EXPANDED TECHNICAL ASSISTANCE PROGRAM

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Report to the
Government of

INDIA

INTEGRATION OF FORESTS AND FOREST INDUSTRIES

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

ROME, 1961

Report No. 1298 Project No.IND/FO

REPORT

to the

GOVERNMENT OF INDIA

on

INTEGRATION OF FORESTS AND FOREST INDUSTRIES

Skeleton

of a

Forestry and Forest Industries Development Program

under India's Five-Year Plans

by

J.A. von Monroy

Rome, 1960

-L-8333

Note

This report deals only with the basic aspects of forest industrial planning for India as a whole and modern technical methods of implementation.

For statistical data the writer refers to the Indian Timber Trend Study, 1958, which is still valid.

More detailed schemes (pre-projects) for the individual States are under preparation; they can only be completed when the results of the raw material tests, initiated by various States and organized by the writer while in Europe, are available.

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INTRODUCTION

In accordance with the technical assistance agreement between the Government of India and the Food and Agriculture Organization of the United Nations, the writer, J.A. von Monroy, was assigned to India to:

> " advise the Government on the development and integration of forest industries, the assessment of existing and potential resources for this purpose and on technical and forest implications for meeting the growing requirements of the country under the aspects of an expanding economy."

The writer arrived in India on 2 May 1959 and left the country on 5 May 1960.

The assignment was requested by the Government for one year; it was intended primarily - as indicated by the Inspector General of Forests - for the collection of basic information and for formulating the principles of an integrated forest industrial development program under India's Five-Year Plans. A second assignment at a later stage was anticipated for preparing detailed schemes and assisting in the phase of implementation after the principles, summarized in the first report, have been scrutinized and accepted by the Government.

Methods of approach and working details were established after the writer's arrival in the country by the Inspector General of Forests, Shri G.G. Takle, and approved by the Secretary, Ministry of Food and Agriculture.

The writer's headquarters were partly in New Delhi for co-operation with the government authorities concerned and partly at the Forest Research Institute, Dehra Dun, for the exchange of views on technical matters.

Nearly 80% of the whole period was spent on tour, visiting all States and territories (except Andaman Islands, Manipur and Tripura) as well as major forest industries for the collection of first-hand information.

The writer wishes to express his sincere gratitude to all government authorities and Indian officers who contributed to his work by guidance and advice, especially to:

Shri G.G. Takle,
Inspector General of Forests (during the last period of his service);

Shri R.C. Soni,
Deputy Inspector General of Forests;

Shri R.N. Datta,
President, Forest Research Institute, Dehra Dun, and his staff;

Shri C.A.R. Bhadran,
Chief Conservator of Forests, Madras, formerly editor of the Indian Timber Trends Study, who contributed greatly to the program of work and to the checking of results;

Shri P.S. Lokanathan,
Director General, National Council of Applied Economic Research, and his staff (Shri V. Kannan kindly acted as liaison officer);

The Forest Departments of all States;

Shri B.N. Prasad,
Senior Research Officer, Forest Research Institute, Dehra Dun, who accompanied the writer to all parts of the country and placed his wide experience at the writer's disposal.

Last but not least, sincere thanks are also extended to Shri L.C. Bhargava, designated by the Forest Research Institute, Dehra Dun, as secretary during the whole period of the writer's assignment. His reliability and enthusiasm were greatly appreciated.

OBJECTIVE AND APPROACH

The Indian Timber Trends Study, based on the 1953-55 situation, is summed up in the following statement* :-

> "Per capita requirement of roundwood is expected to go up by 18% from 1953/55 to 1975, but meanwhile the supply tends to dwindle down by 23%. ---- How will the gap between demand and supply be closed?"

In the last session of the Asia-Pacific Forestry Commission, held in New Delhi (February, 1960), FAO presented the findings for the region as a whole as well as for the sub-regions. According to this report** the requirements of industrial wood in 1975 for South Asia are expected to reach 230% on the basis of the 1953/55 consumption level. India's position within this regional trend is accentuated by the present rate of extreme under-consumption and the rapid progress of industrialization.

The objective of the present study, as determined by discussions with the Inspector General of Forests, may be outlined as follows:

- Analysis of requirements in all major fields of forest produce for the period 1960 - 1975 (with indications up to 1985);
- Assessment and classification of conventional and new sources of raw material, suitable for various groups of requirements;
- Indication of improved techniques for processing these raw materials and increasing forest production along modern lines.

The methods of approach consisted of:

- On-the-spot discussions with the Forest Departments of 14 States to assess present and potential supplies according to types, quantity and costs;
- Interviews with industrial organizations and representatives of end consumers to investigate requirements;
- Survey of present production techniques by discussions with the technical branches of the Forest Research Institute, Dehra Dun, and visits to industrial plants for checking the possibilities for major improvements.

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*) See FAO/ECAFE Timber Trends Study for the Far East; Country Report for India, by the Inspector General of Forests, Government of India, 1958, page 72.

**) See Timber Trends and Prospects in the Asia-Pacific Region; FAO, 1960; Part G, page 7.

The wealth of information and data collected all over the country goes far beyond the limits of this first report; it will serve as a guide for the implementation phase. The present report should, therefore, be considered only as a summary, suggesting the major lines of future development to enable decisions to be made on matters of principle.

Two important points should be clarified at this stage:-

1. Statistics

Forest and forest industries statistics are, up to the present, inadequate. Forest statistics, compiled by the office of the Statistical and Economic Adviser to the Ministry of Food and Agriculture, are based on reports of the States. The forest departments, however, are short of staff and the data are usually not sufficiently checked. They are received at the Ministry with a delay of two years and more. A re-organization of the statistical service right from the bottom is imperative for the ensuring of punctual, reliable data, which can serve for economic planning.

Regarding forest industries, adequate data exist only for the larger types (plywood, matches, pulp and paper). For sawmills and cottage industries no statistics are at present available.

For the present study, these gaps had to be filled, as far as possible, by collecting data on the spot.

2. Basic Assumptions

Forest industrial planning forms only a part of overall economic planning. In this report the following general economic trends have been assumed as indications of the extent of future expansion:-

	1955	1960	1965	1970	1975
Population * (million)	386	417	456	504	563
National income per capita (Rs.)	280	320	380	415	520
Coal production (million tons)	38	55	75	90	100
Finished steel (million tons)	1.3	4.3			
Cement (million tons)	4	13			
Generated power (million Kwh)	8,000	13,000			
Total requirements of energy (in million tons coal equivalent)	131	152	190	240	316

*) See "The Future Growth of World Population", United Nations, Department of Economic and Social Affairs, New York, 1958. (Population Studies No. 28) Medium assumptions.

CONCLUSIONS

1. India's present requirements of industrial wood amount to 4.5 million tons; for 1975 the requirements are estimated at 9.5 million tons and will reach 12 million tons in 1985. (Details see Table 1.)

Requirements and supplies are at present still balanced, to a certain extent, for the country as a whole. Signs of acute shortage, however, may be noticed in various areas and for specific types of industrial wood (matchwood, packaging material, coniferous sawnwood, etc.), resulting in an increase of price level which is at present, in consumption centers, already 50% higher than in Central Europe.

Due to the growth of population and economic expansion, requirements of industrial wood will double by 1975, whereas supplies are likely to increase at the most by 20%, leaving a gap of about 4 million tons in 1975 and 7 million tons in 1985. By the end of the century the gap will reach at least 10 million tons per year.

Supplies of industrial wood are currently derived about 70% from recorded and 30% from unrecorded sources. Unrecorded supplies are tending to decrease at a fast rate and will amount to about 15% only in 1975.

2. Fuelwood requirements - 95% for cooking - are estimated at 60 million tons (i.e. nearly 12 times the amount of industrial wood), and for 1975 at 100 million tons if partial substitution of cowdung by fuelwood will be taken up during this period.

Eighty-five percent of present requirements of fuelwood are derived from unrecorded sources, which will tend to deplete in many parts of the country, unless properly restocked.

3. The situation of "minor forest products", a very important item in India, may be characterized by a few examples:-

a) Tanning material: Present requirements about 30,000 tons of pure tannin. Supplies - about 10% from recorded, 60% from unrecorded sources, and up to 30% from imports. Anticipated increase of demand by 1975: not considerable, due to shortage of hides. But improvement of the pattern of supply by an increase of recorded production is indispensable.

b) Rosin: Till recently partly exported; at present requirements and production more or less balanced; expected gap in 1975 - about 30,000 tons.

c) Medicinal plants: In spite of present favourable ecological conditions, imports required are still around 15 million Rs. This gap can be filled by 1970 by plantations.

d) Essential oils: Distinct export commodities (value of exports about 35 million Rs.). Export capacity can be tripled by 1975.

Table 1

SUMMARY

Estimate
of the present and potential requirements
of
INDUSTRIAL WOOD
- according to major groups -
Period 1960-1975

Groups	1960	1965	1970	1975
	-- In 1,000 tons of round wood -- (50 cft each)			
1. Building Material				
(a) Timber	1,800	2,150	2,400	2,750
(b) Plywood and boards	60	180	310	570
Total	1,860	2,330	2,710	3,320
2. Mining	360	420	570	720
3. Transport and Communication	740	825	900	765
4. Woodworking Industry	400	456	513	595
5. Packaging	380	490	600	710
6. Pulp and Paper	40	120	250	1,100
7. Rayon	-	400	600	800
8. Matches	150	190	220	260
Total: Major requirements	3,930	5,231	6,363	8,270
Minor requirements (cottage industries, handicraft, etc.) 15% of total	590	785	954	1,240
GRAND TOTAL	4,520	6,016	7,317	9,510

Balance of Requirements and Supply
of
INDUSTRIAL WOOD

	1960	1965	1970	1975	1985
	-- In million tons (50 cft each) --				
Requirements	4.5	6.0	7.3	9.5	(12)
Supply : Recorded	3.1	3.5	4.0	4.5	(5.0)
Unrecorded	1.2	1.0	0.8	0.7	(0.7)
	4.3	4.5	4.8	5.2	(5.7)
Balance	- 0.2	- 1.5	- 2.5	- 4.3	(-6.3)

RECOMMENDATIONS

General

As previously indicated, India will be confronted, within a relatively short period, with an acute shortage of industrial wood and several other essential forest products. Since wood is a basic raw material for every developing economy, a gap of this magnitude and at this stage of expansion may seriously affect India's overall development programs. Every possibility should be explored to overcome this critical situation.

Fortunately, modern silvicultural and industrial techniques, if closely coordinated, offer ways and means of gradually solving India's problems, provided action on a high level is taken without delay.

India has a hundred years old forest tradition and is famous for having specialized in the production of valuable but rather slow-growing timbers, such as teak and sal. The fact that, in the modern world, forests should be fully integrated as a basic asset into the context of a developing national economy with its fast increasing and strongly differentiated requirements has, however, not yet been sufficiently realized.

Conservation of resources - similar to the situation in Europe some decades ago - is still the leading principle, whereas an expanding economy, on the eve of modern industrialization, requires the highest tonnage of production of organic raw material within the shortest possible period and at the lowest possible costs.

Similar difficulties apply to forest industries; these have mostly been established by chance without overall planning.

A considerable problem is the fact that there has been, up to the present, no high-level body for the integrated planning of forestry and forest industries from the national viewpoint and for checking and guiding all phases of development.

Details

The recommendations for solving India's forest industrial problems within the period under view may be summarized as follows :

1. Intensification of production

India's forest production does not exceed, at present, 0.1 ton per acre and year. There are, however, considerable areas of very high productivity where 3, 5, 7 and even 10 tons per year can be produced in short rotations by careful selection of sites and plantation of f a s t - g r o w i n g s p e c i e s. Details of implementation were discussed during the visits to the States, at the Ministry of Food and Agriculture and the Forest Research Institute, Dehra Dun.

It is strongly suggested to select 1.5 million acres (i.e. about 1% of India's forest area) in the most productive zones, and to plant, during a period of 10 years, 150,000 acres every year with fast-growing species under a modern system of intensive management. Assuming an annual increment of 3 tons only, at least 4.5 million tons of additional uniform industrial raw material would be available from 1975 on.

Successful i m p l e m e n t a t i o n of this basic scheme requires, before establishment :

(a) careful selection of areas (including ecological analysis);

(b) selection of species with regard to the uses under view;

(c) tentative location of the industrial sites, including power, transportation lines, availability of water, labour, etc.;

(d) arrangements for most intensive management, based on an administrative unit (Forest Division) of not more than 25,000 acres.

The productive capacity of this scheme, although confined to 1% of India's total forest area, would double the quantity of India's present production of industrial wood. Marketing is no problem as plantations and industries have been integrated in advance.

2. Development of the hill forests

The second most important possibility for increasing supplies is the integrated development of the Himalayan coniferous forests. This problem has been studied for decades, but only now has the stage been reached where it can be tackled successfully since :

(a) demand has greatly increased;

(b) major communication lines are under construction or will be built in the near future;

(c) techniques for developing mountain forests have reached a high degree of perfection;

(d) two forest officers have recently been trained in Switzerland in modern logging techniques. They could organize and guide the pilot schemes, assisted by the logging instructors trained under the FAO/Swiss scheme some years ago.

As four States (Punjab, Himachal Pradesh, Uttar Pradesh, Jammu and Kashmir) are concerned with the same problem, it is suggested to concentrate efforts.

The following procedure is recommended :

(1) All four States should participate in a joint venture for more thorough development of the hills.

(2) Each State should appoint a State Logging Officer to deal with all problems of logging techniques, increase of production and reduction of waste.

(3) The mechanized units, at present operating in Kashmir, could serve as the first pilot scheme, to be sponsored by funds from the Central Government and available to each State for training.

(4) Within two years, each State should have its own unit to be worked departmentally for adjustment of techniques, collection of data, and to convince contractors to purchase similar equipment for their own use. Terms of auctioning standing timber should be adjusted in such a way that the purchasing of modern equipment becomes profitable to private parties.

(5) Government units should be operated on a semi-commercial, flexible basis. Technical development, training and evaluation of results may be guided by the officer in charge, Logging Branch, Forest Research Institute, Dehra Dun.

Owing to the importance of this problem, requests for international aid (e.g. from the U.N. Special Fund for Economic Development, or other organizations) may have good prospects, provided a basic organization as indicated has been set up meanwhile.

3. Improved utilization of low-grade timber

A point of similar importance is the improved utilization of non-commercial species and low-grade timber by simple means. A striking example is the scavenging units in Andhra Pradesh, which convert low-grade timber into uniform sizes for economical extraction right in the forest with mobile equipment. These timbers are collected at a central plant for re-processing, including seasoning and preservation when required. By modern methods (finger-jointing with synthetic resin), such short-length timbers can be converted without loss of strength into endless products of very great length, which can then be cut as desired.

In the case of low-grade teak (e.g. Rajasthan), this system would be highly economical and such products could even find an export market.

It is suggested to establish in every State at least five of such units, similar to the plant in Andhra Pradesh, supplemented by equipment for converting short-length timbers into commercial products.

4. Substitution of timber by large-sized boards

One of the reasons for recommending plantations of fast-growing species, intensively managed, on 1% of India's forest area arose from the necessity to produce on a large scale various types of boards, suitable for replacing timber in many fields of construction. An amount of 450,000 tons of raw material from such plantations has been earmarked for 1975 for this purpose, supplemented by 200,000 tons of forest and agricultural waste and 50,000 tons of reeds (in total, 700,000 tons)

This program is indispensable for compensating to a large extent the future shortage of solid timber. Present production is still negligible.

It is further suggested to develop, at an early stage, application techniques for these new products to ensure most economical usages under Indian conditions.

5. Substitution of timber by inorganic products

In most fields where wood is used at present, it will also be an indispensable commodity in the future. There are, however, certain fields where it might be replaced by other products :

Railway sleepers, for instance, are already produced in many countries with good results from pre-stressed concrete. (In Western Germany, 50% of all new sleepers are from this material.) In the estimate for 1975, it has been assumed that about half of the sleeper requirements may be met by this material since cement and steel will be sufficiently available in future.

6. Ensuring pulp and paper requirements

Paper requirements (including cardboard and newsprint) are estimated to increase from 450,000 tons at present to about 2.1 million tons in 1975. To ensure raw material for such quantities, a fundamental change in the pattern of raw material supply and adjustment of techniques in new mills is needed. Experience in many parts of the world has proved that commercial writing paper and newsprint can be produced from 80% hardwoods and only 20% of long-fibre raw material. In the case of newsprint, about 30% of long-fibre pulp is required. (Example: Newsprint factory at Khulna, East Pakistan: daily capacity 100 tons.)

Raw material supply: One million tons of fast-growing hardwoods have been earmarked for 1975 as raw material for paper and 0.6 million tons for dissolving pulp. Up to 0.6 million tons have been reserved for substituting wood by modern cardboard products in case of a shortage in packaging (total 2.2 million tons).

It is recommended that, in planning new pulp or paper factories, the selection of industrial sites and location of plantations should be thoroughly coordinated.

Higher yields: In India, bamboo is being processed by conventional methods with a yield of 45% unbleached and 38-40% bleached. With high-yield methods, yields up to 75% can be reached for unbleached and 55-60% for bleached pulp. In the case of hardwoods, the yields of bleached pulp are still higher.

It is suggested that in issuing industrial licences efficient use of raw material should be considered as an important point.

Dissolving pulp: As a general rule, long-fibre raw material should primarily be reserved for expansion of the paper program, whereas for dissolving pulp in the first place hardwoods should be used. Yields in the case of bamboo are reported to be about 25%, in the case of hardwoods 33-35%.

7. Economizing fuelwood consumption

Ninety-five percent of the fuelwood requirements are intended for cooking. Efficiency is mostly less than 10%. By the improvement of kitchen stoves under FAO guidance, efficiency has been raised to 25% and more, resulting in a reduction of fuel consumption by 50%.

It is recommended to popularize these improved kitchen stoves by incorporating this item into the Community Development Program for action in all rural areas where there is a shortage of fuel.

8. Encouragement of small-scale and cottage industries

Most forest products (a great number of wood species, bamboos, canes, grasses, medicinal plants, essential oils and even certain leaves) are eminently suited for creating additional employment in rural areas. This field is so vast that only after a thorough survey of the existing cottage industries can it be determined which additional lines of production should be taken up and what prospects they offer in the domestic market and for export.

India lacks a number of important raw materials, available in the Far Eastern countries, on which additional cottage industries could be based. By selection of suitable sites and plant introduction, most of these plants could also be made available to India, e.g.

High-class canes:

The medium-thick "Manila-Type", superior for light furniture (available in Celebes and parts of the Philippines).

The thick, spotted "Manaw-Type", for heavier furniture (available mainly in Malaya).

Bamboo specialities:

The light yellow type for interior decoration (available in Taiwan).

The spotted type for ornamental purposes (reported to be available in Korea and Japan).

The solid type, replacing cane for cheaper products (available in Cambodia).

It is recommended for the fostering of additional cottage industries, based on forest products :

- to conduct a survey of existing units with regard to employment, lines of production, type and supply of raw material;
- to enrich the Indian resources of raw material for cottage industries by plant introduction;
- to request technical assistance from countries known for efficient production (Japan) and from areas open for imports (Europe, Nord America), for developing highly marketable . . products.

Implications

Implementation of this basic development program requires :

(a) An organization with authority to coordinate forest and industrial planning, check requirement trends, ensure raw material supply, and to guide the development in all phases of implementation.

(b) Adequate allocation of funds for surveys, preparation of projects, pilot schemes, plantation programs and industrial investments, unless covered by the private sector.

(c) Intensified research in the fields of:

Silviculture: Classification of forest areas with a view to determining areas of highest production capacity to be earmarked for the fast-growing plantation scheme; selection of the most suitable species (including import of seed).

Utilization: Classification of the raw material according to economic availability and suitability for various industrial uses; development of application techniques for new products not sufficiently known in India.

Economics: Analysis of costs, prices and other basic factors in areas proposed for implementation of projects; marketing studies for new products.

(d) Programming requests for international aid and technical assistance:

Pre-investment surveys.
Pilot schemes.
Assistance in planning, implementation and integration of high priority projects.

A. CHARACTERISTICS OF FORESTS AND FOREST INDUSTRIES IN INDIA

1. General

Since forest industrial planning should be integrated into the overall economic pattern of the country, a few basic data may precede:

Population (estimate 1960): 415 million

Geographical area (in 1,000 sq.miles): 1,266.9

Topographical indications:
Percentage of total area -

Mountains (6,000ft.and more)	11 %
Hills (up to 6,000ft)	18 %
Plateaux	28 %
Plains	43 %

Estimated distribution of rainfall:
More than 50 inches per year -
on about one-third of the total area;
30 - 50 inches per year -
on about one-third of the total area;
Less than 30 inches per year -
on about one-third of the total area.

Sources of national income (see Table 2).

Classification of land use in India (see Table 2).

India in the context of world economy: (World - 100)

Population	15 %
Cattle population	20.2 %
Land area	2.4 %
National income	3 %
Railways (number of locomotives, coaches, wagons)	4-5 %
Trucks	0.7 %
Motor cars	0.3 %

2. Forests

India's forest area - according to States is shown in Table 3. Distribution of broad forest types has been estimated as follows :

Temperate		Tropical	
Coniferous	3%	Evergreen	12%
		Diciduous	80%
Broadleaved	4%	Others	1%
	7%		93%

The classification of forests - according to the pattern used by Indian Forest Statistics - is summarized in Table 4; development of recorded production (industrial wood and fuelwood) and its distribution according to States in Tables 5 a - c.

It is striking that the coniferous forests of the hills represent only 3 % of the total forest area but supply nearly 25 % of the timber output (including roundwood).

About 75 % of all revenue is raised from timber and fuelwood, 25 % from minor forest products. (About 20 million buffaloes, cows and bullocks are grazing in the forests.)

The economics of Indian forests in comparison with the situation in technically higher developed countries (Central Europe) are shown in Table 6.

This comparison should serve as a guide for assessing the possibilities for future development.

Two facts require special consideration:

a) The relatively low outturn and - as a consequence - the very modest net profit per acre; this, in spite of a considerable percentage of valuable timbers (teak) and the comparatively high prices of industrial wood at the consumers end.

b) The extremely low contribution of forestry to the national income (forestry 0.6 %, agriculture 50.2 %). The fact that agriculture (net sown area) covers nearly 40%, forestry 22 % of India's total area, explains the necessity to re-orientate forestry towards intensification and closer integration into the expanding industrial economy.

Forest industries.

Development of forest industries in India is still unbalanced. Chemical utilization of forest products (paper)has made remarkable progress; the same is true for match production and tea-chest plywood. Also timber seasoning and preservation have advanced quite fast due to the activity of the Forest Research Institute, Dehra Dun, and the necessity to economize wood as much as possible due to rising prices.

Sawmilling, however, is still in its infancy and great quantities of timber are wasted every year through old-fashioned methods of conversion. In the hill forests with coniferous timber, hand-sawing is still the rule and will continue till extraction is fully reorganized. The system of sawing is closely linked with the system of logging, and only by construction of roads on a large scale can these great losses gradually be reduced.

I. TABLE 2.

SOURCES OF NATIONAL INCOME - 1950/1951

1. Agriculture		51.3 %
Farming	50.2 %	
Forestry	0.7 %	
Fisheries	0.4 %	
2. Mining, Industry, Handicraft		16.1 %
Mining	0.7 %	
Industry	5.8 %	
Handicraft	9.6 %	
3. Commerce, Transport, Communication		17.7 %
4. Other Services		15.1 %

II.

