons daily of craft paper (sulphate)	US doll
1. Wood handling system inclusive barking drums, log splitting chipping etc.	440,000
2. Fibre sections Cooking, 4 digesters of 175 cu.m. each with cooking liquor circulation, heating and instrumentation, emptying, heat recovery, screening and high consistency pulp storage etc.	1,760,000
3. Craft paper machine with drive/trim 3,500 - 4,000 mm complete with packing press, trucks etc.	1,900,000
4. Liquor sections with recovery complete	1,100,000
5. Other sections with extraboiler, turbine, generator, feed water treatment, electricity etc.	<u>1,300,000</u>
Total	6,500,000

General services

Approximately the same as for sulphite and paper mill	1,300,000
Unforeseen	1,000,000
Machinery	<u>6,500,000</u>
Total	8,800,000
Overseas freight and inland transport, about 20%	1,760,000
Erection, about 15%	1,320,000
Buildings (incl. engineering, equipment foundations etc.)	
Craft paper mill      100,000 m <sup>3</sup>	
Storage room for paper <u>20,000 "</u>	
120,000 m <sup>3</sup> à US doll. 12/-	<u>1,440,000</u>
Grand total	13,320,000

V PRODUCTION COSTS EXCL. INTEREST SULPHITE PULP MILL

Raw material: fir and spruce

Production: 100 tons daily, production cost in Rs. per ton.

	Quantity	Unit	cost	Cost per ton	Total
Wood, cleaned and chipped cu.ft.	160		1.55	248.00	248.00
Sulphur	100	kg	0.275	27.50	
CaCO <sub>3</sub> (limestone)	140	"	0.007	0.98	
miscellaneous				7.00	35.48
Power	400	kWh	0.06	24.00	
Steam	3.4	m.tons	9.25	31.55	
Water	300	m <sup>3</sup>	0.01	3.00	
Labour (man hours)					
Operating	10		0.70	7.00	
Repair	2		1.00	2.00	
Repair and maintenance materials				27.00	
Factory supervision and overheads				18.00	
Depreciation on plant and equipment				59.00 <sup>x)</sup>	171.55
Estimated production costs					455.03

x) Buildings 4%, machinery 12%.

VI PRODUCTION COSTS EXCL. INTEREST NEWSPRINT MILL WITH  
GROUND WOOD MILL

Raw material: fir and spruce,  
chemical pulp,

Production: 100 tons daily, production cost in Rs. per ton.

		Quantity	Unit cost	Cost per ton	Total
Wood, cleaned	cu.ft.	68	1.55	105.50	
Chemical pulp	ton	0.2	440 <sup>x)</sup>	88.00	193.50
Power	kWh	1.700	0.06	102.00	
Steam	m.tons	2.8	9.25	26.00	
Water	m <sup>3</sup>	300	0.01	3.00	
Labour (man-hours)					
Operating		12	0.70	8.40	
Repair		3	1.00	3.00	
Repair and maintenance materials				22.00	
Factory supervision and overheads				18.00	
Depreciation on plant and equipment				67.00 <sup>xx)</sup>	252.40
Estimated production costs					445.90

x) Chemical pulp in slush form

xx) Buildings 4%, machinery 12%

VII PRODUCTION COSTS EXCL. INTEREST PRINTING PAPER

Production cost per ton in Rs

		Quantity	Unit cost	Cost per ton	Total
Wood, cleaned	cu.ft	51	1.55	79.00	
Chemical pulp	ton	0.4	440.00 <sup>x)</sup>	176.00	255.00
Chemicals				40.00	40.00
Power	kWh	1.700	0.06	102.00	
Steam	m.tons	2.8	9.25	26.00	
Water	m <sup>3</sup>	300	0.01	3.00	
Labour (man-hours)					
Operating		12	0.70	8.40	
Repair		3	1.00	3.00	
Repair and maintenance materials				22.00	
Factory supervision and overheads				18.00	
Depreciation on plant and equipment				67.00 <sup>xx)</sup>	249.40
Estimated production costs					544.40

x) Chemical pulp in slush form

xx) Buildings 4%, machinery 12%

VIII PRODUCTION COSTS EXCL. INTEREST CRAFT PAPER MILL

Raw material: conifers  
Process (sulphate)