CLASSIFICATION OF LAND USE IN INDIA - 1955/1956 in 1000 acres

	Total	%
Land put to non-agricultural uses	32.614	4
Net sown area	317.981	39.4
Fallow	60.414	7.5
Forests	179.773	22.3
Barren and uncultivable waste	85.054	10.6
Pastures and culturable waste	130.434	16.2
Total land	806.270	100 %

TABLE 3

FOREST AREA

- according to States and Territories -

State or Territory	Reserved Forests	Unreserved forests	Forest Area Total
	..... sq.miles		
Andhra Pradesh	15,508	8,582	24,090
Assam	6,256	11,068	17,324
Andamans	2,080	373	2,453
Bihar	1,491	11,797	13,288
Bombay	17,577	14,534	32,111
Delhi	4	10	14
Himachal Pradesh	636	3,415	4,051
Jammu and Kashmir	8,057 (demarcated)	2,520	10,577
Kerala	3,493	1,293	4,786
Madhya Pradesh	30,439	36,036	66,475
Madras	8,267	-	8,267
Manipur	338	1,987	2,325
Mysore	11,168	2,405	13,573
Orissa	8,568	16,017	24,585
Punjab	216	5,633	5,849
Rajasthan	2,309	14,672	16,981
Tripura	1,200	1,247	2,447
Uttar Pradesh	8,238	7,085	15,323
West Bengal	2,668	1,756	4,424
Total (in sq.miles)	128,513	140,430	268,943
	..... In terms of acres		
	82,248,320	89,875,200	172,123,520
	..... In terms of hectares		
	33,284,867	36,371,370	69,656,237

TABLE 4.

CLASSIFICATION OF FORESTS *

- situation 1955/56-

1. From the outturn point of view			
a) Merchantable dedicated to timber production		125,631	sq.miles
Other forests		89,508	" "
		215,139	" "
b) Inaccessible		53,562	" "
	Total	268,701	" "
2. By legal status			
Reserved		138,791	sq. miles
Protected		64,911	" "
Unclassed		64,999	" "
	Total	268,701	sq. miles
3. By composition			
a) Coniferous		9,736	sq. miles
b) Broadleaved:			
Sal		40,449	" "
Teak		22,445	" "
Miscellaneous		196,071	" "
	Total	268,701	" "

* Source:
Indian Forest Statistics
(Agricultural Situation in India)
June 1959 (Provisional)

TABLE 5a

RECORDED PRODUCTION OF INDUSTRIAL WOOD *

	1949/50	1950/51	1951/52	1952/53	1953/54	1954/55	1955/56
	..... in million cft						
1. Timber							
a) coniferous	37	26	26	29	20	25	32
b) broad leaved	74	80	74	68	67	84	88
Total	111	106	100	97	87	109	120
2. Roundwood							
a) coniferous	1	11	16	4	3	3	2
b) broad-leaved	22	18	24	13	17	23	23
Total	23	29	40	17	20	26	25
3. Pulp and matchwood							
a) coniferous	-	-	-	-		-	-
b) broad-leaved	-	-	-	1	2	1	1
Total	-	-	-	1	2	1	1
GRAND TOTAL	134	135	140	115	109	135	146
	..... In terms of million tons (50 cft)						
	2.7	2.7	2.8	2.3	2.2	2.7	2.9
	..... In terms of million m^3						
	3.8	3.8	4	3.2	3	3.8	4.2

* Indian Forest Statistics 1949/50 - 1955/56.

TABLE 5b

RECORDED PRODUCTION OF FUELWOOD *

	1949/50	1950/51	1951/52	1952/53	1953/54	1954/55	1955/56
	in million cft						
1. Fuelwood							
a) coniferous	20	24	7	10	13	11	12
b) broadleaved	352	369	352	316	307	301	314
Total	372	393	359	326	320	312	326
2. Charcoal wood							
a) coniferous	2	2	1	-	-	-	-
b) broadleaved	27	26	18	8	8	66	56
Total	29	28	19	8	8	66	56
GRAND TOTAL	401	421	378	334	328	378	382
	In terms of million tons (50 cft)						
	8	8.4	7.5	6.6	6.5	7.5	7.6
	In terms of million m^3						
	11.4	12	10	9.5	9.3	10	10.9

* Indian Forest Statistics (1949/50 - 1955/56)

TABLE 5 c

INDICATION OF RECORDED PRODUCTION *

OF INDUSTRIAL WOOD AND FUELWOOD

- according to States and Territories -
(average 1955/56 - 1957/58)

State or Territory	Industrial wood	Fuelwood	Total
	In million cft		
Andhra Pradesh	5.0	13.0	18.0
Assam	7.7	9.0	16.7
Andamans	3.5	0.8	4.3
Bihar	3.8	14.0	17.8
Bombay	17.9	37.4	55.3
Himachal Pradesh	14.3	11.7	26.0
Jammu and Kashmir	20.8	2.0	22.8
Kerala	5.7	5.5	11.2
Madhya Pradesh	22.1	215.0	237.1
Madras	0.8	11.0	11.8
Manipur	0.3	0.8	1.1
Mysore	11.0	27.0	38.0
Orissa	12.4	10.0	22.4
Punjab	4.5	1.5	6.0
Rajasthan	2.0	13.1	15.1
Tripura	0.8	6.4	7.2
Uttar Pradesh	17.0	63.4	80.4
West Bengal	6.5	30.0	36.5
GRAND TOTAL	156.1	471.6	627.7
	In terms of million tons (50 cft)		
	3.1	9.4	12.5
	In terms of m3 (million)		
	4.5	13.4	17.9

* Based on provisional data supplied from the States and Territories.

Note: The above data should be considered as rough indications only, since the reports of the States do not specify to what extent posts, other small timber and charcoal have been included in the data, if collected free of charge. The actual production can be assumed on the average 10% higher for timber and 25 % for fuelwood; this balance is included in the estimate of unrecorded production.

TABLE 6.

ECONOMIC INDICATIONS

Comparison of India's present forest economic situation with the situation in Central Europe

1. Forest Area

per capita - acres -	India	Central Europe
	0.5	0.7

Ratio

1 : 1.4

2. Present Wood Consumption

per capita	India			Central Europe		
	Industrial Wood	Fuelwood	Total	Industrial Wood	Fuelwood	Total
	.....cft			.....cft		
Recorded	0.4	1.0	1.4	17.0	3.0	20.0
Unrecorded	0.2	5.0	5.2	0.5	1.0	1.5
	0.6	6.0	6.6	17.5	4.0	21.5

Ratio between per capita consumption of industrial wood and fuelwood

	India		Central Europe
Industrial wood	1	:	29
Fuelwood	1	:	0.6
Total wood	1	:	3.3

Ratio between total recorded and unrecorded wood consumption per capita

India	Central Europe
1 : 4	1 : 0.1

3. Present Recorded Wood Production

per acre	India	Central Europe
	.....cft	
	4	50

Ratio

1 : 12

4. Accessibility of Forests

a) Percentage of forest area considered accessible (according to present statistics)

	India	Central Europe
	about 75%	about 99%

b) Indication of actual accessibility (length of forest roads in miles per sq.mile of forest area)

India		Central Europe
about 0.3-0.5		8
	Ratio	
1	:	20

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5. Indication of Financial Returns per Acre

	India	Central Europe (example: Switzerland 1956)
Gross revenue	4.4 Rs	110 Rs
Expenditure	1.9 "	45 "
Net revenue	2.5 Rs	65 Rs
	Ratio	
	1 :	26

B. ANALYSIS OF REQUIREMENTS AND SUPPLY OF FOREST PRODUCE (period 1960-1975)

The objective of this principal chapter is to analyse the whole field of wood utilization item by item in order to check trends of consumption and supply and to evaluate the findings as basis for a program of action for each field and for the economy as a whole.

This chapter covers:

1. Building Material
   a) Timber
   b) Plywood and boards
2. Mining
3. Transport and Communication
   a) Railways
   b) Ship- and boatbuilding
   c) Power, telephone and telegraph
   d) Vehicles
4. Woodworking Industry
5. Packaging
   a) Wood
   b) Plywood
6. Paper
7. Rayon
8. Matches

   Summary: Estimate of present and potential requirements of Industrial Wood
9. Fuelwood
10. Tanning Material
11. Lac, Rosin and Turpentine (including other extractives)
12. Medicinal Plants and Essential Oils

I. Building Material

1. Timber

In assessing requirements of solid timber for building purposes, three main fields of consumption should be distinguished:

Housing, non-residential constructions and rural uses.

The bulk of timber (about 80%) is required for housing, the major part for urban areas, whereas in the village cheaper methods of construction prevail.

For housing, certain statistical data are available; the estimates for non-residential construction are based on discussions with the main government agencies concerned (Public Works Departments, Ministry of Defence) the requirements for rural use on indications collected whilst touring the various States.

a) Basic housing statistics

The total number of houses available in India (excluding Jammu and Kashmir) was estimated in 1951 for

Rural areas	-	54 million
Urban areas	-	10.3 "
Total		64.3 million

In 1881, the rural population amounted to 90.8%, in 1951 to 81.7%. Progress of industrialization and improved living conditions in the cities will further expedite urbanization.

The number of persons in one house amounted in 1951 to 5.5 in rural and 5.8 in urban areas.

Number of Rooms per Household

	Rural areas	Urban areas	Cities only
	..... Percentage		
One room	34	44	67
Two rooms	32	28	19
Three rooms	15	12	5
More than three rooms	19	16	9
	100	100	100

Floor Space per Capita

Areas	sq.ft Below-26	sq.ft 26-50	sq.ft 51-100	sq.ft 101-200	sq.ft More than 200	Average floor space per capita
1. Rural	7%	8%	24%	32%	29%	99 sq.ft
2. Urban	3%	16%	25%	28%	26%	89 sq.ft
3. Cities only	4%	30%	20%	24%	16%	67 sq.ft

Technical characteristics: in rural areas about 85% of the houses have mud plinth, 83% walls and mud, bamboo and reeds, 70% roofs of straw, grass or reeds; in urban areas about 44% mud plinth, 42% mud walls, 33% grass and thatch roofs. (For details see Table 7).

b) Building program

Urban areas: During the First Plan period, about 1.3 million houses, i.e. 260,000 houses per year, were constructed in cities and towns. The Second Plan anticipated about 380,000 houses per year with an annual investment of nearly Rs. 2.6 billion or 2,3% of the national income. Even this program was unable by far to fill the existing gap:

The urban population in India increased by 28.7 million between 1931 and 1951, but the number of houses only by 3.2 million. Assuming 4.7 persons per house as the usual rate, there was, even in 1951, a shortage of 2.5 million houses in India's urban areas. This figure meanwhile has increased to 5.9 million, taking into account the need for replacement of over-aged houses and for demolition of slums. It can, therefore, be assumed that during the next plan periods building activity will still increase considerably.

Rural areas: The number of houses in the villages is about 5-times more than in the towns and cities. The need for improvement of the housing situation is equally urgent as about 50 million houses (90%) require reconditioning or should be partly rebuilt.

Economic difficulties, however, for such rehabilities are far great in the rural areas than in the towns, since the farmer can only afford to spend about Rs. 2.- per sq.ft of plinth area, whereas, under urban conditions, 10 - 15 Rs are still considered acceptable, due to the higher level of income.

For rural housing schemes it is therefore indispensable to concentrate on cheap, locally available building material and to reduce labour costs as much as possible by an organized system of self-help.

c) Building techniques *

House types in India are greatly influenced by climate and habit: In the northern plains with hot summers and comparatively low rainfall, houses are built with thick walls and thick roofs but small doors and windows. In the humid regions, the walls are thin and the roofs light and sloping. In regions like Assam, the type of construction is influenced by seismic factors: construction is light and consists to a large extent of bamboo and thatch. The most important building material in urban areas all over India is brick (estimated production: 5,000 million units per year). Northern India accounts for 70% of the production. In rural areas earth, sun-dried bricks, stones supplemented by small timber, bamboos and grasses prevail. Actual timber houses are confined to higher altitudes only.

d) Present level of timber consumption

There is - as already indicated - a distinct difference between the rate of timber consumption for housing in urban and rural areas. For urban constructions, the average requirements per house have been estimated at 40 - 60 cft, thereas in rural areas the requirements (round and sawn) reach hartly 5 - 10 cft.

The biggest items for which wood is being used in urban and rural areas are doors and windows. Compared with Western countries, the consumption of timber for housing in India is extremely low (Central Europe: 250-300 cft and North America 500-800 cft per house). Due to limited availability, the price of structural timbers are about 50 - 100% higher in India than in Europe. The Central Public Works Department calculates that nearly 13% of the costs for finished residential buildings in urban areas account for timber (see Expert Committee Report on Building Works of CPWD, 1949).

According to discussions with the government authorities concerned and local inquiries, the future requirements of timber for:

housing (urban and rural),
non-residential constructions (public works, defence, harbour and wharf development, governmental and private administrative buildings, shops etc,) and
rural uses (fencing, tools, household equipment, rough furnishing, - except carts and rural housing)

can be assumed - in terms of round timber - as follows:

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* see Monograph on Housing situation in India (National Building Organization, New Delhi, 1959)

Estimate of Timber Requirements

for housing, non-residential construction and rural uses

	1960	1965	1970	1975	Percentage of total (1975)
	in million tons of roundwood, 50 cft each				
(1) Housing urban : about 60% rural : " 40%	1.2	1.4	1.6	1.8	65%
(2) Non-residential constructions	0.2	0.25	0.3	0.35	13%
(3) Rural uses	0.4	0.5	0.5	0.6	22%
Total	1.8	2.15	2.4	2.75	100%

Table 7

TECHNICAL CHARACTERISTICS OF HOUSE TYPES IN INDIA

1. Plinth

Area	Mud	Timber, wood, bamboo, reed	Brick, cement, stone	Others
1. All rural areas	84.5%	2.7%	12.3%	0.5%
2. All urban areas	44.3%	1.7%	53.3%	0.7%
3. Cities	20.2%	0.9%	78.0%	0.9%

2. Wall

Area	Mud bamboo, reed	Timber, wood, C.I. sheets	Brick, cement, con-crete	Others
1. All rural areas	83.2%	0.9%	15.5%	0.4%
2. All urban areas	42.1%	2.0%	55.2%	0.7%
3. Cities	21.7%	6.0%	72.1%	0.2%

3. Roof

Area	Straw, grass, thatched, bamboo or reed	Corrugated sheets, asbestos sheets, tiles, etc.	Cement con-crete	Others (bricks in mortar etc.)	Others
1. All rural areas	69.6%	23.5%	1.7%	2.4%	2.8%
2. All urban areas	32.9%	33.6%	19.2%	10.3%	4.0%
3. Cities	14.5%	27.2%	43.5%	12.5%	2.3%

Source: Monograph on Housing Situation in India (National Buildings Organization, New Delhi, 1959)

2. Plywood and Boards

In order to reduce wasteful consumption of sawn timber, large-scale production of various types of sheet material from organic sources is imperative.

a) Commercial plywood

India's plywood industry started with the production of tea chests which reached recently 100 million sq.ft per year. Development of commercial plywood was comparatively slower. In 1947, production amounted to 5.8 million sq.ft and increased till 1959 to 45 million. It is assumed that a production up to 150 million sq.ft (commercial plywood) for furniture, boat-building, doors and even structural units would find a ready market. A great number of species which cannot be used for tea chests due to smell or colour would be available for this purpose.

The raw material requirements would develop under this program as follows:

Estimate of Timber Requirements for Expansion of the Production of Commercial Plywood

	1960	1965	1970	1975
	.....in million sq.ft			
Tentative production target	50	100	125	150
	...in 1,000 tons of roundwood... (50 cft each)			
Timber requirements	40	80	100	120

b) Fibreboards

World production of fibreboards is assumed to exceed 4 million tons in 1960.

There are at present only two fibreboard factories in India, one in Bombay State with a capacity of about 30 daily tons and a second with a provisional capacity of 15 tons in Kerala, to be enlarged up to 30 daily tons. The first factory uses as raw material nearly 30 hardwood species in mixture (including bark), supplied from forests; the second mainly waste from the neighbouring plywood factory.

Fibreboard imports in the past were confined to 15 - 20,000 tons per year, partly due to shortage of foreign exchange, partly to lack of knowledge about fields and methods of application.

In Western countries, techniques of fibreboard production have reached a high stage of perfection and no further basic improvement of techniques can be expected in the near future. A great deal of research and development, however, has recently been devoted to techniques of fibreboard application for various uses, and due only to this fact fibreboard has become an indispensable commodity in modern construction. This line of applied research is still lacking in India, and it is suggested to fill this gap as soon as possible by also using the experiences of more industrialized countries.

Under this assumption fibreboard requirements, at present limited to 15 - 20,000 tons, are likely to increase within 15 years up to 150,000 tons. For such a broad development scheme, production techniques should be thoroughly adjusted to tropical requirements. The main points to be considered are:

(1) Differentiation of products: Softboards (spec. gravity about 0.3) for insulation are expected to get only a limited market in India due to sudden changes of humidity and attack by termites; but by impregnation with certain bituminous products adjustment for specific purposes is possible. Hardboards (spec. gravity 1.0 and more) will gain a much wider market (in housing, non-residential construction and transportation) if carefully air-tempered. They are, however, not suitable for all climates due to the tendency of warping under extreme conditions. Medium hardboards (spec. gravity 0.6 - 0.7) are up to now the most suitable type for tropical areas. Due to lower density they do not warp. To ensure high stability they should be produced with a thickness of 8 - 10 mm. Boards of this type require for economic production a moulding press.

The Indian market is expected to absorb these three types in the following ratio:

Softboards	:	10%
Hardboards	:	30%
Medium hardboards	:	60%

(2) Selection of raw material: For softboard, bagasse can be used with good results, as practised in general countries; for hardwood any kind of soft- and hardwoods (including waste from plywood plants), provided the composition of species can be kept somewhat uniform. The same is true for medium hard boards which allow up to 25% of fillers (e.g. coconut coir dust or others).

(3) Processing methods: Differences in tropical raw materials can be overcome by a light chemical treatment of the chips if combined with a pressure of 10 - 15 at. This procedure allows the reduction of cooking time to about 20 minutes and ensures - after hot air tempering - improved water resistance of the board.

(4) Capacity: For production of medium hardboards by applying moulding presses a minimum economic capacity of 20 daily tons (in 3 shifts) is still feasible, whereas for hard- and softboard a minimum capacity of 30 - 50 daily tons is needed.

Estimates of Raw Material Requirements for Production of Fibreboards

	1960	1965	1970	1975
	.....in 1,000 metric tons.....			
Tentative production target	15	50	100	150
Raw material requirements:	...in 1,000 tons of roundwood..... (50 cft) equivalent			
a) wood (solid)	20	50	100	150
b) refuse from wood industries; agricultural residue	(3)	(20)	(30)	(40)

c) Particle boards

In 1960, world production of particle boards is expected to reach about 1.5 million tons. In Central Europe production of particle boards surpassed fibreboards, in Western Germany even plywood.

This new type of board was developed on an industrial large scale only after the last war and can be manufactured in great variety:

light boards	:	0.2 - 0.4 spec. gravity
medium heavy boards	:	0.4 - 0.8 " "
heavy boards	:	0.8 - 1.2 " "

About 95% of the production in Central Europe ranges between 0.55 and 0.65, i.e. similar to natural wood.

The main reasons for the fast development of the particle boards industry are:

Nearly every species, except those heavier than 0.7, can be used even in small billets from 3 inches diameter on.-

Practically no water is required.-

The product is large-sized, uniform in its properties but variable in thickness from 8 - 30 mm.-

Warping, shrinkage and splitting is practically eliminated.-

Offcuts can again be joined to large units by synthetic resin without loss of strength.

A considerable number of factories have been established in tropical areas during the last few years (South America, Africa and Asia). Of special interest is the factory in Thailand, using mixed tropical hardwoods, and plant in Taiwan, based on bagasse.

There are, however, some special features to be considered under Indian conditions:

(1) Economy: In Europe the breakdown of production costs shows roughly the following characteristics: Wood: 20%; binder (synthetic resin): 17%; steam: 4%; electricity: 4%; wages and salaries: 11%; depreciation: 7%; repairs: 10%; cost of marketing: 27%.

For a rapid development of the market, the price of particle boards should be about 15% lower than plywood of the same thickness.

In India, synthetic glue is 50 - 100% more expensive than in Europe; this would greatly handicap the sound development of the industry. In future - according to information received from Hindustan Steel Ltd., Ranchi - chemicals for synthetic resin from the three steel plants Rourkela, Bhilai and Durgapur will be available in the following quantities:

Phenol-pure	1,000 tons per year	) based on an annual out-
Cresol-pure	500 " " "	) put of 3 million tons
Xylenol-pure	150 " " "	) of steel ingots.
Total	1,650 tons per year	

Since steel capacity will further increase, there is a good chance of meeting the requirements of the anticipated particle board industry by the domestic supply of binders, provided arrangements can be made to reserve these quantities primarily for forest industries.

(2) Selection of raw material: In principle, all species, except the very heavy ones, can be used. There is, however, a limitation in the degree of mixture. Heavy and light species require grading according to weight groups, so that the mixture can be kept uniform. Bagasse represents an excellent raw material for particle boards, confirmed by the laboratory tests of the Forest Research Institute, Dehra Dun, and the industrial runs in Taiwan with a daily capacity of 50 tons.

(3) Technical aspects: In Central Europe, about 90% of all particle boards are produced by plate presses, 10% by extruding methods.

Some basic points, important for programming of industrial production, are:

Debarking of wood is indispensable; storage of the raw material in water considerably increases the quality of the chips.-

Particles for high-class boards should be produced in a standard thickness of 0.2 mm for the covering layer and 0.4 mm for the core. For one-layer board the average thickness should be 0.3 mm; the width may vary between 2 - 10 mm, the length between 20 - 30 mm.-

For smaller plants, for which expensive three-layer machines cannot be afforded, a similar effect can be achieved by an air circulation device which places the thinner chips on the outer side, the heavier ones inside of the board.-

During the last ten years the time for treating the board in the hot press has been reduced (for boards 19 mm thick) from than 20 minutes to 10 minutes, under efficient control even to 5 minutes, resulting in considerable increase of production.

(4) Plant capacity: Particle boards should be produced at a price at least 15% less than plywood of the same thickness, in order to replace gradually also solid timber in various fields. The world trend, therefore, leads to the highly mechanized plants of 100 - 200 daily tons capacity with electrical control of all phases of production. Under Indian conditions, where the sources of raw material are scattered, a capacity of 30 daily tons (in 3 shifts) or 10,000 tons per year should be assumed as the minimum, provided the layout of the plant allows doubling of the capacity at a later stage.

Under the assumption that domestic supply of synthetic resin can be ensured, the following program is proposed:

Estimate of Raw Material Requirements

for Production of Particle Boards

	1960	1965	1970	1975
	....in terms of 1,000 metric tons....			
Tentative production target	5	20	50	100
	in terms of 1,000 tons per roundwood .....(50 cft) equivalent.....			
Raw material requirements:				
a) wood (solid)	-	20	40	100
b) refuse from wood industries; bagasse	(5)	(10)	(30)	(40)

d) Waste boards

India has large hidden resources of low-grade waste - not suited for fibre or particle board production - in forest areas (reed grasses in Assam, Bengal and Uttar Pradesh), from forest industries (match factories, katha production, sawmills: Calcutta, Andamans, Kerala), and still bigger supplies of agricultural waste (bagasse, cotton stalks, rice husk, etc.). It is assumed that 0.5 million tons of such unused organic material could easily be collected at regional centers for industrial purposes.

Recently two processes have been put into industrial operation which enable utilization of low-grade waste: one in North America which concentrates on use of short-fibred sawdust for production of high-class furniture boards ("cultured wood": plant at Meridian, Mississippi, USA), the second in Austria, converting sawdust, reeds and similar refuse into large-sized building boards for construction (partitions, ceilings, roofs) and utility furniture. Both processes are characterized by the following facts:

No synthetic resin is required since the cellulosic material itself acts as a binder, i.e. in the case of the American process by chemical means, in the European process by a thermic-mechanical treatment.-

Both processes produce a medium heavy board, as preferred in construction. They are already operating on industrial scale.

Cost data are at present only available with the European factory, which produces the boards at 50% of the costs compared with resin bound particle boards. (The present plant has an outturn of 10 tons per day in 2 shifts, due to shortage of sawdust; larger plants of the same type are in planning stage in Scandinavia).

It is suggested to study both processes carefully and to import - as a first stage - some commercial quantities of boards for practical experimentation under Indian condistions.

If these trials prove technically and economically successful, large additional resources could be put to profitable use for substitution of solid timber.

With regard to availability of raw material and marketing prospects, the following production program can be anticipated:

Tentative Production Program

of Medium Heavy Building Boards from Organic Waste
(without use of synthetic resin)

	1960	1965	1970	1975
	.....in 1,000 metric tons.....			
Tentative production target	-	30	60	100
Quantity of raw material (forest and agricultural waste) required	....in 1,000 tons of roundwood... (50 cft each) equivalent			
	-	(40)	(75)	(100)

c) Mineralized woodwool slabs and hollow blocks

International statistics on these important products are not yet available. A tentative assessment of production in Central European countries indicates that Western Germany produces at least 700,000 m^3 of mineralized woodwool slabs, Austria about 300,000 m^3 = 1 million m^3 in these two countries only. (About 0.3 m^3 of wood are required for 1 m^3 of mineralized woodwool products).

In industrialized countries, wood consumption for fibre and particle boards gradually exceeded requirements for woodwool products; in most tropical areas, however, these products rank first since they represent an ideal building material for low-cost housing and - in the form hollow blocks - even for tall buildings.

The importance of this material for the tropics results from the following facts:

Mineralized woodwool products can be produced in relatively small industrial units with an investment of about US$ 150,000 for manufacturing material for nearly 5 low-cost houses per day.

Due to mineralization (by magnesite or cement) the products are termite-proof and to high extent fire and water resistant.

Production of woodwool requires small timber from 4 inches diameter on; specific gravity should be not more than 0.5 - 0.6; the contents of extractives is confined to less than 1% sugar, 2% tannin or 3% oil. Small quantities of gums and resins are usually tolerated.

Mineralized woodwool products provide a very effective insulation against heat.

Plastering is easy and can either be done by hand or by machine spraying.

Production in the tropics started prewar in Africa and has meanwhile been extended to Burma, Malaya, Ceylon, British North Borneo and Hongkong; here - due to acute housing shortage - the largest production developed.

Some years ago, hollow blocks were also made from the same material, primarily for taller buildings in urban areas. For this product even wood shavings, coir dust or bagasse can be used. By pouring concrete, with a relatively small cement content, into the holes, construction can considerably be reenforced, requiring only little steel.

Although production seems easy and practicable in small plants, specialized machinery and good deal of "know-how" is required to ensure high-grade products and economy.

For the permanent construction of low-cost houses in the tropics, mineralized woodwool is in the first line for technical and economic reasons. Fortunately, India has sufficient raw material (e.g. from plywood and match factories, thinnings from light and medium heavy species) to initiate a considerable production without delay. This production, however, can be increased by a very large extent as soon as plantations with fast-growing species yield their first thinnings.

The following program is suggested:

Tentative Production Program

for mineralized woodwool slabs and hollow blocks

(especially earmarked for low-cost housing)

	1960	1965	1970	1975
	in terms of 1,000 tons (50 cft each)			
Tentative production target	-	150	300	600
Quantity of raw material required:				
a) wood (solid)	-	30	70	200
b) industrial refuse in wood equivalent	-	(20)	(30)	-

f) Reed boards

Reed was considered for long time a minor forest product only to be used by villagers for thatching and other local purposes. In recent years it has become a raw material of some international significance, after modern machinery was developed for compressing this bulky material into "endless" boards, stitched by wire.

The main technological characteristics of this material are:

High insulation capacity, nearly equal to cork. (one inch board supplies an insulation effect of a two feet brick wall).

High durability, due to the silicate content of the outer layer.

Light weight (spec. gravity 0.2).

Stiffness in the width, high flexibility in the length (easy bending).

Simple production.

Variation of thickness: 2 - 5 cm.

Reed boards of this type are being produced in 19 countries (including Iran and Iraq); total production per year has been estimated at 150 million sq.ft.

The biggest production plant (yearly output 20 million sq.ft) operates in Western Germany, using imported reed from Hungary and Rumania. By 1959 one plant had already been erected in India (Uttar Pradesh) with a capacity of 3.6 million sq.ft per 8 hours.

The largest resources of reed are in Assam (yearly availability up to 400,000 tons of which nearly 50% are suitable for this purpose).

For exploiting the reed resources in Assam, the factory should be erected near the river, so that the product can easily be shipped by boat to the Calcutta market.

Yearly production capacity of 1 machine:	1 million sq.ft (in 1 shift)
Requirements of wire per year:	45 tons
Price per machine:	US$ 10,000.-
Number of machines to be suggested per factory:	at least 3

Since raw material is plentiful along India's great river systems, the following development program is suggested:

Tentative Production Program

of reed boards

	1960	1965	1970	1975
	.....in million sq.ft			
Tentative production target	3	20	60	100
Requirements of raw material	...in terms of 1,000 metric tons..			
	1.5	10	30	50

3. Summary

a) Requirements of commercial plywood, boards and allied products

The present requirements of sawnwood may be estimated at 2 million tons, 50 cft each (or 100 million cft).

In 1975, the requirements will amount at least to 3.2 million tons according to indications gathered by analysing consumption trends of major items. Supplies of sawnwood from existing sources cannot be increased to such an extent within a 15 year period. Substitution of solid wood by new types of processed wood (including reeds and agricultural residue) is indispensable for filling the gap.

b) Tentative production program

The proposals have been based on raw materials which are mainly unused up to now. Table 8 shows types and quantities of raw material could be made available for this purpose. Under this program requirements will reach 450,000 tons of roundwood equivalent in 1975, supplemented by about 200,000 tons of waste from various sources.

Implementation of this 1960 - 1975 program would result in an increased additional production (in metric tons) of

	1960	1975
Commercial plywood:	15,000 tons	40,000 tons
Fibreboards :	15,000 "	135,000 "
Particle boards :	5,000 "	100,000 "
Waste boards :	nil	100,000 "
	35,000 tons	375,000 tons

Accordingly, 1975 production will exceed the present production level by about 10 times.

By converting timber or substitutes into large-sized sheet material (such as plywood and building boards), usually considerably thinner than sawn timber, the quantity of finished material - in terms of area - is larger than the volume figure indicates, resulting in a striking increase in economy.

The above mentioned four types are primarily meant for construction activities in urban areas. For rural and semirural requirements, including low-cost housing projects, an additional group of large-sized building material (mineralized woodwool products and reed boards) had been proposed which can be produced at a very economic price. 200,000 tons of low-grade wood and 50,000 tons of reed (mainly from Assam) have been earmarked for this purpose. These products represent a very important additional contribution in order to substitute sawnwood.

c) Technical and economic indications

Table 9 summarizes some of the main characteristics of the proposed products from the viewpoint of economic planning. The data should be regarded as rough indications only.

d) Development of markets

Most of the above products and their application are not yet sufficiently known in India. For this reason even the present modest plants have had some difficulties in disposing their products. Two points, therefore, are essential:

To make full use of all experience from abroad in the application techniques of these new products (e.g. by means of technical assistance).-

To ensure attractive prices for these products for facilitating timber substitution (see Table 10).

e) Indication of investments

Table 9 shows which investments - according to the present state of techniques - can be assumed per ton of daily production (based on the present Central European price level). Table 11 indicates the average yearly investments required for reaching the anticipated production capacity in 1975.

Table 8

SUMMARY

TENTATIVE PRODUCTION TARGETS

Commercial Plywood and Boards

		1960	1965	1970	1975
		..... in million sq.ft			
1.	Commercial plywood	50	100	125	150
		....in 1,000 metric tons			
	Commercial plywood	12	25	30	40
2.	Fibreboards	15	50	100	150
3.	Particle boards	5	20	50	100
4.	Waste boards	-	30	60	100
	Total:	32	125	240	390
		... in 1,000 tons (50 cft each)....			
5.	Mineralized woodwool products	-	150	300	600
		..... in million sq.ft			
6.	Reed boards	3	20	60	100

Table 8 a

TIMBER REQUIREMENTS

Commercial Plywood and Boards

	1960	1965	1970	1975
	..... in 1,000 tons of round wood (50 cft each)			
1. Commercial plywood	40	80	100	120
2. Fibreboards:				
a) wood (solid)	20	50	100	150
b) refuse from wood industries; agricultural residue	(3)	(20)	(30)	(40)
3. Particle boards:				
a) wood (solid)	-	20	40	100
b) refused from wood industries; agricultural residue	(5)	(10)	(30)	(40)
4. Waste boards	-	(40)	(75)	(120)
5. Mineralized woodwool products:				
a) wood (solid)	-	30	70	200
b) industrial refuse	-	(20)	(30)	-
Total: Wood (solid)	60	180	310	570
Total: Refuse	(8)	(90)	(165)	(200)
	..in 1,000 metric tons of reed ...			
6. Reed boards	1.5	10	30	50

Table 9

S U M M A R Y

of some

technical and economic indications

for production of plywood and various boards

	Plywood (3 piles)	Fibre board (medium hard)	Particle board	Waste board	Reed board
Assumed plant capacity (daily tons)	20	30	30	20	6
Thickness (mm)	4	8 - 10	8 - 30	25	25
Av. specific gravity	0.65	0.65	0.6	0.6	0.2
	Requirements per metric ton of finished products				
1. Raw material (metric tons)	2.7	1.3	1.2	1.1	1.2
2. Synthetic binder (kg per ton of finished product)	60	0 - 10	80	-	(only wire 100 kg)
3. Power (Kwh)	200	550	350	450-550	10
4. Heat (in terms of steam: tons)	1.5	3.5	2.5	1	-
5. Water (tons)	1 - 10	60	0.2	1	-
6. Labour (working hours for production)	80	15	10	15	20
7. Investments per daily ton (3 shift): US$	30,000	40,000	35,000	25,000	10,000 (1 shift only)

Table 10

INDICATION OF PRICE RATIOS

(based on Central European price level)

	Product	Assumed thickness mm	Allowable price of sq.ft Rs
1.	Commercial plywood	4	0.50
2.	Fibreboard (hard)	4	0.35
3.	Particle board (3 layer type)	19	0.85
4.	Waste board	25	0.45
5.	Mineralized wood-wool slabs	25	0.40
6.	Reed boards	25	0.35
For comparison:			
7.	Sawnwood (spruce-fir)	25	0.60

Table 11

INVESTMENTS

required for

Implementation of the proposed Program

in order to substitute sawnwood by other organic products

(commercial plywood and various types of boards)

---- Period 15 years ----

		Annual investment US$
1.	Commercial plywood	200,000
2.	Fibreboards	1,200,000
3.	Particle boards	750,000
4.	Waste boards	550,000
5.	Mineralized woodwool slabs and hollow blocks	800,000
6.	Reed boards	100,000
		3,600,000 per year for the period 1960-1975

Requirements in foreign currency: about 70%

Note:

Products 1-4 are mainly meant for construction in urban areas, 5-6 for low-cost housing in rural areas.

II. Mining

India's coal production is expected to reach 50 million tons in 1960 and about 100 million tons in 1975. The main production centers are Bihar and West Bengal, which supply about 80 % of the total output.

For 1,000 tons of coal nearly 4 tons (50 cft each) of pitprops are required, which is less than 50 % compared with Western Europe, mainly due to the difference in mining conditions.

Besides pitprops, Indian mines consume considerable quantities of sawnwood for sleepers and constructions which - in terms of roundwood - equal about 80 % of the quantity required for pitprops.

The question whether the present rate of timber requirements (4 tons of pit props for 1,000 tons of coal) will increase in future when mining has to include deeper seams cannot be answered at the present stage.

According to indications received from the National Coal Development Corporation, Ranchi and other sources, future demand may develop as follows :

Tentative Requirements of Pitprops and Sawnwood
(both mainly hardwoods)

in Indian Coal Mines.

Assumed Coal Production	1960	1965	1970	1975
	..... in million metric tons			
	50	60	80	100
Requirements of	..... in 1,000 tons of round wood (50 cft each)			
Pitprops	200	240	320	400
Sawnwood (in terms of roundwood)	160	180	250	320
Total (roundwood)	360	420	570	720

III. Transport and Communications

1. Railways

a) Mileage and gauge

The main system of transportation in India are the railways. The breakdown of mileage (1958) according to gauges:

	Route mileage	Track mileage
Broad gauge	16,246	27,235
Meter gauge	15,481	19,297
Narrow gauge	3,162	3,573
Total	34,889	50,105

In the Asia-Pacific region, India ranks first in track length - 35 % of the total are in India, 25 % in Australia, 21% in Japan, 7% in Pakistan 3% in Indonesia, 2.6% in New Zealand and 1.6% in Thailand.

b) Percentage of wooden sleepers *

The use of wooden railway sleepers in India compares with other countries in the Asia-Pacific region (in 1953) as follows :

	Wood	Steel	Cast Iron	Concrete
India				
Broad gauge	20	27	53	-
Meter "	72	24	4	-
Narrow "	70	29	1	-
Australia	99	1	-	-
Burma	100	-	-	-
Japan	100	-	-	-
Malaya	100	-	-	-
Thailand	100	-	-	-

* Study on Wood Sleepers in the Asia Pacific Region, FAO, 1957 (revised).

c) Requirements and supply in the past

India's annual sleeper requirements amounted, during the period 1954-58 up to 300,000 vol. tons (15.0 million cft.), the annual production during the same period only to 120,000 tons. The balance had mainly to be imported. One-third of the requirements were intended for new constructions, two-thirds for normal replacement.

d) Technological trends

In 1959 the Timber Committee of the Economic Commission for Europe arranged a study on utilization of wood for railway sleepers and investigated the prospects of wooden sleepers in comparison to other materials.

A countrywise forecast of the annual requirements of various sleeper types indicated that steel sleepers are out-of-date. Of the total European demand, about 80 % are expected to be met during the next few years by wood, 4% by ordinary concrete and 16% by pre-stressed concrete.

Use of pre-stressed concrete has been favoured by constructing tracks with long-length welded rails. In Western Germany, 50% of all new sleepers are

already from this material which is strongly competing with wood. Which type of sleeper will finally prevail is mainly a question of price, since the basic technical problems have meanwhile been solved.

e) Estimate of future requirements

In the Indian Timber Trend Study (1958) it was assumed that of requirements (estimated at 200,000 tons converted or 350,000 tons roundwood) only one third can be met from domestic production. Meanwhile, however, the Railway Board included a great number of additional formerly rejected semi- and non-commercial species into the supply program and organized sufficient capacities for chemical treatment. By this approach the railways will be able to secure their total requirements from indigenous sources, so that imports can be spared. For details regarding future requirements and pattern of supply see Table 12.

f) Summary

(1) For the railways in India with a track length of about 50,000 miles, domestic supply of sleepers is an important problem. Modern factories for large scale production of sleepers from pre-stressed concrete are not yet available and wooden sleepers will still keep their position for a decade or more. In the long run, pre-stressed concrete is expected to take the lead, since cement is plentiful and wires from high-class steel may also be produced in due course. Steel sleepers, however, used up to now as an alternative to wood in India are now being discarded in most parts of the world and are likely to disappear also in India.

(2) According to these general trends the requirements of wooden sleepers may roughly be anticipated as follows:

1960	1965	1970	1975
..... in tons of roundwood (50 cft. each)...			
350,000	400,000	400,000	200,000

Timber requirements for railway coaches and wagons are shown in III/4 below.

2. Ship- and boatbuilding.

In the Indian Timber Trend Study (1958) consumption of timber for shipbuilding has been estimated at 10,000 tons of sawnwood per year (equal to about 15,000 tons of round-wood), mostly teak. This figure, however, represents only the requirements of the few large shipbuilding yards and does apparently not consider the great number of fishing-, house- and country-boats operating on lakes (Kashmir), the great river systems and along the coast.

This large fleet is one of the big but hidden timber consumers, similar to country carts in the rural areas. As no enumeration of these boats for the country as a whole exists, the requirements had to be estimated according to zones and can safely be taken (including consumption of large shipyards) as:

1960	1965	1970	1975
..... in 1,000 tons of roundwood (50 cft. each)			
120	140	180	220

3. Power, telephone and telegraph

Consumption of timber for poles has, up to now, been negligible in India. The Post and Telegraph authorities are concentrating on steel poles and only in exceptional cases establishment of wooden poles has been considered for rural areas.

The Water and Power Commission, however, is interested in applying wooden poles to a larger extent for rural electrification schemes and to foster even the use of joined poles in areas where sufficiently long poles are not available.

The yearly requirements for this purpose are estimated at 200,000 pieces.

The main center of requirement is the South, whereas the major quantity of long and straight poles is produced in the northern hills, resulting in heavy transportation costs.

The Andaman Islands were expected to supply considerable numbers of mangrove poles to the South. But due to difficulties in extraction from marshy lands, treatment before dispatching and transport from the islands to the main land, the supplies have been small up to now. Increase of supplies from the islands by mechanized extraction, establishment of additional treating plants and improved transport facilities should be seriously considered. Simple but effective preservation methods, suitable for use at site right after felling, will greatly reduce transportation costs ("osmose process").

Requirements, likely to be met if joined poles will be applied to larger extent, are estimated as follows :

1960	1965	1970	1975
..... in 1,000 tons of roundwood (50 cft. each)			
10	15	20	30

4. Vehicles

a) Railway coaches and wagons

In assessing the timber requirements in this field, two conflicting trends can be noted:

the great efforts for increasing the domestic production of coaches and wagons, and

the tendency to eliminate wood as far as possible from this line of construction.

The general impression is that the present timber requirements will continue on the same level for some time.

b) Trucks and buses

About 80% of all trucks and buses still have wooden bodies. But the tendency to replace or reduce wood as a structural material is obvious.

Requirements per unit will decrease, but the number will considerably increase. Therefore, timber consumption for the period under review can still be assumed at the present rate.

c) Carts

In India there are about 11 million country carts, drawn by animals and 95% are built from wood. The number is still increasing (1946: 8 million; 1956; 11 million). The wood requirements exceed greatly those of a) and b) although supply is mostly derived from unrecorded sources. These carts will still be indispensable to the rural economy for many years to come.

TABLE 12

Estimate of Timber Requirements for all types of vehicles
(Summary)

	1960	1965	1970	1975
	.... in 1,000 tons of roundwood (50 cft each)			
a) Railway coaches and wagons	60	65	70	75
b) Trucks and buses	50	55	60	65
c) Carts	150	160	170	175
Total roundwood	260	270	300	315

Estimate of Timber Requirements for transport and communication.
(Grand total)

	1960	1965	1970	1975
	... in 1,000 tons of roundwood (50 cft. each)			
1. Railways (sleepers)	350	400	400	200
2. Ship- and boat-building	120	140	180	220
3. Power, telephone and telegraph	10	15	20	30
4. Vehicles (railway coaches, trucks and buses, carts)	260	270	300	315
Total	740	825	900	765

IV. Woodworking Industries

1. Furniture

The present timber consumption of the furniture industry is estimated at 110,000 tons sawn - or about 150,000 tons roundwood.

The requirements according to species may be assumed with

teak	60 %
other broadleave species	29 %
conifers	1 %

By 1975 requirements are estimated to increase up to 150,000 tons sawn - or 225,000 tons of roundwood.

2. Textile mill accessories

Utilization of indigenous timbers is mainly confined to production of bobbins. Annual timber requirements amount to about 36, 000 tons roundwood. (Labour force employed in this industry: about 8,000).

Shuttles are mainly produced from imported timbers. Some installations for production of compressed wood have recently been ordered.

3. Pencils, battery separators, tool handles

These three items require about 14,000 tons of sawnwood (or 21,000 tons of roundwood).

4. Other woodworking industries.

Timber consumption of the great number of additional small industries (toys, sports goods, shoe lasts and heels, spools, picture frames etc.) is estimated to be equal to the quantity required by items 1 - 3.

5. Summary

Estimate of Timber Requirements of the Woodworking Industry.

Items	1960	1965	1970	1975
	... in 1,000 tons of roundwood ..... (50 cft. each)			
Furniture	150	170	190	225
Textile accessories	36	40	45	50
Pencils, battery separators, tool handles	14	16	18	20
Other woodworking industries	200	230	260	300
Total :	400	456	513	595

V. Packaging

1. Requirements and supply in the past

In every developing economy, packing material and packaging techniques require special attention in the context of the efficient distribution of goods. This is particularly true for India, due to the long transportation distances and the great variety of commodities to be shipped.

Two groups of packing material can be distinguished in India:

Commercial products:

Wood
Plywood
Paper and Board;

Semi- and non-commercial products:

Bamboo
Grasses

Among the commercial products, wood is required for heavy boxes and crates, plywood for tea chests (tea export), paper and board for distribution of smaller commodities.

The semi- and non-commercial products (bamboo and grasses) are mainly confined to the rural areas for distribution of agricultural products.

a) Wood (sawn).

The main fields of application are: packing of agricultural and horticultural products, such as apples, oranges, tea)for domestic consumption); distribution of beverages (lemonades, beer, etc.); industrial products (cigarettes, margarine, soap etc.) and other commodities.

Since statistical data about requirements of wood for packaging are lacking, information from end-consumers in various parts of the country have been compiled:

Estimated total consumption
per year:

300,000 tons (in terms of roundwood of 50cft);
roughly 20% conifers
" 80% hardwoods.

Demand greatly exceeds supply, especially as far as softwoods are concerned.

b) Plywood

Use of plywood as packing material is confined to tea for export; India's tea production increased from 230,000 tons in 1939 to about 420,000 tons in 1956-57. Centers of production: Assam (about 50%), West Bengal (24%) Kerala (10 %) and Madras (8 %).

India is self sufficient in production of tea chests. Production increased from 28 million sq.ft in 1947 to about 100 million in 1959. Distribution of production (based on data of authorized capacities up to 1958): Assam 28 %, North Bengal 10 %, Calcutta 28 %, Kerala 23 % Mysore State 8%. Meanwhile production in Assam increased considerably.

Assuming that 0.8 tons of roundwood are required on the average for the production of 1,000 sq.ft., present requirements for tea chests plywood would amount to:

80,000 tons of round timber per year.

c) Paper and board

Present consumption of wrapping paper and cardboard as actually used for packaging is estimated at 90,000 metric tons per year, i.e. about 25% of the total paper consumption of the country.

d) Bamboo

Requirements of bamboo for packaging have been assumed at 30 million pieces per year (about 120,000 metric tons).

e) Grasses

There are no estimates regarding requirements of grass for packaging, although the quantity may be considerable; this item should, therefore, be discarded for the time being.

Technological trends

Overall requirements for packaging are increasing with economic development, industrialization and progress of communication. There is, however, a strong tendency for differentiation: In Central Europe (Austria) the value of packing material consumption nearly doubled from 1954 to 1959. The highest increase could be noticed with plastics, paper and paper board (finished); wood kept its position, whereas consumption of textiles for packaging dropped considerably.

a) Wood (solid)

Consumption of solid wood for packaging shows the following international technological and economic trends:

Economizing wood consumption in packaging is imperative for reduction of costs

and of shipping weight.

Construction of wooden boxes and crates became a matter of engineering. Application of coated nails, which increase nailing strength up to 50% and introduction of stitching machines which allow a considerable reduction of the board thickness, are only a few examples along this line.

The most recent development, which saves up to 50% wood, is the wire-bound folding chest, extensively used in North America and European countries. For this purpose, the wood is not sawn but converted by special slicers into thin boards after steaming. By an automatic machine, wires are fixed on one side of the boards, resulting in production of strong, flexible units which can easily be folded and assembled for final use. The main advantages are: Less wood but greater strength; easy storing, shipping, re-shipping and re-use; reduction of costs and shipping weight. The minimum quantity of raw material required is about 5,000 tons per year and plant. For areas of raw material surplus, such as the Andamans, this line of production offers good prospects and would contribute to more efficient utilization of short length and small sized timber. Calcutta and Madras would offer favourable markets.

b) Plywood.

With regard to tea-chests, only two technological trends may be mentioned:

Replacement of plywood by special types of fibreboard. Experiments along this line have recently been initiated in Ceylon. Preliminary results are promising.

Use of plastic bags, protected by light wooden chests as described above.

Both possibilities are still in the experimental stage.

c) Cardboard and finished cardboard products.

The future of economic packaging for light and medium heavy goods lies in the application of cardboard and its manifold corrugated products. This line of packaging has shown a great increase in many parts of the world during the last decade. In Central Europe, cardboard packaging is still confined by the railways to a gross weight of 75 Kg. Recently cardboard containers, in combination with wood or other materials, have been developed for a gross weight of more than 1,000 kg.