Production: 150 ton daily, production cost in Rs. per ton

		Quantity	Unit cost	Cost per ton	Total
Wood, cleaned and chipped	cu.ft	165	1.55	256.00	256.00
Na <sub>2</sub> SO <sub>4</sub> (salt cake)	kg	85	0.275	23.38	
CaCO <sub>3</sub> (limestone)	"	225	0.007	1.58	
Miscellaneous				7.50	34.10
Power	kWh	800	0.06	48.00	
Steam:	m.tons				
Consumed		7.3			
Produced in alkali recovery		4.3			
Net consumption		3.0	9.25	27.75	
Water	m <sup>3</sup>	300	0.01	3.00	
Labour (man-hours)					
Operating		12	0.70	8.40	
Repair		3	1.00	3.00	
Repair and maintenance materials				30.00	
Factory supervision and overheads				22.50	
Depreciation on plant and equipment				74.08	216.63
Estimated production costs					506.73

x) Buildings 4%, machinery 12%

$$\begin{array}{r}
 212 \\
 12 \\
 \hline
 424 \\
 212 \\
 \hline
 2544 \quad | \quad 172 \\
 172 \\
 \hline
 624 \quad | \quad 13
 \end{array}$$

The first part of the document discusses the importance of maintaining accurate records and the role of the board in overseeing these operations.

It is noted that the board has a duty to ensure that all financial transactions are properly documented and that the accounts are kept up to date.

The document further outlines the responsibilities of the board members, including the requirement to act in the best interests of the organization.

In conclusion, the board is urged to continue its diligent oversight and to ensure that all members are held to the highest standards of conduct.

The second part of the document addresses the financial performance of the organization over the past year.

It is reported that the organization has achieved a significant increase in revenue, which has allowed for the expansion of its services.

However, it is also noted that there have been some challenges in managing expenses, and the board is working to address these issues.

The document concludes with a statement of confidence in the organization's future and a commitment to transparency and accountability.

(Suomennos)

(Sopimuksessa mainitut liitteet säilytetään ulkoasiainministeriössä)

## Suomen ja Intian hallitusten välinen

### SOPIMUS

#### teknillisen avun antamisesta Intialle

Suomen Eduskunnan asetettua Suomen hallituksen käytettäväksi varoja yhteistyötä varten Intian tasavallan kanssa metsätalouden ja metsäteollisuuden edistämiseksi alempana esitetyllä tavalla, ja

koska Suomen ja Intian hallitukset uskovat tällaisen yhteistyön vahvistavan Suomen ja Intian välisiä ystävyysiteitä,

Suomen ja Intian hallitukset ovat päättäneet solmia edellämainittua tarkoitusta varten sopimuksen.

#### 1 artikla

1. Valmistavien toimenpiteiden tultua loppuunsaatuiksi, Suomen hallitus antaa Intialle apua tämän sopimuksen määräysten mukaisesti ja käytettävissä olevien varojen asettamissa rajoissa lähettämällä kaksi asiantuntijaa Beas-joen alueelle sekä olosuhteiden sallissa ympäröivien alueiden havupuumetsiin tutkimaan ja selvittämään metsäteollisuuslaitosten perustamismahdollisuuksia sekä raaka-aineen hankintaa.

2. Suomen hallitus asettaa Intian hallituksen käytettäväksi neljä 400 000 markan suuruisia apurahaa metsätalouden ja metsäteollisuuden opintoja varten Suomessa, ei kuitenkaan 12 kuukautta pitemmäksi ajaksi. Apurahat annetaan Intian hallituksen valitsemille ja Suomen hallituksen hyväksymille henkilöille.

#### 2 artikla

1. Edellämainittujen tarkoitusten edistämiseksi Suomen hallitus sitoutuu seuraavaan:

## AGREEMENT

### between the Government of Finland and the Government of India on Technical Assistance to India

Whereas the Parliament of Finland has placed at the disposal of the Government of Finland funds to co-operate with the Republic of India for promoting forestry as specified hereinafter, and

Whereas the Governments of Finland and India believe that such co-operation will strengthen the ties of friendship between Finland and India,

The Governments of Finland and India have decided to conclude an agreement for the above purpose.

#### Article 1

1. Within the terms of this agreement the preliminary arrangements being terminated and subject to the funds made available, the Government of Finland will furnish assistance to India in the form of sending two experts to the area of river Beas and also if the existing possibilities allow, to the conifer forests of the surrounding regions, to study and ascertain the possibilities of setting up forest industries and the supply of raw material.

2. The Government of Finland shall place at the disposal of the Government of India four fellowships 400 000 marks each for studies in forestry in Finland for a period not exceeding 12 months. The fellowships shall be given to persons selected by the Government of India subject to the approval of the Government of Finland.