The cardboard industry in every advanced country has created modern laboratories for tailoring the packaging units according to the technical and economic requirements of each commodity to be transported.

These general trends are important for India since

(1) Wood, particularly softwood, is expensive and in short supply. Use of

wood as packing material should therefore be confined to agricultural products from rural areas where rough handling and storage in the open cannot be avoided.

2) Cardboard in India is still in short supply and quite a few industries (soap factories, etc.) are compelled to stick to wooden boxes although they are anxious to switch over to cardboard. Establishment of additional cardboard factories and plants for conversion of cardboard into finished packing material should get adequate priority.

3) From the forestry viewpoint, cardboard and corrugated products pave the way for incorporating hardwoods to a large extent into the program of supply. There are at present considerable hardwood resources (e.g. Andhra Pradesh) which should be exploited for conversion into fast growing plantations. Under the proposed afforestation program additional large quantities of hardwoods will be made available within 10-15 years, so that ample supply can be expected.

3. Estimate of present and future requirements.

A tentative estimate of requirements and pattern of supply for all major types of packing material (see Table 13) illustrates the changes to be fostered.

4. Summary.

India's total raw material requirements for packaging will almost triple during the next 15 years. The smallest increase is anticipated for tea-chest plywood, due to the limitations of tea export. Also bamboo consumption as packing material in rural areas will only slightly increase.

For wood, doubling of the present requirements has been assumed since wooden boxes and crates are indispensable for heavy goods in areas where rough manual handling cannot be avoided.

The greatest increase, however, is expected for packing paper, cardboard and its finished products. Cardboard should gradually replace wood for packaging of light and medium heavy goods, provided rail or truck transportation is available.

Suggestions.

Establishment of an industrial unit for supply of modern wooden packing cases from the Andamans to Calcutta and Madras.

Incorporation of applied research in packing problems related to forest products into the program of the Forest Research Institute, Dehra Dun.

Initiation of a packaging Development and Information Center for popularizing efficient packaging techniques (in cooperation with the European Packaging Federation, 3 rue la Boétie, Paris VIII, or the National Packaging Institutes in Europe and North America).

TABLE 13

ESTIMATED REQUIREMENTS OF PACKING MATERIAL

Type of product	1960	1965	1970	1975
Sawnwood - 1000 tons (50 cft each)	150	200	250	300
Plywood (tea-chests only) million sq.ft.	100	110	120	130
Paper and cardboard (confined to actual packaging) 1000 metric tons.	90	180	250	400
Bamboo 1,000 metric tons	120	140	160	180

PATTERN OF POTENTIAL RAW MATERIAL SUPPLY

Type of raw material	1960	1965	1970	1975
	in 1,000 tons of roundwood; 50cft. each.			
1. Wood (round)	300	400	500	600
2. Plywood (logs)	80	90	100	110
Total : Round wood	380	490	600	710
In terms of 1,000 metric tons	340	440	530	630
3. Paper and cardboard * (confined to actual packaging):	160	330	400	700
4. Bamboo	120	140	160	180
GRAND TOTAL - in 1,000 metric tons	620	810	990	1.510

* Note:
Raw material in future mainly hardwoods.

VI. Paper

Supply of adequate quantities of paper at a reasonable price, indispensable for the improvement of literacy, information, packaging and many other uses, is one of the most important objectives of India's Forest Industrial Development Program.

1. Development of Indian paper consumption

Indian paper consumption trends for the past (1925 - 1958) are summarized in Table 14. World paper consumption at present exceeds 60 million tons (about 22 kg per capita) and is expected to rise 1975 to more than 100 million tons (or 33 kg per capita of world population). India's present consumption is less than 1 kg but should reach at least 4 kg in 1975 in order to keep pace with the general economic and cultural development of the country and gradually to compensate for the present under-consumption.

2. Organization of the industry

There are three major types of paper industry in India:

a) Large scale industry, producing the bulk of commercial papers (present production: about 300,000 tons).

b) Small scale industry, producing mainly straw and mill boards (present production: about 50,000 tons).

c) Cottage industry, producing handmade paper (present production: about 3,000 tons).

Employment: The first two groups of industry employ about 30,000, the last group about 10,000 people.

Distribution of paper production (1958) according to States, in Table 15, shows that West Bengal, the former center of paper production, is still leading with about 30%; it is followed by Bihar, Orissa, Andhra Pradesh and Bombay. Considerable changes, however, are under way as there is a trend of decentralization and a shift towards the sources of raw material.

3. Technological charactoristics of raw material

Unlike conditions in the temperate zone, India, being mainly a tropical country, has to deal with greatly diversified raw materials. Selection of raw materials for various types of paper can be facilitated by a technological classification according to specific gravity, fibre length, fibre diameter, wall thickness, content of ash and extractives. Such an overall classification does not yet exist for Indian raw materials.

The following tentative data, collected from the Wood Anatomy Branch of the Forest Research Institute, Dehra Dun and other sources may give some indications as far as fibre length is concerned:

Type of raw material	Fibre length
a) Bamboo	
Dendrocalamus strictus	3 - 4 mm
Bambusa arundinacea	3 "
Melocanna bambusoides	2 - 2,5 "
b) Wood	
Coniferous:	
Pinus longifolia	3 - 4 mm
Pinus khasya	2.5 - 4 "
Pinus merkusii	4 - 7 "
Pinus excelsa	3 - 5 "
Pinus morinda	3 - 4 "
Abies pindrow	3 - 5 "
Broadleaved species:	
Boswelia serrata	1 mm
Dalbergia paniculata	0.9 "
Cassia simea	1.2 "
Sterculia alata	1.1 "
Eucalyptus globulus	1.1 "
Brussonetia papyrifera	0.8 "
c) Grasses	
Eulaliopsis binnata (Sabai grass)	1.8 mm
Sacharum munja (Munj grass)	2 "
d) Sugar cane bagasse	1.7 mm

4. Anticipated paper requirements

An estimate of Indian paper requirements for the period 1960 - 1975 has been compiled in Table 16, which also contains a tentative breakdown according to major paper types. Due to the present under-consumption, the rapid growth of population and progress in literacy and industrialization, it has been assumed that the present consumption of 450,000 tons will increase to 2.1 million tons during a 15 year period. (The FAO/ECAFE forecast expressed the 1975 requirements of cultural papers for South Asia as 520% of the 1953-55 consumption; see Timber Trends and Prospects in the Asia Pacific Region, G 6).

5. Tentative Program of raw material supply

The changes in the pattern of raw material supply during the last three decades are indicated in Table 17. During the first stage, as domestic production was still small, Sabai grass (Eulalipsis binnata) contributed the bulk of the raw material. The more the production developed, bamboo, which was formerly sometimes considered as weed, became the major source of supply. In future, however, new raw materials must be incorporated into the program of supply to meet rapidly the increasing demand. Table 18 summarizes the tentative production targets and the pattern of potential raw material supply for the period 1960 - 1975.

Justification:

a) Bamboo

By the development of new bamboo areas (especially in Assam), improved silvicultural methods and establishment of bamboo plantations in ecologically favourable areas, the yearly production can undoubtely be raised from 700,000 tons to 1,6 million tons during the period under view. The present average yield from existing forests may be estimated as follows:

Dendrocalamus strictus	: 0.5 tons airdry per acre and year
Bambusa arundinacea	: 0.7 " " " " " "
Melocanna bambusoides (Assam)	: 2.0 " " " " " "

Increase of yield can be expected by introduction of new fast-growing bamboo species from other tropical areas (South East Asia and Africa)

Theoretical yield data (up to 5 tons per acre and year), as reported from some parts of Japan under horticultural management are misleading and should not be anticipated for Indian conditions.

b) Wood

Coniferous species: The present pulpwood contribution of the hill areas is negligible (about 10,000 tons per year), since the transportation costs are prohibitive. On the other hand, groundwood from conifers is not only indispensable for newprint but can be added as admixture to a great number of paper types for reduction of costs. Two programs should be followed up in this respect:

(1) Development of the Himalaya region by new methods of extraction after major communication lines have been established under the new roadbuilding program;

(2) Introduction of fast growing tropical pines from Central and South America into the South-Indian States, especially to Mysore and Madras where conifers are practically unavailable.

Broadleaved species: The most important program for ensuring adequate pulpwood supply is the establishment of extensive plantations with fast growing broadleaved species, under rotations of 10 - 15 years, on carefully selected areas with the highest ecological production capacity.

A ten-years afforestation program with an annual plantation area of 150,000 acres has been suggested, resulting in a total area of 1.5 million acres after ten years.

Industrial experience in many parts of the world proved that the bulk of commercial papers can be produced from 80% shortfibre hardwood pulp mixture with 20% longfibre pulp from conifers or bamboo.

For such plantations, areas should be selected with a potential production of at least 3 tons per year and acre for ensuring a final annual output of about 4.5 million tons of raw material.

Such scheme would require only 1% of Indian forest area, but would more than double India's present production of industrial wood.

Supply of broadleaved species for pulpwood under such a scheme has been indicated for 1975 at only 1 million tons, as plantations may start in the first stage on a smaller scale and part of the raw material should also be made available for other industrial uses such as packaging, boards, matches, etc.

This scheme is considered the backbone of Indian forest industrial development.

c) Bagasse

For the end of the Second Plan, the yearly production of bagasse has been estimated at 3.75 million tons (calculated bone dry). The main centers are:

Uttar Pradesh	2.0	million tons
Bihar	0.6	" "
Bombay	0.3	" "
Andhra Pradesh	0.2	" "
Punjab	0.15	" "

Since it will take some time gradually to replace bagasse by other fuels in the sugar mills, a potential supply of 800,000 tons of bagasse has been assumed for paper in 1975.

d) Sabai grass

Supplies are not likely to increase; they have been taken as 50,000 tons per year.

e) Tall grasses

Assam has a potential production of 400,000 tons of tall grasses per year. Since grasses will be used for other purposes also, a quantity of 200,000 tons has been assumed for 1975.

6. Adjustment of techniques

The supply of raw material indicated in Table 19 will be insufficient to meet the full requirements unless the methods of paper production are also made economic, according to modern techniques.

The possibilities may be summarized as follows:

a) New types of fibrous raw material

Pre-war, paper production was concentrated more or less entirely on long fibre material; short fibre material was considered suitable only for low grade paper or cardboard. New techniques (cold caustic soda process, mechano-chemical process, monosulphite process, etc.) proved that more or less every fibrous raw material can be put to economic use for specific lines of paper or cardboard production if the raw material can be made available in sufficient quantities at reasonable price and if the methods of production are thoroughly adjusted to the technological properties of the raw material and to the product under view. Due to the great diversity of raw material, this point is of special importance for Indian conditions. Industrial trials have been initiated.

b) Higher yields

The pulping methods up to now mainly used in India enable only a yield of 35 - 40% (bleached). By modern methods, the following yields can be anticipated for all major types of raw material:

Chemical pulp:		
bleached	65%	- Conifers and certain types of hardwoods
Semi-chemical pulp:		
bleached	70%	- Conifers, hardwoods, bagasse
bleached	55%	- Bamboo
unbleached	75%	- Bamboo, conifers, hardwoods, bagasse (depithed)
Mechanical pulp:	90%	- Conifers, hardwoods

For most types of paper to be produced in India, an average yield of 60% may be assumed in future if modern production methods are applied.

7. Administrative implications

In order to foster technical development along the above lines and to guide the expanding industry, the Ministry of Commerce and Industry established the Development Council for Pulp, Paper and Allied Industries which cooperates closely with the Pulp and Paper Branch of the Forest Research Institute, Dehra Dun and other institutes concerned.

Whereas the industrial aspects of paper development are efficiently organized, the administrative procedure for ensuring adequate raw material supply still needs reconsideration. The sources of forest raw material in India are the monopoly of the States. The majority of existing and future factories will depend on several States for supplies. Up to now, prices of raw material and systems of sale differ considerably from State to State, a fact harmful to the sound development of forest industries and the encouragement of private initiative. The following points, therefore, should be considered on a high level:

a) Establishment of a suitable machinery for cooperation of States according to regions for ensuring long-term raw material supply to the existing factories and the industries under negotiation.

b) Fixation of rates and terms of sale to ensure industrial economy.

c) Decision about long-term leases to encourage investment by industries in roadbuilding, improvement of working methods and increase of yield.

Allowable raw material rates: As the price of paper has been fixed by government, the allowable forest rates can only be calculated on the basis of raw material costs at factory site, taking into account also the transportation costs of the finished products to the market.

From the technological viewpoint, the following rates may serve as indication:

Type of raw material	Allowable average costs per metric ton airdry at factory site
Spruce and fir pulpwood (debarked)	100 Rs
Bamboo	75 "
Sabai grass	65 "
Hardwoods	60 "
Tall grasses	50 "

If high-yield methods - as mentioned above - can be introduced in new factories, a gradual increase of allowable raw material costs may be anticipated, resulting in the development of more remote areas and the intensification of forest operations.

8. Indication of investments

a) Industrial investments

According to the proposed program, paper production will be increased within 15 years from 380,000 tons to 2.1 million tons, requiring an additional production capacity of about 2 million tons per year or 6,000 tons per day. Assuming that 50% of the production will be based on semi-chemical pulp and groundwood, the investments per daily ton can be estimated at US$ 120,000. The total investment required within 15 years will amount to US$ 720 million, or roughly US$ 50 million per year, of this about 70% (= US$ 35 million) in foreign currency.

Since India is producing paper machinery in the near future, the requirements of foreign currency will gradually decrease.

b) Forest investments

(1) Plantation program with fast-growing species: This program deals with the establishment of 150,000 acres of plantations per year during a 10-year period. Assuming the average costs per acre with 120 Rs (including nurseries and preliminary roadbuilding), the annual investment will amount to 18 million Rs.

(2) Development of pilot schemes in the Himalayas: it has been anticipated that the pulpwood supply from the hills can gradually be increased from 10,000 to 100,000 tons per year. This requires pilot schemes for the introduction of suitable extraction methods and training of staff. An amount of 5 million Rs per year during a period of 4 years is required for this purpose. (Equipment should be secured by way of Technical Assistance)

9. Summary

a) Indian paper consumption is estimated to rise from 450,000 tons to 2.1 million tons during the period 1960-1975. Increase of per capita consumption from 1 kg to 4 kg.)

b) Present production amounts to 350,000 tons. Imports (about 20% of the total consumption) consist mainly of newsprint and specialities. According to the development program, the total requirements in 1975 (2.1 million tons) can be met by domestic production.

c) Main lines of development:

Utilization of new types of raw material (hardwoods, bagasse, tall grasses).

Application of high-yield pulping methods, wherever feasable, for economizing raw material consumption.

Substitution of bagasse by coal or other fuels for utilizing about 25% of the bagasse output as paper raw material.

Establishment of large-scale plantations of fast-growing hardwoods (150,000 acres per year) on areas with the highest production capacity.

d) The industrial investments are estimated

	at 235 million Rs per year
the forest investments (establishment of fast-growing plantations and gradual development of the Himalaya region)	at 23 million Rs per year
Total	258 million Rs per year

TABLE 14

DEVELOPMENT OF INDIAN PAPER CONSUMPTION.

(including paper board and newsprint)

- in 1000 tons -

Years	Imports	Exports	Production	Apparent Consumption
1924-25	84.9	-	27.0	111.9
1930-31	114.7	-	39.6	154.3
1935-36	166.6	-	48.0	214.6
1940-41	105.1	4.8	87.7	188.0
1945-46	54.9	-	108.4	163.3
1950-51	109.4	1.7	107.6	228.1
1955-56	148.0	2.0	187.7	333.7
1958	71.0	2.0	277.2	346.2

Source: Paper Industry in India, by V. Podder, 1959, Page 77.

TABLE 15 .

DISTRIBUTION OF MAJOR PAPER PRODUCTION CENTERS

according to States - in 1,000 tons -

	1923	1958
1. West Bengal	24.4	77.7
2. Orissa		40.3
3. Bihar		48.1
4. Uttar Pradesh	1.8	26.2
5. Punjab		17.2
6. Madhya Pradesh		2.5
7. Bombay		22.9
8. Andhra		20.6
9. Madras		-
10. Mysore		9.0
11. Kerala		8.7
Total	26.2	273.2

Source: Paper Industry in India, by V. Podder, 1959.

TABLE 16

ANTICIPATED PAPER REQUIREMENTS

1960 - 1975

according to paper types

- in 1,000 tons -

	Item	1960	1965	1970	1975
1.	Paper and Board				
	(total, excluding newsprint)	350	700	1,200	1,800
	Tentative breakdown:				
	a) Writing and printing	200	400	700	900
	b) Wrapping and packing	60	130	200	400
	(1) Kraft	(35)	(70)	(130)	(250)
	(2) Others	(25)	(60)	(70)	(150)
	c) Miscellaneous varieties	20	40	100	200
	d) Pulp and paper board	70	130	200	300
2.	Newsprint	100	150	200	300
	Grand Total	450	850	1,400	2,100
3.	Rayon Pulp		(100)	(150)	(200)

TABLE 17

DEVELOPMENT OF RAW MATERIAL SUPPLY FOR PAPER PRODUCTION IN THE PAST

Types of Raw Material	1924 - 25		1944 - 45		1958 - 59	
	1,000 tons	Per-centage	1,000 tons	Per-centage	1,000 tons	Per-centage
Bamboo	6	13 %	187	69 %	450	70 %
Sabai grass	26	55 %	60	22 %	50	9 %
Wood pulp imported	8	17 %	7	3 %	30	5 %
Waste paper	7	15 %	6	2 %	25+)	4 %
Hemp etc.			9	4 %	25	4 %
Bagasse	-	-	-	-	20	3 %
Spruce wood	-	-	-	-	7	1 %
Salai wood	-	-	-	-	25	4 %
Total	47	100 %	269	100 %	632	100 %

+) excluding waste paper supply to mill board plants

Source: Paper Industry in India, by V. Podder, Delhi 1959, page 27

TABLE 18

TENTATIVE PRODUCTION TARGETS

	Products	1960	1965	1970	1975
		..... in 1,000 tons			
1.	Paper and paper board	350	700	1,200	1,800
2.	Newprint	30	150	200	300
	Total: Paper	380	850	1,400	2,100
3.	Dissolving pulp		100	150	200
	Grand Total (including dissolving pulp)	380	950	1,550	2,300

TABLE 19

PATTERN OF POTENTIAL RAW MATERIAL SUPPLY

	Types of fibrous raw material	in 1,000 tons airdry			
1.	Bamboo	700	1,200	1,400	1,600
2.	Wood				
	coniferous	10	20	50	100
	broadleaved	30	100	200	1,000
3.	Bagasse	100	300	600	800
4.	Sabai grass	50	50	50	50
5.	Tall grasses	-	50	100	200
	Total	890	1,720	2,400	3,750
6.	Waste paper	60	100	200	250

VII. Rayon

1. Requirements

Indian requirements for rayon are increasing fast. In 1955 consumption amounted to 38,000, in 1956 to 66,000 tons or 0.2 kg per capita, i.e. in weight nearly 20 % of Indian paper consumption. Domestic rayon production reached 17,000 tons in 1956, but additional factories have been licensed meanwhile.

World production of rayon yarn doubled from 1937-1957; staple fibre output increased about seven times during this period, resulting in a total rayon production of 2.5 million tons or about 1 kg per caput of world population.

2. Raw material for dissolving pulp

From 1975 on, annual requirements of dissolving pulp in India are likely to exceed 200,000 tons.

If bamboo is being considered as a raw material for this purpose, as suggested by Japanese experts, a yield of 25 % at the most can be anticipated, resulting in a total requirement of 800,000 tons of bamboo per year from 1975 on.

It is generally accepted that long fibre raw material, such as conifers and bamboo, should primarily be reserved for paper, whereas short fibre material, especially hardwoods, can successfully be used for dissolving pulp if modern processing methods are applied.

Indian bamboo contains - according to the Japanese investigations - about 3.7 % ash in the outer and 1.5 % in the inner part, but this ash consists to about 66 % of SLO_2, a point which needs careful consideration and adjustment of techniques.

In the case of hardwoods, this difficulty does not arise. In Central Europe yields of 35 % with temperate hardwoods are usual. As far as tropical hardwoods are concerned, the government of Indonesia initiated large-scale trials several years ago with more than hundred tropical hardwood species at the Technical University, Bandung; these proved that there is practically no difference in yield between temperate and tropical hardwoods provided the processing methods have been adjusted according to the technological characteristics of the raw material.

In order to compare Indonesian with some Indian species in this context, FAO made arrangements for the incorporation of four fast-growing hardwood species from India into the testing program at Bandung.

The main results (based on the report of Professor Dr. R.J.H. Bisanz, August 1960) may be summarized as follows:-

a) The experiments were conducted according to the sulphate process, partly with and partly without pre-hydrolysis, depending on the specific properties of the species: investigations of the viscose produced, supplemented the raw material tests.

b) The yield of dissolving pulp varied between 33% and 38%; similar to the results achieved with Indonesian species. The alpha cellulose content was also satisfactory, since for rayon and staple fibre 90 % are considered adequate (for cord 95 %).

c) The four Indian species have been classified according to their suitability for rayon pulp in the following succession:-

Eucalyptus globulus,
Anthocephalus cadamba,
Cassia simea,
Dalbergia paniculata

3. Changes in production techniques

The above results confirm that from fast-growing Indian hardwoods - separately processed - high yields can be expected by adjustment of techniques. A different point, however, is the utilization of mixed tropical hardwoods for dissolving pulp. According to recent European experiences, this problem can also be solved by observing the following principles:-

a) All species with higher ash content than 2% should be discarded.

b) Hardwoods in tropical areas should always be debarked soon after felling, since otherwise the yield will greatly decrease.

c) If transportation of the pulpwood to the mill can be arranged within a few days after felling, debarking should be centralized at mill site for reducing costs. The Swedish Cambio debarking machine which operates with pressurized water (20 - 30 at) is considered at present the most efficient equipment for this particular purpose.

d) If the wood contains gums or resins which may cause difficulties in the chemical process, a storage period of several months - preferably at mill site - should be arranged. The period required depends on the local climatic conditions and should be fixed by practical experiments.

e) Chipping of each species should be done separately. Combined cooking of mixed species is allowable, provided the composition of species is kept uniform.

f) Recent experiences also indicate that for production of high-class dissolving pulp from hardwoods, a two-stage process (first stage: treatment with magnesium sulphite, followed by treatment with magnesium bisulphite) should be preferred to the conventional sulphate method. This process is worth investigating as regards Indian raw materials.

4. Summary

a) Indian requirements of rayon pulp are likely to increase to at least 200,000 tons within 10 to 15 years.

b) Fast-growing hardwoods, such as Eucalyptus globulus, Anthocephalus cadamba, Cassia simea, proved well-suited for this purpose if processed separately; a yield of 35 % can be expected.

c) Utilization of mixed tropical hardwoods appears possible by observing certain precautions regarding ash content, composition of species, etc.

d) The proposed afforestation program with fast-growing species, primarily intended for ensuring supplies for the paper program, should include requirements for rayon pulp, estimated at 400,000 metric tons of pulpwood in 1970 and 0.6 million tons from 1975 on.

e) By the time these plantations mature, existing resources in Madras state (Eucalyptus globulus, Acacia decurrens), natural forests in Andhra Pradesh - earmarked for conversion into fast-growing species - and in case of emergency even bamboo, may fill the gap for the transition period.

VIII. Matches

1. Production and consumption trends

Prior to the first world war, nearly the total requirements of matches in India were met by imports, mainly from Sweden and Japan.

Yearly consumption at that time amounted to about 300,000 cases (each case 50 gross of match boxes, 60 sticks per box). From 1924 on, a large mechanized industry developed. In 1928 the domestic production amounted to about 360,000 cases and in 1951 total requirements of nearly 580,000 cases (or 29 million gross boxes of 60 sticks each) were produced in the country.

Development during the last decade is as follows (all figures are in cases of 50 gross 60's):-

	1950	1955	1959
Production	540,643	666,486	714,258
Export	1,510	10	4,798
Import	118	2	3
Apparent consumption: Total	539,251	666,478	709,463
Apparent consumption: (No. of sticks per head/day)	1.81	2.09	2.11

Per capita consumption in some other countries for comparison with India:

Indonesia	1.6	sticks	per	capita	/ day
Burma	2.2	"	"	"	"
Egypt	2.4	"	"	"	"
Spain	2.6	"	"	"	"
Greece	2.8	"	"	"	"
United Kingdom	6.5	"	"	"	"
India	2.1	"	"	"	"

Match consumption in India is expected to increase during the next 15 years by about 5% per year along the following lines:

	1960	1965	1970	1975
Total:	744,936	931,170	1,117,404	1,303,638
Per capita: (sticks/day)	2.19	2.57	2.92	3.23

2. Organization of the industry

The match industry in India is grouped into four categories (Class A - D) according to production capacity of the individual plant:-

	Production according to groups of industries		
	1950	1955	1957
	- in cases of 50 gross 60' -		
Large industries (Class A): (Factories producing more than 500,000 gross boxes or 10,000 cases per year)	389,175	366,666	479,318
Medium-sized industries (Class B): (Factories whose production does not exceed 500,000 gross boxes per year, but exceeds 100 gross boxes per day)	143,740	280,775	214,395
Small-sized industries (Class C and D): (Factories whose production does not exceed 100,000 gross boxes, or 25 gross boxes per day)	7,729	19,045	20,545

It may be assumed that the large sized industries are producing at present about 65%, the medium sized industries about 30%, the small sized industries less than 5% of the total.

In order to increase employment, the Government favoured the medium and small sized industries by rebates in excise duty, resulting in a considerable rise of production by these groups during the last decade.

The total labour force employed in the match industry is estimated at 40,000.

3. Requirements and supply of matchwood

Consumption (in terms of roundwood) developed during the last decade as follows:-

1950 : about 90,000 tons of 50 c.ft. (Quarter
1955 : " 111,000 " " " " girth
1958 : " 119,000 " " " " formula)

Breakdown of present requirements according to major factories (Class A) and sources of supply: see Table 20.

The suitability of the various matchwood species for splints or boxes according to quality groups appears from Table 21.

Percentage of species consumed is available only with the large industry (see Table 22).

Present consumption of matchwood per case (of 7,200 boxes) is estimated at 0.18 tons. As the diameters are gradually decreasing due to shortage of supply, a consumption rate of at least 0.2 tons per case should be anticipated for the future.

Estimate of Future Matchwood Requirements

- in tons of 50 c.ft. -

1960	1965	1970	1975
150,000	190,000	220,000	260,000

The importance of the match industry within the national economy results from three facts:

Matches are a commodity required by every household in urban and rural areas.

Match production provides - directly or indirectly - employment on a large scale.

The match industry supplies more than 100 million Rs by excise duty to the Central Government.
(One ton of timber, costing about 200 Rs at factory site, yields roughly 250 gross of match boxes equivalent to an excise duty of more than 1,200 Rs).

The future of this industry is mainly a question of ensured raw material supply. Required is a total matchwood area of 130,000 acres (net), assuming a yearly increment of 2 tons per acre as an average.

Unless immediate action is taken, this important industry will face acute difficulties in 5-10 years' time in raw material supply, resulting in a considerable drop of match production and in the closing down of factories.

Touring all States it was noticed that the practical results of the matchwood plantation program, encouraged by subsidies from the Central Government, are up to now negligible compared with present and future requirements. The main difficulty results from lack of efficient coordination between industrial planning and long-term programming of raw material supply on a national scale. This basic point will be discussed separately.

Some measures for clarifying and mitigating the situation during a period of transition may be suggested:

a) A countrywide and realistic survey of matchwood resources and of the annual yield to be expected during the period 1960 - 1975 is imperative.

b) All species suitable for match production, should be reserved for this superior purpose and not be allocated for secondary uses such as packaging material, etc.

c) Matchwood should reach factories within a three-weeks period after felling, as otherwise the waste considerably increases and the strength of the match sticks is being reduced. Arrangements with railways and shipping lines (Andamans) should include matchwood in the first transport priority to prevent deterioration.

d) The Match Industry may be asked to cooperate in a plantation scheme on suitable rural areas in Kerala and other States by distribution of seedlings to villagers interested in growing matchwood. Such a system has been successfully applied in some other countries.

e) Government agencies concerned, assisted by Women's Associations, may try gradually to popularize coloured matches which would also allow the use of wood of greyish colour at present being discarded for matchsticks.

f) To make use of small diameters not suited for peeling, new small sized machines for production of splints are at present being developed to enable processing of small logs even of 10-15 cm diameter and above.

g) In some countries in the temperate and tropical zone conifers (Europe: Picea excelsa; Indonesia: Pinus merkusii) are also being used for matches by applying efficient pressure bars and adjustment of chemical treatment. As new areas of conifers are likely to be developed in the hills during the near future, the suitability of such additional species by adjustment of processing methods should be investigated on an industrial scale.

4. Aspects of substitution

For tropical countries with high humidity during certain seasons, the production of match sticks from cardboard cannot be recommended. Utilization of cardboard has, however, proved successful for match boxes in various countries where matchwood is getting scarce (e.g. Turkey). 40% of the raw material can gradually be spared by substitution of this kind. This requires considerable investments both for, new factories producing special cardboard and additional machinery for the match industry.

5. Summary

a) The Indian match industry is well organized and is meeting the requirements of the country by 100%.

b) The requirements of matchwood will almost double during the next 15 years. Resources are inadequate. New plantations have not developed according to expectation. About 135,000 acres of matchwood plantation area (net) - distributed according to centers of consumption - are indispensable for the ensuring of demand.

c) A brief program of action has been proposed for mitigating the situation during a period of transition.

d) Due to climatic conditions, the substitution of matchwood by cardboard for splints is not recommended. It could only be considered for boxes as an ultimate measure in case of acute shortage.

e) Estimate of Future Matchwood Requirements

- in tons of 50 c.ft. -

1960	1965	1970	1975
150,000	190,000	220,000	260,000

TABLE 20

BREAKDOWN

OF MATCHWOOD REQUIREMENTS ACCORDING

TO MAJOR FACTORIES (A CLASS)

AND SOURCES OF SUPPLY

	Sources of supply	Requirements per year
Alambazar, Calcutta	West Bengal, Bihar Orissa, Andamans	15,000 tons (750,000 c.ft)
Clutterbuckganj (near Bareilly)	Uttar Pradesh, Nepal	13,000 " (650,000 ")
Dhubri (Assam)	Assam	9,000 " (450,000 ")
Tiruvottiyur, Madras	S. Kanara (now part of Mysore), Kerala, Madras, Andhra, Andamans	12,500 " (625,000 ")
Ambarnath (near Bombay)	N. Kanara (now part of Mysore), Bombay, Madhya Pradesh, N. Orissa, Andamans	18,000 " (900,000 ")
	Total	57,500 tons (3,375,000 c.ft)

TABLE 21

SUITABILITY OF VARIOUS MATCHWOOD SPECIES FOR SPLINTS OR BOXES

(x = suitable, o = unsuitable)

CATEGORY I
(superior quality)

Mainland Species	Splints	Boxes
Ailanthus excelsa	x	o
Ailanthus malabarica	x	o
Salmalia (hitherto Bombax) malabaricum	x	x
Evodia roxburghiana	x	o
Andaman Species		
Anthocephalus cadamba	x	o
Bombax insigne	x	x
Canarium euphyllum	o	x
Endospermum malaccense	x	x
Sideroxylon longipetiolatum	x	x
Sterculia campanulata	x	o

CATEGORY II
(medium quality)

Mainland Species		
Canarium strictum	o	x
Lophopetalum wightianum	x	x
Machilus macrantha	o	x
Spondias mangifera/acuminata	x	x
Trewia nudiflora	x	o
Mangifera indica	o	x

TABLE 22

MAJOR MATCHWOOD SPECIES

USED ACCORDING TO REGIONS

Estimated percentage of the species
(WIMCO/AMCO factories)

Name of Species	Ambernath %	Calcutta %	Madras %	Bareilly %	Dhubri %
1. Ailanthus excelsa	5.3	-	6.3	-	-
2. Ailanthus malabarica	-	-	19.0	-	-
3. Alstonia scholaris	17.9	-	7.0	-	-
4. Eleocarpus oblongus	3.3	-	3.9	-	-
5. Eleocarpus tuberculatus	-	-	4.5	-	-
6. Evodia roxburghiana	1.0	-	1.0	-	-
7. Gyrocarpus americanus	3.7	-	-	-	-
8. Hymenodictyon excelsum	8.0	-	9.5	-	-
9. Machilus macrantha	24.4	-	8.0	-	-
10. Mangifera indica	1.9	-	3.0	-	-
11. Symplocos spicata	-	-	0.1	-	-
12. Bombax malabaricum	8.7	62.8	12.0	80.0	100.0
13. Canarium euphylum	11.4	12.0	20.0	-	-
14. Bombax insigne	2.5	-	3.4	-	-
15. Sterculia campanulata	-	23.8	0.1	-	-
16. Endorspermum malaccense	4.0	1.2	1.3	-	-
17. Sideroxylon longepetiolatum	0.05	0.03	0.07	-	-
18. Anthocephalus cadamba	0.5	0.2	0.07	-	-
19. Trewia nudiflora	-	-	-	20.0	-
20. Canarium strictum	8.4	-	-	-	-

S U M M A R Y

Estimate of the present and potential requirements of

INDUSTRIAL WOOD
- according to major groups -
Period 1960 - 1975

Groups	1960	1965	1970	1975
	... in 1,000 tons of roundwood ... (50 cft each)			
1. Building Material				
a) Timber:				
Housing	1,200	1,400	1,600	1,800
Non-residential constructions	200	250	300	350
Rural uses	400	500	500	600
	1,800	2,150	2,400	2,750
b) Plywood and boards:				
Commercial plywood	40	80	100	120
Fibreboards	20	50	100	150
Particle boards	--	20	40	100
Waste boards	+)	+)	+)	+)
Mineralized woodwool products	--	30	70	200
	60	180	310	570
Total a + b	1,860	2,330	2,710	3,320
2. Mining	360	420	570	720
3. Transport and Communication				
a) Railways (sleepers)	350	400	400	200
b) Ship- and boatbuilding	120	140	180	220
c) Power, telephone and telegraph	10	15	20	30
d) Vehicles (coaches, trucks, buses, carts)	260	270	300	315
Total a - d	740	825	900	765
4. Woodworking Industry	400	456	513	595
5. Packaging				
a) Wood	300	400	500	600
b) Plywood	80	90	100	110
Total a+b	380	490	600	710
6. Pulp and Paper	40	120	250	1,100
7. Rayon	--	400	600	800
8. Matches	150	190	220	260
Total: Major requirements	3,930	5,231	6,363	8,270
Minor requirements (cottage industries, handicraft, etc.) 15% of total	590	785	954	1,240
GRAND TOTAL:	4,520	6,016	7,317	9,510

+) based on forest or agricultural residue

IX. Fuelwood

1. Energy consumption pattern in India (in comparison to other countries)

Indian present consumption of energy is estimated at 0.35 tons coal equivalent per capita and year, i.e. about 20% of the per capita world average. According to present forecasts, the total energy requirements of the country will more than double by 1975. It is, therefore, of paramount importance to investigate what contribution forestry (or more general: tree growth) can render in this field and which line should be followed.

World trends in the pattern of energy consumption (heat and power) according to major souces for the period 1860 - 1940 appear in Table 23.

Striking is the tremendous increase of "primary energy" (such as coal and oil), whereas fuelwood - formerly the most important item - decreased by more than 90%. Agricultural residue (including dung), however, remained more or less stable during this long period.

Trends in India - in comparison with some other eastern and western countries - are also shown in Table 23.

2. Requirements and Supply of Fuelwood in the Past

a) Requirements

About two-thirds of India's present energy consumption is still based on "secondary sources", such as fuelwood, charcoal, agricultural residue and dung (see Table 24: Pattern of Energy Supply in India). The bulk of the total energy - about 70% - is used in households. Present requirements of fuelwood (including charcoal) are estimated at 32 million tons of coal equivalent (or nearly 25% of the total energy requirements of the country).

b) Supply.

Estimate of Present Fuelwood Supply

Recorded	450 million cft
Unrecorded	2,450 " "
Total	2,900 million cft
= about 60 million	tons (50 cft each)
= " 85 "	m3
= " 30 "	tons coal equivalent.

During the period 1950 - 1956 the data of recorded production varied considerably (see Indian Forest Statistics 1949/50 - 1955/56), the highest figure being 8.4 million tons of 50 cft (= 421 million cft) in 1950/51, the lowest 6.5 million tons (= 328 million cft) in 1953/54. According to provisional data recently supplied by the States, recorded production rose apparently to about 9 million tons. This figure has been accepted as a basis of calculation (see Table 25: Balance of Supply and Consumption of Fuelwood). Wood for charcoal amounts to about 15% of the recorded production.

The most essential fact to be considered in planning fuelwood supply is the gradual decrease of unrecorded production due to over-consumption in the densely populated areas. It is therefore indispensable to increase recorded production to fill the gap.

3. Future Requirements

According to the National Council of Applied Economic Research, the demand for energy is expected to rise from about 154 million tons coal equivalent in 1960 to 316 million tons in 1975.

In 1955 more than 65% of the total energy were still derived from secondary sources (fuelwood, charcoal, agricultural residue and dung), about one-third of this from fuelwood.

The 1960 - 1975 forecast is based on the assumption that the increase of requirements, including supplies to urban households, will be met totally by primary fuels. The rural areas, however, will be left more or less to the secondary fuels. The problem is aggravated by the fact that cow-dung should gradually be substituted by other fuels in order to increase agricultural production. It has been estimated that an additional production of 9 million tons of feed grain per year can be anticipated under such a program, considering the nitrogen content only.

Unless new inventions basically change the pattern of energy, fuelwood consumption, supplemented by agricultural residue, represents the only solution for substitution of cow dung in those areas where the low purchasing power is the limiting factor.

4. Means of Economizing Fuelwood Consumption

During the past few years, FAO, assisted by Swiss Bilateral Aid has initiated comprehensive investigations into the possibilities for increasing the efficiency of cooking devices used in the East. Research carried out by the Fuelwood Laboratory of the Central Forestry Association of Switzerland, Solothurn (officer in charge: Mr. H. Singer), proved very successful and has been followed up by practical work in Indonesia (1959/60) for checking the results under tropical conditions and the training of personnel in the construction and efficient handling of such devices. The results may be summarized as follows:-

a) Charcoal burners

Efficient use of charcoal for cooking is quite easy due to the high calorific value, the low flame and the absence of tar. Efficiency depends mainly on the insulating properties of the material (usually burned clay) and the distribution of holes in the grate for ensuring proper circulation of air. Cooking efficiency ranges between 30-35%.

For larger kitchens (restaurants, etc.) another type has been suggested which can accommodate several cooking vessels and contains grates of different sizes according to the type of food to be prepared.

b) Wood-burning kitchen stoves

Fuelwood requires - compared with charcoal - an entirely different technical approach in order to make full use of the large flame and high percentage of volatile matter. When cooking food on an open fire in the traditional way, efficiency does not exceed 5-10%. Even in kitchen stoves without a chimney, where slits serve as an outlet for smoke, efficiency is usually the same.

Scientifically designed kitchen stoves, although locally built, but supplemented by appropriate types of cooking vessels reach a cooking efficiency of 25-28%, requiring only half the fuel compared with traditional types.

Such stoves can either be built low or high, depending on local customs. (Fig. 19).

The increase of efficiency from 10 to about 28% can mainly be attributed to the following interrelated facts:

		Improvement
(1) Installation of a chimney for disposal of smoke		
(2) Correct design and dimensions of fire channel		10%
(3) Facility for regulation of air (by a door or brick, for adjusting the opening of the firehole)		
(4) Increase of the number of cooking places from two to three for making better use of the large flame	about	4%
(5) Use of appropriate types of cooking vessels, extending about 2 inches into the fire channel in order to make full use of the flame		4%
Total increase of efficiency		18%

The Planning, Research and Action Institute, Lucknow (Uttar Pradesh), initiated a similar study on Indian Smokeless Chulas (published in a report on Rural Health, PRAI Publication 146, 1957). The results of the work in Indonesia will be published by FAO in due course.

c) Room heating in hill stations

Great quantities of fuelwood are required in Indian hill stations, especially in hotels, for the heating of rooms during the cold season. The traditional fireplaces have a very low efficiency which can be more than doubled by a proper design as applied in Switzerland. (See drawing: Figs. 20 and 21)

The improvement consists mainly in a system of air circulation: The chimney is divided by a thin sheet iron plate into two chambers, of which the inner chamber serves for disposal of smoke, whereas the heated air of the outer chamber is directed into the room.

These examples prove that the consumption of fuelwood can be greatly economized and reduced by 50% through simplified modern techniques applicable in urban and rural areas. It should, however, be kept in mind that various factors (climate, type of fuel, pattern of nutrition and general customs) require a differentiation and certain adjustment of techniques according to regions.

5. Possibilities for increasing fuelwood supply

If decision will be taken to replace gradually also cow-dung by fuelwood, (within a 20 years development program), fuelwood requirements in 1975 may be estimated as follows:-

Usual requirements:	about 30 million tons coal equivalent
Partial replacement of cowdung :	" 20 " " " "
Total	about 50 million tons coal equivalent
or	" 100 million tons of fuelwood

Increase of consumption has not been taken into account since it should be compensated by more economical use as indicated above.

As the unrecorded sources of fuelwood available in the past are likely to decrease, we anticipate that 80% of the total should be made available by new plantations.

A quantity of 80 million tons of fuelwood per year requires a gross area of about 60 million acres, assuming an annual increment of 1.5 tons per acre and year.

Under a 20-year development program, 3 million acres should be planted every year to ensure the usual fuelwood requirements and gradually substitute cow dung by other fuels.

The Land Use Classification under way in several States should examine to what extent areas suitable for village forests can still be made available within such a national program.

The silvicultural and economic principles on which a plantation program of this kind could be based have been discussed in the FAO publication "Fuelwood Plantations in India" by J. N. Sen Gupta, Rome, 1958.

6. Summary

Fuelwood represents a basic problem in India's Rural Development Program: domestic supply of oil is inadequate, coal plentiful but difficult to distribute over large areas and usually not suited for cooking in village households; secondary fuels (fuelwood, agricultural residue and dung) still prevail; availability of agricultural residue as fuel will continue, unrecorded production of fuelwood tends to decrease in densely-populated areas; cow dung will be badly required for manure and should be substituted by other types of fuel.

Increase of village forests by rural communities or individual farmers under government guidance seems the only possibility for filling the gap and providing the fuel at a price which the farmer can afford.

The efforts for increased supplies should, however, be supplemented by the more economic use of fuel, since improved, locally-build cooking devices could greatly reduce consumption. Both increasing production and economizing consumption should simultaneously be taken up under the Community Development Program in cooperation with the forest authorities concerned.

Tentative Estimate
of
FUELWOOD REQUIREMENTS

	1960	1965	1970	1975
	.. In terms of million tons .. (50 cft each)			
Normal requirements	60	60	60	60
Partial replacement of cow dung	-	-	20	40
Total	60	60	80	100
	.. In terms of million tons .. coal equivalent			
Usual requirements	30	30	30	30
Partial replacement of cow dung by fuelwood in rural areas (under a 20-year development program)	-	-	10	20
Total	30	30	40	50

NOTE: Increase of consumption due to population growth should be compensated by popularizing more efficient cooking devices and substitution with primary fuels.

TABLE 23

CHANGES IN THE PATTERN OF ENERGY CONSUMPTION *

I.

WORLD

Percentage of major sources of energy

	1860 %	1900 %	1920 %	1940 %
Bituminous coal	24.6	54.3	58.2	49.2
Anthracite	-	-	-	3.7
Lignite	0.7	3.5	4.9	6.4
Crude oil	0.02	2.3	6.8	14.2
Natural gas	0.69	0.9	1.4	3.7
Wood	57.1	22.1	11.8	5.6
Hydro	-	0.03	0.2	0.5
Agricultural residue (incl. dung)	16.7	16.7	16.7	16.7

II.

INDIA

Percentage of major sources of energy

	1880 %	1900 %	1920 %	1940 %
Coal	1.4	6.2	20.2	20
Crude oil	-	0.3	1.5	1.8
Wood (recorded production only)	4.7	4.4	3.7	3.7
Dung	94	89.1	74.4	74.4

III.

JAPAN

	1920 %	1940 %
Coal	52.8	61.2
Lignite	0.3	0.2
Crude oil	1.4	7.6
Wood	43.4	27.8
Hydro	2	3.2

IV.

ARGENTINA

	1920	1940
	%	%
Coal	26.1	9.5
Crude oil	26.7	49.1
Wood and charcoal	30.6	20.4
Agricultural residue (incl. alcohol)	18.4	16.7

V.

UNITED STATES

	1860	1880	1900	1920	1940
	%	%	%	%	%
Anthracite	6.7	11.8	13.7	11.1	4.9
Bituminous coal	5.7	21.7	51	61.6	45.5
Lignite				0.2	0.2
Crude oil	0.1	1.8	2.4	13.1	31.3
Natural gas	0.3	0.8	2.4	3.8	9.8
Wood	87.1	63.8	28.3	10.9	7.5
Hydro	0.1	0.1	0.1	0.4	0.7

VI.

UNITED KINGDOM

	1860	1880	1900	1920	1940
	%	%	%	%	%
Coal			100	99.8	92.4
Crude oil				0.2	7.5
Hydro					0.04

VII.

GERMANY

	1860	1880	1900	1920	1940
	%	%	%	%	%
Coal	77.9	91.8	74.5	59.6	66.4
Lignite			21.5	37.3	27.6
Crude oil	-	-	0.05	0.03	2.4
Gas					0.01
Wood	22	8.2	3.8	3.6	3.6
Hydro	-	-	-		0.2

VIII. **

INDONESIA

Percentage of major sources of energy

	1938 %	1950 %	1956 %
Coal	5.83	3.51	3.56
Oil products	6.75	10.12	19.80
Hydro	1.87	2.19	2.67
Wood	85.55	84.18	73.97

* Source: ENERGY IN THE FUTURE by Palmer Cosslett Putnam. Macmillan and Co. Limited, St.Martin's Street, London. (1954.) Page 439.

** FAO Report No. 546.

TABLE 24

PATTERN OF SUPPLY OF ENERGY IN INDIA (1955)

- In million tons coal equivalent -

I. Primary Sources

1.	Coal	32.3
2.	Electricity	9.6
3.	Oil products	6.5
	Total ...	48.4

II. Secondary Sources

1.	Fuelwood (solid)	31
2.	Charcoal	1
3.	Agricultural residue ..	23.5
4.	Dung	39
	Total	94.5

I + II
Total : 142.8

BREAKDOWN OF MAJOR ENERGY REQUIREMENTS

according to major end uses

- In million tons coal equivalent -

Households ...	99.4
Industry	19.2
Transport	13.2
Public services	1.2

CONSUMPTION OF VARIOUS TYPES OF ENERGY IN HOUSEHOLDS:

Urban and Rural Areas

- In million tons coal equivalent -

		Urban	Rural	Total
1.	Coal	2.0	-	2.0
2.	Electricity	0.2	-	0.2
3.	Kerosene	0.3	-	0.3
4.	Fuelwood (incl. charcoal)	8.5	23.5	32.0
5.	Agricultural residue, etc.	5.0	18.5	23.5
6.	Dung	4.0	35.0	39.0
	Total	20.0	77.0	97.0

TABLE 25

BALANCE OF SUPPLY AND CONSUMPTION OF FUELWOOD

Estimate: 1958/59

Supply			Consumption
Source	Quantity million cft		
I. Recorded Production			
1. Fuelwood	400		
2. Wood for charcoal	50		
Total recorded		450	Households: 95% Other uses: 5%
II. Unrecorded production			
1. Fuelwood	2,300		
2. Wood for charcoal	150		
Total unrecorded		2,450	
GRAND TOTAL (I + II)		2,900	

= about 83 million m3
= " 50 million metric tons
= " 25-30 million tons coal equivalent

TABLE 26

ESTIMATE

OF TOTAL ENERGY CONSUMPTION IN INDIA

by type of energy and major end uses
1955 - 1975

- In million tons coal equivalent -

	* Primary Energy					** Secondary Energy	
	Industries	Transport	Services, etc.	Households	Total	Mainly Households	GRAND TOTAL
1955	17.9	12.1	3.1	4.3	37.4	93.7	131.1
1960	28.7	14.9	6.0	10.0	59.6	92.5	152.1
1965	45.4	18.7	12.0	18.9	95.0	95.1	190.1
1970	67.6	21.7	22.0	32.7	144.0	96.3	240.3
1975	105.0	28.4	45.0	58.5	236.9	79.0	315.9

* Primary Energy: Coal, oil, natural gas, hydroelectric power.