#### Article 2

1. In furtherance of the aforementioned purposes the Government of Finland agrees to the following:

- a. maksamaan kahden asiantuntijan palkat,
  - b. maksamaan asiantuntijain matkat palvelukseenotto paikalta maahantulopaikkaan vastaanottavassa maassa ja takaisin,
  - c. maksamaan kaikki Suomen lähettämien asiantuntijain vakuutuskustannukset,
  - d. maksamaan suunnitelman toteuttamisesta Suomessa aiheutuvat kustannukset,
  - e. Suomen hallitus voi suorittaa asiantuntijan vaimon matkakustannukset, mikäli tämä seuraa aviopuolisoaan Intiaan kuuden kuukauden pituiseksi vähimmäisajaksi, edellyttäen, että asiantuntijan tosiasiallinen palvelusaika Intiassa ylittää kuusi kuukautta.
2. Edellämainittujen tarkoitusten edistämiseksi Intian hallitus sitoutuu seuraavaan:

- a. ollessaan virkamatkalla asiantuntija nauttii samaa kohtelua kuin Intian hallituksen I asteen virkamies ja hänelle suoritetaan joko 15:00 tai 12:50 rupian suuruinen „päiväraha” riippuen asiantuntijan oleskelupaikkakunnalla sovellettavasta asteikosta, sekä „matkakorvaus”, joka vastaa tosiasiallista ensimmäisen luokan juna- tai lentolipun hintaa, sekä junamatkan ollessa kysymyksessä 12 pies’in suuruinen korvaus maililta tai lentomatkan ollessa kysymyksessä 1/5 lentolipun tosiasiallisesta hinnasta peittämään matkan aiheuttamat satunnaiset kustannukset,
- b. joko huolehtimaan asiantuntijain kuluksesta tai suorittamaan virantoimituksesta aiheutuvat kuljetuskustannukset (autokorvaus mukaanluettuna asiantuntijan käyttäessä omaa autoaan virkakäyttöön ja keskimääräisen maililuvun ylittäessä kuukaudessa 300); matkoja asunnon ja toimipaikan välillä ei katsota virkamatkoiksi,
- c. antamaan omalla kustannuksellaan asiantuntijain käytettäväksi asianmukaiset toimitilat ja välineet,
- d. (i) asettamaan käytettäväksi paikallista teknillistä ja hallinnollista henkilökuntaa samoin kuin työvoimaa asiantuntijain tehtäviensä suorittamiseksi tarvitsema toimisto-henkilökunta ja sihteerit sekä muu apu mukaanluettuna,
- (ii) suorittamaan virallisesta yhteydenpidosta aiheutuvat kulut, puhelinmaksut ym.,
- e. hankkimaan mahdollisesti tarvittavia varusteita.

- a. to pay the salaries of the two experts,
  - b. to pay the travel of the experts from their place of recruitment to the point of entry into the recipient country and vice versa,
  - c. to pay all the costs of any insurance provided for the experts sent by Finland,
  - d. to pay the expenses arising from the implementation of the plan in Finland,
  - e. the Government of Finland may cover the travel expenses of the expert's wife in case she accompanies her husband to India for a minimum stay of six months provided the actual duration of the expert's service in India exceeds six months.
2. In furtherance of the aforementioned purpose the Government of India agrees to the following:

- a. While on official tour the experts will be treated as First Grade Officers of the Government of India and will receive „daily allowance” at the rate of Rs. 15:00 or Rs. 12:50 depending on the rate applicable to the station where the expert stays and „travelling allowance” equal to the actual first class rail or air fare plus an allowance at the rate of 12 pies per mile in case of rail travel or 1/5th of the actual air fare in case of air travel, to cover the incidental expenses connected with the journey,
- b. the Government of India will either provide transport or bear the cost of transportation on duty (including a car allowance where the expert uses his own car for official purposes and the average minimum monthly mileage exceeds 300); trips between residence and office will not be regarded as transport on duty,
- c. to provide to the experts, at its own expenses, adequate office facilities and equipment,
- d. (i) to provide local personnel services, technical and administrative as well as labour and including clerical, secretarial or other assistance required by the expert to enable him to carry out his duties,
- (ii) to pay the cost of official communications, telephone, etc.,
- e. to provide such equipment as may be needed.

## 3 artikla

Intian hallitus korvaa ja vapauttaa Suomen hallituksen ja sen asiantuntijat kaikista vastuuvaatimuksista, kanteista, vaatimuksista, vahingoista, kustannuksista tai maksuista, jotka johtuvat kuolemantapauksesta, henkilön loukkaantumisesta tai omaisuuden vahingoittumisesta tai kaikista muista menetyksistä, jotka aiheutuvat välittömästi tämän sopimuksen edellyttämän virantoimituksen aikana tapahtuneista teoista tai laiminlyönneistä tai ovat yhteydessä niihin.

## 4 artikla

1. Asiantuntijat ovat vapautetut maksamasta Intian tuloveroa.

2. Asiantuntijat saavat tavallisten matkatavarasääntöjen sallimien tullivapaiden tavaroiden lisäksi tuoda maahan tullia maksamatta liitteessä I mainitut koti-irtaimistoon ja ammattivälineistöön kuuluvat esineet (mukaanluettuna henkilökohtaiseen käyttöön tarkoitettu auto) sillä ehdolla, että nämä esineet viedään takaisin, kun asiantuntijat tehtävänsä päätettyään lähtevät Intiasta, ja että asiantuntijat, mikäli joku näistä esineistä luovutetaan Intiassa, suorittavat Intian hallituksen tai muun viranomaisen maksaman tullin takaisin.