** Secondary Energy: Fuelwood, agricultural residue, dung, etc.

Source: DEMAND FOR ENERGY IN INDIA. National Council of Applied Economic Research, New Delhi. Asia Publishing House, 1960. Pages 32-33.

X. Tanning Material

Assessment of requirements and supply of tanning material should be based on a brief analysis of the tanning and leather goods industry as well as on the availability of livestock and hides according to regions.

1. India's leather and leather goods industry

India's total leather production per year is estimated at 135,000 tons, of this roughly 120,000 tons vegetable tanned leather and 15,000 tons chrome tanned.

There are four types of tanning industry in the country :

(a) Organised, large tanneries using both vegetable and chrome tanning.
(b) Small-scale chrome tanneries (mostly in the Calcutta area).
(c) Small-scale vegetable tanneries, mainly situated in South India and specialized in semi-finished products (largely goat skins for export).
(d) Village tanneries, producing vegetable-tanned hides and skins.

Statistical data are only available with the organized large-scale industry.

Distribution and Capacity of the Organized Tanneries *

State	Vegetable Tanning		Chrome Tanning	
	No. of units	Annual capacity (in terms of cow hides) (Numbers)	No. of units	Annual capacity (in terms of cow hides) (Numbers)
Uttar Pradesh	12	2,238,720	5	888,000
W. Bengal	2	306,000	2	339,000
Madras	5	390,000	3	165,000
Bombay	3	200,400	1	120,000
Mysore	2	132,000	1	60,000
Bihar	1	316,800	-	-
Punjab	1	96,000	-	-
Madhya Pradesh	1	30,000	-	-
Orissa	1	27,000	1	7,800
Andhra Pradesh	1	120,000	-	-
	29	3,856,920	13	1,579,800

Production of Tanned Hides

(in terms of cow hides)*

Year	Vegetable Tanning (Nos.)	Chrome Tanning (Nos.)
1950	1,514,400	495,600
1955	1,635,600	676,700
1957	1,791,855	630,462

From the above figures, it appears that only about 50% of capacity is being utilized, mainly due to shortage of raw hides in the country.

The most important line of leather processing is the production of footwear.

The bulk of the footwear (about 90%) is being produced in small-scale or cottage units, and 10% only in large-scale factories.

Estimated Quantity of Footwear Production * per year

	Western Type	Indian Type	Total
	... Million pairs ...		
Small-scale and cottage units	13.0	74.0	87.0
Large-scale factories (1957) - mainly West Bengal and Uttar Pradesh	4.37	3.0	7.37
Total	17.37	77.0	94.37

* Source: JOURNAL OF THE INDIAN LEATHER TECHNOLOGISTS' ASSOCIATION (Vol.6, May-June 1958, No.3; pages 107 and 113).

Estimated Consumption Rates

Total leather:	0.3 kg	per capita and year
Footwear:	0.2 pairs	" " " "

For comparison

Indonesia	0.17	per capita and year
Yugoslavia	0.6	" " " "
Europe (total	1	" " " "
United Kingdom	2	" " " "

Employment

The number of persons employed in large-scale industry (tanneries and production of leather goods) is estimated at 10,000, whereas employment in the small-scale and cottage industry is estimated by the National Income Committee's Report (1954) at 763,000, i.e. about 6.6% of the total labour force employed in all small enterprises.

2. Supply of hides

The total livestock population of India in 1945, 1951 and 1956 has been estimated as follows:

	1945	1951	1956
	... million heads ...		
Cattle	136.0	155.2	158.6
Buffaloes	40.6	43.4	44.9
Sheep	37.7	39.0	39.3
Goats	46.3	47.1	55.4
Horses and ponies	1.4	1.5	1.5

For distribution of bovine population (cows and buffaloes) according to States, see Table 27; estimated supply of hides, Table 28 .

3. Requirements and supply of tanning material

(a) Requirements

For production of one ton of finished leather, usually one ton of wattle bark equivalent is required.

India's total leather production - excluding goat and sheep skins, which are mostly exported semi-tanned - amounts to nearly 120,000 tons, requiring about 120,000 tons of wattle bark equivalent.

It was previously anticipated that village tanneries, which produce almost 40% of the total, would not need to be included in a program for supply of commercial tanning material as they collect their requirements locally from non-commercial sources.

Due to shortage of hides in the country and the inferior quality of leather produced up to now by most village tanneries, it is essential to reorganize this sector and to supply more and more uniform tanning material also to the village tanneries for improvement of quality.

At present, the bulk of the commercial requirements is still confined to the industrial sector, but gradually village crafts ought to be included in a program of organized supply. The trend of commercial requirements may therefore be estimated as follows :

1960 :	70,000	tons	of	wattle	bark	equivalent
1965 :	80,000	"	"	"	"	"
1970 :	95,000	"	"	"	"	"
1975 :	110,000	"	"	"	"	"

(b) Supply

There are practically no reliable data about the prospects for meeting the demand since the major part of the present production is unrecorded. A techno-economic survey for clarifying the situation is indispensable. Such survey should be based on technical units, such as wattle bark equivalent.

For practical reasons, a distinction may be made between primary (commercial) tanning materials and secondary types, mostly locally used.

(1) Primary tanning materials

This group is mainly represented by wattle (Acacia decurrens or A. mollissima) and babul (Acacia arabica).

Anticipated Production
in tons

	1960	1975
Wattle ...	3,000	10,000
Babul ...	27,000	50,000
Total ...	30,000	60,000
In terms of wattle bark equivalent	20,000	40,000

Wattle: Ecological conditions for growing wattle on a large scale are only favourable in the hills of Madras State and in certain areas of Assam. All trials for commercial production of wattle in the northern areas (Punjab, Uttar Pradesh) have not proved successful and should be ruled out of a realistic program.

Unfortunately, the wattle plantations under the Forest Department in Assam are confined to only a few hundred acres. Much larger tracts of

suitable land exist in the tribal areas, but cannot be made available for this purpose. Madras, therefore, is the only State which accounts for commercial supply in the future.

According to experience in other countries in the East, the annual increment may be anticipated with 0.3 tons of dry bark per acre.

Babul: Whereas wattle is only being grown by the Forest Department, babul bark is derived to a large extent from private areas. The center of the best babul bark is Punjab. The tanning industry claims that there are considerable differences in quality according to ecological conditions and strains. Further research in this field is suggested.

(2) Secondary tanning materials

Among the great number of additional tanning materials, the following are the most important :

Goran bark (Ceriops roxburghiana) from the Sunderbans, available in a quantity of 3-5,000 tons per year;
Konan bark (Cassia fistula);
Avaram bark (Cassia auriculata);
Karada (Cleistanthus collinus);
Myrabolans (Terminalia chebula).

The resources of these species are scattered and only available in limited quantities, except myrabolans, which is used for special products only and therefore available for export. (Value of exports in 1958: crushed and whole 4.8 million; fruit extracts 0.4 million; total = 5.2 million Rs.)

For most of these secondary tanning materials, no reliable production data exist as they represent unrecorded supplies mainly.

4. Additional possibilities

(a) Production of extracts and blends

Production of extracts and blending is essential for utilizing a great number of additional species which are partly in large supply but can only be used economically in mixtures. Examples are the bark of sal (estimated tannin content up to 15%) and several oak species in the foothills of the Himalayas (tannin content up to 25%).

(b) Introduction of new species with high tannin content

Wattle is an exotic species which has been introduced with great success in India as well as in several other countries. Unfortunately, ecological conditions in India allow plantation of wattle only in very limited areas, inadequate to meet requirements. There are, however, a

number of other species, especially in Australia, which have a high tannin content and may be suitable for Indian conditions. A special study of this aspect of plant introduction is recommended.

(c) Substitution

Waste liquor of the paper industry, especially when using hardwoods, is being converted in Central Europe on a commercial scale into certain types of tanning material for export to South America. The best results have been achieved by blending natural products with about 30% of this new material. Some details are added on page 99. It is suggested to supply certain quantities to the Central Leather Institute, Madras, as well as to commercial tanneries to find out whether this production should be taken up in India.

5. Summary

(a) India's total yearly leather production is estimated at 135,000 tons, of which about 120,000 tons are vegetable tanned. For one tone of finished leather, roughly one ton of airdry wattle bark (or wattle bark equivalent) is required, amounting to 100-120,000 tons of wattle bark equivalent for the whole country (including cottage industries)

(b) Domestic supplies of primary tanning material in India are inadequate (value of imported tanning material up to 10 million Rs per year). Even by incorporating more and more secondary tanning materials from barks, leaves and fruits, requirements can presumably be met only up to 60% within the country under the present pattern of supply.

(c) Considerable improvements can be achieved by setting up extraction factories in several parts of the country for reduction of waste and production of blends from various types of secondary tanning material (including sal, oak, etc.), resulting in higher efficiency and development of additional resources.

(d) Introduction of new species with high tannin content from other parts of the world, specifically suited for India's ecological conditions, is promising.

(c) Partial substitution of natural tannin by products from waste liquor of the pulp factories is likely to increase supplies by 30%.

TABLE 27

DISTRIBUTION OF BOVINE POPULATION

according to States

	Million head	Bovine per 1,000 of human population
Andhra Pradesh	16.1	500
Assam	5.5	592
Bihar	17.3	432
Bombay	25.2	497
Jammu and Kashmir	2.1	453
Kerala	3.0	210
Madhya Pradesh	27.1	988
Madras	11.4	372
Mysore	11.3	561
Orissa	8.6	570
Punjab	9.8	568
Rajasthan	15.3	915
Uttar Pradesh	32.4	485
West Bengal	12.0	434
Others	2.1	490
INDIA :	199.2	528

Source: INDIAN AGRICULTURAL ATLAS (1958, page 92)

TABLE 28

ESTIMATED SUPPLY OF HIDES

(excluding goat and sheep skins)

TO ALL TYPES OF TANNERIES

Region	Big tanneries	Small industrial tanneries	Village tanneries	Total (million units)
	- In millions of cow hide units -			
South Kerala, Mysore, Madras, Andhra Pradesh	0.4	6.0	3.0	9.4
East Orissa, Bihan, W.Bengal, Assam	0.4	1.0	1.0	2.4
North Uttar Pradesh, Punjab, Jammu and Kashmir, Himachal Pradesh	1.4	1.5	3.0	6.9
West Bombay, Madhja Pradesh, Rajasthan	0.1	1.5	2.0	3.6
Total :	2.3	10.0	9.0	21.3

POSSIBILITIES FOR CONVERTING WASTE LIQUOR FROM PULP FACTORIES INTO TANNING MATERIAL

Even before the war, waste liquor from pulp factories was used in several European countries to a small extent for conversion into some kind of tanning material. These experiments have been activated meanwhile by cooperation between paper technicians and leather experts, with the result that a certain stage of perfection has now been reached. The products found a good market in Europe and abroad.

Experience was as follows:

1. Waste liquor, produced by the sulphite or monosulphite process, is primarily suited for this purpose. The best raw material represents waste liquor from rayon pulp factories, using hardwoods. This was one of the reasons why this particular production has been favoured in Austria, where large quantities of rayon and staple fiber are produced from hardwoods (beech).

2. Waste liquor must be evaporated at site and then further processed and refined into various grades of tannin.

3. Application is restricted to mixtures with natural tannins; it can be used to an extent of 30-50%.

4. Under European conditions, this product is about 20% cheaper than imported extracts (contents of active tannin about 60%).

5. The outturn of waste liquor in rayon pulp factories is more or less equal to the production of pulp (if related to dry matter).

XI. Lac, Rosin and Turpentine (including some other extractives)

1. Lac

Lac is the secretion of the lac insect (Laccifer lacca), parasitic on certain trees such as Butea monosperma, Zizyphus mauritiana, Schleichere oleosa and others.

Lac has been known in India and China for several thousand years. In early times, attention was mainly directed not to the resin but to a purple-red liquor obtained by soaking the lac secretion in water for use as medicine and for dyeing silk and leather. From about 1870 on, Western countries became keenly interested in lac resin and the number of uses expanded rapidly.

(a) Production

World consumption of lac - in terms of crude resin (Sticklac) - may be estimated for the average of the last ten years at 60,000 tons. About 70% has been supplied from India, the rest from Thailand, and, to a small extent, from Burma. In India, the States of Bihar and Madhya Pradesh are the main production centers.

India's Production, Import and Export of Lac

(Average: 1947-1955 in metric tons)

Production	Imports	Total	Internal use
	Sticklac		
37,980	4,315	42,295	1,150

Exports

Shellac	Seedlac	Sticklac	By-products	Total
17,480	9,080	150	2,270	28,980

Note: In refining sticklac into shellac or seedlac, a yield of about 60% has been presumed under Indian conditions

During the last few years, Thailand's production of crude lac has been steadily increasing, whereas India's lac production has remained more or less stable.

Pre-war, Thailand's annual production, which amounted only to about 3,500 tons, was exported to India for refining. After the war, Thailand's

share rose to about 22,000 tons and is likely soon to reach the level of India's production. The percentage of exported crude resin from Thailand to India gradually decreased, however, to 20%, the major quantity being processed within the country.

(b) Export

From the above table it appears that only 3% of Indian lac production is used locally. Lac, therefore, is a distinct export commodity. The value of exports reached in 1954/5 was about 105 million Rs.

(c) Consumption trends

The question has been frequently raised as to whether lac as raw material will gradually be replaced by synthetic products on the world market. For several Indian States this problem is crucial, since lac export supplies a large amount of foreign exchange and also ensures employment for a very great number of people in rural areas. At present there is no definite answer to this question.

Past trends, however, may render some indications:

Annual quantity of lac export from India				Prices (per maund = 37 kg)	
1830	...	300	tons	Rs	20
1895-1900	...	8,000	"	"	45
1910-1915	...	20,000	"	"	35
1936-1937	...	41,600	"	"	22
1948-1954	...	29,700	"	"	119

From these data, it appears that a further increase in production in India is doubtful, since raw material supplies from Thailand are diminishing. Export prices fluctuate considerably due to differences in annual crop and competition. The pattern of consumption has also changed: pre-war, the gramophone record industry was one of the main consumers, this meanwhile has switched over to synthetic products. At present, the woodworking industry ranks first, followed by various other industries dealing with insulation, moulded compositions, production of grinding wheels, lamination of paper, etc.

In order to have up-to-date information from the Central European market, the writer forwarded a questionnaire to various industries and research centers, asking their suggestions.

In general, the opinion prevails that lac has specific properties, superior to synthetic products for a number of conventional and new applications. It will be a matter of price, standardization, research and progressive combination with other products to what extent lac can maintain its position in the world market.

References: Shellac, - Angelo Bros. Ltd., Calcutta, 1956.
Uses of Lac, - Indian Lac Research Institute, Ranchi, Bihar, 1959.

2. Resin and Turpentine

Resin is indispensable for the sizing of paper, production of soap, paints, varnishes and a great number of other uses. The marketing of turpentine, which represents about 25% of the distillation products, has become a problem in most parts of the world, since it is being replaced by cheaper products based on mineral oils. Conversion of turpentine into new products (synthetic camphor and insecticides) may gradually solve this surplus problem, closely connected with the economy of resin production.

Present world production of resin is estimated at 500,000 tons excluding USSR and mainland China. Two-thirds are supplied from the USA, the major part by extraction of stumps. Resin production in mainland China is also increasing fast (present estimate: about 100,000 tons production capacity per year).

(a) Resources

Indian pine resources may be assessed as follows :

Pinus roxburghii (Chir pine, syn. P. longifolia) : about 3,200 sq. miles;
Pinus wallichiana (Kail, syn. P. excelsa) : about 900 sq. miles;
Pinus khasya : Confined to the tribal areas of Assam and therefore to be discarded for the time being.

At present, only Chir pine can be taken into account for large-scale resin supply.

(b) Production

Estimate of Resin Production (1959)
- According to States -

Uttar Pradesh	12,400	metric tons
Himachal Pradesh	6,700	" "
Punjab	6,500	" "
Jammu and Kashmir	2,600	" "
Total :	28,200	metric tons
In terms of rosin, about :	20,000	metric tons.

(c) Export

Some years ago, resin was still in surplus and available for export; domestic demand, however, has meanwhile increased to such an extent that it will become difficult to meet even internal requirements.

Exports in 1955	4,014 metric tons.
Exports in 1959	Negligible.

(d) Estimated requirements for resin

Consuming industries	1952	1960	1965	1970	1975
	- In metric tons -				
Paper ...	2,000	7,500	13,000		
Soap ...	5,000	10,000	17,000		
Surface coating ...	2,500	5,000	9,000		
Disinfectants ...	500	900	1,800		
Total:	10,000	23,400	41,800	(60,000)	(85,000)

(e) Development of supplies

In 1958, about 65% of the resin production was supplied by organized, large plants and the balance by small-scale units. The present production of about 20,000 tons may gradually be increased to 30,000 tons by development of additional areas, by improvement of tapping methods, training of labour force and an adequate system of payment to encourage workers to achieve higher yields. Under present conditions, the yields vary considerably (from 200 kg = about 5 maunds per 100 blazes in Jammu and Kashmir to 400 kg = about 10 maunds in Punjab), partly due to ecological conditions but to a large extent caused by differences in working methods and efficiency.

There are two other points which require special attention for increasing resin supplies :

(1) Establishment of a more uniform price policy :

At present the rates fixed by the governments for the sale of resin vary up to 50%, since government plants usually get concessional rates which, however, are inadequate for development of more remote areas. A high-level decision is required for adjusting prices of raw material and finished products in such a way that maximum supplies will be ensured in the future.

(2) Production of resin from pine stumps :

Up to now, this method, widely used in the USA, has not been applied in India, as most pine forests are located in mountainous areas where prevention of soil erosion is of the utmost importance. There are, however, also considerable pine stands on flat ground or on gentle slopes. A classification of Chir pine areas from the topographical viewpoint is recommended to find out to what extent extraction of stumps may supplement in the future the conventional methods of resin production.

For a transition period, imports of resin will be indispensable until all domestic sources have been fully developed.

3. Katha and Cutch

Katha - in combination with betel leaves - is the main ingredient for "pan", used extensively all over India for chewing. It is extracted from the heartwood of Acacia catechu (Khair). Annual production of Katha is estimated at 3,000 tons, of which about 50% is derived from industries, the rest from small cottage plants. (Value of production from all sources: 20-30 million Rs per year.)

The heartwood of this species contains about 3-4% of extractable katha but, in addition, some 6% of cutch, which is at present recovered only to a small extent. Investigations by the Forest Research Institute, Dehra Dun, in cooperation with the Central Leather Research Institute, Madras, proved that cutch - after blending with other extracts (babul, wattle, myrabolans) - can be used as tanning material for various types of leather. The Forest Research Institute developed a type of small equipment for producing cutch along with katha on a cottage industry scale.

The potential production of cutch is estimated at 10,000 tons of actual tanning material.

Integrated production of katha and cutch along modern lines will create additional employment and reduce foreign exchange, otherwise required for tannin imports.

References: KATHA AND CUTCH INDUSTRY - by Dr. Sadgopal, The Himachal Times, December 1956.

MANUFACTURE OF KATHA AND CUTCH ON A COTTAGE-SCALE BASIS - by B. S. Varma, T. R. Rao, T. C. Pathak and S. V. Puntambekar, Indian Forester, November 1958.

CUTCH AS A POTENTIAL TANNING AGENT IN SMALL-SCALE AND COTTAGE INDUSTRY - by Dr. Sadgopal (Symposium on Tanning as a Small-scale Cottage Industry), 1959.

XII. Medicinal Plants and Essential Oils

India is one of the richest countries in medicinal plants and essential oils, but production is still insufficiently organized and can be considerably increased by making use of the great variety of ecological conditions and the resources of cheap labour.

Large quantities of medicinal plants which could be grown within the country are still being imported (imports in 1958 estimated at 15 million Rs). Essential oils, however, are distinct export commodities (export value in 1958 about 35 million Rs).

1. Medicinal plants

For the collection of basic data and evolving a realistic development program, close cooperation with the Central Indian Medicinal Plants Organization (Council of Scientific and Industrial Research, New Delhi) was established. This organization (CIMPO) agreed with the following work program :

Estimate of requirements of the most important medicinal plants (confined for practical reasons to 19 items in the first stage).

Assessment of imports and exports.

Planning of production, including selection of ecologically most suitable localities for growing these plants under the guidance of the Forest Department or other agencies concerned.

Proposals for more efficient marketing.

Tentative data derived from this cooperation are compiled in Tables 29 and 30.

Preliminary results may be summarized as follows :

(a) The supply of medicinal plants in sufficient quantities and at reasonable prices should include both the western pharmacological as well as the various indigenous medicinal systems practised in the country.

(b) Unorganized and wasteful collection of plants from scattered natural resources, leading to extermination of valuable species, should gradually be replaced by the establishment of efficient plantations under scientific control.

(c) For the time being, efforts should concentrate on those States which are already specializing in the production of medicinal plants and which - from the ecological viewpoint - are specifically suited for such cultivation (Jammu and Kashmir, Madras, Kerala, West Bengal, Assam).

(d) The main incentive for increasing production consists in a thorough forecast of requirements, stable prices and arrangements for proper marketing under government guidance.

The greatest handicap, which prevented increase of production in the past, was the lack of information about consumption trends, prices and marketing channels. This problem could be solved by entrusting CIMPO, or a similar organization, with the coordination of production, quality control and arrangements for proper marketing.

2. Essential oils

This sector is already more advanced since the channels of supply and export were organized in former times. There are, however, still great opportunities for an additional increase in production and larger returns in foreign exchange.

The most economically essential commodities are :

(a) Sandalwood oil (Santalum album)

Annual production amounts to about 100 tons; export value nearly 10.5 million Rs; price of the oil about 120 Rs per kg.

(b) Lemongrass oil (Cymbopogon flexuosus)

The main constituent "citral" is used for the synthetic manufacture of Vitamin A. India supplies about 80% of world requirements in lemongrass oil. (Total about 1,500 tons.) Yield of fresh grass per acre amounts to 700 tons. Total area under cultivation estimated at 50,000 acres (mainly in Kerala). Methods of cultivation, distillation and marketing need still further development. Value of exports about 15 million Rs.

(c) Palmarosa oil (from rosha grass: Cymbopogon martini, variety motia)

Perennial herb, 5-8 feet high, growing in dryer localities of Kashmir, Punjab, Bihar, Rajasthan, Madhya Pradesh and South India. Production of oil about 90 tons per year. Value of export 1.6 million Rs (1956-57).

(d) Eucalyptus oil

Yearly production about 15-20 tons

(e) Vetiver oil (Vetiveria zizanioides)

Yearly production: 8-10 tons. Wide scope for expansion, especially in South India, but with seed from North India.

(f) Agar oil (from wood of Aquilaria agallocha)

Production mainly in Assam. The oil develops in parts of the wood due to infestation by certain fungi. Yearly production of oil about 80 kg. Price per kg around 1,880 Rs. Mainly used as incense.

(g) Himalayan cedar oil

Oil extracted from waste wood of Cedrus deodara by mobile equipment. Used as cheap perfume in soap.

TABLE 29

LIST OF 19 MOST IMPORTANT INDIAN MEDICINAL PLANTS SUGGESTED FOR LARGE SCALE PROPAGATION

Sr. No.	Item	Imports 1958 Quantity lbs	Imports 1958 Value Rs	Exports 1958 Quantity lbs	Exports 1958 Value Rs	ESTIMATED REQUIREMENTS Quantity lbs	ESTIMATED REQUIREMENTS Estimated value Rs	Expected Market Price per lb.
1	Anothum graveolens					373,000	279,750	0.75
2	Atropa belladonna (about 50%leaves and 50% roots)					280,000	420,000	1.5
3	Datura innoxia (seed)	At present no imports and exports. Production still unorganized.				18,000	180,000	10.0
4	Datura stramonium					60,000	120,000	2.0
5	Dioscorea deltoidea					1,500,000	1,500,000	1.0
6	Digitalis lanata					100,000	150,000	1.5
7	Digitalis purpurea					150,000	225,000	1.5
8	Ipomea purga					100,000	100,000	1.0
9	Rauvolfia serpentina			290.976	581.952	1,200,000	3,000,000	2.5
10	Camphor	605,124	1,206,856			850,000	2,875,000	4.4
11	Citronella oil (from Citronella grass)	223,976	1,089,291			450,000	2,500,000	5.9
12	Ergot	1,320	35,988			85,000	1,050,000	12.0
13	Geranium oil	20,377	1,140,528			30,000	2,850,000	95.0
14	Glycyrrhiza glabra (Liquorice root)	1,682,240	758,539			3,000,000	2,250,000	0.75
15	Ipecacuanha root	18,480	734,978			100,000	4,000,000	40.0
16	Lavander oil	38,109	656,997			40,000	1,000,000	25.0
17	Menthol	168,105	4,133,046			180,000	5,500,000	30.6
18	Patchouli oil	17,544	299,409			17,000	491,300	28.7
19	Pyrethrum	210,560	362,235			560,000	1,000,000	1.9

Source: CIMPO (Central Indian Medicinal Plants Organization), New Delhi

TABLE 30

MEDICINAL PLANTS

INDICATION OF ACTIVE INGREDIENTS, MAIN LINES OF APPLICATION AND SUITABLE LOCALITIES OF GROWTH

Sr. No.	Item	Active ingredients	Application	Suitable Locality
1	Anothum graveolens	Not less than 2.5% v/w of volatile oil	Stomach	Rajasthan, Punjab and U.P.
2	Atropa belladonna (about 50% leaves and 50% roots)	Not less than 0.3% of the alkaloide calculated as hyoscyamine	Cramploosener	Kashmir, Himachal Pradesh and Nilgiris
3	Datura innoxia (seed)	-	Seasickness	Kerala
4	Datura stramonium	Not less than 0.25% of the alkaloide calculated as hyoscyamine	Asthma Bronchitis	Kashmir, Hamachal Pradesh, Kerala
5	Discorea deltoidea	-	Hormon	Himachal Pradesh, Punjab Hills, Kashmir
6	Digitalis lanata	-	Heart	Himachal Pradesh, Kashmir, and Nilgiris
7	Digitalis purpurea	-	Heart	" " "
8	Ipomoea purga	-	Laxative	Nilgiria, Kerala
9	Rauvolfia serpentina (export)	Not less than 0.8% of total alkaloids of Rauvolfia	Bloodpressure Sedative	Kerala, U.P.
10	Camphor	Not less than 96.0% of $C_{10} H_{16} O$ (Camphor)	Heart Incense, Med.	It is doubtful if Ocimum kilimandscharicum will meet the demand. It is necessary to develop synthetical manufacture of Camphor
11	Citronella oil (from Citronella grass)	Ceylon oil: Not less than 59% w/w of acetylisable constituens, calculated as geraniol. Java oil: Not less than 85% w/w of acetylisable constituents, calculated as geraniol	Toilet soap	Madras, Annamallais

Table 30 (cont.)

Sr. No.	Item	Active ingredients	Application	Suitable Locality
12	Ergot	Not less than 0.2% of the total alkaloids, calculated as ergotoxine, of which not less than 15% consists of water-soluble alkaloids of Ergot, calculated as ergometrine	Female sickness	West Bengal (Darjeeling Hills)
13	Geranium oil	Bourbon oil: Not less than 25% w/w of esters calculated as gerantyl tiglate French, Algerian and other African oils: Not less than 20% w/w of esters, calculated as geranyl tiglate	Toilet soap Perfumery	Kerala, U.P.
14	Glycyrrhiza glabra (Liquorice root)	-	Cough Stomach ulc.	Jammu, Punjab and Western India
15	Ipecacuanha root	Not less than 2% of total alkaloids of Ipecacuanha, 50% of which should be emetine	Throat trbl. Vomitive	West Bengal (Darjeeling)
16	Lavander oil	English and Commonwealth oils: 7.0 to 15% w/w of esters calculated as linalyl acetate Foreign oils: 35-50% w/w of esters calculated as linalyl acetate	Perfumery .	U.P., Kasmir and Nilgiris
17	Menthol	-	Inhalation	Jammu, South India, U.P.
18	Patchouli oil	-	Perfumery	Madras Hills, U.P.
19	Pyrethrum	Not less than 0.7% of total pyrethrins (Pyrethrin I and Pyrethrin II	Insecticide	Kashmir, Himachal Pradesh

Source: CIMPO (Central Indian Medicinal Plants Organization) New Delhi

C. LINES OF FUTURE DEVELOPMENT

The following notes are attached in order to illustrate the lines of future industrial development :

1. Tentative list of selected integrated and semi-integrated forest industries suggested for establishment under government guidance within the Third Plan (Table 31).

2. Summary of possibilities for developing additional small-scale industries in India, based on forest products (see page 116).

After priorities have been fixed by the Government, the following p r o c e d u r e usually applies :

(a) Arrangement of industrial runs with the raw materials under study for adaptation of products to local market requirements; adjustment of production techniques to the characteristics of the raw material concerned; calculation of costs.

(b) Selection of most suitable sites for ensuring adequate supplies of raw material, water, power, transportation, labour and other requirements.

(c) Preparation of a technical and economic pre-project, including investigation of market; this pre-project would also serve as a basis for the preparation of tenders before purchasing equipment and hiring staff.

(d) Training of staff and labour.

(e) Erection of plant and initiation of operations.

For phase(a)-(c) technical assistance could be requested for consultation in all matters of principle. Phases(d)and(e)should be left to well-known industrial firms, which can take the legal responsibility for machinery, training of staff and smooth operation of the plant.

Table 31

Tentative list

of

SELECTED INTEGRATED AND SEMI-INTEGRATED

FOREST INDUSTRIES

suggested for

establishment under Government Guidance

within the Third Plan

The following list indicates a few selected industries - within India's Forest Industrial Development Program to be proposed for the Third Plan - which represent some important new lines of technical and economic development.

These schemes will require, for successful implementation, special government guidance and encouragement to ensure proper t e c h n i c a l integration of various phases of production within the main unit or e c o n o m i c integration with supplementary lines of production within the national economy.

A. MECHANICAL WOOD AND BAMBOO INDUSTRIES

State	Type of Production	Type and estimated quantity of raw material per year	Indication of investment costs million Rs	Justification
1. Rajasthan	Integrated conversion of large quantities of small teak logs			The large areas of degraded teak forests in the Banswara district badly need improvement by regeneration under an intensive coppice system
	a) sawmilling, seasoning, planing, jointing	20,000 tons (first stage) doubling after 5 years	1.5 (20% in foreign currency)	Availability of about 40,000 tons of small teak log per year.
	b) convertions of refure (edgings, offcuts etc.) into shaving boards	9,000 tons (first stage: doubling after 5 years, i.e. after thorough development of markets	5.0 (60% in foreign currency)	Only by integrated utilization can these large quantities be converted into useful products and can find a ready market.
			Total 6.5	
2. Uttar Pradesh or Madhya Pradesh	Factory for production of Package furniture from high class shaving boards, in combination with slized veneers and small quantities of timber			There is, up to now, practically no production of modern package furniture in India, inspite of the long shipping distances. Experience in other countries shows that packaging greatly reduce shipping costs.
	a) small plant for mechanical processing of timber (partly using products from 1 a);	small teak, mainly to be supplied from 1 a	0.3	Furthermore, these new types are especially designed for application of new semi-finished products, such as shaving boards in combination with small-sized timber.
	b) slicing plant for production of veneers from decorative types of teak and other species not used up to now for this purpose;	teak, gradually incorporating also other species (about 40,000 cft per year; surplus veneers for export)	1.5 (70% in foreign currency)	Such a factory would supplement existing furniture production. Teak veneered package furniture would also find an export market.
	c) joinery for production of package furniture (incl. machinery for veneering of shaving boards)	teak shaving boards to be supplied from factory 1 b	1.0 (60% in foreign currency)	
			Total 2.8	

State	Type of Production	Type and estimated quantity of raw material per year	Indication of investment costs million Rs	Justification
3. West Bengal	Factory of production of units for low-cost houses (mineralized woodwool slabs and hollow blocks)			West Bengal, especially Calcutta area, is in great need of low-cost houses with high insulation capacity, adjusted to the wet climate.
	a) plant for production of such units	about 4,000 tons of low-class timber for production of woodwool or special chips (supplemented by jute sticks, reeds and agricultural residue;) main binder: cement	1.2 (about 60% in foreign currency)	High-class woodwool products, manufactured according to advanced methods, proved successful for low-cost housing in many parts of Europe, Africa and East Asia.
	b) small plant for production of additional timber units	500 tons of round timber	0.3 (about 40% in foreign currency)	
			Total 1.5	
4. Andamans	Factory for production of cheap, large-sized building boards from sawdust and similar waste without use of synthetic binders. (Suuhha factory would supplement production under 3, since Calcutta would be the main market	4,500 tons of sawdust, industrial and forest refuse	2.2 (about 70% in foreign currency)	Industrial production of large sized, rather light but stable boards (spec. gravity: 0.4-0.6) has successfully been taken up in Europa and North-America by applying part of the wood waste as binder. These boards can easily be sawn, nailed, screwed and plastered. They are used for partitions, ceilings, doors and in combination with aluminium or plastic foils - for light roofing due to high insulation capacity. This material offers interesting possibilities in India for substitution of timber in fields of construction where large sized units are required and resin bound boards would be too expensive.

State	Type of Production	Type and estimated quantity of raw material per year	Indication of investment costs million Rs	Justification
5. Andhra or Mysore	Set of modern mobile scavanging units, combined with a central plant for seasoning, preservation and jointing of non-teak species and defective teak	about 4,000 tons of non-teak (or supplemented by defective teak)	a) 5 mobile units 0.3 (40% in foreign currency b) 1 central plant 0.5 (10% in foreign currency) Total 0,8	Large quantities of non- and semi-commercial species are still left unused in the forests. The same is true for lops and tops of teak and other commercial species. Only by an integrated utilization (i.e. conversion of the low-grade timber in the forest and modern refining in central plants), can extraction be made economical. Such activities should be guided by technical and economic research for thorough development of markets.
6. Rajasthan or Madhya Pradesh	Production of high-class tool handles for industry, public works, handicrafts and agriculture	500 tons of Anogeussus sp. (to be tripled after three years)	sawmill, seasoning plant and modern turnery 0.3 (20% in foreign currency)	In Rajasthan and especially in Madhya Pradesh (Bastar area) are considerable quantities of Anogeusses sp. which - after grading and proper treatment - are suitable for various types of tool handles. Local demand for tool handles will greatly increase due to industrialization. Production should be started on a modest scale, but expanded according to development of markets. Even exports are feasible after efficiency of production has been established
7. Madhya Pradesh	Plant for production of high-class bamboo-mats of various designs (Semi-finished material for cottage industries and export).	500 tons (first stage)	equipment for splitting, bleaching, dyeing, weaving impregnating and hot-pressing 0.4 (50% in foreign currency	A preliminary investigation of the Central European market proved that this product, initiated years ago by the Forest Research Institute, Dehra Dun, could be exported on a large scale if design and colour would be thoroughly adjusted to the taste of customer. A unit for economic production, demonstration, training and development would open a new field for export and further processing by Indian cottage industries

B. CHEMICAL AND SEMI-CHEMICAL WOOD INDUSTRIES

State	Type of Production	Type and estimated quantity of raw material per year	Indication of Investment costs million Rs	Justification
1. Kashmir	Factory for production of semi-chemical pulp and cardboard for high-class packaging material (about 10,000 tons of cardboard per year; partly to be supplied to the production under B 3)	Coniferous pulpwood from the Pir Panjal Forest Division (about 13,000 tons of airdry wood per year)	9.0 (70% in foreign currency)	Kashmir can supply a certain quantity of pulpwood, especially from the Pir Panjal Forest Division. This quantity does not seem to be sufficient for a modern integrated chemical pulp and paper factory. But production of high-yield semi-pulp and processing into cardboards can be considered a paying proposition. The demand for packaging material will greatly increase in the Third Plan. Provision should be made to meet these important requirements for gradually replacing wood as packaging material.
2. Andhra	Factory for production of cardboard from hardwood (about 10,000 tons per year)	Mixed hardwoods (about 13,000 tons of airdry wood per year)	10.0 (70% in foreign currency)	Hardwoods are well suited for production of special types of cardboards, characterized by high rigidity. Andhra has large areas of mixed hardwoods which require regeneration by faster growing species. Conversion into cardboards would be a suitable use for the existing resources.
3. Uttar Pradesh	Factory for production of modern finished packaging material from various types of cardboards (to be supplied from the factories B 1 and B 2)	10,000 tons (about 50% of the products from the factories under B 1 and B 2)	4.0 (70% in foreign currency	This factory is intended for processing of semi-finished material into finished, mainly corrugated products, specifically adjusted to the requirements and goods of various industries.

SUMMARY

Possibilities for

Developing Additional Small-scale Industries in India

Based on Forest Products

I. Wood

1. Mobile scavanging units in the forest areas.

2. Plants for further conversion and refining of semi-finished products from plants under 1.

3. Preservation and seasoning plants for commercial, semi- and non-commercial timbers.

4. Plants for production of tool handles and agricultural implements.

5. Plants for processing of sawdust into large-sized building material.

6. Plants for production of high-class furniture mainly from non-teak species (package type for facilitating shipping).

7. Plants for production of mineralized woodwool slabs and hollow blocks.

8. Plants for decentralized production of semi-finished material for the match industry.

9. Processing of wood waste into high-class plastics according to new methods by use of small quantities of crude phenel available from coke ovens of the steel mills.

10. Production of differentiated types of wood flour for the plastics industry.

11. Production of pencil slates from indigenous raw materials by improved methods.

II. Bamboo

1. Semi-mechanized plants for processing of bamboo into high-class finished products (as practised in Japan).

2. Production of resin bound bamboo mats (as demonstrated by the Forest Research Institute, Dehra Dun) as a basic raw material for handicrafts.

III. Reed Grasses

1. Plants for production of high insulating building boards from reed grasses in small units with low investments.

2. Small plants for production of semi-chemical pulp from reed grasses according to high-yield methods.

IV. Fibres

1. Production of endless mats of high elasticity and durability for upholstery (cars, furniture, beds, etc.) in order to replace foam rubber. (Raw material: coconut and various other fibres.)

2. Production of ropes and other goods from sisal by improved methods (now cultivated by various forest departments in dry areas).

V. Tanning Materials

1. Processing of various tanning raw materials (myrobolans, bark from mangrove, sal, etc.) into high-class tannin extracts.

2. Use of extracted waste (incl. waste from Katha and Cutch production) for new types of building material.

VI. Fruits

1. Processing of cashew nuts grown by several forest departments into export commodities.

2. Industrial utilization of cashew nut shell.

VII. Medicinal Plants, Essential Oils, etc.

1. Enterprises for grading, drying and processing of medicinal plants.

2. Enterprises for efficient extraction of oils from various forest raw materials.

3. Grading and purification of gums and lac for export.

ILLUSTRATIONS

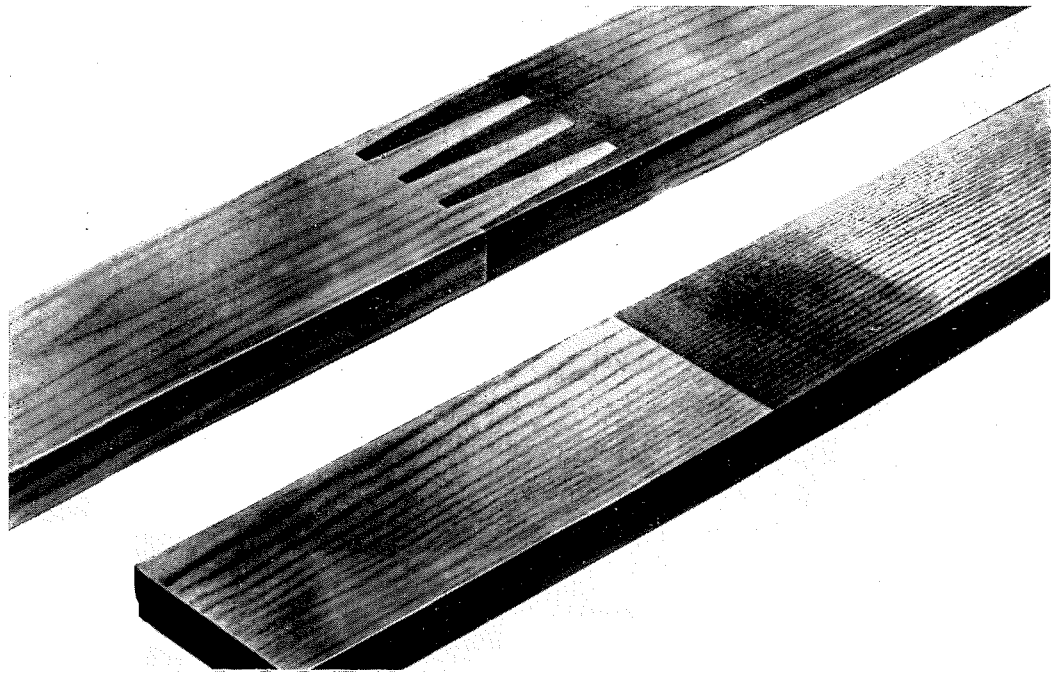

Figure 1. *Finger-jointing of short wood pieces for producing timber of any length (recommended for doors, windows, railway wagons, structural timbers, sleepers). Experiments for jointing are under way.*

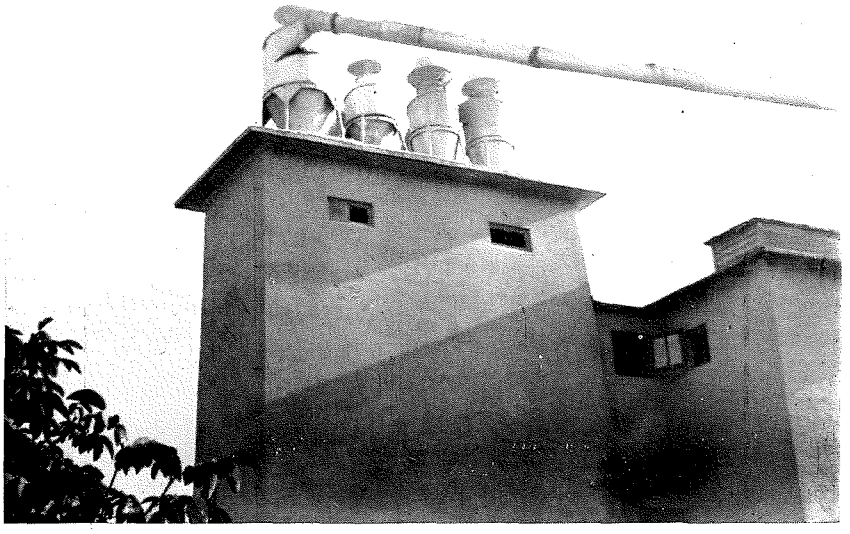

Figura 2 Silo for storage of sawdust and other waste material.

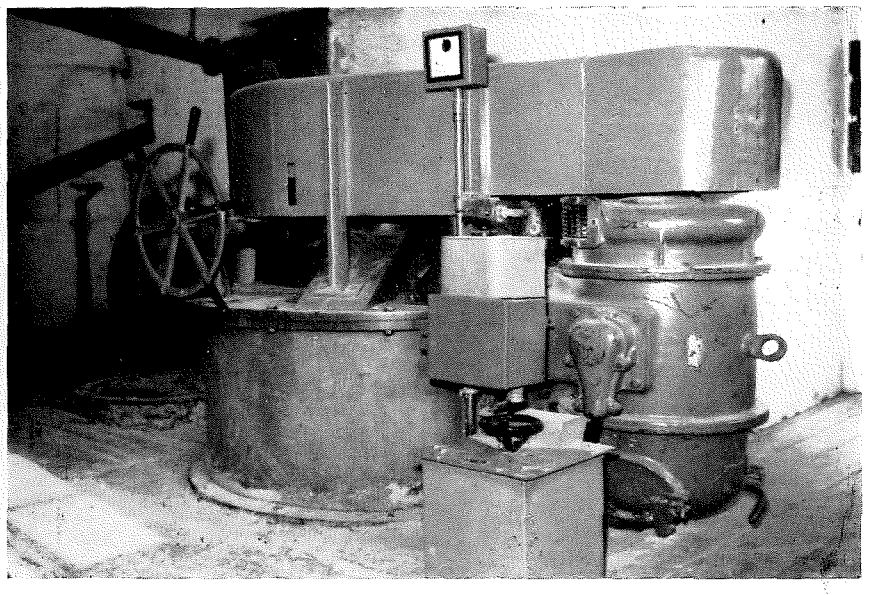

Figure 3. Machinery for production of binders from wood waste by a simple mechano-thermic process.

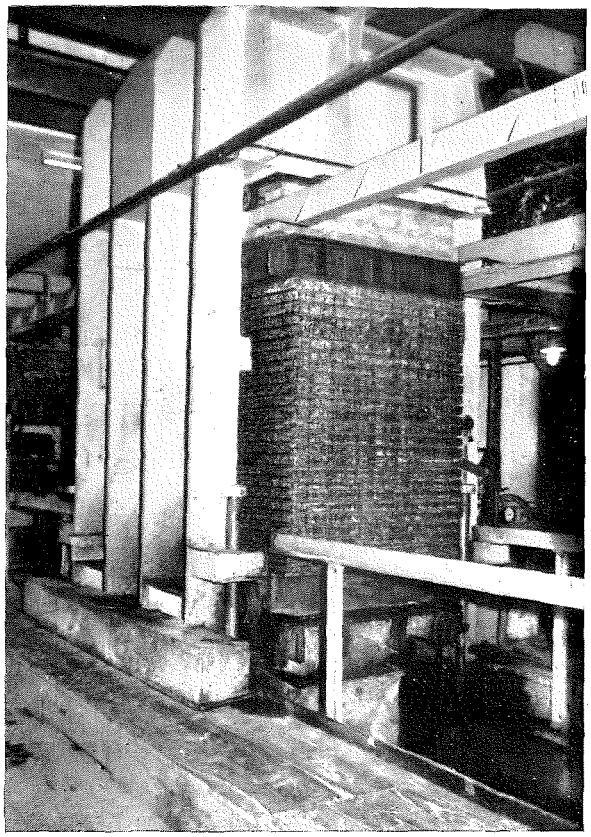

Figure 4. Drainage of molded boards by pressing.

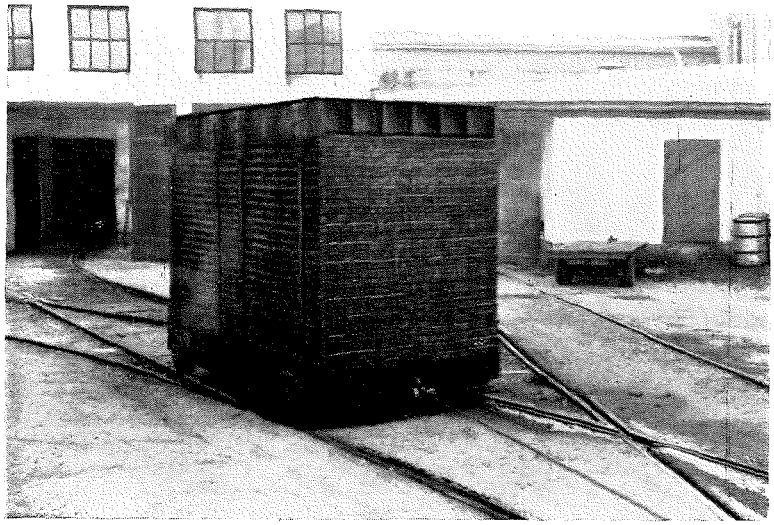

Figure 5. Boards on the way to the high temperature treatment plant.