Tällaisten esineiden tulliselvitys tapahtuu siten, että Suomen hallitus huolehtii siitä, että asiantuntijat täyttävät liitteessä II mainitun todistuslomakkeen, ja lähettää sen neljänä kappaleena finanssiministeriölle (talousasiainosasto), joka lähettää tarvittavat kappaleet asianomaisille tulliviranomaisille, kehoittaen näitä sallimaan tavaroiden maahantuonnin vaatimatta asiantuntijoilta niistä muuten maksettavaa tullia ja asettamaan tällaisen tullin finanssiministeriön (talousasiainosasto) maksettavaksi.

## 5 artikla

1. Intian hallitus antaa sopivan, asianmukaisesti kalustetun asunon Intian hallituksen I asteen virkamiehiin nähden voimassa olevan asteikon mukaan tai milloin tämä ei ole mahdollista, suorittaa 15 rupian suuruisen päivittäisen vuokratukustannuskorvauksen (vuokratorkaus). Kysymykset „sopiisuudesta” ja kalustuksen „asianmukaisuudesta”

## Article 3

The Government of India shall indemnify and hold harmless the Government of Finland and their experts against any and all liability suits, actions, demands, damages, costs or fees on account of death, injuries to person or property, or any other losses resulting directly from or connected with any act or omission in the course of performance of official duty under this Agreement.

## Article 4

1. The experts shall be exempt from payment of Indian Income tax.

2. In addition to the duty-free concessions available under the normal Baggage Rules, the experts will be permitted to import without having to pay Customs Duty thereon, certain Household and Professional effects (including one personal automobile) mentioned in Annexure I on the condition that these articles will be exported back when the experts leave India on completion of their assignments and if any of these articles are disposed of in India, Customs Duty originally paid by the Government of India or other authorities concerned will be refunded to them by the experts.

The procedure for clearance of such articles from Customs will be that the Finnish Government will have the certificate at Annexure II executed by the experts and forward it in quadruplicate to the Ministry of Finance (Department of Economic Affairs) who will forward necessary copies of it to the concerned Customs Authorities asking them to pass the goods without charging the customs duty payable thereon from the experts and raise the necessary debit on account of such duty against the Ministry of Finance (Department of Economic Affairs).

## Article 5

1. The Government of India shall provide suitable accommodation appropriately furnished on the scale laid down for First Grade Officers of the Government of India or if that is not possible, pay a contribution towards rent (rent allowance) of Rs. 15: 00 per day. Questions of „suitability” and the „appropriateness” of furnishing are to be

desta" ratkaistaan kussakin tapauksessa molempien hallitusten edustajien kesken. Milloin vuokratörvaus suoritetaan asiantuntijalle hänen toimipaikassaan, tämä suoritetaan hänelle silloinkin, kun hän on virkamatkalla, sairauslomalla tai säännönmukaisella lomalla.

2. Intian hallitus antaa asiantuntijoille samaa lääkintähuoltoa ja sairaalahoitoa kuin Intian hallituksen I asteen virkamiehille.

#### 6 artikla

Intian hallitus ryhtyy kaikkiin tarkoituksenmukaisiin toimenpiteisiin helpottaakseen asiantuntijain toimintaa ja auttaakseen asiantuntijoita saamaan sellaista apua ja sellaisia helpotuksia, joita heidän tehtäviensä suorittaminen voi vaatia.

Asiantuntijain työn edellyttämät kokeet suoritetaan Intian hallituksen kustannuksella.

Tämä sopimus, joka tulee voimaan 14 päivänä kesäkuuta 1957, on tehty kahtena englanninkielisenä kappaleena New Delhissä 14 päivänä kesäkuuta 1957.

Suomen Tasavallan hallituksen puolesta:

*Aaro Pakaslahti*

Intian Tasavallan hallituksen puolesta:

*H. M. Patel*

decided in each case between representatives of the two Governments, when rent allowance is payable to an expert at his headquarters, this will continue to be paid to him while on tour, on sick leave, or on ordinary leave.

2. The Government of India shall provide for medical care and hospitalization of experts as for First Grade Officers of the Government of India.

#### Article 6

The Government of India will take all practicable measures to facilitate the activities of the experts and to assist the experts in obtaining such services and facilities as may be required to carry on those activities.

The experiments necessitated by the expert's work will be carried out at the expense of the Government of India.

This Agreement, which enters into force 14th day of June 1957, has been done in two English copies at New Delhi, this day of 14th June, 1957.

For the Government of the Republic of Finland:

*Aaro Pakaslahti*

For the Government of the Republic of India:

*H. M. Patel*

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