Figure 6. Godown with finished construction boards.

Figure 7. Sanding of boards for doors and utility furniture.

Figure 8. Bungalow built from waste boards (cement coating).

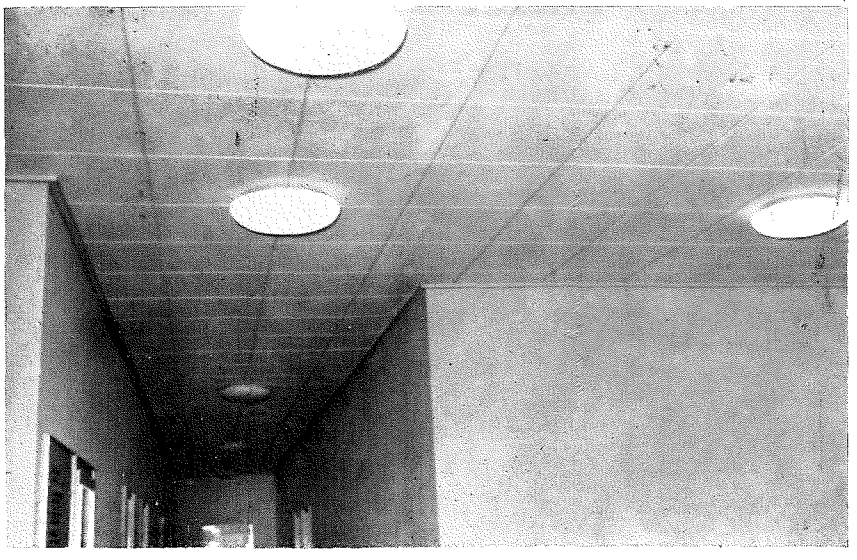

Figure 9. Waste board ceiling with decorative grooves.

Figure 10. Utilization of mineralized wood-wool slabs for low-cost houses.

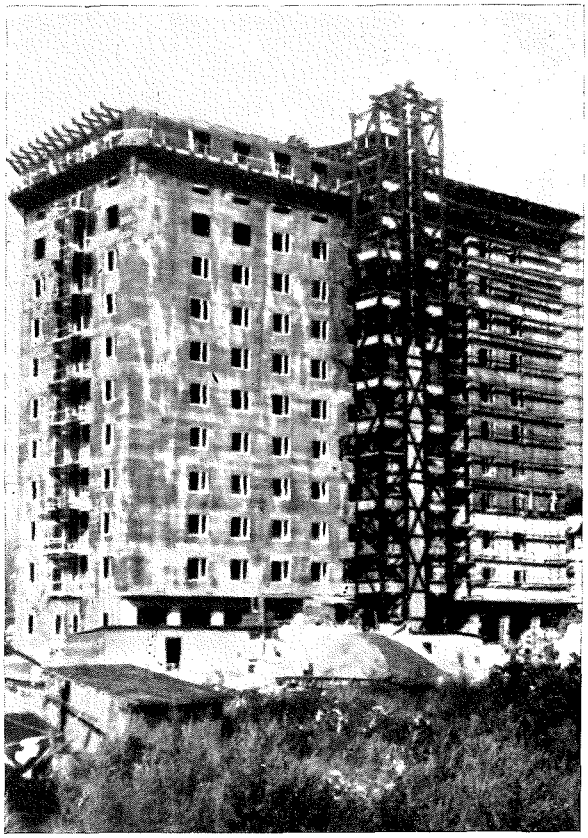

Figure 11. Utilization of mineralized wood-wool products for skyscrapers.

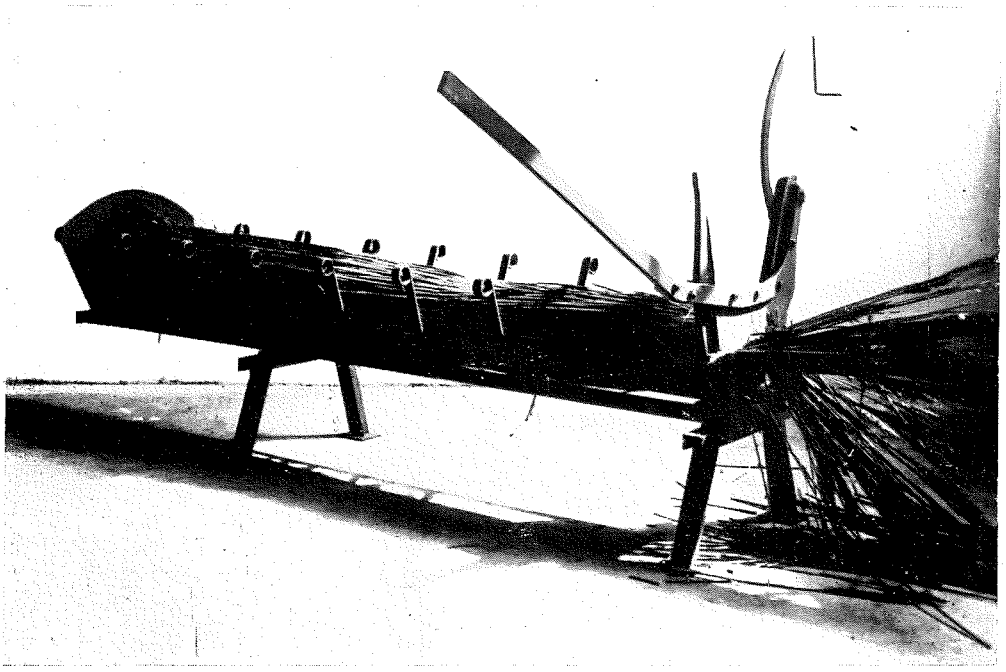

Figure 12. Bundling reeds and cutting into lengths.

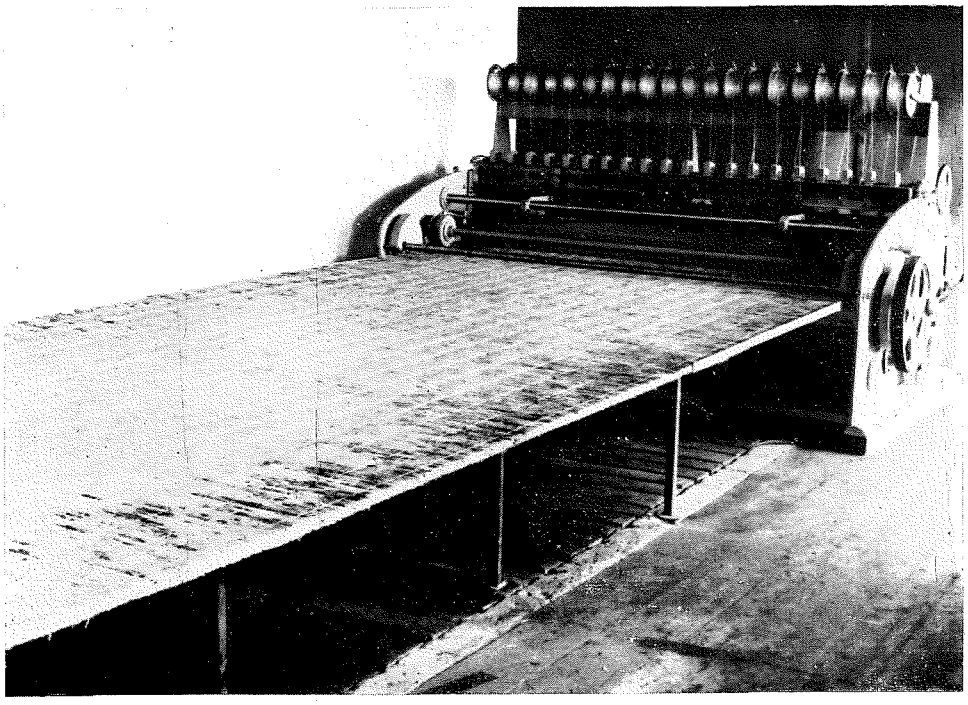

Figure 13. Machine for continuous production of reed boards (variation of thickness : 2 to 5 cm.).

Figure 14. Mounting reed boards in a building.

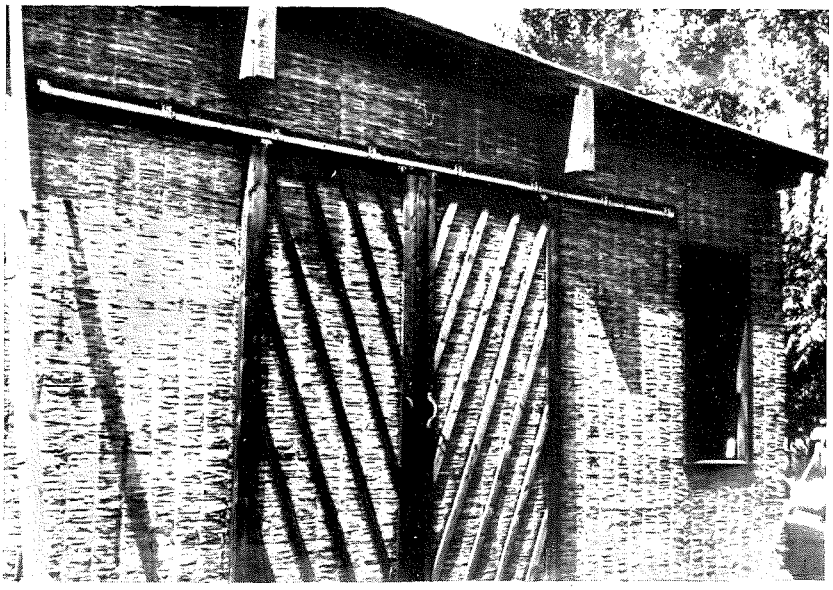

Figure 15. Shed eonstructed from reed boards.

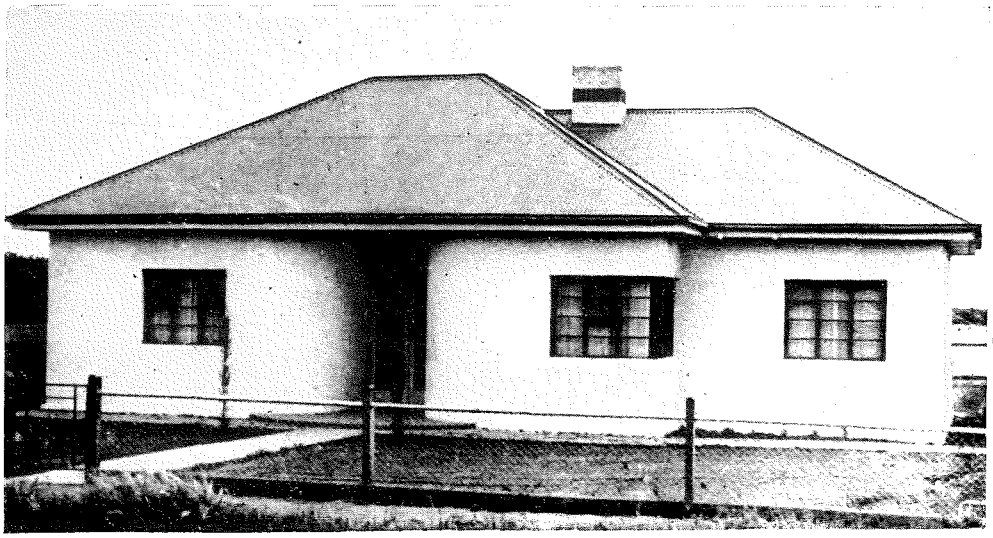

Figure 16. Reed board bungalow after plastering.

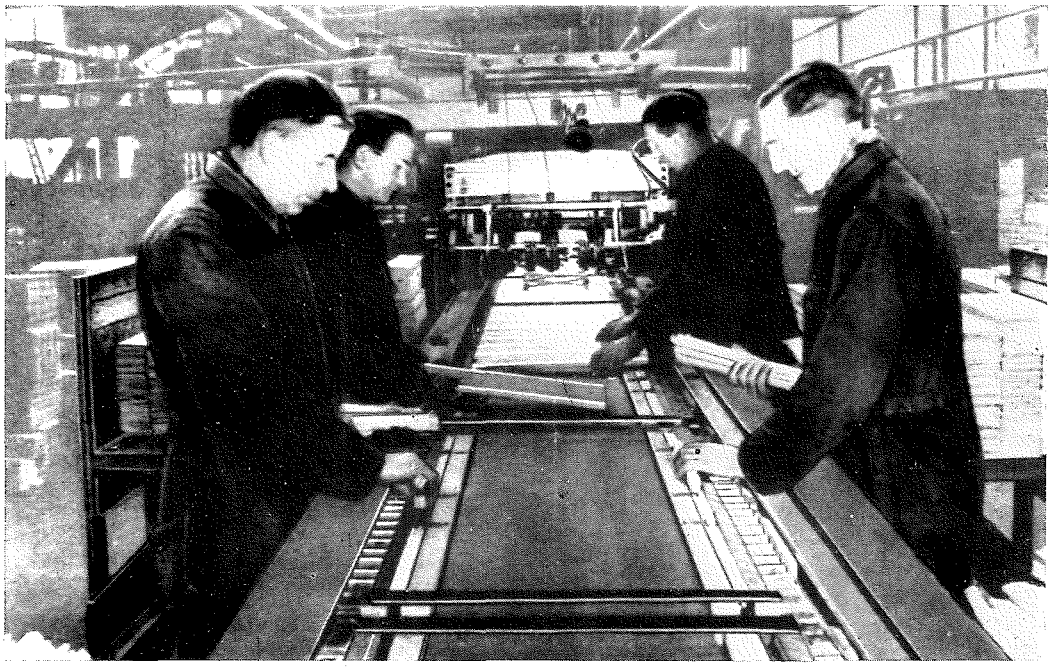

Figure 17. Mass production of strong wire-bound folding boxes using sliced wood only 5 cm. thick.

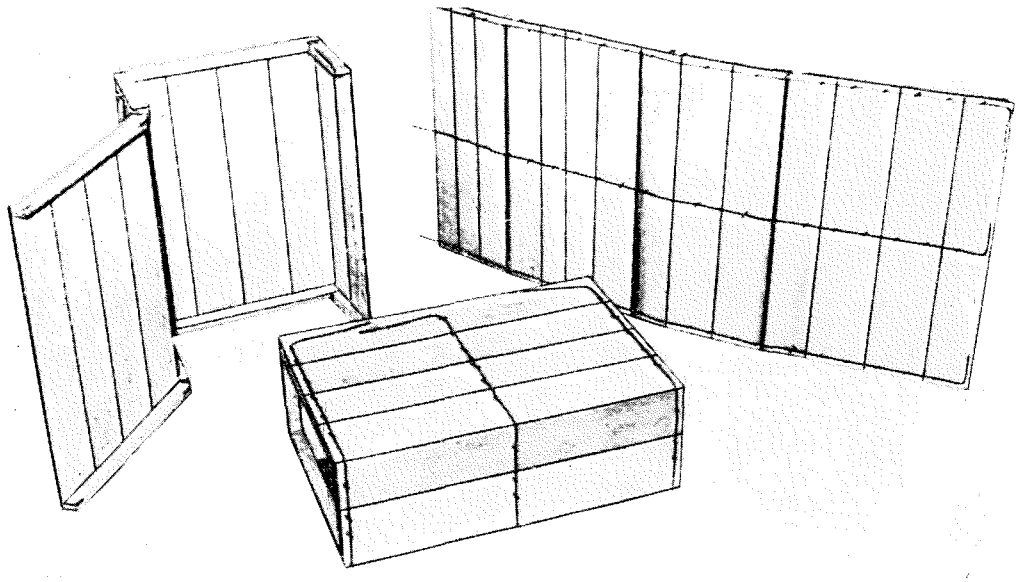

Figure 18. Wire-bound folding boxes ready for use.

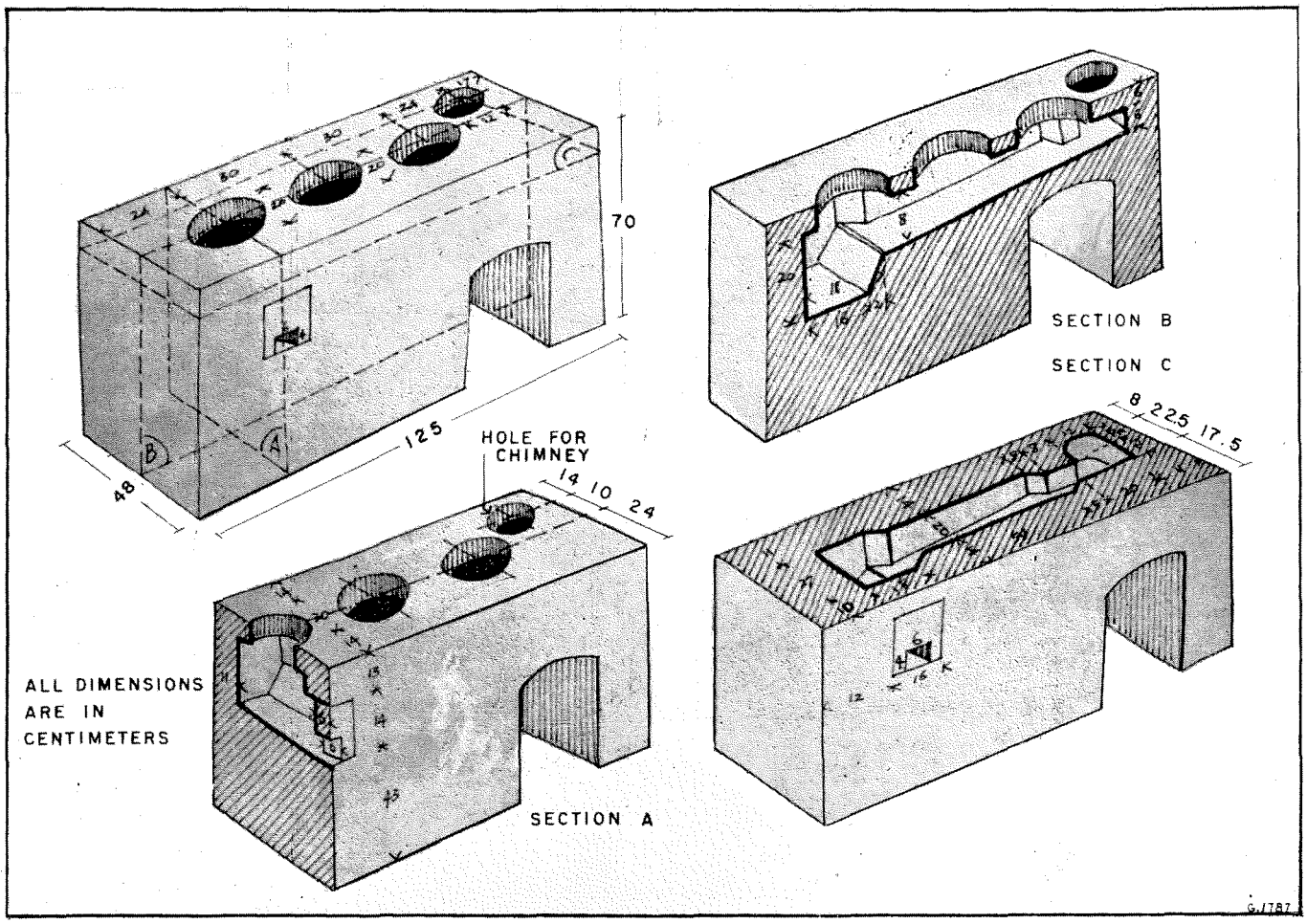

Figure 19. Diagram of kitchen stoves, three- and two-hole type, developed by the Food and Agriculture Organization of the United Nations and the Central Forestry Organization of Switzerland for the more efficient use of fuelwood in Indonesia.

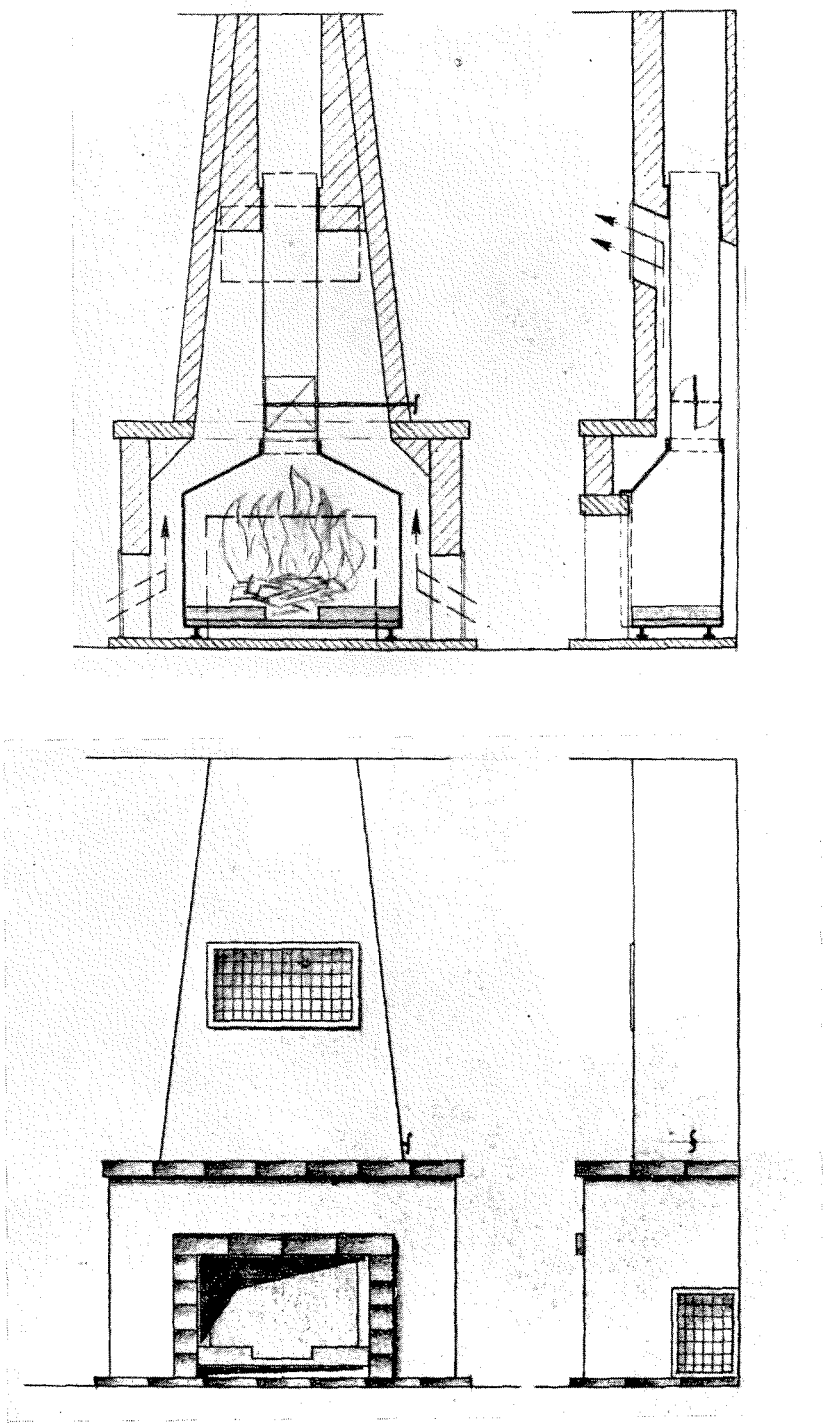

Figure 20. Two illustrations of a high efficiency fireplace. The hot air is redirected into the room (recommended for economizing fuelwood in hill stations).